AN ECONOMETRIC ANALYSIS OF THE EFFECTS OF INSTITUTIONS AND ECONOMIC TRANSFORMATION ON AGRICULTURAL LAND PRICES: CASE OF MALAYSIA

by

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ABSTRACT

This thesis seeks to investigate key drivers of the agricultural land market in a country undergoing economic structural transformation. The Ricardian land price model is extended to reflect different scenarios with regards to flexibility of land supply and competition for alternative uses for land. In addition, the study examined various non-market influences on price: (i) state intervention to determine and stabilise land supply for competing uses; (ii) transaction costs in land exchange and utilisation, and (iii) imperfect market competition arising from excess surplus situations and differences in buyer and seller characteristics.

Their impacts on the agricultural land market are described via an estimation of a hedonic price model using parcel-level data (n = 2222) taken from a period of 7 years for four states in the Central West coast of Peninsular Malaysia. The data covers agricultural land with and without strong development potential. The latter comprise of land with continued oil palm, rice, rubber cultivation potentials. An additional category is vacant or idled agricultural land with relative small development potential. Results show that estimated coefficients of all land attributes in the model (road frontage, proximity to urban centres, population growth, land restrictions and year of sale) are significant. However their individual implicit value differs across different land categories. The spatial econometrics exercise was inconclusive in identifying the type and degree of spatial bias present in the data.

The effect of economic transformation and expectations in the economy is further examined via a moving correlation analysis using hedonic price indexes constructed from a longer set of sales data (15 years). Price of farmland with clear development potential appears to correlate positively with value and volatility of development rent (which is proxied by the stock market property index), while price of farmland with pure agricultural potential is correlated with value and volatility of agricultural rent (proxied by the stock market plantation index).

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Chapter I
INTRODUCTION

1.1 BACKGROUND TO THE RESEARCH PROBLEM

Land is central to food security, social welfare and identity of the people. The value of land is one that is more than the sum of the buildings, livestock, or plants on the land. A truly constructive economic analysis of land price cannot afford to ignore local conditions with respect to past and current land use and tenure systems, social hierarchies, cultural philosophies and preferences, and local population dynamics. Methods by which the market and institutions for land work to allocate land to different uses often generate outcomes that are beyond the usual descriptions of economic demand and supply. Many of the transaction costs and market imperfections evident in a land market are in fact enduring legacies of institutions and systems in the past. Land-use planning functions of the state, widely employed to address market failure, inadvertently segments the land market via fixing total land supply for specific uses. These institutional (non-market) influences on price of agricultural land remain a poorly understood area, and are very seldom investigated empirically. It is generally admitted that such line of research is fraught with data difficulties, and inconsistent outcomes, not least attributable to decentralisation of records and possible abuses of power over land. Yet, in order to do justice to the subject of land prices, it is necessary to model the research functions in a way that will be most in tune with economic realities on the ground.

There are numerous institutional issues to be considered. The market in developing economies provides an important method of transferring land from less to more productive producers; but at the same time, can become a channel for land concentration in the hands of individuals with greater resource reserves, but who are not always efficient agriculturalists. As the economy evolves to embrace surplus-creating activities other than agriculture, the market for land becomes gradually dominated by non-agricultural demands. Non-agricultural use of land includes use for industrial and commercial activities, infrastructure building such as highways, administrative centres, residential amenities and recreation and so forth. Growth of industries dependent on agricultural input generates additional pressure on land price whereas population growth creates a larger excess demand for food and residential needs. Capital-rich agents with positive expectations of price trends bring in speculative demand pressures into the market. The resulting effect of all the changes is that agricultural land prices are pushed upwards beyond the present values of its expected stream of income from farming.

If government intervention deemed inevitable, it is important to ensure that the methods, scope and extent must be such that equity and efficiency in land ownership and use are maximised. In addition, welfare effects should be empirically validated and reviewed from time to time. There are bound to be differences in the impact of a policy to different groups in the society, and even within different categories of agriculturalists. These impacts need to be measured objectively. For example, it is often argued that state's zoning of land for agricultural use is inefficient for overall development growth as well as restrictive to individual owners' capital growth prospects. This is because decisions to resolve an externality in favour of one party might constitute welfare loss for another.[1] In a democratic system, the majority might make known their preference in the repeated games of electing their representatives.[2] If the majority like to see new economic opportunities coming their way, they would vote for the candidate that can deliver development. In another constituency (or in another period), voters might indicate that they prefer 'greener' policies for their area. Many question if land price distortion through controls is not an omnipresent characteristic of the land market. There is an abundance of literature seeking to estimate the cost of protecting agriculture for its public goods' value to the society and to whom does the benefits of these programmes accrue (see Brunstad *et al.*, 1995 for instance).

Equally important questions include: Are the country's overall land resources utilised efficiently to ensure a stable supply to meet the predicted increasing growth in demand? Does allowing conversion to take place easily contribute to premature

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[1] The subject can be argued in a Coasian bargaining context, where property rights are already properly defined (but can be flexible) and transaction costs are high.

[2] North (1990) and others have written extensively regarding voting behaviour and the agency problem between elected representatives and the constituents.

development of some areas? Has there been adequately effective method to quantify the costs associated with urban sprawl as a source of economic inefficiency – loss of public good amenities from the development of green space and the pollution and financial costs of commuting (since fuel is heavily subsidised in some countries) within the larger resulting ‘urban’ area). Can land conversion be better planned to ensure that a reasonable amount of land profitably remain in agricultural use; if not to fully meet the critical needs of the people, at least to cushion against adverse food balance of payment deficits? A small but crucial step in the debate requires research to empirically determine what are the critical trends and drivers of market price for agricultural land. This is where the thesis fits in i.e. to help provide an understanding of the key processes and influences on agricultural land exchange and development.

1.2 RESEARCH QUESTIONS

Basically, the thesis aims to present an institutional and empirical study of the agricultural land market. Specific sets of questions that it seeks to address are:

i. How do institutional factors affect land prices and quantity of land exchanged? More precisely, how do land controls affect the quantity and stability of land stock for agricultural and development uses? What are the ways transaction costs in land acquisition and use affect market participation and outcome? How does imbalance in the market power between sellers and buyers affect prices?
ii. How does proximity to major cities affect land prices? Are prices stable over the period studied? Are the effects differentiable according to non-agricultural potential of the land?
iii. Are land prices influenced by the land’s spatial distribution over different regions? How can spatial interaction between observations be modelled? What is the degree of spatial bias in the data?
iv. Can land speculation, land banking and land idling be explained by the land’s role as an asset that provides opportunities for future returns in higher but unknown use?

1.3 APPLICATION TO THE MALAYSIAN LAND MARKET

Literature has established that land market studies are highly contextual in their research questions and evidences. Malaysia provides an interesting case for a study of land market in an emerging economy for a number of reasons. Firstly, it has a long established land registration system protected fairly well by a comprehensive national land code. This is a departure from many studies in development economics which dealt with the lack of clear and secure property rights for land in communal/hierarchical land systems. At this present time, Malaysia is more concerned with sustainability of the agricultural sector and a large part of this issue relates to organisation and optimisation of her existing agricultural land resources. Malaysia's land rental market is relatively weak compared to other advanced agricultural nations. One reason is the inability to adjust land rents to correspond to changes in factor or output prices. Close social and kinship relations between the landowner and his tenants mean that costs of re-negotiating rents are financially and psychologically higher than it is otherwise. Many landowners are also hesitant to lease out land on long-term basis if they believe the future value of land will rise.

Secondly, Malaysia's situation presents an opportunity to study the effects of land divisibility and transferability on price. Poverty and informational imperfections force individuals to use land as a source of credit. In event of default, the land will be transferred to the lender. The land registration system allows landowners can sell fractions of their holdings, just enough to cover for income shortfalls or extra consumption needs. Another source of land fragmentation is the way land is passed on from one generation to another. If an owner dies intestate, all his heirs can lay claim on his land (although in different proportions). One of the children will have to be persuaded (if able) to buy out all of his or her siblings' shares. Alternatively, they can sell off the land to an outsider (related or non-related) and divide the sale proceeds accordingly. Both options have their own drawbacks and challenges; so much so that today, many problematic lands are left not efficiently utilised. Other factors equally important in contributing to the country's problem of abandoned land can be broadly categorised into physical, economic and institutional factors. In short, Malaysia is unique in that there is pressure on the land stock from development needs, but at the same time, there are also large amounts of land which are left underutilised. The combined effect of the two is simply a decline in the supply of actively used agricultural land in the country.

Thirdly, the Malaysian economy is distinguished from the rest of the developing world in that it was once the world's biggest producer of two highly important agricultural commodities, namely palm oil and rubber, despite being one of the physically smallest Asian countries. However, the 1980's saw this position eroded by competition and volatile market conditions, which eventually led to a period of massive economic transformation. Malaysia's foray into manufacturing and service-based activities proved to be a spectacular success, so much so that within a period of less than three decades, it has earned the label of East Asian's "Newly Industrialised Economy". Among the most glaring consequences of rapid economic growth in the period, was the spectacular increase in development demand on existing agricultural land. In promoting the new economy, agricultural land was allowed to be developed in an almost unplanned and uncoordinated way. As a result, a person who owns land constantly holds the option to either continue farming or develop the land, to realise its capital gain. The two-fold effects of this trend on agricultural land market is as follows: firstly, the development value of the land will enhance its price; secondly, as more land conversions take place, the declining supply of agricultural land will push prices even higher. Since agriculture in developing economies is typically labour-intensive, outflow of resources to other economic sectors will cause production costs to rise. It is apparent that without significant increases in agricultural returns to land, farmland prices became beyond the reach of genuine farmers who seek to purchase land for continued agricultural use.

1.4 RESEARCH CONTRIBUTIONS

The analysis in this thesis is novel in four respects which is listed here in no particular order. The first contribution is in the form of a unique and extensive dataset constructed from various sources to contain detailed information on land sale prices, forms of land-control, distance to an urban centre and highway access points and population pressures surrounding the observed parcel. The data which came from public-domain sources was then converted into digital form to facilitate its use in statistical and geographical software packages. This is believed to be the first attempt at integrating as many important sources of parcel descriptors as possible to resolve sparse data difficulties in Malaysia. Hence, it could inspire other similar studies in the developing world to push the envelope where data is concerned. To our knowledge, it is also the largest study for Malaysia in terms of geographical scale (sales from 27 districts in total) and subject focus (5 categories of agricultural land). The model is easily expandable to incorporate other observations and variables in the future.

The second contribution is in terms of a unique natural experiment opportunity in that the range of data allows us to discover different shadow price of attributes across different categories of land. Empirical work on agricultural land prices using the hedonic method often suffers from sample selection bias i.e., the sample is made up of either mostly already developed land or mostly non-developable agricultural land. As will be shown in the data chapter, the Malaysian land sales data comprise parcels which are neatly categorised as either (i) developable agricultural or rural land; or (ii) agricultural land with little or no foreseeable development potential. The latter category comprises parcels whose potential returns from continued agricultural use is still superior compared predicted development returns. Furthermore, since the specific agricultural use is known, the thesis will be able to show inter-sectoral differences in agricultural land price determinants. Of particular significance is the 'vacant land' category which comprises land not actively cultivated but exhibits no particular development potential. The separation of parcels into specific categories allows the empirical estimation of the marginal value of land attributes according to different uses, which should greatly inform sectoral-specific policy suggestions. There are also specific information about the type of restriction on the parcel. In short the data allows us to test the effect of various land control instruments, agricultural activities and locations all at the same time.

The third contribution of the thesis is in its fairly thorough analysis of the institutional features that contribute to the economic characteristics of the country and by extension, the pattern of land use and prices. It is probably the first study to systematically measure the impact of different land-use regulations on value of land and hence provide indications on their respective effect on welfare. The estimation results will reveal the effect of three types of land controls on prices: agricultural use title conditions, group settlement land conditions and Malay Reserve land conditions. Previous empirical studies based on institutional data may use data limited to the institution (e.g., land settlement scheme, or land preservation programme etc.), hence again must be corrected for sample selection bias. The thesis described the land reform and other important milestones in the economy which created the three forms of institutional effects on price (land-controls, transaction costs and market imperfection) discussed in Chapter 2. Later these institutional effects are reflected in the problems concerning land fragmentation, land abandonment and flexible land control system and agrarian reform agencies.

The fourth contribution is in a new approach to study real option behaviour in the agricultural land market. The Real Options argument possess great potential for explaining behaviour in the markets given the uncertainties brought by possibility of land-use changes in a rapidly transforming economy. Plots of agricultural land typically possess greater value than the expected discounted return to current agricultural use if the land is presumed adaptable to development plans in future. The thesis's method involves firstly, the construction of a price index for land that accounts for the heterogeneous characteristics of land, the hedonic land price index. The thesis then apply a moving correlation analysis on a medium-length series of data to test the relationship between land price and the potential payoffs from projects that can be accomplished on the land. As a proxy for the latter, stock market index of the respective sector is used. The methods developed are computationally feasible and could be widely applied and extended in scope and time.

1.5 CONCLUSION

The Malaysian experience can provide insights to other developing countries undergoing economic transition in how market and non-market forces affect agricultural land prices. In the absence of a comprehensive land-use plan for non-urban areas and because of regional development objectives, land-control authorities in Malaysia in the past has appeared to be somewhat liberal in allowing agricultural land to be converted to development use. This creates opportunities to speculate or withhold land from productive activities which in turn, further reduces the stock of land in productive agricultural use. Developable agricultural land can be defined as traditionally agricultural land that has the potential to earn more in development use. If the market perceives that land-use conditions of such lands can be rescinded in the near future, then the market price will adjust accordingly to reflect the development potential of the land rather than its intrinsic agricultural value. As a result, there will be a positive gap between prices of agricultural land with different potentials. The contributions made in the thesis are expected to enhance our understanding of the land market operations and its interactions with formal and informal institutions.

1.6 THESIS STRUCTURE

Beyond the introduction and conclusion chapters, the thesis is organised into six additional chapters. The six can be consulted as three possible stand-alone sections covering three aspects of the agricultural land price study: institutional analysis (chapters 2 and 3), empirical estimation of key determinants of price (Chapters 4 to 6) and examination of real options behaviour in land prices over time (Chapter 7).

Chapter 2 will outline the theoretical framework with respect to market determination of land prices by first reviewing Ricardian rent theory i.e. the market under fixed supply of land and single land use (agriculture) assumptions. The discussions are extended by relaxing these assumptions, specifically to reveal effects of planning, transaction costs and market imperfection. In the latter half of the chapter, an overview of two valuation methods, the conventional present value formula and the hedonic price modeling approach, will be given. The former is more suitable if there is a long time series for land prices and essentially allows the researcher to determine key drivers of price changes over time. The second method employs cross-sectional data and works on the premise that land's price should be a function of the quantity and quality of different attributes present on the land.

Chapter 3 basically sets the research in a historical and political context; by reviewing events and policies that brought about the pattern of administration and use of land in Malaysia today. The overview describes traditional Malay land arrangements, land reforms introduced under British rule, agrarian reforms soon after independence and finally, structural economic changes in the 80's and 90's. The chapter also discusses several important land-related institutions, the effect of land titling on land transferability and land fragmentation as well as the twin problems of land abandonment and land conversion to development use.

Chapter 4 defines the scope and focus of the cross-sectional study. It begins by discussing hedonic attributes commonly used in land price studies. As the chapter to proceeds to describe the data identification process, it will be revealed why some of the variables listed earlier are not included in the Malaysian land price model and why some others are. The chapter shows how specific variables are constructed to suit the hypotheses testing objectives for the model. The study involved two types of agricultural land, one with development potential and the other, without. The latter category is then divided according to specific potential agricultural use. The chapter ends by describing the salient features of the dataset.

Chapter 5 describes the empirical methodology used in the thesis by explaining the principles that guide functional form choice and variable selection, tests for structural stability and corrections for spatial bias. Finally, the chapter provides guidelines for the interpretation of the results and the calculations of the 'conditional' marginal implicit values of the individual land attributes.

Chapter 6 presents the results of the model estimation as applied to the Malaysian dataset. Sales value of developable and non-developable agricultural land are analysed as a function of the physical and locational characteristics of the land. In addition, a disaggregated version of the hedonic model is estimated to investigate the existence of geographically distinct land markets. Spatial econometrics methods are employed to detect spatial biases in the data. The chapter ends with a lengthy substantive discussion of the individual results.

Since development motives feature significantly in the thesis, Chapter 7 will be devoted to the 'Real Options' theory. The chapter reviews in detail the theoretical concepts and literature concerning real options. An extensive numerical example is provided to help explain sources, determinants, valuation methods and types of options agricultural land can represent. The second half of the chapter is devoted to explain the data, hypotheses and trend analysis method used to reveal real options behaviour in the market for land.

Finally, Chapter 8 concludes the thesis, highlights the major findings of the thesis, discuss briefly several policy directions, areas of future research, and the limitations contained in the study.

Chapter 2
THEORETICAL FRAMEWORK

2.1 INTRODUCTION

Land price determination remains an important topic in growth and development studies because of its ability to explain land-use patterns. In areas where the population pressures are rising, the resultant economic diversity brought forth competition for agricultural land to suit expanding non-agricultural uses. Commercial and industrial interests, for whom accessibility to buyers and labours is a critical factor, are usually willing to pay high prices for sites nearer to population centres.[3] Ultimately, for any given location, land is a function of its best use, which is determined by economies of agglomeration described above. Economic activities for which the two factors are less critical would soon make way for other activities as the market duly adjusts to allow the 'highest and best' use of land dictate price and allocation of land.

The government may be compelled to intervene in the market allocation process to ensure that land-use for different needs are stable and sufficient, particularly for agriculture. In societies where there is substantial support for agriculture as a public good,[4] enormous amount of lobbying effort and public funds are channelled to control growth in areas which are traditionally agricultural. This chapter illustrates the effect of state intervention in particular to create segmented markets by which by separate equilibrium points are observed. Regardless how strong the non-agricultural demand for land is, there are two additional market-altering features that are entirely unique to land markets across the board but sorely lacked the attention they deserve in land-price literature. The first is the presence of transaction costs in one or more phases of land's acquisition and use and the second is market imperfections arising from disproportional numbers of sellers and buyers and market influence. This chapter explores the possible sources of these influences and the manner in which markets are affected. Later, it demonstrates that because agricultural land is far from

[3] For a full theory of locational advantages and development of urban land market, please refer to Lean and Goodall (1966).

[4] Agriculture exhibits characteristics that produces positive externalities such as food production, open space and environmental benefits.

homogeneous, the usual static general equilibrium concept in which total market demand for land and total market supply intersect is not applicable. A standard valuation method for land employs the Net Present Value (NPV) formula, which forms the basis of empirical studies on land price determinants over time or over a cross-section of parcels.

The chapter is organised as follows: Section 2.2 will present and extend the Ricardian model of a land market to include the effects of government intervention, transaction costs and market power on market equilibrium. Sections 2.3 and 2.4 will discuss the theoretical underpinnings of the Net Present Value formula and the hedonic approach to land pricing respectively. Section 2.5 summarises and concludes.

2.2 THEORY OF LAND RENT

The importance of land to the economy had long been recognised in Western economic thought, as manifested by a large amount of classical writings on the "theory of rent". Land has been at the centre of early economic theories on income flows, surplus value, tax, trade and so forth. Traditionally, land is owned as a symbol of wealth and a source of income and subsistence. A person with surplus land can rent it to earn economic income for himself and provide one for his tenants. A land tenancy arrangement holds that the landowner contributes his land and often some measure of operating capital and management, while the tenant farmer contributes his labour. The rights that a tenant enjoys over the land and the form and manner of rental payment vary across systems (over different times and countries), the details are either written down in a contract or based on the norms in the society. The concept of rent as the return specifically attributable to land is fundamental to classical and neo-classical approaches to land pricing, both of which will form the cornerstone of this chapter's discussions. The underlying assumptions of the theory with regards to supply of land and market competition is examined and subsequently changed to suitably reflect three important external influences on modern land markets.

In economic theory, land as a gift of nature is said to earn a "pure economic rent" because there is no alternative use for its supply. Land supply is regarded as fixed or perfectly inelastic. Adam Smith (1776) defined rent as the price paid for the use of land, derived from the surplus output value after the costs of cultivating and maintaining the land had been met. However, he said that rent is not necessarily proportionate to the landowner's improvement and maintenance expenditures, although its rate is largely influenced by earnings from agricultural activities on the land. Ricardo (1815 in Evans, 2004) described more systematically the relationship between rent and land price.[5] According to him, the amount of land available to the society is relatively fixed and thus, price of using land (as given by rent) will increase if demand for land increases. He simplified the economy as a huge farm suitable for producing a single commodity i.e., corn. As shown in Figure 2.1,[6] the hypothetically complete national economy is characterised by a fixed land supply, given by *OX*. The supply of land is represented by the vertical line *RX*. The intersection between the demand curve for land, *AA'*, and the supply curve, *RX*, marks the equilibrium price of land, *OP*.

If price falls below the equilibrium, the amount of land demanded by all individuals exceeds the existing amount in supply. Competing buyers will bid up price in order to secure the amount of land they desire. If price rises above the equilibrium, this means that the amount of land demanded by all individuals is less than the existing amount in supply. Competing sellers will bid price down to dispose the amount of land they planned. At the equilibrium price, market clearing occurs in that all individuals, collectively, are prepared to hold the entire stock of land. Any sale transaction will involve the same price per unit of land. This is because, if it becomes evident that there are other units selling at higher (lower) prices, the seller (buyer) will normally seek to renegotiate the sale agreement. In other words, market competition will ensure that the same rate of rent prevails for all units of land.[7]

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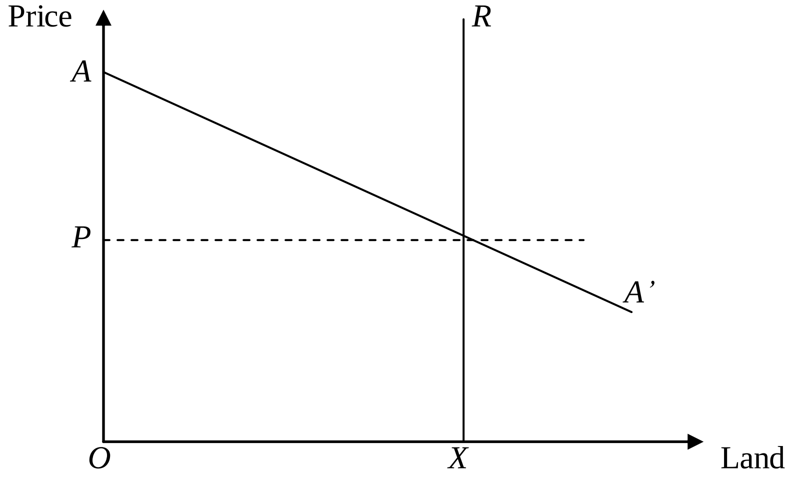
5 In adopting this assumption, Ricardo did not allow for discovery of new land or productivity-enhancing technology. These and many other assumptions that hold the Ricardian system together have been heavily criticised as fallacious and confusing. A comprehensive review of the Ricardian rent debate would be lengthy and is not one of the main objectives of the thesis.

6 For the diagrams and their related discussions, we borrow heavily from Evans (2004).

7 For a more detailed description of how the problem of land's indivisibility is resolved for all the participants of the market i.e., determining the actual volume traded, Lloyd (1992) provides a detailed theoretical and diagrammatic explanation on how automatic adjustments take place continuously in the market to solve this "intra-market disequilibrium". The number of transactions that will actually take place is not dependent on the equilibrium price, rather on the degree of 'misallocation' at that equilibrium price. A buyer whose valuation of the land unit exceeds that of the seller is more likely to secure an exchange. On the other hand, unless the landowner is in very

Figure 2.1. Ricardo's model of the land market



Price inelasticity of land supply implies that the same quantity is available to the market at any level of prices. Ricardo therefore argued the direction of causation should be that the price of land's output will determine its rent, and not the other way around. This is due to the nature of land's demand being a derived one. In other words, at equilibrium, the total stock of land is priced according to changes in demand for land's output rather than changes in the supply of land. Ricardo further explained that rent levels can be indirectly influenced by imperfections in the output market, including from trade protectionism. Referring to circumstances brought about by the Corn Law in England, he wrote (1815, p.38)

> *It is not really true that the price of corn is high because the price of cornland is high. Actually the reverse is more nearly the truth; the price of cornland is high because the price of corn is high. Because the supply of land is inelastic, land will always work for whatever is given to it by competition. Thus the value of land is completely derived from the value of the product, and not vice versa.*

Lean and Goodall's (1966 p.241) "location theory" example can be used to illustrate how the Ricardian rent concept is applied to explain modern real estate pricing. Say that two buildings with similar layouts are built on two different plots of land, *A* and *B*. Yet, the building in plot *A* is expected to attract a higher price owing to its would-be superior view or nearness to open space. In other words, the two plots are not interchangeable despite having identical buildings. Because there is only one such

urgent need of funds, he is more likely to decline any purchase offer that is below his own valuation of the land's worth. Therefore, an exchange is essentially a process of reallocation from one agent to another agent whose estimates of the land is higher.

plot in each geographical position, it can be said that the supply of land in each spot is perfectly inelastic. The difference in the would-be market prices of the developed properties will show itself in the difference in the plot values. The developer is willing to pay more for site *A* up to the difference in the market prices of the two would-be properties. Even if the developer purchased both sites at the same price and spent the same amount on constructing the two buildings, it is still unlikely that he would later sell both properties at the same price. This example shows that pricing of the land plots follows the amount the market is willing to bear for each of them, which is in turn, determined by the price of their respective outputs (reflecting land's derived demand nature).[8]

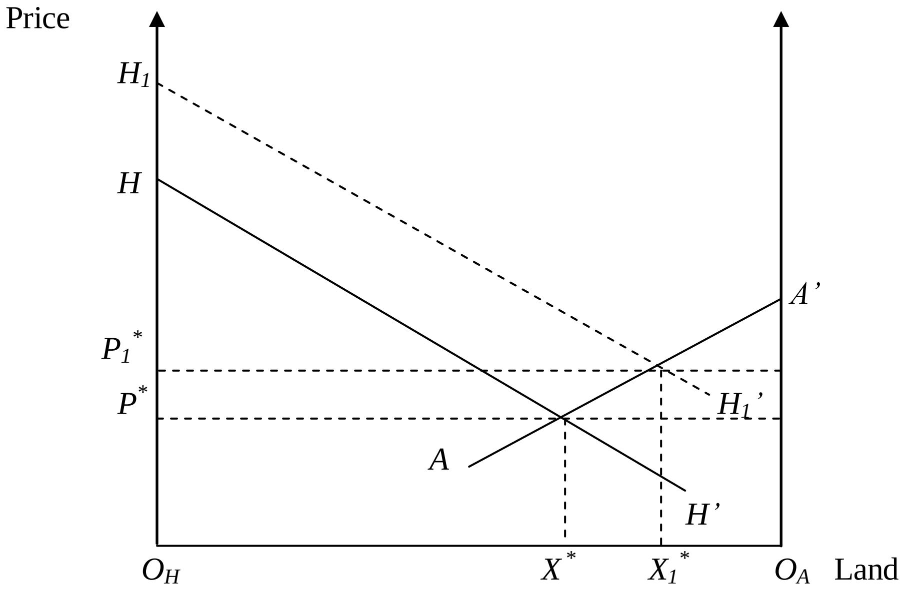
As with any theory, the applicability of the Ricardian conclusions essentially depends on how the model assumptions are observed to be true for the economy in question. One may ask under what circumstances does the first assumption regarding single-use of land (agriculture) still holds today. Agricultural use of land may still dominate in regions with sizeable stocks of land relative to its rural population whereby the agricultural land market of these regions tends to be more insulated from development or population pressures simply because there is ample room for cities to grow organically without encroaching on agricultural land. Pressures from development demand are typically well spread-out so as not to cause major deviations in land prices from the land's agricultural valuation (Platinga and Miller, 2001). Canada, the United States, and China are examples of regions with green belt states that are large, contiguous and considered economically 'separated' from urban hubs in the country.

In the rest of the world, economic transformation and population growth usually mean increasing competition for land to feed non-agricultural needs. Figure 2.2 demonstrates the resulting equilibrium conditions when the Ricardian assumption of single land-use is relaxed. The total area of land available at a location is represented along the horizontal axis by $O_H O_A$. Demand curve for development land, which for the sake of simplicity is assumed to mean land for housing construction, *HH*', slopes

[8] With respect to planning, they argued that fixing maximum prices of land will not be able to lower prices of property, but merely result in the difference between the controlled price and the market price of the land accruing to someone else other than the landowner.

downwards from the left-hand vertical axis while demand for agriculture land, *AA'*, slopes downwards from the right-hand vertical axis. Note that the market equilibrium price is found at the intersection of the two demand curves, at P^*. The amounts of land for development and agricultural purposes dictated by the market are O_HX^* and O_AX^*, respectively. Any price above P^* means that the total amount of land used in both uses is less than the total stock of land available; whilst any price less than P^* implies shortage of total land desired for both uses.

Figure 2.2 Model of Market with Competing Land-Uses



The graph demonstrates that the law of one price prevails 'at the margin', since if it does not, arbitraging landowners would try to transfer their land from the lower-price use to the higher-price use until there is a single price for land with the given set of characteristics. Changes in factors affecting demand for either type of land's output, will be duly reflected in the changes in the equilibrium price of land. Suppose that demand for houses increases because of falling mortgage rates in the economy. The resulting increase in demand for development land can be shown by a shift from *HH'* to H_1H_1'. Without a corresponding shift upwards in *AA'*, the resulting premium or gap between existing price, P^*, and the new equilibrium price, P_1^*, will induce even more farmers to sell their land to developers. The amounts of land for housing and agriculture would stabilise at $O_HX_1^*$ and $O_AX_1^*$, respectively.

Figure 2.2 aptly depicts the double-layered problem faced by agriculturalists in a market for land without government intervention i.e. no planning or land-use control.

As long as there is increasing development demand for agricultural land, the effect is **smaller** hectarage of agricultural land ($O_A X_1^*$); on sale at a **higher** price than before (P^*). Coughlin and Keane (1981) argue that even if relatively small amounts of land are sold to non-agricultural purchasers, land values in the whole affected area will tend to rise. The sale of land at prices above those that had prevailed in an area tends to increase the value of all land. This is because prices convey information which existing landowners normally use to adjust their expectations. Particularly sensitive situations are:

(i) if the land is right at the 'margin of tranference', (a term borrowed from Barlowe, 1986); for example at the urban fringes;

(ii) if scattered development is allowed to take place, leaving undeveloped pockets of agricultural land uneconomic or cut off from access to agricultural input and output markets

(iii) if the overall physical land resource of the society is limited, combined with situations of high labour and input costs of agriculture

(iv) if an originally greenfield area is redesignated as a new population centre.

With respect to the last situation above, it is normal for governments to launch new hubs of economic activities in their pursuit of more balanced regional development. This will in turn jumpstart land price appreciation in the area.[9] Similarly, falling costs of commuting (as communication and transportation facilities improve) encourages private land developers to create low-density townships in areas not considered urban-fringes.

Naturally, there are bound to be spill-over effects on the market for farm outputs. As cost of production escalates due to higher cultivatable land prices, margins of return from farming will fall across the board. In some cases, rising land costs might still be offset by higher returns from shifting towards high-value crops.[10] In other circumstances particularly where prices of the farm output are subject to ceilings, and there is no financial support to cushion the impact of rising land prices or help them switch to other crops, farmers may be forced to give up agriculture altogether. Hence

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9 However, not all anticipated development projects eventually materialise, or if it does, it could be many, many years after it was first anticipated.

10 Livanis et al. (2006) found evidence in a U.S. study that urban farmers seek higher returns by reallocating production activities from commodity-oriented agriculture to higher-valued crops such as vegetables and fruits that require high transportation costs otherwise. Ultimately, they argued that only agriculture in high-valued crops can persist at urban-fringes.

it is common to find where there is growing and consistent development demand on agricultural land, agriculturalists tend to under-invest (with the exception of truly large and resilient agro-businesses) when profit margins have been consistently poor.

2.2.1 Effect of Planning

The above discussion brings us to an important feature of modern land markets, i.e., state intervention to resolve problems arising from competing demands on land. The intervention can be in the form of direct land-use conditions, planning permission or zoning, purchases of development rights and land easement contracts, all of which ultimately can alter the supply of land available for different land needs.[11] More importantly, market for land is segmented is now segmented is such a way that there is an inelastic overall land supply for each of the competing uses.[12] Such efforts are primarily aimed to protect agricultural land from development and control urban growth, and can be found in countries such as the U.K., EU, Japan and South Korea. Motivations for these measures range from aesthetic (e.g., preservation of idyllic countryside) to nationalistic (e.g., securing national food supply) and economic (e.g., protecting the agricultural export industry and to correct market failures). Land controls are seldom used to replace the market mechanism entirely in allocating land for specific uses. However, its considerable influence on land supply and/or demand cannot be ignored (Needham, 1992).

Figure 2.3, (adopted from Evans, 2004, p. 78) depicts an economy where land supply is fixed by way of government land controls. Note two important departures from the Ricardian corn land model:

(i) there are viable competing land uses to agriculture; and
(ii) the fixity of supply is state-sanctioned, hence changeable.

Under the land-control measures, a specified amount of land, O_HX is allocated for development and O_AX for agriculture activities. The vertical line RX defines the

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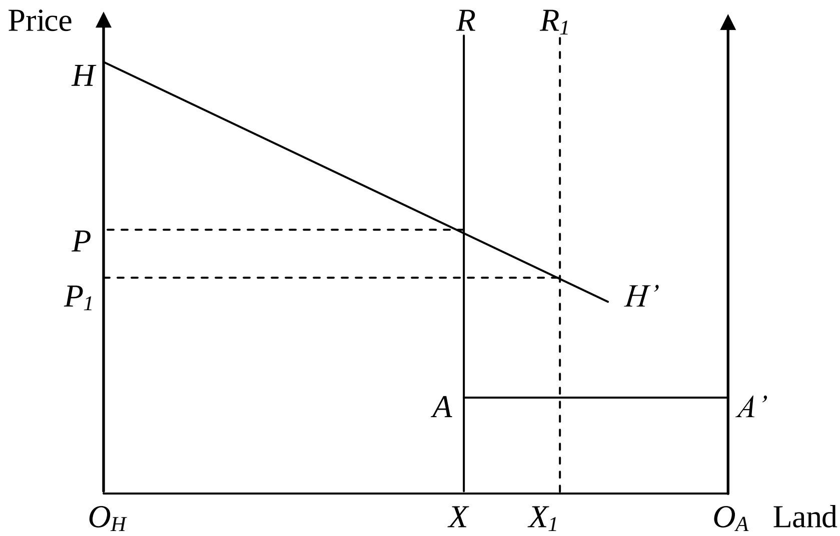
[11] Evans (2004) explains that a planning permission system significantly reduces the clout developers hold in the land market simply because the application's outcome is uncertain. Needless to say, the stricter the planning permission mechanism, the lesser the impact of speculation pressures on price.

[12] Fixity of land can arise from more natural circumstances. If quality of land desired is as specific as it is in some economic uses (with respect to location, temperature, infrastructure, mineral deposit etc.), then supply for this specific type of land is more or less naturally invariable. Only a fixed amount of land is available regardless of price.

overall supply of land for each of the two uses. Demand for development and agricultural land are still *HH*'and *AA*' respectively. If all of the land is on offer at the same time and the same price, intersection of *RX* and *HH*' gives the equilibrium price of development land, $O_H P$; and the intersection of *RX* with a presumably perfectly elastic *AA*' gives the market-clearing price of agricultural land, *AX* or $O_A A'$. A demand curve for agricultural land which is elastic implies that the society believes agricultural output can be easily sourced from outside the region. Since demand for land is derived from the demand of its output, if demand for agricultural output is elastic, demand for agricultural land would also be elastic.

Figure 2.3 Market with Fixed Housing and Agriculture Land Supply



The figure shows that as a consequence of separation of supply of land for specific uses, large differences in prices, approximately the amount equivalent to *AP*, will prevail between the two types of land.[13] Say that there is now a move to reallocate land from agriculture to development use as aging agriculturalists retire and/or change their land status to development land to attract higher asking prices. State-approved land-use change is shown as a shift in the vertical supply curve from *RX* to R_1X_1. If demand for development land stays constant, then overall price of development land would fall from *P* to P_1. This demonstrates that in a system where land supply is **fixed** but **changeable**, equilibrium price can be determined by both the **demand** and **supply** of land. More specifically, demand for land is determined by demand for its output whilst supply of land is determined by the land control

[13] Within the same spatial unit, substantial price discontinuities can be expected for adjoining parcels of land subject to different land-use objectives (see Cheshire and Sheppard, 2005).

authorities. Note that even as supply of land available for agriculture declines to O_AX_1, due of the elastic nature of agricultural land demand, the equilibrium price of agricultural land remains at *A* rather than move upwards to reflect the smaller stock of land.

To recap, the classical Ricardian land model is held together by the assumptions that agricultural land supply in the model is stable, all potential land is actively cultivated and there is very small possibility that land is converted to other uses, such that land price is entirely demand-driven. In reality, the assumption of fixed supply of land is more appropriate to reflect the supply of land facing the society, for whom total stock of land is not changeable. To the society, there is no opportunity cost of using land and thus land prices can be determined solely by demand. If two competing uses are allowed, price will equate at the margin. State intervention to fix the amount of land for different uses would result in price differentials, depending on the price elasticities of the two demands.

In his discourse on land, Ricardo assumed that land differs in quality, and that people always begin by cultivating the most fertile parcels of land. Diminishing marginal returns and population growth will eventually force cultivation of inferior lands to cope with greater demand for food. Inferior land (those which are less fertile or less accessible) can be improved though this entails additional costs to the landowner, and this is duly reflected in higher prices in the market. Ricardo's 'marginal land' concept presupposes that people are always able to identify and cultivate the most fertile land in the economy first, before moving on to less fertile tracts. However, if the opposite is true, i.e., people start at a certain land quality and gradually move on to a better plot of land, the same conclusion prevails. In order to part with their land, owners of higher quality land must be induced with offers of higher prices, i.e., corresponding to the amount equivalent to the forgone benefits from the land's best alternative use. Hence, from the point of view of the individual, rental on land is simply a cost of production because there are opportunity costs of using the land.

To illustrate the concept of opportunity cost, it is useful to distinguish between two aspects of land quality, namely 'use-capacity' and 'highest and best-use' (Barlowe, 1986, p.12). The former basically refers to:

(i) land's accessibility, measured by the time and costs needed to "reach other related resources, market and amenities"; and

(ii) resource quality which is the land's relative ability to produce the desired products, returns or satisfaction.

Therefore, the use-capacity of agricultural land is most commonly measured by indicators of soil characteristics, topography as well as climatic advantages. On the other hand, the use-capacity of housing land normally concerns access to amenities, transport networks and so forth. Nevertheless, it can generally be assumed that the better the use-capacity, the higher the value of the plot of land is vis-à-vis others within the **same** land category. On the other hand, 'highest and best use' of land involves valuation that **transcends** all categories of land use.[14] Typically, the highest and best value of land is revealed by first listing all legally permissible uses at the time and in the future. Of these, the owner chooses one that is physically and financially feasible and promises the highest return, net of the land's improvement or preparation costs.

If land is freely transferable between uses, the value of the opportunity costs is largely based on highest 'use-capacity' considerations. Intuitively, as more land is diverted away from the production of which it has a high use-capacity, the higher the opportunity costs incurred in producing each additional unit of the alternative output.[15] For instance, as more and more agricultural land with high use-capacity for say, crop X, is acquired for increase production of Y, which is say, housing units; the amount of forgone X output per unit of land will rise. Hence, landowners will insist on higher prices to release their land for additional Y development.[16] This demonstrates that for an individual, land supply is a function of its price i.e., the supply curve facing him is not inelastic. In the absence of zoning or land-use controls, agricultural land can be freely converted to meet population's increasing needs for residential and commercial properties. The actual amount of land traded for this purpose is therefore limited only by the "willingness and ability" of agricultural

[14] 'Use-capacity' and 'highest and best use' of land changes over time as opportunities and shifts in the economy, land legislation and human relations take place.

[15] The Law of Increasing Costs does not apply to all commodities at all times. This assumption is usually made to provide a logical basis for an upward sloping supply curve.

[16] It is inevitable that as land becomes scarcer as a factor, firms would be expected to try to use land more intensively and/or to substitute for its use, other goods and factors of production, thereby affecting the resulting pattern of land-use.

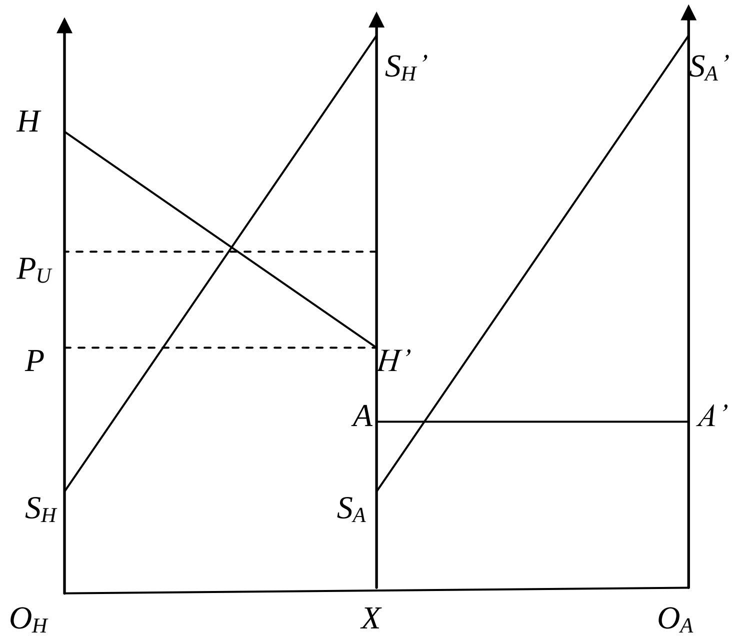
landowners to sell land at different level of prices. Since market supply of land is variable (inelastic), it follows that supply will be just as important as demand in determining the market equilibrium price.[17]

Figure 2.4 is modified to show a market where the state divides land to two different uses in equal amounts, such that $O_HX=O_AX$. Let's assume, for simplicity, an area is split into two halves and that landowners are randomly and equally divided between the two segments. Two identical market supply curves, S_HS_H' *and* S_AS_A', emerge to represent the respective development and agricultural **market** supply curves of land. Note that the slope of the twin supply curves, S_HS_H' and S_AS_A' should double the slope of a single supply curve in a single land-use model (not shown). This is to reflect the smaller number of landowners in each segment. Subject to the overall limit of land in each use, higher prices will be needed to induce landowners to sell additional units of land.

Since development is not allowed in the area represented by part (b) of the graph, demand for development land, *HH*', is only applicable in (a). Its intersection with S_HS_H' occurs at P_U which is significantly higher than *P*. It is also worth noting that despite the higher value of P_U, amount of land traded within (a) is substantially less than the state-planned amount of development land, O_HX. In other words, not all the land in (a) will actually be traded and developed. All of the land in (a) will be traded only if *HH*' shifts upwards to equilibrate at point O_HX. In the absence of regulations concerning maximum time frame for sale and development, landowners in (a) would naturally wait for higher demand for houses to push *HH*' upwards for them to obtain higher prices for their land. It could also be that some landowners are unwilling to sell because of the close-to-zero probability of ever acquiring land in the same area again (Basu, 1990) or because of some institutional constraints.

[17] An extensive model on price equilibrium conditions for a two sector land market is provided by Robison *et al.* (1985). Because both sectors are allowed to compete for the acquisition of the same parcels of land, the market will eventually equilibrate at a common price which equates the excess demand in the developable land market and the excess supply in the agricultural land market.

Figure 2.4 Model of Market for Land with Planning Restrictions



The price of agricultural land, *AX* or *O_AA'* again depends on the position and elasticity of the elastic demand curve for agricultural land, *AA'*; whereas the quantity of agricultural land actually traded depends on the intersection of S_AS_A' and *AA'*, which could also be lower than the amount planned by the state. Overall, it is worth noting that the difference between the market equilibrium price of development and agricultural lands is significantly larger now that market supply are considered i.e., equivalent to the amount AP_U compared to *AP* i.e., if all **all** of the developable land is on offer. The section next address another external influence on market equilibrium the existence of transaction costs.

2.2.2 Effect of Transaction Costs

Transactions costs in an exchange generally diverts positive tangible amount of resources from both the buyer and seller (Buitelaar, 2004). It is often viewed as dead weight loss that should be minimised at all costs if efficiency of the market and the subsequent production process are to be enhanced. With respect to land, there are transaction costs at almost all levels of land acquisition and use. Examples of transaction costs in an private-to-private exchange include search costs, negotiation costs, brokerage commissions, title fees, insurance, duty stamps, surveyors fees, notary fees, recording fees. If land is acquired directly from the State, normally there are costs of application, negotiation, land premiums and capital gains taxes involved.

Subject to the approval of the State authority, an individual can be issued either a grant or a lease (both being instruments of land alienation) to give him a set of rights over a particular parcel of land. Subsequently, if planning permission is also necessary, the landowner incurs additional costs to comply with land-use or building regulations (plan-preparation costs), contracting costs, appeal costs as well as later pay costs in the form of 'planning' of 'development' gains to the authority upon approval of the proposed development project.[18] The extent of transaction costs depends on a multitude of factors, some of which are discussed here:

2.2.2.1 The initiating party

Normally, if a private individual applies to the State to obtain ownership of land through the alienation process, most if not all of the transaction costs involved are borne by him. However, if the land alienation comes within a scheme of State or Federal development plans for the larger area or region to stimulate the local economy, then it is possible that a larger proportion of the transaction costs involved in its distribution and use are absorbed by the government. In other words, the State may use its powers of eminent domain or other gentler forms of persuasion, to facilitate the whole process of land assemble, infrastructure preparations and so on and so forth.

2.2.2.2 The number of parties involved

The smaller the number of parties involved in the land exchange or the land's agricultural/development project, the smaller the associated transaction costs. In many developing countries, land reform initiatives usually involve the creation of institutions aimed at internalising as much transaction costs as possible for the individual farmers. Examples of such institutions include farmer associations, Federal-initiated agricultural extension agencies and land settlement agencies. These institutions work to inform and regulate general terms of behaviour, liability and benefits in contracts in a manner that promotes the interest of the farmers by helping them minimise the costs and delay when engaging with external parties in open

[18] The authority's planning gains, which can be up to a certain percentage of profits anticipated from the project, can be exacted in the form of cash payments or subsidies, transfer of land in another location, provision of low-cost housing or commercial areas for small income groups of the population. Because the planned developable area is limited and there are competing buyers, local authorities can be tempted to act monopolistically to maximise its total revenue from planning gain.

market contracts (for production and marketing linkages) or when engaging with related government agencies; which can be considerably problematic given the varied interests, information and financial capacities amongst the farmers. Empirical support by Ciaian and Swinnen (2009) and Vranken *et al*. (2007) showed that if landownership is small and fragmented, the landowners tend to face a more complicated set of transaction costs than larger-scale land entities when they enter the land market either as sellers or buyers.

The same logic applies to landowners cum developers, who normally need to interact with a wide-range of government agencies and private service providers in the execution of their proposed development plans (see Buitelaar, 2004, Baland and Platteau, 1997).[19] Nevertheless, these forms of governance are equally susceptible to transaction costs of their own (e.g., between the landowner and the institution in organising and enforcing collective agreement as well as the cost of monitoring efficiency and transparency between the parties), asymmetric information and rent-seeking problems. Empirical investigation of these 'institutional transaction costs' on individual landowners is today an active strand of research (Keogh and D'Arcy, 1999).

2.2.2.3 Degree of Uncertainty

Whilst planning regulations saves the society from suffering from haphazard development construction (i.e., there are fewer negative externalities compared if the development took place unregulated) there is still need for continuous monitoring during and after the plan has been executed. The developer, for instance, must undertake the costs of measuring compliance and success as well as the cost of mitigating possible risks. In emerging markets, where land investment contracts are relatively a new concept, hence are usually simple and brief, the government must help to anticipate problems and grievances and suggest realistic remedies and compensation for stakeholders' loss of welfare, where applicable. Aggravated parties must be accorded the room to lodge complaints and be objectively heard. Naturally, the more detailed the plans and contracts, the lesser the degree of uncertainty in the plan's outcome.

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[19] Examples of technical parties to the 'plan' are the land surveyors, officers from the agricultural extension services, environment monitoring agencies, water and irrigation services and so on.

2.2.2.4 Rent-seeking Behaviour

Paying land premiums (for land alienation) and development gains (for land development) are common in many countries and is in fact an important method to fund public infrastructure or to compensate parties affected by the land's utilisation. However, due to the difficulty in accurately quantifying the social costs from the land's use, premiums imposed are often arbitrarily determined and negotiable behind closed doors. There is ample opportunity for rent-seeking associated with the land alienation and land development processes, if the procedures and/or approvals are not transparent. Either due to the opportunity to obtain additional state revenue (and expand economic diversification objectives) or to the dubious connections between the developer and the government officers, the state can appear to favour development over preservation of agricultural land. The overall effect can interfere with actual production incentives and costs and tilt the market in favour of development demand for land.

Basically, there are two major implications from the existence of transaction costs in an asset market (Buitelaar, 2004). Firstly, they create individual inertia that prevents agents from transacting as much of the assets as they would like in that period or even forever. As such, transaction costs can be responsible for slowing down the process of reallocating land via the market as owners withhold supply because of their inability to resolve additional burdens relating to the exchange and so forth. If the prospect of profit from farming is persistently weak, a farmer may be induced to turn his back on the land in favour of a less complicated income opportunity. Secondly, as shown above, the presence of transaction costs implies that the price of the asset might not reflect society's demand and supply of similar land accurately. Depending on the type of transaction costs involved and its extent, the market is likely to settle at a lower equilibrium point as supply shift downwards as lesser land is being offered at all price levels. Similarly, if there is considerable transaction costs in purchasing and carrying out desired plans for the land, we can observe smaller amounts of land demanded at each price level. Lence and Miller (1999) found that it is possible for the observed prices of an asset to deviate from levels suggested in a competitive asset market model; yet the results can still be consistent with market theory once transaction costs considerations are incorporated.

2.2.3 Effect of Market Imperfections

In theory, land price adjusts automatically to reach a level that eventually clears the market, notwithstanding the type or degree of imperfection present in that market. This section examines two sources of market imperfections particularly common in agricultural land market in developing economies. Firstly, market power which is attributable to ‘excess surpluses’ or ‘excess demand’ of agricultural land in a given location. Cotteleer *et al.* (2007) explained that because land is heterogeneous and cannot be relocated, and the market for land is to a great extent typically local and thin, there are very few buyers and sellers in the market. ‘Excess surplus’ situations can arise when the market is, for some reason, not able to clear all the land offered for sale. Excess surplus can also originate from the prevalence of scattered and haphazard development, often leaving small uneconomic pockets of agricultural land whose owners are no longer willing to operate. Land plots that are subdivided by way of inheritance or other methods are also likely contributors to ‘excess surpluses’. On the other hand, ‘excess demand’ arises if market valuation of certain parcels of land is suddenly enhanced through changes external to the market. An example of this in Malaysia relates to the sudden surge of demand from non-Malay buyers for land newly-released from the ‘Malay Reservation’ restriction (which, as the name indicates, prohibits sale of certain land to Malays). Individual sellers face a relatively steeper demand curve consistent with the greatly increased market power that sellers hold with respect to these parcels. The extent of the market power depends on the number of sellers and buyers interacting in the same market. The higher the number of sellers over buyers, the stronger the market power held by the latter and vice versa, taking into account transaction costs.

Secondly, market imperfections can arise from differences in buyer and seller characteristics. In their empirical examination of agricultural land prices in Netherlands, Carter and Mesbah (1993) argue that ignoring the characteristics of buyer and seller leads to “omitted variable bias on the estimated shadow prices in such models.” In size-sensitive markets, the ability of producers to negotiate through multiple inputs and output market imperfections differ greatly according to farm size. Larger farmers are able to enjoy a systematic and better access to working capital that allows them to earn higher returns per pound invested; and therefore are likely to outbid smaller farmers competing for available land wanting to benefit from economies of size but without sufficient financial and marketing resources. The relationship between land market imperfection and land concentration continues to receive interest particularly in the development economics literature. Because of its scope and specific data requirements with respect to the buyer and sellers' characteristic, this relationship is not empirically estimated in this thesis.

In order to overcome uncertainty with regards to planning approvals, developers can seek alternatives to the open market by securing development partnerships with local authorities.[20] Either the local authority alienates state-owned land or it acquires privately-owned land on the developers' behalf. Prior to the latter, speculators with asymmetric information (private knowledge of the land takings proposal) would try to buy as much land as possible to guarantee profit from the difference in the purchase and land compensation prices. The larger their accumulated land stock, the stronger they stand in the compensation negotiations. This is another example of market power's effect on the exchange value of land.

To summarise, the section showed that there are theoretical grounds to assume that the market equilibrium for land can be influenced by the nature and extent of state-intervention, transaction costs and market imperfections. The first two induce shifts in the demand and supply of land, while the last induces changes in price elasticity of the demand and supply curves. In the next section, we delve into the theoretical underpinnings of standard techniques to determine land price.

[20] Needham and de Kam (2004) discuss two mechanisms in which land is exchanged outside the market: (1) firms acquire land banks by approaching state or local governments and entering into trust agreements with them to develop the land; (2) state or local authority purchase or alienate land, lay out and service the land with infrastructure and then sell the serviced sites on to firms for development. In other instances, the government acquires land further ahead of time, say in the development of an administrative territory such as Putrajaya in Malaysia. The government then progressively releases land for development, even that in the form of leaseholds. In a system where all land is owned by the Crown such as in Hong Kong, land is sold by the government with attached land-use conditions. All these methods are still perceived as 'positive planning' in the sense that it can help control haphazard development from taking place without giving cause for land prices to shoot upwards unchecked.

2.3 PRESENT VALUE APPROACH TO LAND VALUATION

There are basically two empirical approaches to estimate agricultural land values. The first investigates the determinants of price over time by identifying the dynamic relationships between land values and various macroeconomic factors. The method can be linked to the classic capital asset pricing formula which states that price of an asset equals the sum of its discounted future stream of income or returns arising from possession and utilisation of the asset. In general, the Net Present Value (NPV) formula allows one to estimate the direct long-run equilibrium relationship between land price and returns to land, as well as identify immediate and delayed effects of changes in expectations regarding inflation, economic growth, tax and subsidies on demand and supply of land (see empirical studies by Burt, 1986, Alston, 1987, Featherstone and Baker, 1987, Tegene and Kuchler 1993; Lloyd 1991; Falk 1991; Clark, Fulton and Scott, 1993, Lence and Miller 1999, Just and Miranowski 1993; Chavas and Thomas, 1999, Schmitz, 1995). However, empirical estimation of the price function by this formula can be difficult to realise for certain economies given its need for consistent and long series of average land rental values and other macroeconomic data, not to mention that it is best applied in a context of relatively homogenous use of land.

The identification of a separate demand and supply curve for land is arguably both impossible and unnecessary. Theory shows that there is symmetry between potential buyers and current owners of land; simply because the factors that influence the demand for land are usually the same factors that influence its supply. Both buyers and sellers are usually aware of the land's income-generating potential and other intangible benefits from its ownership, despite assigning different values to each of them.[21] Instead, a seller or landowner usually forms a baseline value of the land that represents the minimum price he is willing to sell his land at, if at all, based on the present value of his expected net income stream from the land's use. Lean and Goodall (1966) explained that if competition between potential buyers forces the market price higher relative to the seller's valuation of the land, then the prevailing market price will become the benchmark for the minimum price acceptable. This minimum price is often referred to in the literature as the seller's reserve price. For

[21] Readers may benefit from more extensive discussions in Currie (1981), Lloyd (1992), Dunford (1985) and Lean and Goodall (1966), among others, for various interpretation of the bid-price model for land.

any price lower than this, the seller will not be interested to sell. Therefore, whether or not a transaction takes place depends ultimately on the set of factors that influence the seller's reservation price.

In considering the purchasing decision, a prospective buyer typically compares marginal returns from investment in the land versus other economic investments. The margin of returns from land depends on a large number of uncontrollable variables including market demand trends (from income and population changes), local and foreign supply, competition and access to markets, fiscal and monetary constraints or incentives, and availability of cheap or quality input and technology. The buyer would also do well to consider his risk tolerance levels and follow-on or back-up investment strategies. He would ultimately come to an estimate of the present value of net income receivable from the land that would make the investment worthwhile for the time frame he has in mind. This estimate is then used to derive a maximum 'offer price' i.e., the highest price he would go to secure the land. Competition between sellers of similar pieces of land may force down prices, hence the prevailing market price can be used by prospective buyers to set their threshold prices. This price is called the buyer's limit price. It is important to note that the market price does not alter the buyer's subjective valuation of the land; rather it only alters the **maximum** price he is willing to pay for it because naturally he will not want to offer more for the land than he has to. A prospective buyer withdraws from the market if his limit price is still insufficiently high to induce the seller to sell the land. Essentially, the eventual market-clearing exchange price is influenced by how far the buyer's limit price is above the seller's reserve price.

Although offer prices and reserve prices are not observable in practice, it is possible to determine the value of land through a single reduced-form function. Lloyd (1991) describes the extended present value models which reflect adaptive, naïve and rational expectation mechanisms. Each specification is logically deduced from a common present value hypothesis and then tested for empirical validity using data on average land prices and rents form England and Wales. The real discount rates represent the marginal rate of substitution between present and future consumption of the representative agent involved in the land market. A constant rate may seem unduly restrictive but it may be argued that due to the long-term nature of land purchase, participants are most likely to use a single rate to discount future earnings. An individual i's demand curve at time t, D_{it} is a function of his valuation price, P_t; and $\sum_{i=1}^{n} Q_{it}$ is the total stock of land available. Therefore,

$$D_{it} = D_{it}(P_t) \qquad \text{for } i=1,\dots,n \qquad \text{(Eq.2.1)}$$

At equilibrium, aggregate demand from all agents wishing to hold land must be equal to the amount of land available in the market, hence

$$\sum_{i=1}^{n} D_{it}(P_t^e) = \sum_{i=1}^{n} Q_{it} \qquad \text{(Eq.2.2)}$$

An agent's (either buyer or owner) decision to hold land is based on his or her valuation price compared to valuations by others. If their individual valuations are higher than the reserve value, demand is created up to the amount of land available. However, assume that at a specified price, $\tilde{P}$, there exists a non-negative excess demand, ED_{it}, from m agents which is shown as

$$ED_{it}(\tilde{P}_t) = D_{it}(\tilde{P}_t) - Q_{it} \quad > 0 \qquad \text{for } i=1,\dots,m \qquad \text{(Eq.2.3)}$$

The remaining agents in the market, (n-m) have a non-negative excess supply, ES_{it}, which comes about from having lower valuation of the land than the offer given to them. This is shown as the surplus of land stock over demand for land at that price

$$ES_{it}(\tilde{P}_t) = Q_{it} - D_{it}(\tilde{P}_t) > 0 \qquad \text{for } i=m+1,\dots,n \qquad \text{(Eq.2.4)}$$

At equilibrium, the excess demand and excess supply are equated such that

$$\sum_{i=1}^{n} ED_{it}(P_t^e) = \sum_{i=n+1}^{n} ES_{it}(P_t^e) = 0$$

or

$$\sum_{i=1}^{n} D_{it}(P_t^e) - Q_{it} = Q_{it} - \sum_{i=1+n}^{n} D_{it}(P_t^e) \qquad \text{(Eq.2.5)}$$

Rearranging the terms, we obtain

$$\sum_{i=1}^{n} D_{it}(P_t^e) = \sum_{i=1}^{n} Q_{it} \qquad \text{(Eq.2.6)}$$

Using a_{0i} and a_{1i} which are the intercept and slope of the demand curve, respectively, r as the opportunity cost of fund taken from interest rate in the financial market and R_{it} as the net return to land from pecuniary and non-pecuniary sources, we can express the equilibrium condition in another way,

$$\sum_{i=1}^{n}\left(\frac{a_{0i}-rP_t}{a_{1i}}\right)=\sum_{i=1}^{n}\left(\frac{a_{0i}-R_{it}}{a_{1i}}\right) \quad \text{(Eq.2.7)}$$

Solving for P_t and simplifying further, we arrive at a single reduced-form equation

$$P_t=\frac{R_t}{r} \quad \text{(Eq.2.8)}$$

which is the cornerstone of the Present Value approach. Note that the previous demand and supply functions are now indistinguishable and therefore need not be specified separately.

2.4. HEDONIC PRICE MODELING

The second empirical approach investigates the relationships between land values and value-creating attributes of the land. It is impossible for buyers and sellers to employ a single market price for a good as heterogeneous as land. Each parcel of land exhibits a unique combination of attributes and hence its valuation should be a function of the quantity and value of the different attributes present in the combination. This forms the underlying principle of the Hedonic Price Model (HPM). Formally stated, a heterogeneous good can be characterised by a set of all its utility-bearing attributes or characteristics, which Rosen (1974) calls a "tied package of characteristics"; whereby the price of the good can be estimated as a function of a vector of its attributes' values.[22] In the hedonic pricing technique, price of each one of the land's utility-producing attributes is estimated to reflect their individual economic scarcity and worth. The hedonic approach to valuing individual attributes of a good is simply an extension of the NPV principles whereby the implicit price of an attribute represents the discounted present value of future benefits of having that attribute in the land. However, because these attributes are not traded independently of each other, a mechanism that allows for non-market valuation is necessary, which will be described shortly. Cross-sectional data on individual parcel values are employed to examine inter-unit variations that lead to differences in price.

HPM upholds the symmetry between demand and supply-related functions, such that their identification and separate estimation are both unnecessary and impossible. For an explanation regarding the symmetry of demand and supply in the HPM

[22] The earliest known empirical study on the effects of a good's attributes or qualities on its price was that of Frederick Waugh in his 1928 paper, "Quality Factors Influencing Vegetable Prices".

framework, we reproduce Elad, Clifton and Epperson's (1994) description of Rosen's 1974 model of hedonic pricing and implicit markets together with its refinement by Epple (1987) and Palmquist (1989).

2.4.1 Hedonic function and Market Equilibrium[23]

The hedonic method for valuing the attributes of differentiated goods is normally undertaken using a two-stage approach. In the first stage, a hedonic price function is estimated using information regarding a good's selling price and its attributes. Price is modeled as follows

$$P(Z) = P(z_1, z_2, ..., z_n) \qquad \text{(Eq. 2.9)}$$

where *P,* is the selling price that emerges from the interaction between buyers and sellers for a specific type of good with *Z* attributes, while z_k is the k^{th} attribute of the parcel. It is inherently assumed that the characteristics of the good are objectively measured in the sense that all consumers perceive the amount of an attribute identically, although they may value these attributes differently.

If it is assumed that there is a large number of differentiated units of the good available in the market, prospective buyers would face a choice among the various combinations of Z that is continuous (Fulcher, 2003). The competitive market equilibrium condition is simply that quantities of the good with a fixed bundle of attributes offered by sellers must equal the quantities demanded by buyers favouring the same bundle of attributes. At this price, no individual can improve his position and all optimum choices are feasible. An individual buyer is unable to influence the equilibrium price schedule in Eq. 2.9. Although the price a buyer pays depends on the bundle of attributes chosen, he will not be able to find a lower price for a similar package. Likewise, the owner/seller cannot influence the equilibrium price schedule. Changing the selling price of the good is only possible through altering the combination of attributes in it, and this involves employing additional resources. Therefore, it can be safely argued that Eq. 2.9 is essentially based on an equilibrium determined by the joint market-maximising behaviour of all demanders and suppliers of the good with a given vector of attributes in the market. To explain the joint-

[23] This sub-section benefits from conceptual discussion found in various theoretical papers on HPM namely by Rosen (1974), Epperson (1994), Epple (1987), Palmquist (1989), Taylor (2003) and many others.

maximising behaviour of buyers and sellers in more detail, the next sub-section is devoted to describe bid and offer functions operational in the market.

2.4.2 Buyer's Bid Function

Let's say buyer *j* has a utility function $u^j = U^j(\mathbf{z},\mathbf{x})$ where **z** is the vector of a good's attributes described in Eq. 2.9, while **x** is a composite numeraire of all other goods consumed. The latter essentially reflects income left after purchasing the good with the **z** vector of characteristics. Note that land does not enter into the function directly, because it is the attributes of the goods that provide utility to its owner. If the price of **x** is set to unity, then income can be measured in units of **x**. The buyer faces a budget constraint $m^j = p(\mathbf{z}) + \mathbf{x}$ where m^j is his income. In other words, he maximises utility by choosing **z** bundle of land attributes and **x** other goods subject to m^j. The first-order condition of this maximisation problem can be written as

$$\begin{aligned} U^j_{z_i} &= \lambda^j \cdot p_i \qquad\qquad i = 1,\dots,n \\ U^j_x &= \lambda^j \\ m^j &= p(\mathbf{z}) + \mathbf{x} \end{aligned}$$

where the subscripts on the functions denote partial derivatives, p_k, is the marginal price of attribute *k*, and λ^j is the Lagrange multiplier. From the first order conditions, it can be seen that the marginal rate of substitution between an attribute and the numeraire good is equal to the marginal price of the attribute,[24]

$$\frac{U_{z_k}}{U_{x},} = \frac{\partial p}{\partial z_k} = p_i \qquad \text{where } k = 1,\dots,m \qquad \text{(Eq. 2.10)}$$

Following this, a buyer's willingness-to-pay for alternative values of $(z_1,\dots,z_n)$ at a given utility index and income can be summarised as $\theta(z_1,\dots,z_n;U,Y)$; whereby θ_{z_k} is interpreted as the buyer's implicit marginal valuation of z_k at a given level of utility and income. At the market equilibrium, an increase in the buyer's bid (arising from a marginal increase in one of the attributes) must equal the increase in the market price of a land with similar differences in the same attribute i.e., the

[24] It is normally assumed that p_k is concave to reflect $z_{k.}$'s implicit price falling with increasing quantities of z_k . This corresponds with the concept of diminishing marginal utility i.e., a buyer's marginal willingness to pay for an additional unit of the attribute increases but at a decreasing rate. Admittedly, concavity and diminishing marginal utility cannot be generalised to all attributes of a good. Whether one is ultimately concave, convex or linear still very much depends on the attribute is being examined. More regarding the issue is discussed later in the section.

derivative of the hedonic price equation with respect to this attribute. Otherwise, the buyer could easily increase his profit by owning land with different attributes at the same price, causing market disequilibrium.

If buyer's characteristics are added to the bid function, the utility function will appear as

$$u^j = U^j\left(\mathbf{z}, \mathbf{x}, \alpha^j\right) \qquad \text{(Eq. 2.11)}$$

where α represents buyer *j*'s skills, risk tolerance, education level, age and other factors that differentiate him from other buyers. Thereafter, the estimated partial derivative of the utility function, obtained by regressing the marginal implicit prices of an attribute, *P*(z_k) on parcel attributes and buyer characteristics becomes

$$\theta^j_{z_k} = \frac{U_{z_k}(\mathbf{z}, Y^j - p(\mathbf{z}), \alpha^j)}{U_x(\mathbf{z}, Y^j - p(\mathbf{z}), \alpha^j)} \qquad \text{(Eq. 2.12)}$$

Likewise, θ_{z_k} is interpreted as the buyer's willingness-to-pay for (or marginal implicit value of) z_k at a given income, utility level and buyer characteristics. Since each individual's utility function depends on their vector of preference and personal characteristics and income levels, the bid function is different for each person; this proves that marginal attribute prices for a given attribute differ between buyers.

2.4.3 Seller's Offer Function

On the seller's side, the vector of attributes that matters can be divided into endogenous or man-made attributes, **z1,** and those that cannot be altered or produced, **z2**.[25] Say M^h**(z)** is a vector of output prices and β is a vector of non-land input prices. Under optimisation rules, seller *h*'s total cost function is represented by $C = C(M, \mathbf{z1}, \mathbf{z2}, \beta)$. By varying the endogenous attributes, **z1**, given the price function *p*(**z1**), sellers can maximise profits according to a profit function,

$$\pi^h = M^h p(\mathbf{z1}, \mathbf{z2}) - C(M, \mathbf{z1}, \mathbf{z2}, \beta), \quad \text{subject to } \pi \geq 0 \qquad \text{(Eq. 2.13)}$$

If the seller's characteristics including his access to credit, amount of other resources including experience, encapsulated in *γ*, are included in the function, then the seller's willingness-to-sell for alternative values of $(z_1, ..., z_n)$ can be written as

[25] In the context of agricultural land, **z1** are parcel attributes that are changeable by the seller e.g., parcel size, fencing, erosion control, infrastructure, and road access, while **z2** examples are soil depth, climate, elevation and location of the parcel.

$$\phi^h(z_1,...,z_n;\pi,\beta,\gamma)\,. \qquad \text{(Eq. 2.14)}$$

It follows that the marginal reservation price a seller has for z_k is

$$\phi^h_{z_k} = \frac{C_{z_i}\left(\mathbf{z1,z2},\pi,\beta,\gamma^h\right)}{M} > 0 \qquad \text{and} \qquad \phi_\pi = 1/M > 0 \qquad \text{(Eq. 2.15)}$$

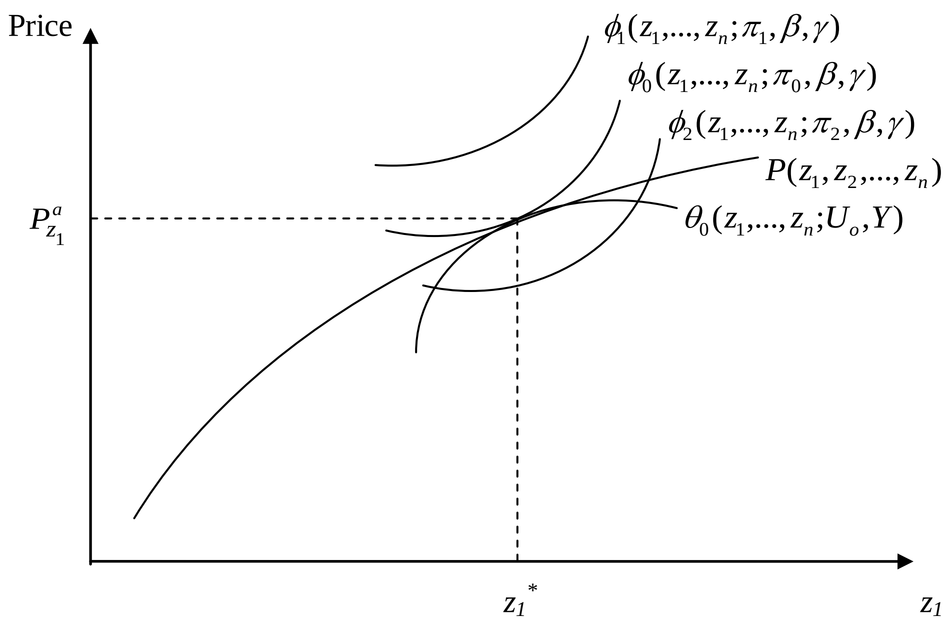
This offer-price function is also increasing in z_k. The partial derivative of the offer function with respect to **z1** is non-negative since it is equal to the marginal cost of that attribute. A seller maximises profit by equating the marginal offer price for the k^{th} endogenous attribute to its marginal cost in the market. In other words, the marginal revenue expected from additional unit of attribute k must equate the marginal cost of its production per unit sold.

The second derivative of the offer-price function equals to the slope of the marginal cost function at a profit-maximising equilibrium. A non-negative value or convex offer-price function implies that at higher levels of profit, the price offered by suppliers for an additional unit of the attribute is higher. Therefore, sellers maximise profit by equating marginal offer price for **z1** to marginal price in the market. On the other hand, it can be easily seen that for an attribute which is not alterable, **z2**, the marginal production costs is zero. Therefore, the offer price for the attribute should equal its market price, since a lower offer price means that the landowner is sacrificing profit, while a higher price will likely be rejected. Hence, **z2** price tends to be completely demand-determined.

2.4.4 Equilibrium Price Schedule

The quantity and implicit price of any specific attribute is derived from the tangent points between bid and offer functions for the attribute (refer to Figure 2.5, which originally appears in Rosen, 1974). The equilibrium price schedule, *P(z)* as it varies with changes in z_1, holding all other attributes constant, buyers' bid function, $\theta_0(z_1,...,z_n;U_o,Y)$ intersects with sellers' offer function, $\phi_0(z_1,...,z_n;\pi_0,\beta,\gamma)$, to give the equilibrium market price for attribute z_1 . The sellers' offer functions, $\phi_1(z_1,...,z_n;\pi_1,\beta,\gamma)$ represents a higher profit objective, while $\phi_2(z_1,...,z_n;\pi_2,\beta,\gamma)$ represents a lower profit objective. Note that the figure is drawn such that the total price paid for z_1 increases at a decreasing rate (this reflects diminishing marginal returns of the attributes). Price schedule changes to eliminate surplus demand or supply for the attribute brought about by shifts in demand or to a lesser extent, shifts in supply. Basically, the equilibrium price of an attribute will correspond to the minimum value of its average cost, *ceteris paribus*, and the point where the marginal value of the attribute equates the marginal cost of producing the attribute. It follows that if the supply of a good with given attributes is totally inelastic (meaning all of the good's attributes are exogenous), offer functions are not required and bid-price functions are sufficient to derive market equilibrium prices (Freeman, 1979).

Figure 2.5. The Hedonic price function



To sum, the hedonic price function is essentially an envelope of the equilibrium interactions between all buyers and sellers of a differentiated good, based on the interaction of bid and offer price functions for various quantities of individual attributes. The hedonic function adjusts to eliminate excess supply and demand for each specific bundle of attributes. However, because price difference generally equalises on the margin and on the average, identifying demand and supply for a good based on estimated hedonic price functions is not possible.[26] Rosen (p.54) wrote

> *In fact, those observations are described by a joint-envelope function and cannot by themselves identify the structure of consumer preferences and producer technologies that generate them.*

[26] For more about the demand and supply identification problem, please refer to Brown and Rosen's 1982 paper.

The market-clearing condition for each attribute in equilibrium is naturally restrictive. Cotteleer (2007) shows that excess surplus or excess demand situations can cause market disequilibrium which would in turn introduce measurement errors into the estimates of the bid and offer functions for each attribute. Additional problems include:

(i) lack of agreement about how buyer and seller characteristics should be itemised and measured; and

(ii) costs of obtaining information on buyers' and sellers' characteristics and personal relationships, information on output and input prices over time can only be obtained through survey or personal interview methods which are often prohibitive and very likely to suffer from poor response rates (see Palmquist 1989).

There have been several studies which attempt to estimate bid and offer prices of a specific attribute in question. Nevertheless, the estimation of the hedonic price estimation is critical to shed light on price determinants, and remains until today an important area of empirical research.

2.4.5 Empirical Literature Review

The HPM technique has been widely popular for studying markets for goods with differentiable qualities.[27] In urban economic studies, researchers use estimated marginal values of the apparent attributes or 'conditions' of developed properties to help predict prices of unsold comparable properties at a similar locations.[28] In real estate applications, house price is a function of its structural (e.g., number of rooms and bathrooms, size, age of house) and environmental (e.g., proximity to schools and social amenities, composition of neighbourhood) characteristics. Forecasting is easily done where there is a known and constant hedonic price schedule. The marginal benefit of a particular quality is measured by the increased price of a unit exhibiting the said quality over units without it. Similarly, if the additional quality is endogenous i.e., a result of owner's improvements on the land, the initial price would change to reflect the prices of other parcels with similar upgrading.

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[27] For a comprehensive summary of HPM applications in economics, please refer to Taylor (2003). We also benefit immensely from Taylor's excellent elucidation of HPM's important modeling issues, many of which are incorporated throughout the chapter's discussions.

[28] A comparable piece of land refers to undeveloped land displaying similar attributes to the parcels already developed and sold (refer to Can, 1992).

In agricultural economics, HPM is particularly useful to examine urbanisation effects arising from spatial proximity of agricultural parcels to urban boundaries. This branch of enquiry has its roots in the bid-rent model introduced in von Thünen's late eighteenth century paper. The model, in its simplest form, holds that the resulting equilibrium pattern of land-use can be described by concentric rings of residential development around an urban centre and decreasing residential density as distance from the urban centre increases, mostly due to higher transportation costs. The model has been extended in various ways to examine the effects of urban sprawl on agricultural land prices at urban-fringe areas. However, not all research in agricultural land studies automatically feature urbanisation as a major influence on price. HPM has been applied to empirically estimate a wide-variety of items including values of land from government-sponsored improvement programmes (such as irrigation and pollution control), climatic change, tax on land, soil quality, desirable landscape features (such as waterfront) and undesirable ones (such as view of slum areas, proximity to swine farm), among other things.

There are at least two important underlying assumptions relating to traditional or basic HPM that merit mention. First is the assumption of zero regulation on land-use. Secondly, HPM assumes that buyers and sellers have perfect information regarding parcel attributes, which naturally includes factors that are capable of influencing its productive capacity in both current (agricultural) and future use (development). The HPM approach quite unrealistically assumes prospective buyers are able to objectively value land by aggregating the value of all its attributes. Furthermore, as Elad *et al*. correctly point out, although land exists nationwide, the markets for land are often localised with only a relatively small percentage of land changing hands each year. Both scenarios point to a situation where land buyers and sellers are not likely to have perfect knowledge of either the parcel or the market. The more the information is disorganised, uncertain and/or unavailable, the more substantial the costs of information-gathering would be. Nevertheless, the usefulness of the hedonic modeling technique to estimate price lies in its convenient and flexible form, especially when the parcels involved are heterogeneous and are subject to varying external influences. Its popularity is evident in the vast number of studies and applications, including in the realm of policy assessment where many studies specifically measure welfare gains or losses corresponding to changes in one or more attributes of the good concerned. The method is well-accepted in agricultural land pricing analyses and this is shown by the extensive list of empirical work using HPM to estimate determinants of land price, as summarised in Table 2.1.[29]

[29] As mentioned earlier, the second-stage estimation requires additional data on individual buyers and sellers, input and output type and prices and so forth. Such studies are often undertaken using extensive questionnaires, either extracted from periodic institutional surveys, or as a one-off research effort.

Table 2.1. Summary of Literature on Hedonic Price studies on Agricultural Land

AUTHOR, YEAR	IMPORTANT VARIABLES	DATA	ESTIMATION TECHNIQUE
Hushak & Sadr (1979)	Parcel size, distance, transport access, real tax rate, distance and building value.	Sales data Ohio areas (stratified sampling)	Ordinary Least Squares
Chicoine (1981)	Distance, use of neighbouring plot, soil, existence of sewage, road frontage	Sales data U.S. 1970 – 1974	Ordinary Least Squares
Dunford, Marti & Mittlehammer (1985)	Distance, soil, roadfrontage, buyer's perception of current and future development rate.	Survey data Clark County, U.S. 1978	Generalised Least Squares
Pardew (1986)	Parcel size, distance to mountains, effective tax rates, sewage presence, land improvement	Survey data from Nevada 1977	Two-stage: 1. linear hedonic function 2. bid-offer functions
Shonkwiler Reynolds (1986)	Parcel size, distance to population centres, development potential	Sales data from Sarasota and Manatee 1973-1981;	Probit, Ordinary Least Square, Instrumental Variables method
Oltmans, Chicoine, & Scott (1988)	Parcel size, land improvement, soil productivity rating (*SPR*), distances measures, time dummy	Sales data Illinois, 1975 – 1984	Ordinary Least Squares
Palmquist & Danielson (1989)	Parcel size, soil quality, soil wetness, percent of cropland, presence of community housing, and good buildings	Survey data from North Carolina, 1979-1980	Ordinary Least Squares
King & Sinden (1994)	Parcel size, distance, soil, river frontage, buyers' characteristics	Survey data from Manilla shire, NSW	Ordinary Least Squares (four models)
Xu, Mittelhammer, & Barkley (1993)	Productivity, distance to market and improvements	Survey data 1980-1987, Washington State, U.S.	Ordinary Least Squares (accounting for truncation bias)
Elad, Clifton & Epperson (1994)	Parcel size, proportion of cropland, distance, reason for purchase, year of sale	Sales data from Georgia, 1986-1989	Ordinary Least Squares
Bockstael (1996)	Parcel size, public services, zoning, distance to population centre, percentage of various land-use in the area.	Sales data Patuxent River, U.S. 1990	1. OLS Hedonic developed land price 2. Probit analysis of conversion decision
Roka and Palmquist (1997)	Parcel size, crop-type, ownership-type, population density, farm yield, soil quality	Survey data from Corn Belt region, 1994- 1996	Ordinary Least Squares
Craig, Palmquist & Weiss (1998)	Canal and ocean indicator, percentage of improved land, population density, year of sale	Sales data from antebellum area, U.S. 1850, 1860	Ordinary Least Squares
Hardie, Narayan, Gardner (2001)	Per acre value of agricultural returns, expenses, median house price, distance	County-level pooled data from Mid-Atlantic U.S. 1982, 1987, 1992	Fixed effect model, Generalised Least Squares
Nickerson & Lynch (2001)	eligibility for government support, parcel size, percentage of prime soil, distance to nearest preserved parcel	Sales data, 1994-1997, Maryland	Ordinary Least Squares, Reduced form Probit equation

Table 2.1. Continued

AUTHOR, YEAR	IMPORTANT VARIABLES	DATA	ESTIMATION TECHNIQUE
Maddison (2000)	Parcel size, presence and types of structures, population density, climate changes, elevation, soil grade,location, distance to market	Sales data from England and Wales, 1994	Ordinary Least Squares
Bastian et. al (2002)	Productivity rating, diversity of use, improvement, distance to town, regional dummy	Appraisal data; 1989-1995; Wyoming	Ordinary Least Squares, Maximum Likelihood
Patton & McErlean, (2003)	Parcel size, distance to market, conacre rent, potential use	Sales data, Northern Ireland, 1996 -94	Ordinary Least Squares, Instrumental Variables,
Plantinga et al. (2004)	per acre value of agricultural return, change in population, travel time to two nearest metropolitan area	County-level cross section data New York county, 1997	GLS, spatial auto-correlation
Larkin et al. (2005)	Percentage of area already enrolled in a preservation programme, distance to nearest city, value of natural attributes, groundwater, natural resources.	Sale price in 65 land preservation programmes in Florida, 2000	Ordinary Least Squares
Towe, Nickerson & Bockstael (2005)	Distance to urban centre, amenities, development cost, use of neighbouring plot, agricultural returns, option to preserve	Sales data from Maryland, 1990.	Hazard model that track the parcels until they are converted to non-agricultural use.
Duvivier (2005)	Expected land rent, compensatory payment, population density, growth rate of residential land price, market size, parcel size	42 Belgian districts: panel data, 1980-2001	OLS, time random effects, tests for regional effect
Huang *et al.* (2006)	Parcel size, soil quality, land improvements, distance to urban centres, population density, income, inflation	County level Illinois time-series cross-section data 1979-1999	Ordinary Least Squares, Maximum Likelihood
Tsoodle, Golden & Featherstone (2006)	Parcel size, average annual rainfall, percentage of improved land, population density, average rental, average productivity	Sales data from Kansas, U.S. 1986 - 2000	Ordinary Least Squares
Isgin & Forster (2006)	Parcel size, distance, population growth, population density, locational dummies, potential use	Survey data Ohio U.S.	Ordinary Least Squares, Instrumental Variable
Bekkerman (2007)	Expected net farm income, rate of unemployment, average median income, median house values	County-level panel data, census years, U.S., 1978-02	Generalised Method of Moments
Cotteleer, Stobbe, van Kooten (2007)	Land preservation programme, fragmentation index, crop type, distance to urban and transport centres, GDP, interest rates, land elevation, parcel size	Sales data, Vancouver Island, 1974- 2002	Bayesian Model Averaging
Maddison (2008)	Parcel size, buildings, distance to city and towns, urban index	Sales data, 1994-1996, England and Wales	Spatial and temporal econometrics

It is apparent from the literature table above that there is a large number of possible explanatory variables in a hedonic price model for agricultural land - where many are actually proxies representing actual characteristics of interest. There are no theoretical arguments pointing towards a specific set of explanatory variables, allowing the researcher to choose variables that best suit his research objectives and the market he is studying, subject to data availability and quality. The approach to variable selection can be summarised as a mix of classical and Bayesian i.e., researchers draw on previous studies to select variables, and then calculate parameter estimates and t-values according to classical statistical standards (Andersson, 2000).[30] Hence one can find studies that enthusiastically embrace a large spectrum of factors to ensure better model fit; whilst in others, rigorous statistical tests are employed to filter variables for a simpler parsimonious model, albeit with lower goodness-of-fit. In addition, researchers typically prioritise the variables that support his research questions (e.g., if he is studying the effect of land restrictions on price), sometimes at the risk of overlooking other important determinants of price.

To illustrate the problem of variable selection, we list the various types of land values data used in the literature as the dependent variable:

- actual sales price;
- assessed value, obtained from tax valuation records;
- survey-based value and
- listing price.

Actual sales price is said to present smaller potential bias and greater potential precision than the rest. However, there are drawbacks to using actual sales values in a pricing model. Firstly, there is the possibility of error, omission and inconsistency in recording the transaction values and parcel details. Secondly, the researcher must arbitrarily establish the criteria of sales acceptable for inclusion into the regression sample. For instance, if a parcel is sold at a price that appears unreasonable or against competitive-market trends, should it be discarded? What then would constitute a

[30] The classical statistical method requires that the model specification is determined prior to estimation, and must be theoretically justified. Explanatory variables are not to be rejected because of any failure to attain a desired statistical significance. On the other hand, the Bayesian method allows one to use empirical results of previous studies in deriving its prior distribution. The posterior distribution is simply a weighted average of the prior distribution and the distribution arising from new observations added (Andersson 2000, p. 295)

reasonable or ‘fair’ value and what if the samples come from various places with distinct market characteristics? The use of actual transaction values no doubt requires that the researcher owns an in-depth knowledge of the local market; but this will be dependent on whether there is efficient dissemination of information coming from sufficient transaction volumes in the first place.

On the other hand, assessed and survey-based land values are considered susceptible to measurement error problems simply because they are obtained via opinions of market participants or observers. Because of the subjective nature of its formation, there is the possibility of a strong correlation between the land value and its explanatory variables which causes estimated implicit prices of attributes to be inefficient. Malpezzi (2003, for housing data) found mixed opinions regarding the merit of using self-reported values - variances for owner assessment are high, in some studies biases are modest, while others biases are substantial. The fourth type of land values data, listing prices, is basically the prices advertised in property classified section of local news sources. Essentially, they are asking prices for the land since the actual price agreed are usually lower that the amount advertised after negotiations are completed; and therefore may also include measurement errors with respect to actual market accepted value of the said land. Regardless of the merits or shortcomings of each data type, a researcher’s ultimate choice is often decided by accessibility, practicality (e.g., whether it can be obtained in electronic form) and consistency (i.e., having the same definition and recording method over time and space intended for the study) principles.

In respect to the explanatory variables, agricultural-centric attributes include parcel size, soil erosion rates, land quality, elevation levels, irrigation investment and potential, eligibility for government payments, climatic changes, distance to market for inputs and outputs. Non-agricultural factors include size of land parcels, distance to a ‘central business district’(Hushak and Sadr, 1979, Chicoine, 1981, Pardew, 1986, Shonkwiler and Reynolds, 19886, Bockstael, 1996, Shi, Phipps and Coyler, 1997, Hardie and Narayan, 2001); use of neighbouring plot (Chicoine, 1991, Shi, Phipps and Coyler, 1997); regulation and taxes (Bentick, 1979, Chicoine, 1981, Pardew, 1986, Capozza and Li, 2002); access to public amenities and level of infrastructure and so forth. Bockstael (1996) introduced variables that reflect spatial arrangement of economic activities around the parcel of land. She argued that spatial organisation of activities can ultimately impose a considerable and dramatic effect on land pricing behaviour. It follows that if development (including residential, industrial and commercial activities) is scattered within a larger agricultural region, the advantages of having farms located nearby to each other is somewhat eroded. This will go on to the extent that land values will rise and shift towards the highest and best use of the land.

More recent studies adopt a spatial perspective, amongst them Pace and Gilley (1997), Basu and Thibodeau (1998), Maddison (2002), Patton and McErlean (2004) and Cotteleer *et al*. (2007). In general, the writers are of the view that in addition to parcel's attributes, agents form their valuation of a land parcel on the basis of comparable parcels sold within the same area. The spatial dimension means that the final selling price of a given parcel most likely echoes the prevailing price of adjacent or neighbouring lands which are sold earlier or around the same time as the parcel. Vendeveer *et al.* (1998) used Geographical Information Systems in their data work and found both visual and empirical evidence of spatial autocorrelation in agricultural land prices. In extreme cases, the use of prevailing local price totally replaces an assessment of aggregate value of plot attributes. Ignoring this phenomenon will result in inefficient empirical estimations.

2.5 CONCLUSION

The chapter began by establishing the Ricardian model assumptions and market outcomes, in particular the notion of land price being market-determined rather than determining the market. Subsequently, assumptions of the model were revised to reflect another context where because of opportunity costs involved in using land, landowners seek to be compensated with higher prices for parting with additional units of their land. It is critical to distinguish between the supply facing the society (inelastic) and the supply curve facing the individual (elastic), because market equilibrium in the former is determined entirely by demand while in the latter, the equilibrium is determined by both demand and supply curves. The chapter also discussed factors leading to situations where (i) government intervenes to stabilise supply of land between competing uses through its land-use control and planning functions, (ii) transaction costs exists at various stages of land acquisition or use, and

(iii) conditions emerge which allow either buyers or sellers to accrue some degree of market power. Specifically, transaction costs in exchange and utilisation of land are deadweight losses to buyers and/or sellers, both in terms of time and funds. It slows down the process of land reallocation in the market as buyers and sellers sought to resolve various issues that can increase price of land over and above its NPV. To some extent, transaction costs can result in smaller amounts of land entering the market, as indicated by a downward shift in supply. Alternatively, demand curves for land shifts downwards as prospective buyers voluntarily or involuntarily withdraw from the market or sellers were willing to accept lower prices for their land. In either case, the market will equilibrate at a lower point i.e. lower price and lower quantity exchanged. Market power can emerge through imbalances in the number of suppliers and buyers or their characteristics. The effects of 'excess surplus' and 'excess demand' (Cotteleer, 2006) is evidenced by changing slopes of the relevant curves. For instance, in the presence of 'excess surplus' of land, demand for land can be expected to more elastic.

The chapter then reviewed the underlying principles of land valuation methods and how the supply and demand identification problem is resolved. Using the capital asset pricing methods, it should be possible to empirically estimate the determinants of land price over time. Value of land is essentially the sum of income generated by its use minus the cost of using the land and discounted to its present value. However, specific land-use, income and cost amounts and discount rates must be known and stay constant throughout the land's useful life i.e., assumptions that are untenable if land-uses are relatively variable. As will be revealed in the chapter on data, cross-sectional land values data are more easily available in some countries compared to a long time-series of economic variables and average land prices. Chapter 4 will continue with the data constraint issues introduced here and discuss how they led to the use of hedonic pricing model approach to estimate land price relationships for Malaysia.

The literature review sub-section 2.4.5 provided some glimpses of the complexity of model building in the hedonic pricing approach despite the extensive body of work already completed with respect to pricing agricultural land in western developed countries. Two particularly challenging aspects are how to model development uncertainty and spatial biases in the price function. Ultimately, the usefulness of a hedonic model fundamentally depends on the ability of the researcher to capture (and measure) pertinent attributes accurately. Over-specified or under-specified functions result in biased estimates and are therefore unreliable.[31] As a whole, the theoretical principles outlined in this chapter will be used to inform and frame our data search and empirical modeling processes. This will be supplemented by insights provided in the next chapter via a brief historical overview of the Malaysian economy and a critical examination of the effects of land-use policies, transaction costs and market imperfection on the Malaysian agricultural land market.

[31] This is due to increased standard errors and Type II errors.

CHAPTER 3
MALAYSIAN AGRICULTURAL LAND USE AND INSTITUTIONS

3.1 INTRODUCTION

As with many developing countries, Malaysia's land policy evolves dynamically to support her changing growth and equity goals. However, it is important to recognise external factors other than development demand which are able to influence the land market equilibrium. They include the three which were discussed in theoretical terms in Chapter 2 namely, state-enacted land-control instruments to fix supply to alternative uses, transaction costs in land dealings and market power to alter prices or supply. These factors are often regarded as indirect legacies of institutions introduced in the past; their enduring influences very apparent in the pattern of land-use and prices that we see today. The chapter will describe the important milestones in the country's land-use policy and how various categories of agriculturalists are formed. This will be followed by a critical analysis of formal and informal institutions which are instrumental in shaping the market for agricultural as it is today. In its entirety, the chapter should be useful in allowing us to map the right questions to explain agricultural land price while answering yet others such as why current policy measures, in particular those relating to agriculture, fail to effectively address the decline in agricultural production and hectarage.

The chapter is organised as follows. Section 2 will provide a brief but comprehensive overview of the political and economic changes that took place in Peninsular Malaysia with respect to agricultural growth and land use. This will include the introduction of the land titling system, agrarian reforms and effect of structural economic shift away from agriculture. Section 3 critically examines factors associated with land fragmentation, land abandonment, land control and agrian reform agencies. Finally, in Section 4, we conclude by providing a summary of points discussed and presenting a graph (following Evans in Chapter 2) to describe the Malaysian land market in a nutshell.

3.2 HISTORICAL OVERVIEW

Malaysia is a relatively small country with a total land area 329,750 square kilometres. Peninsular Malaysia, which is the geographical focus of the thesis, takes up less than half of the total land area at 132,090 square kilometres.[32] The area which is almost the size of England is home to about 27.8 million people. Malaysia is a federation of 9 former Malay states, 2 Straits Settlement states and 3 federal territories in the Peninsular and 2 states in the Borneo island. Hence it should not be surprising that Malaysia's land use pattern varies a great deal among the regions, as a result of the different socio-political history as well as the varying levels of investment, both domestic and foreign in each area. Out of the total land area in Peninsular Malaysia, an estimated 11.3 million hectares or 34.5 percent falls under Class I to Class III category of soils which are found suitable for agriculture. The country enjoys excellent weather for the cultivation of various tropical crops and grains; hence it is one of the world's largest producers of rubber and palm oil.

The section will trace a number of important milestones in Malaysia's history that directly or indirectly influenced the market for agricultural land. It will also reveal how dualism in the agricultural sector evolved. Today, private large-scaled plantations, whose modern approaches to production have helped to create the country's initial wealth base in the past, exist alongside the smallholders who form the majority of the agricultural population and traditionally make up the country's political base. The smallholder category can be further broken down to three different groups of farmers: (i) independent smallholders operating on their own land under low capital and low technology modes; (ii) land settlers operating on land owned by group settlement schemes; and (iii) farmers cultivating State land on short-term basis via renewable licenses. For this, the overview will take us back to pre-colonial Malay territories and end in modern Malaysia.

3.2.1 Malay States

The economy of the Malay Archipelago is historically more dependent on its trading activities than on agriculture by virtue of its strategic location in the Eastern spice market. The Malay customary land system is based on subsistence agriculture but

[32] http://en.wikipedia.org/wiki/Geography_of_Malaysia

there were simple but sufficient laws well in place to protect security of tenure and other aspects of land use, as described by various historical documents in particular the *Kanun Melaka*. Typically, land was appropriated to whomsoever willing to undertake the clearing and cultivation of land on a continuous basis i.e., “menghidupkan tanah” (give life to the land). It follows that an individual’s claim to land can be rescinded if he ceases to cultivate the land over an extended period of time, as the situation implies that he must then be in control of more land than he needs to support himself and his family. However, the system does allow the hiring of farm labour and share cropping, particularly during the harvest seasons.[33]

Major crops at the time were rice, either the wet or dry (or hilly) variety. Usually a tenth of the land’s yield, is paid to the territorial chiefs as tributary payments. Note that these payments were not designed as compensation for land use; rather to represent payment for protection and to symbolise their allegiance to the Chief or Ruler. The main source of income for the ruling class had always been tax on trade (or toll tax), profit from trading activities, revenue from mining or agricultural activities, instead of agricultural tax from land occupied by their subjects. There was no bond between the subjects and the Rulers on account of land per se in the way that is common in European history. The ‘Asiatic’ (Wan Hashim, 1988) decentralised form of government is unlike the European feudal system, in that the former’s ruling class accepted payments from peasants living on land under their control more to assert their political sovereignty than to assert their proprietorship over land, as described by Wan Hashim (1988, p. 52)

> *.. As land were plentiful, and the ruler and the district or territorial chiefs did not have powerful armies of the their own to keep the subject class (peasants) intact or tie them to the soil, dissatisfied peasants could always move on to another area to seek the protection of a more reasonable chief.*

The fluidity in the population means that a young family or a newcomer to the society has merely to ask the village head for land and he will be directed to abandoned land plots in the village or to the jungle fringe where he can carve out a new plot of land to start a new life in the community (see Yusuf, 1989). Land is not collectively owned, each household utilises separate plots of land to feed itself and

[33] According to the Canon Laws of Malacca, *Melaka Kanun*, cultivating land which belonged to others is allowed under certain conditions and produce-sharing arrangements (Sandhu and Whitley in Basir, 2005)

save some amount of surplus for bad weather. The notion of capital and surplus accumulation, in the form of land, is entirely alien to the society. Communal trust in society works in such a way to ensure that no one in the community would be landless and unable to feed themselves and their family.

3.2.2 British Malaya (1874 – 1957)

This period is particularly important because it represents a phase of transition from the traditional self-sustaining economy to a market-based one for land. By the late 19th century, all of the nine states in the then Malaya (except Penang, Malacca and Singapore which were already under direct British rule) eventually came under British political and administrative control through the Residential System (in Federated Malay States) and the Advisory System (in the unFederated Malay States).[34] Although a strong system of property rights were already in place in the traditional system, the British found the lack of well-defined land boundary system to be a serious issue. Land borders at the time used simple physical items for instance, a particularly large tree, a stream and so on. The British hence considered that a more European-based land system would be more effective in promoting the government's ability to regulate future ownership, control and use of land as well as to provide a steady and significant stream of revenue for the colonial government (especially in the form of land taxes). In order to make way for the proposed land reform, the British's concept of 'crown land' must first be wholly embraced by the states. It means that all land was declared as belonging to the respective Sultans and by default the then British-controlled State administrators.[35] Beginning in 1879, two types of leaseholds were introduced, leasehold in perpetuity and leasehold for a fixed period (initially not exceeding 999 years).[36] The land titling system named after Robert Torrens rests on the principle that rights to land were based on registration of titles - the owner of the land is established by virtue of his name being on the

[34]For this reason, one will find the Malayan land code is not a direct replication of the English property law, rather an amalgamation of various land legislations practiced by different states prior to the British-introduced land law.

[35] There was some amount of initial resistance to these new laws. Among those documented are those in Kelantan in 1915 and Trengganu in 1928 in opposition to what was perceived to be unjust laws that severely curtailed people's freedom and free access to land. More importantly, the new laws contravene the spirit of religion with respect to land – that land belong only to God, and men are merely its trustees.

[36] The first state to adopt the new system was Perak whereby the Sultan is proclaimed as the absolute owner of all state land with unlimited power of disposal (a concept now well-embedded in Malaysian modern land codes).

centrally kept land register. Rights to land were no longer founded on occupation and use, which means that the existing traditional land tenure systems became obsolete automatically.[37] Owners of small land parcels (mostly the Malay peasants) registered their lands at the local *Mukim* district offices, while owners or larger land units registered their holdings at the State's Land Registry office – the technical cut-off size of land being 40.47 hectares between the two levels of land registry.

In one swift stroke, land became a marketable commodity (via the land title document) with an exchange value that could be pegged to the market. Malaya's vast tracts of lowland tropical rainforest, particularly in the western coast states were alienated to Europeans and to a smaller extent, the Chinese investors to create company-managed plantations. Dun (1982, p.83-85), wrote in his 1952 thesis on Malaya's colonial economy wrote,

> *About 1890, (Sir Hugh Low, Perak's British Resident) later distributed these rubber seeds among the planters and at about the same time the governments of the Federated Malays states offered blocks of land of 1,000 acres apiece to planters who could introduce a permanent cultivation. By the turn of the century, the Malayan governments, in order to encourage capitalists to invest money in rubber, adopted a very liberal policy in regard to granting land for cultivation. It was provided that there would be no limit to the amount of land that could be held and that the land would be sold at a very low figure to encourage cultivation... There was to be no land taxation but all rights to minerals underneath the land were vested in the state…At the end of 1926 the total Malayan rubber-planting acreage was about 2,250,000 acres, more than half of the total world acreage.*[38]

Since the Malays only registered land that they were occupying for dwelling and peasant farming purposes at the time of the system's introduction, their land sizes were typically very small and the locations were very near to existing villages.

[37] Torrens title is a system of land title where a register of land holdings maintained by the State guarantees indefeasible title to the person(s) named in the register. Each parcel of land is identified by reference to a numbered deposited plan and is subject to a separate folio in the register. All subsequent transfers, easements and the creation and discharge of mortgages on land are recorded in the register. The system was able to sidestep the problems of uncertainty, complexity and high bureaucratic costs that would arise should the British land title system by adopted, mainly because it relies on proof of an unbroken chain of title back to a good root of title; something that lacking in the Malaysian circumstances. For more details, see http://en.wikipedia.org/wiki/Torrens_title and The Malaysian Torrens System, Salleh (2001).

[38] Malaya's lucrative run in rubber production was severely interrupted when the U.S. economic depression in the 1930's reduced demand for rubber for her U.S. automobile industry. By then, the Malayan rubber industry had been over-invested thanks to generous government policies and high world prices before the period. To prevent major losses to their investment, new uses for rubber were sought. The British also attempted to lobby producing countries into agreeing to voluntary curtailment of production, but the effort failed due to various reasons (Dun, 1982).

Interestingly, the native Malays were not initially interested in the 'new' crops as they were neither used to nor receptive to the idea of working as wage labourers in foreign-owned farms. Therefore, to resolve shortages of labour in the rubber industry which was (and still is today) very labour-intensive, the British brought in workers mainly from Southern India.[39] The British administrators saw little need to integrate the immigrant communities with the Malays, whom they left relatively undisturbed in their own economic environment. Consequently, the Malay peasant agricultural economy did not appear to have undergone much expansion beyond the existing village settlements, or beyond its traditional crops and methods of production. A number of the Malay agriculturalists later ventured into private small-scale rubber planting on their land, particularly in Johor (Basir, 2005). However, the land policies of the time were structured to encourage maximum return from prime agricultural land. For example, according to the law, tracts of land with road frontage cannot be subdivided. This indirectly prevented the capital-poor Malay rubber planters from acquiring lands with good accessibility to the market.

By the middle of the 19th century, the Malayan colonial economy was overwhelmingly private sector-driven and dependent on exports of rubber and tin (refer to Table 3.1). Rubber alone contributed to 60% of Malaya's export earnings in 1956.

Table 3.1: Exports by Commodity for Federation of Malaya 1956

Commodity	Value (RM million)	Percentage
Food, Beverages and Tobacco	99.5	4.4
Coconut and Copra	59.4	2.6
Crude Palm Oil and Kernel	48.5	2.1
Rubber (all types)	1,378.1	60.1
Timber	32.1	1.4
Tin (all types)	471.7	20.8
Iron Ore	51	2.2
Other Commodities	123.7	5,5
Total	2,264	100

Source : Annual Report, 1957 from Dun (1982)

However, the British had long been acutely aware of the importance of rice cultivation to supply local (Malay) and immigrant (Chinese and Indian) communities

[39] Southern Indians were initially brought in as indentured workers. Later, better migration incentives and administration were introduced, including the setting up of Tamil Immigration Fund. These measures encouraged greater influx of migrants to meet higher demand for rubber plantation workers (Basir, 2005).

with their staple food. Malay rice farmers, whose numbers are falling as many shifted to rubber-planting, typically operated small units of holdings averaging 2.5 acres, which might be sufficient to cover his own needs and rental (if its share-cropping land) but not much else. To encourage higher supply, the British administrators recommended that large tracts of land suitable for rice to be offered to Chinese capitalists. However, Malay rulers objected on the grounds that because rice cultivation was the only economic activity Malays were dominant in at the time, the sector should not be opened to others until they are able to reasonably compete in other economic realms. The availability of cheap foreign supplies of rice was distressing local farmers' profit margins anyway, hence non-Malays were not interested in the sector either. Dun wrote (1982 p. 162),

> *As late as 1949, Malaya became the second-largest rice importing country in Asia second only to India, and importing more than as much as China did in the same year...*

It is hardly surprising that Malay poverty was worst in the rice sector. By the 1950s, the government introduced a Guaranteed Minimum Price (for rice) and irrigation projects for rice sector, as well as credit cooperatives to solve general farmers credit woes, as well as a Colonial Welfare and Development Fund to promote capitalism in Malay peasant economy through technical and capital support (Dun, 1982).[40]

Another notable development during the period was the establishment of "New Villages". After the Second World War, in order to cut off the Chinese squatter community's interaction with communist guerrillas,[41] the British believed it was necessary to re-settle them in newly established higher-security communes away

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[40] Other interesting readings on the development of agricultural dualism in Malaysia are H.C. Chai, (1964) "The Development of British Malaya, 1896-1909", Oxford University Press; T.H Silcock, (1961) "The economy of Malaya: Relevance of the Competitive Laissez-Faire Model, in C.B. Hoover (ed.) "The Economic Systems of the Commonwealth", Durham U.S.A. and T.H. Silcock,(ed) (1961) readings in Malayan Economics, Easter University Press Ltd, Singapore

[41] The First and Second World War caused a great number of the Malayan Chinese to be unemployed because of disruption of trade and the termination of new projects on newly-opened estates. The displaced would later form small farming settlements at jungle-fringes on state-owned lands. After the wars, some reverted to their former occupations or found new jobs in the mining or commercial industry. Basically, Chinese squatters have moved in and out of farming as circumstances forced them to. After the Second World War, these Chinese agricultural communities were easy targets for communists to obtain information, fresh food supplies and recruits. Due to the increasing threat posed by the communist Malayan People's Anti-Japanese Army on British interests in Malaya, a state of emergency was declared in the summer of 1948, which then set in motion the establishment of New Villages. The Malayan Emergency state was finally lifted in 1960.

from the jungle fringes. To induce the squatters to relocate, the "new villages" where they were resettled were provided with infrastructure, electricity and clean water, schools and community centres and so forth. They were also offered a form of short-term land tenure called "Temporary Occupational License" (TOL) on surrounding land plots, to enable them to be self-sufficient in food production.[42] The license eventually became an important instrument of land management for the State to meet people's short-term needs for land.

To summarise, the British rule brought with it major land reforms in the then Malaya. The land titling and TOL system allowed for more efficient land control and taxation system. More importantly, the system was able to encourage large capital investment in agriculture and commercial infrastructure which later provided the young independent country the necessary foundation for further economic growth and diversification.

3.2.3 Independence and Agrarian Reforms

By the time Malaya achieved her independence in 1957, it became quite obvious that the spill-over effects from the prosperous export sector were not well-spread out. Development had been mostly centred in the rubber plantations, tin mines and urban areas while the traditional, more labour-intensive, small-scale rice, coconut and fishing sectors remained backward. Malays continued to form the poorest section of the population, but at the same time were the most politically vocal. Table 3.2 shows that between 1950 and 1955, public allocation for social services (RM80,000) was only around one tenth of the financial support allocated to strengthen infrastructure and export-based agriculture (totalling RM746,000). Social services involved education, housing, welfare and village development. However, in the following five-year plan, social expenditure allocation increased by more than one and a half times to RM213,000. This plan's period corresponded with the time when the government's anti-communist campaign was at its peak and many New Villages were established across the country.

[42] Bruce Ross-Larson (1978) argued that "although the curfews and fences erected to curtail movement were to disappear after a few years, this pattern of residence was to continue, whereas (before) most Chinese had not been urban dwellers, the Chinese suddenly became almost exclusively urban". However, this statement could be an over-generalisation, since not all Chinese new villages progressed into urban areas. The level of poverty among the new villagers is still notably high in many areas.

Around the same time, the Malay rural population continued to be characterised by uneconomic farming units and low agricultural returns. Additionally, many of the farmers were working on lands they did not own (Aziz, 1964 and others). The 1960 Agricultural Census shows that 59 percent of all farms were less than 4 acres, while over 90 percent were less than 10 acres. In the rice sub sector, 54 percent were less than 2.75 acres while 97 percent were less than 10 acres,[43] and over 80 percent of the rice farms were not owned by cultivators. Apart from the small farm size, lack of fertiliser and pest control measures as well as the weather risks resulted in very marginal returns and hence little capital-accumulation possibilities.

Table 3.2: Changes in Sectoral Allocation of Public Expenditure in Malaysia's Five-year Plans (in nominal RM'000)

Five Year Plans	1MaP	2MaP	3MaP	1MP	2MP	3MP	4MP	5MP	6MP	7MP	8MP
Period	1950-1955	1956-1960	1961-1965	1966-1970	1971-1975	1976-1980[a]	1981-1985[a]	1986-1990[a]	1991-1995[a,b]	1996-2000	2001-2005
Economic											
Agriculture	189	265	543	1,087	2,370	6,488	7,992	7,427	9,019	5,460	7,860
Infrastructure	577	513	906	1,539	3,373	7,739	10,278	8,208	10,832	15,730	21,965
Industry	-na-	16	27	85	1,608	4,256	6,595	3,981	5,752	5,864	10,295
Others											
Social	**80**	**213**	**491**	**975**	**1,431**	**5,495**	**10,340**	**9,046**	**13,468**	**19,803**	**37,518**
Defence	-na-	141	81	126	370	862	7,742	2,955	8,408	9,188	10,750
Administration	-na-	-na-	93	739	1,105	6,309	839	1,241	1,888	4,803	11,217

Source: Malaysia Plan document, various issues. MaP = Malaya Plan; MP = Malaysia Plan
(a) Public expenditure in the agricultural sector now includes rural agricultural development
(b) The government ceased to finance new land resettlement schemes after this period

The young government was fully committed to balanced development and correcting gross income inequality. State intervention came most notably in a series of agrarian reform measures in the 1960s and 1970s. The reform was implemented in stages according to the country's five-year economic plans.[44] Sukor Kassim (1984) summarised the economic strategies as follows:

[43] The thesis does not delve into the debate whether size of farm affects efficiency levels. However, even if we assume that smallholders are more efficient, questions remain whether the yield would be adequate to keep the household free of debt, given the low-level technology, threat of pests and plant disease, unpredictable rain as well the farmer's dependence on middlemen for other financial needs.

[44] Malaya changed her name in 1963, when Sabah and Sarawak, the two states located in Borneo Island and Singapore joined the federation. Singapore left Malaysia in 1965.

(i) intensification: *in situ* development to enhance productivity of existing small landholdings through the application of new technology, improved planting materials, fertilisers, replanting support, better drainage and irrigation, and pest and disease control.

(ii) extensification: opening new land settlements to extend the area of land in production by bringing new land under cultivation.

(iii) diversification: increasing the range of products produced through the introduction of wider cultivation of new crops such as oil palm and cocoa, or by increasing the value added to processing before export thus increasing the opportunities for rural wage employment.[45]

Forms of government's direct support are until today limited to (i) subsidies to purchase fertilisers and seeds, productivity incentives for rice, and (ii) replanting grants for rubber. To raise living standards of the rural population, considerable expenditure on developing physical infrastructure and social amenities were made, as reflected in the social expenditure row in Table 3.2; expenditure in the First Malaysia Plan doubled from the previous period and continued to increase thereafter. The first two agrarian strategies basically created a new class of agriculturalists i.e. organised smallholders (as opposed to independent smallholders) with the ultimate aim to realise economies of scale in terms of production, mechanisation, management and marketing. The two are given special attention in the following sections due to their significant effects on land use and ownership.

3.2.3.1 *In situ* development

According to the Second Malaysian Plan document, the number of smallholders in the country was approximately 750,000 with half of them Malay; and 90 percent of all smallholders held less than 10 acres of land (see Wan Hashim, 1988). With volatile prices, low technology and uneconomic land sizes, the smallholders sector were at the time in dire need of restructuring and support. Two of the institutions set up to facilitate massive transformation of the smallholders sector, namely the Federal Land Consolidation and Rehabilitation Authority (FELCRA) and the Rubber Industry Smallholders Development Authority (RISDA). The former, established in

[45] By 1970, the agricultural diversification initiative was well on its way as timber and oil palm emerged as increasingly important export commodities.

1966, is tasked to salvage and rehabilitate derelict land schemes, and small holdings; while the latter, established in 1973, is responsible to rehabilitate and consolidate small parcels of land into more economic-sized holdings, in addition to providing agricultural extension services to participating smallholders. To encourage rubber smallholders to replant their aging and therefore low-yielding trees, special grants were distributed based on the number of hectares involved. The grants are to fund tree re-planting costs and support the farmers through the period before the trees mature, which is on average 7 years. Additionally, participants are given income if they participate in farm maintenance and work activities (although today many do not because of age and location factors). In return for the income as well as managerial and marketing support received, participants must comply with restrictions regarding land-use and output sales outlet.

The Third Malaysian Plan (1976-1980) saw the introduction of a more comprehensive approach to *in situ* development to provide "an integrated setting for rural urbanisation into the designated areas". Six "Integrated Agricultural Development Projects" (IADPs) for both new and *in situ* land were implemented in Muda[46] (MADA), Kemubu (KADA), Kedah (KEDA), South Kelantan (KESEDAR), Middle Trangganu (KETENGAH), Southeast Pahang (DARA), Southeast Johor (KEJORA) and Jengka; involving a total of 923,565 hectares, of which only 52 percent is cropland. Of the cropland, almost 42% are planted with rice.[47] The projects have been fairly successful in infusing capital and technology into the traditional sector. The rural population was given educational and commercial opportunities on a much higher scale, with the aim of promoting non-agricultural income opportunities.

3.2.3.2 New land settlement

The second set of agrarian reforms involves the creation of new land settlement projects basically aimed to reduce population pressure on existing land resources, remove the hardcore poor (the landless and the underemployed) to more economic-sized farms elsewhere. The move created a new class of landowners in which land is

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46 The MUDA scheme covers large rice areas in Perlis, Kedah and Kelantan. The scheme made possible the irrigation of about 237,000 acres of traditionally rain-fed rice land, enabling double cropping of rice in a single year.

47 For more details, refer to http://www.moa.gov.my/web/guest/industri_padi_beras

operated similar to private plantation companies but proprietorship belongs to smallholders. There were various types of land settlement schemes operated by state and federal agencies which is essentially agrarian institutional ownership of agricultural land (as opposed to private ownership), one that is prominent and still active is run by the Federal Land Development Authority (FELDA). FELDA was set up in 1956 as one of the agencies entrusted to deliver economic promises made by the pro-independence party in 1955. The schemes require that states allocate large blocks of virgin land to FELDA, although the schemes were largely funded through Federal budget allocations. The first scheme took off in 1957. Generally, settlers were given a suitable social and physical environment for them to live in and work in the forms of communes. Land is cleared and prepared for planting by government contractors before the settlers move in to work.[48] Production processing facilities, managerial and technical assistance were established in a way to encourage modern agricultural practices. In the pioneering schemes, each settler was assured that once all payments to FELDA were made (through monthly deductions from his farm revenue over a period of 15 years), land where his farm and house are located will be registered under his name. However, the land title comes with several restrictions –it cannot be subdivided, sublet or mortgaged. For schemes launched after January 1978, the settlers were promised individual titles to the land for his house but not the farm. Instead, they were made 'collective' owners of the scheme's cultivated land in a cooperative farm system. Participants in the newer schemes (launched after 1985) are rewarded with 'shares' of the farm assets through the FELDA Investment Cooperatives (FIC). The shares, which are non-transferable, would entitle the participant to dividends and bonuses in place of rents, based on the portion of the land that he would acquire otherwise (approximately 10 to 15 acres per settler as in the pioneering FELDA schemes). Additionally, the ownership of scheme-built house and the surrounding orchard land is no longer automatic but offered as an option to be included in the contract.

Basically, by opening up land settlement schemes on virgin state lands, the government was able to steer clear of probable political unrest and court proceedings that usually follow government land takings. Today there are more than 300 FELDA

[48] In earlier schemes, settlers have to clear the land themselves.

land schemes in Peninsula Malaysia alone. Overall, the FELDA land settlement models have made a remarkable contribution in increasing agricultural land hectarage in the country, as demonstrated by Table 3.3, and is widely acknowledged as one of the most successful agrarian reform models in the developing world in addressing problems of spatial imbalances of population distribution, landlessness and unemployment.

Table 3.3 Size of New Land Settlement Schemes in Peninsular Malaysia according to various Malaysia Plans (in hectares)

	2MP (1971-1975)	3MP (1976-1980)	4MP (1981-1985)	5MP (1986-1990)	6MP (1991-1995)
FELDA	149,482	24,223	161,600	175,745	14,930[c]
Others Agencies [a]	95,134	142,701	198,870	160,000[b]	97,000[c]
Private plantations and semi-public entities	48,018	72,028	57,100	17,551	123,090

Source: Malaysia Plan document, various issues

(a) Includes group planting schemes on new land managed by FELDA and RISDA

(b) Figure include land development undertaken by Sarawak Land Development Authority

(c) Beginning with the 6MP, FELDA has ceased the opening of new land schemes.

Nonetheless, because of the high costs involved in the preparation of virgin jungle land for modern large-scale farming, the scheme cannot be easily replicated and sustained in the long run. As the population grow, the model can no longer be relied on to solve poverty arising from land-deficit. There is already tremendous strain on available land resource, public funds and manpower to run existing schemes. If increasingly marginal lands are used, the cost of preparing and improving the land will be higher. Furthermore, as other demands for land grew, the States are growing hesitant to release land for agricultural settlement purposes. It is also apparent that land-to-farmer ratio is still high in smaller states. In allocating land for these schemes, the states normally insist that at least half of the settlers must come from the local population. Since Pahang and Johor are land-rich states with large and numerous schemes, a disproportionate number of FELDA settlers originates from these two states; while the landless from more densely populated but small states such as Selangor are relatively disadvantaged. Due to various problems and constraints, the government stopped opening new FELDA schemes by the Sixth Malaysian Plan (6MP). This decision coincided with the government's goal to promote economic diversification which included non-agriculture-related poverty eradication measures.

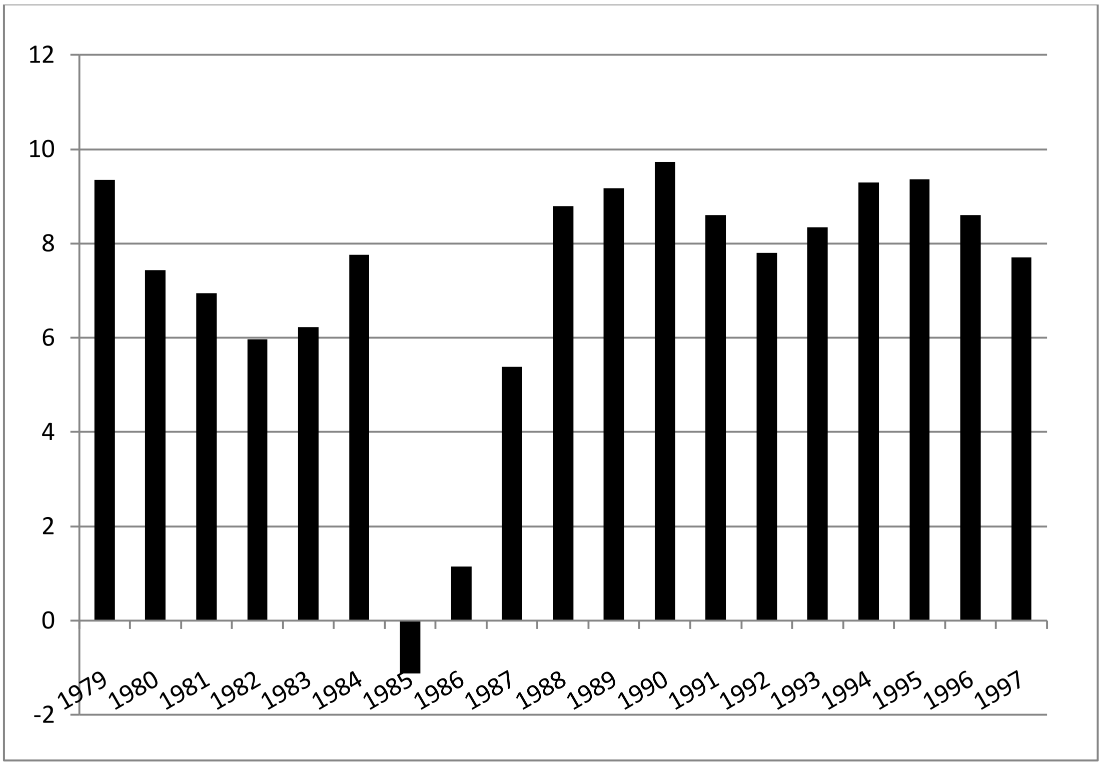
Up to this point, the chapter has shown how the four classes of agriculturalists emerge and the institutional constraints they are bound to. The following section will discuss important milestones and institutions associated with structural changes in the economy and its impact on agricultural land and the agricultural sector.

3.2.4 Economic Structural Transformation of the 80's and 90's

The need to look for other sources of economic growth became most pronounced in the early 1980s as prices of main export commodities dived dramatically. The fiscal stimulation programmes introduced were not sufficient to cushion the impact of the slump in rubber and palm oil markets on the agricultural sector. The markets' continued sluggishness was blamed on the prevailing oversupply conditions then (from over-investment in the commodities' production during periods of high prices the decade earlier). Better inventory management and farm productivity also contributed to the problem of excess stock (Thong, 1987). At the same time, newer and cheaper supply emerged in the form of Thailand and Indonesia, for rubber and palm oil, respectively.

On the domestic front, public sector spending was relatively high due to counter-cyclical initiatives taken after the first oil shock of 1979. Since national five-year plans were devised partly based on a projection of public revenues to be received in the planned period, substantial drops in export revenues could substantially compromise the plans' implementations. Hence, the government was forced to look for other sources of revenue, including by borrowing extensively from international agencies and countries. By mid 80's, the Malaysian economy quickly found itself in a 'twin deficit' position with respect to the budget and balance of payments, as well as registering negative GDP growth (see Figure 3.1). Clearly, a new and reliable engine of growth was desired to complement income from the agricultural sector.

Figure 3.1 Real GDP growth in percentages (1978=100)



Source: Department of Statistics, Malaysia

Economic diversification policies were soon undertaken in earnest. Public sector expenditures, including for agriculture, were rolled back to give way to promoting more private sector-led growth. An industrial development programme was duly launched, initially aimed at promoting import-substitution economic activities as well as agricultural commodities' downstream industries. Various policies and incentives included in successive Industrial Master Plans were specifically tailored to reduce the cost of adjustment and time lag for the country's resources to be transferred, particularly land and labour, from agriculture to newer sectors especially manufacturing and heavy industries. Public expenditure to promote industrial and commercial activities rose by more than four times from the 1971-75 period compared to the 1981-85 period (see Table 3.2 earlier). High quality infrastructure is made available to ensure better commercial linkages between existing urban centres in Selangor and Penang and the emerging cities and industrial hubs, mainly in the west coast of the Peninsular. The construction of the 966 km North-South Expressways which connects all eight states in the west coast of the Peninsular was completed in stages between 1982 and 1994, and was a particularly significant example.

The economic transformation strategies paid off handsomely in the form of high growth rates in the period between 1987 and 1997 (see Figure 3.1), just before the Asian financial crisis. Malaysia also benefited immensely from its strategic location in the middle of the dynamic Asia-Pacific region to emerge as one of the region's Newly Industrialised Economies (NIEs). Malaysia's competitive labour and land resources as well as attractive fiscal incentives were successful in attracting large amounts of foreign direct investment, particularly into the manufacturing of electrical and electronic goods, which were very labour-intensive. The transformation from an agricultural-based economy to one that is industrial-based took place at a greater speed than the North American and European experience – allowing very little time for its agricultural sector, particularly the small agriculturalists, to adjust and maintain their place in the overall economy. Attention to agriculture faltered at almost all political, commercial and individual levels. Kamal Salih (1990) is among those who wrote about the near stagnation of agriculture, especially traditional agriculture, since 1980 by linking it to the "Booming Sector Syndrome".[49]

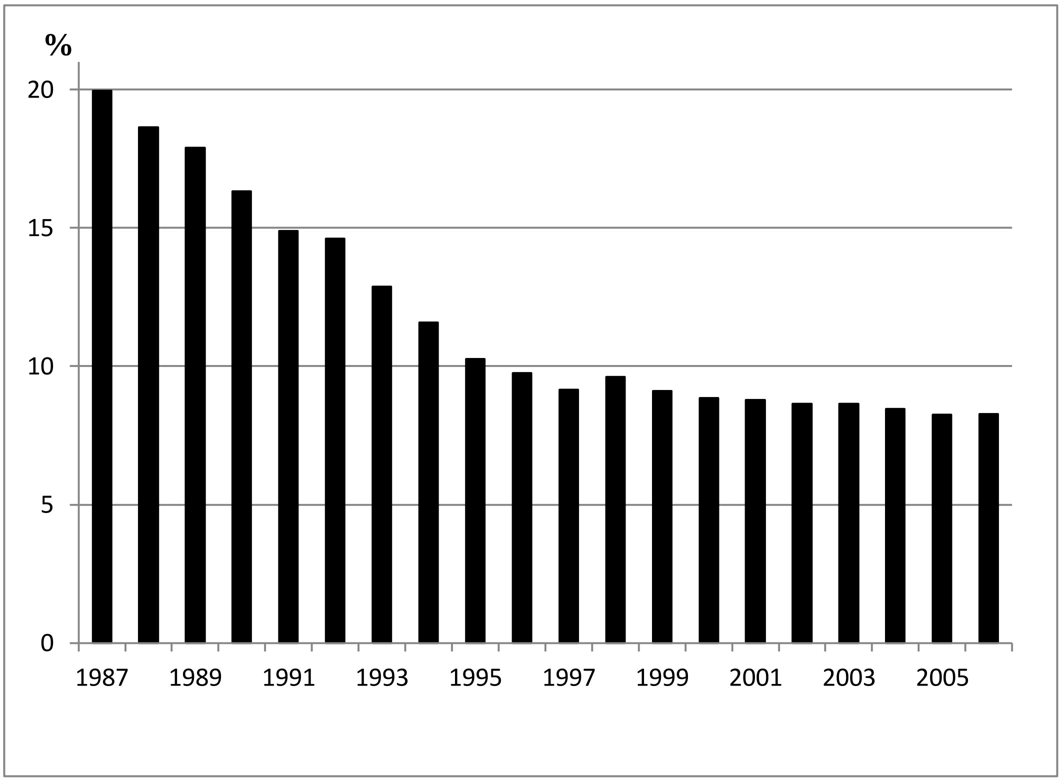
Because of adverse commodity market conditions and manpower and technological deficiency, the income from agriculture was unable to grow at a parallel rate as manufacturing (see Figure 3.2). The first and the second National Agricultural Policy (NAP)[50] which were drafted to promote modernisation and commercialisation of smallholder sub-sectors had appeared to grossly underestimate small farmers' ability to adjust to the rapid changes occurring within and outside their communities. The government also admitted to "leakages in the delivery of (agricultural) support programmes" (Sixth Malaysian Plan 1991:p. 104). By 1995, contribution of agriculture to GDP fell to half the level it was in 1987. Land also lost some of its importance as an investment instrument for the individual as the new economy

[49] The Booming Sector Syndrome refers to a situation where non-agricultural sectors such as oil and gas production, manufacturing, construction, timber having relatively prospered, diverted a large proportion of the available investment in capital, young, high quality manpower and land from agriculture.

[50] The first NAP ran from 1984 to 1990 while the second NAP should cover the period between 1991 and 2000. In the wake of the Asian currency crisis, a third NAP (1998 – 2010) was put together to immediately address past weaknesses or gaps in policy and delivery system formulated in the previous NAP's.

brings forth a wider and more attractive array of investment opportunities to suit both hedging and capital growth requirements. New educational and employment opportunities that had been limited in the past considerably reduced interest in farm work, causing critical labour shortages for the farms. Table 3.4 shows that labour force engaged in agricultural, hunting and forestry activities almost halved within a span of ten years between the period 1987 to 1997 (from 28.6% to 16.9%).

Figure 3.2 Agriculture, Hunting and Forestry as a Contribution to GDP (%)



Source: Department of Statistics, Malaysia

Table 3.4 Agricultural Workers as a Percentage of the Malaysian Labour Force

Year	1982	1987	1992	1997	2002	2007
Total Labour Force	5431	6457	7319	8784	9886	10889
Employment in Agriculture, Hunting and Forestry	1636	1846	1536	1481	1317	1437
Percentage	30.1	28.6	21.0	16.9	13.3	13.2

Source: Department of Statistics, Malaysia

The period of structural transformation in the 80's and 90's saw exponential growth in non-agricultural demand for land. Non-agricultural companies began to acquire large land stocks purely for capital gains and inflation hedging purposes; whilst more applications were made to convert agricultural land to commercial, residential or industrial lands. The seemingly unrelenting trend and the uncoordinated way agricultural land were approved for conversion brought far-reaching consequences on remaining agricultural interests. Interest in food production was already weak both as far as the farmer and the government is concerned. In the 3rd Malaysian Plan (1975-1980) document, the Federal government declared that they were ready to increase imports of rice if world prices continue to be lower than domestic prices.[51] By 1993, the self-sufficiency target for rice was down to 65 percent as the sector grapple with a declining supply of agricultural manpower and land resources. Figure 3.3 shows that the total rice planted area (from granary and non-granary areas) fell slightly in the early 80's then returned to previous levels but continued to stay constant despite increasing demands for rice from a growing population. The rate of land expansion for the cultivation of food crops continued to lag far behind that of export crops (compare Figures 3.3 and 3.4 for rice and oil palm hectarage growth respectively). Higher demands for food from urban population growth did not translate into higher demands for local produce as expected mainly because: (i) food demands were met by cheap foreign imports, as in the case of rice and; (ii) the urban diet which was increasingly leaning towards foreign fads and cuisines which did not really involve local produce.

Figure 3.5 shows that total land cultivated with rubber reached its peak in the second half of the 60's and has steadily fallen ever since. The decline is due to the combined effects of weaker prices (driven down by competition and synthetic substitutes), shift to other agricultural use particularly oil palm cultivation, conversions to development use and high cost of labour. Figure 3.5 shows that smallholders' hectarage increased dramatically in the 60's and 70's as land settlements schemes emerged and rubber was the preferred crop for the schemes. However, by the end of the decade, a large proportion of the trees would have reached their productive expiration. Smallholders are generally unable to bear the high costs of replanting or switching to oil palm whereas the plantations had been able to respond much quicker and more efficiently to market changes by virtue of their superior capital position and strategic management ability.

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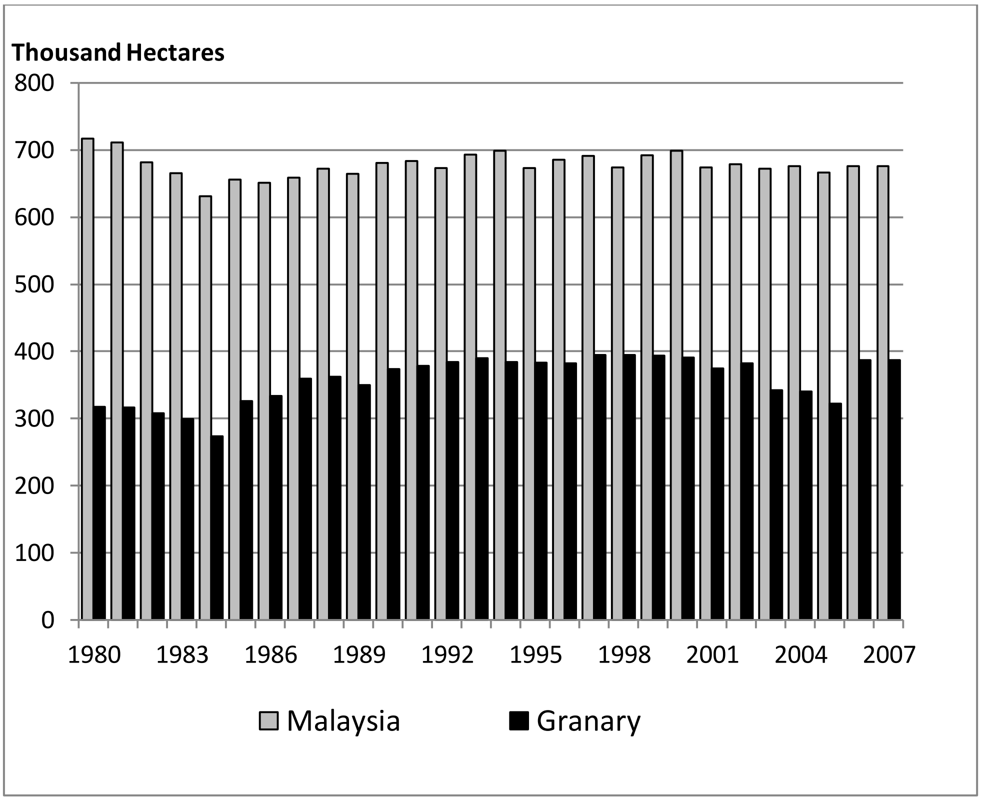
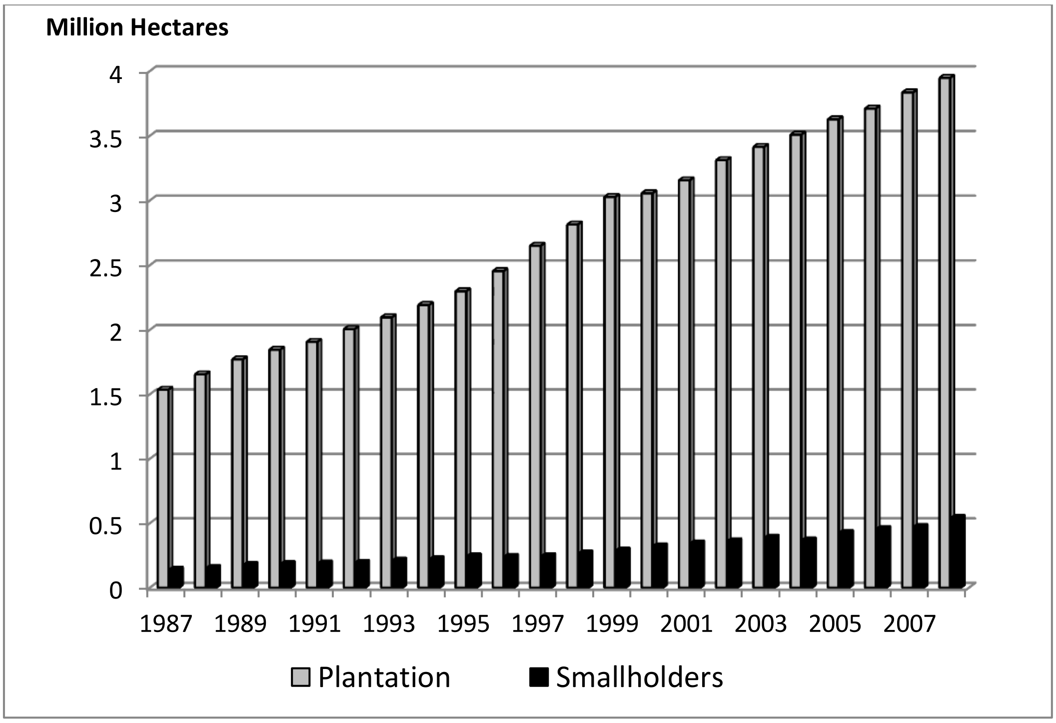
[51]There are presently eight granary areas – five in the west coast, two in the east coast of the Peninsular and one in East Malaysia. Granary areas are basically agricultural areas which have received agricultural infrastructure that was aimed to improve rice production yields.

Figure 3.3 Rice Hectarage in Granary Areas compared to Malaysia's Total



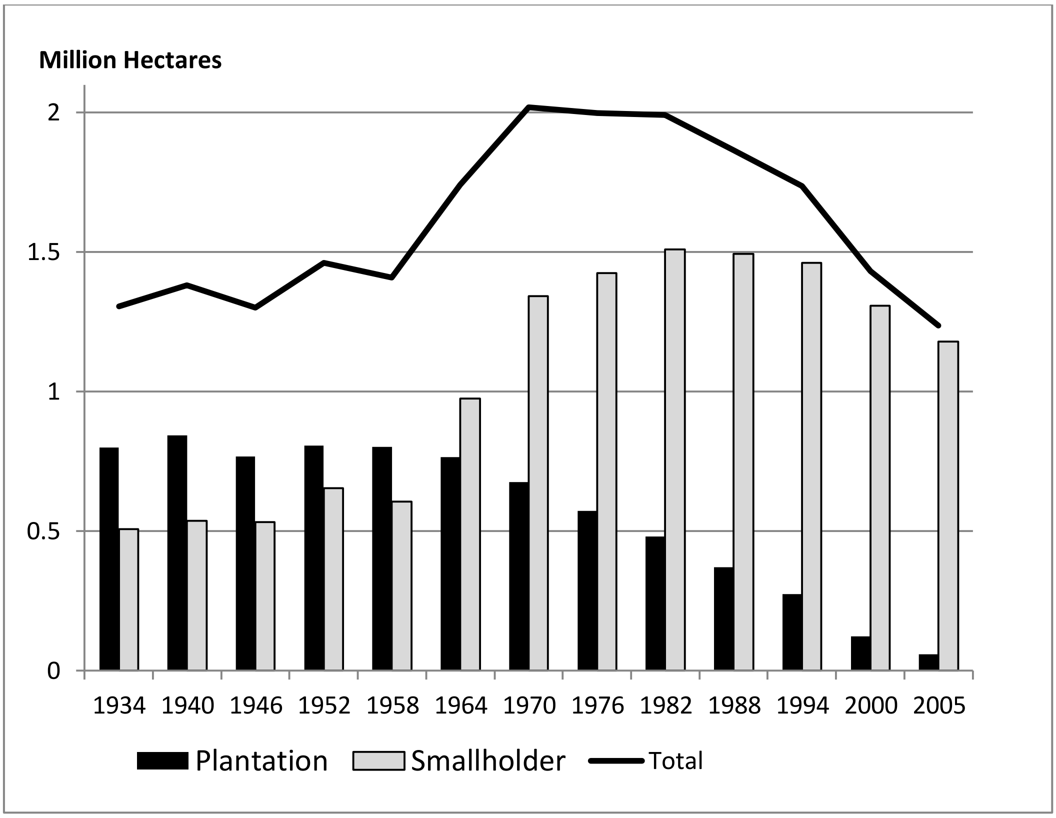
Source: Department of Statistics, Malaysia

Figure 3.4 Oil Palm Hectarage by type of Agriculturalist (1987 - 2008)



Source: Department of Statistics, Malaysia

Figure 3.5 Rubber Hectarage by type of Agriculturalist (1934 – 2006)



Source: Department of Statistics, Malaysia

3.2.5 Asian Financial Crisis and Beyond

The economy's industrial growth momentum was rudely interrupted by the East Asian currency crisis which began in mid-1997. At about the same time, there were also adverse market impact from the Severe Acute Respiratory (SARS) outbreak and the Iraqi crisis. Nevertheless, the ringgit's depreciation proved to be a blessing to Malaysian export sectors (including rubber and palm oil companies) because international prices of Malaysian exports became more competitive relative to other international producers outside South East Asia. The excess liquidity from the higher volume of sales was translated into more land acquisitions as plantation companies expanded their land banks in a weak land market.

Conversely, individual consumers struggled with the dire consequences of the crisis in the forms of higher food import prices and insufficient domestic supply. In 1997, Malaysia's food import bill was as high as RM9 billion (GDP was approximately

RM19 billion) which reflected her overdependence on foreign food supply.[52] The currency crisis exposed the depth of the agriculture's sector problems and this prompted another turning point in the sector's policy approach. The third NAP (1998 – 2010) was put together in the aftermath of the currency crisis to resolve two main issues: (i) how to reduce import dependence; and (ii) how to optimise existing agricultural resources. The plan aims to transform the agricultural profile of the country, in particular to promote the perception that "agriculture is business", particularly with respect to food and agri-based pharmaceutical products. This approach is slowly showing positive results. In the last few years, the agricultural sector registered a favourable growth through better export performance. Agricultural land uses showed an increase from 5.9 million to 6.2 million hectares during the 2000-2005 period, largely as a result of expansions in palm oil, coconuts, vegetables and fruit hectarage (Department of Agriculture, 2009). Agriculture land use was expected to increase at an average rate of 1.5 percent during the plan period, although mostly for oil palm plantations in East Malaysian states of Sabah and Sarawak. However, enhancing national food security continues to be a challenging task despite there being no shortage of individual success stories of farmers earning good income from their food farming businesses.

To summarise, this section on Malaysian political economy showed how land institutions and regulations develop in response to changing social and economic needs over time. Needless to say, an in-depth understanding of the issues affecting different types of agriculturalists is essential if effective agricultural promotion policies are to be found. However, the subject is beyond the scope of this thesis. Rather, the political economy section will serve as a backdrop to our examination of how the events described are able to influence land prices by making references to the theoretical discussion in Section 2.2 with respect to effects of state intervention, transaction costs and market imperfections on a land market.

[52] The amount is roughly equivalent to GBP 1.36 billion; for a population of only 25 million people at the time.

3.3 EFFECT OF FORMAL AND INFORMAL INSTITUTIONS

The land reforms introduced by the British set in motion an entirely new method of acquiring, utilising and exchanging land. Although its main intention was to enhance property rights and thus, investment security on land, the new system also created a way for the state authority to **control** and manage land supplies for agriculture and other subsequent uses of land (Wilcox, 1978), particularly before the emergence of comprehensive land-use plans at national, state, district and municipalities levels at the time. The previous section described how the land reform introduced by the British created a new notion of land as an economic asset. Hence, this section will also show how land titling system interacts with existing institutional structures (such as the informal credit and land inheritance systems of the Malays) to create additional layers of **transaction costs** and **market imperfections** compared to other land markets. To promote clarity, the discussions will take place in the context of four major issues in the Malaysian land market: (i) land fragmentation; (ii) land abandonment; and (iii) land-use regulations and (iv) agricultural schemes regulations.

3.3.1. Land Fragmentation

In the traditional land system, ‘sale’ of land typically involved paying *pulang belanja* or ‘returning expenses incurred on the land’. The premise for this transaction is that the land never belonged to the vendor but the Creator, hence the vendor should be compensated only for his efforts to clear the land in the beginning plus whatever improvements he brought to the land over time (Fujimoto, 1983). In contrast, the Torrens system dictates that the registered owner of the land possesses full and indefeasible rights of the land’s utilisation and disposal, whether in exchange with other goods or money. Since direct borrowing with interest is not allowed in the Malays’ Muslim faith, and formal credit sources are almost non-existent, a system of “conditional sale” was the popular mode of lending (Mohkzani, 1995). In this system of *jual janji*, a person ‘sells’ his property for a sum of money and surrenders his land title to the buyer. He would then be allowed to pay back the loan interest-free in instalments to regain ownership of the land. However, if the seller/debtor wished to continue working or staying on the land, he must enter into a supplementary contract in which the he became a tenant of the buyer/creditor. Defaulting on the loan and the rental would result in the land sale to be ‘complete’ i.e., realised; or *putus* in the Malay language. Losing land by this method was not uncommon since the simple farming methods and uneconomic land size seldom left much surplus for loan servicing and rents.

Another form of farmer’s credit involving land was the *padi kunca* system. Farmers often relied on middlemen for pre-harvest credit; for which re-payment was made during harvest time in *kunca*s (a volume measure) of rice. Because the price of rice is usually lowest at harvest time, one *kunca* of rice is valued less during harvest time than pre-harvest time. Usually the farmer had to surrender more *kunca*s to the creditor compared to the value of loan. Needless to say, this practice pushed the debtors deeper into debt. The creditors or middlemen would soon amass large amounts of land which they are neither able nor interested to operate in any efficient way (especially since the parcels are generally small in size and are scattered all over the area). These parcels are then leased to new individuals as tenanted land. Such land-based market for credit grew to correspond to the increase in the local population and influx of the more finance-savvy Chinese and Indians. The informal credit systems of *jual janji* and *padi kunca* were largely responsible for land concentration and the problem of landlessness and inequity in the society. The rate of land transfers from Malay interests to Chinese or Indian middlemen had become so worrying that by the early 1950s, various forms of Malay Reservation land regulations were introduced by the state authorities to disallow designated Malay-majority areas from being transferred to non-Malay individuals.

Land titling has also caused significant changes to the way the land inheritance is recorded and executed. Many Muslims die intestate and this usually leads to complicated asset division issues. The Islamic law of inheritance laid down specific details of inheritance and shares of the whole estate allocated to the various types of heirs.[53] For the Malays, in absence of other significant assets, a deceased’s land must be distributed to all heirs according to their respective inheritance shares. This

53 Primogeniture is not adopted in Islamic inheritance system even though the cultural practice of passing the estate to the eldest offspring is still common in traditional agricultural societies. Even then, some form of compensation or assurances are necessary regarding continued well-being of the other heirs. The Islamic inheritance jurisprudence states that all male and female children of the deceased have rights over the estate. In fact, Islam allowed additional categories of heirs provided that certain conditions are fulfilled.

creates situations whereby two or more people inherit a title in various individual proportions as a result of which none can take ownership of the land until others have renounced their right to the inheritance voluntarily or in exchange of other assets or payments (buy out the others' shares in the land). The title registration system allows co-ownership of land to be recorded on the title although partitioning the land is a possible option[54]. Refer to Appendix 3A for a brief description of land partition and other land transmission scenarios in the case of multiple owners.

If one of the heirs passes on before the land-partitioning or buy-out process is completed, then his or her heirs will be added to the existing list of heirs, although their collective share is limited to what is inheritable by their deceased father or mother in the first place. In some cases the number of heirs has become so large that many are no longer reachable for decisions. Naturally, the extent of **transaction costs** from negotiation and administrative procedures involved to obtain mutually agreed decisions regarding the parcel would be enormous. It would make sense to set up a firm to manage the land and assume the heirs' interests as shares in the firm, but this is only economically worthwhile if the land parcel is considerably large and highly productive. With respect to small holdings, the heirs usually find it more practical to sell the whole parcel collectively (regardless of the market price for land for a quick and swift solution) or partition the land. The latter move which will allow the individual heir to independently decide what is to be done with their portion of the land.[55]

Issues relating to co-ownership of land continue to complicate government efforts to encourage more efficient land utilisation. All co-owners must agree to surrender their decision-making rights to one of them through the use of Power of Attorney before the land can be included in government agricultural schemes. Obviously this is to ensure simpler negotiations and payment processes. However, many in the family might not agree or are interested in such long term commitments, not to mention willing to bear the legal and administrative costs of registering their individual

[54] The heirs can register their claims on the land, paving the way for partitioning to be done. Provided that an individual's share of the land is large enough (at least 0.4 hectares), and that others consent to his/her intention to withdraw from the original plot, the person can apply to the authorities to issue separate land titles according to everyone's share of the land.

[55] Despite this, many families are unable to reach a consensus regarding the land's future, even if they agree to sell, some might want to wait for better market prices for their land. As shown earlier, the delay in decision-making will only exacerbate the inheritance issue further.

claims (particularly if their respective stake is very small and they are also very poor). In general, many would prefer a one-off payment from selling their stake in the land rather than annual dividends from the land's use. It is hardly surprising that a large number of inherited plots of land are left unsold **and** unutilised. It is reported that as of January 2007, there are unclaimed properties and land worth a total of RM330 million and approximately 1,000,000 land titles which have not been transferred to the rightful heirs either because they cannot be tracked or cannot come to an agreement to mutually benefit from the division of the estate (Amanah Raya Berhad, 2008). This problem is not exclusive to Muslims but to other ethnic groups as well since the level of awareness regarding estate planning is still very poor across the board.

However, it must be stressed that the informal credit system and the land inheritance system are not flawed in themselves. For instance, the traditional credit system is no different with modern credit mechanisms in the use of land titles as loan collaterals. It is just that small farmers are more vulnerable to unpredictable weather and small profit margins such that their ability to repay loans is severely limited, hence the high rate of default. The problem with the Muslim *faraidh* inheritance system is not in its principles, but rather in its execution. In addition to the asset distribution system described earlier, a Muslim is given testamentary powers where he can propose a reasonably fair distribution of his or her property and even allocate a maximum of one third of the property to non-heirs or charity. Transfer of assets to prospective heirs during the lifetime of the parent, especially if it concerns indivisible assets, is also encouraged most notably using the instrument of *hibah* and trusts. This can ensure that suitable amount of consultations and payments (if necessary) can be made. In general, proper estate planning is will ensure that no one in the family is left financially deprived after the death of a person. Yet, 'planning for death' is still taboo for most people particularly the older generation, as evidenced by the depressing statistics above.

The foregoing discussions showed how the traditional credit system and inheritance principles became important land transmission mechanisms in the Malaysian context, particularly in contributing to the land fragmentation problem. As long as there is credit default involving land and as long as people are reluctant to adopt estate planning measures, one can expect land fragmentation to increase over the years. Such a situation would promote 'excess surplus' conditions in the area's land market whereby the relatively smaller number of prospective buyers are able to exert their **market power** to push down prices.

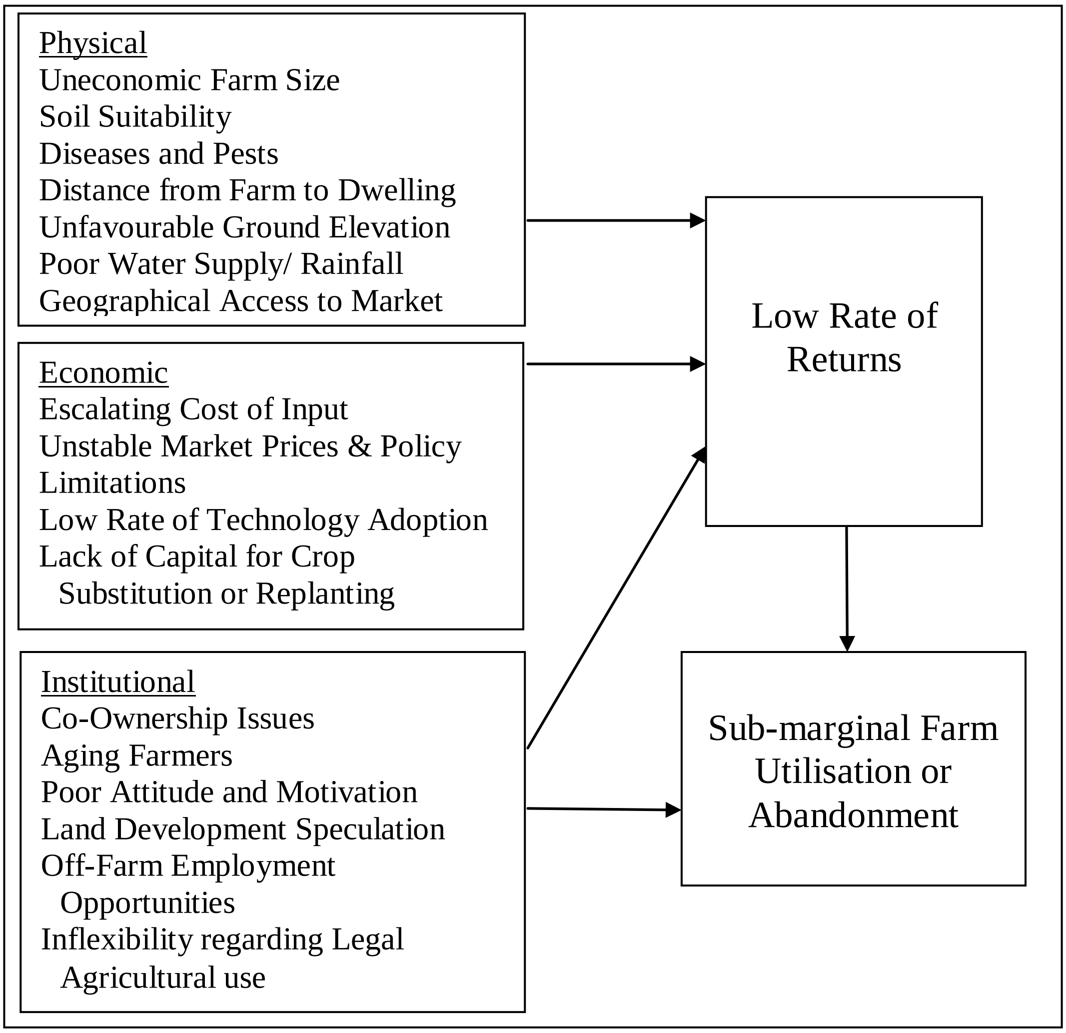
3.3.2 Land Idling

Within the Malaysian land law, abandoned agricultural land is defined as agricultural land which has been alienated to a private individual or firm but not cultivated after three years, or alienated agricultural land with suitable infrastructure for double-cropping (if rice land) but is only cultivated once a year (MOA, 1982). The definition also includes rice land with water supply and suitable for off-season crops but not planted with other than the seasonal rice crop. Based on this definition, as at 1981, the Ministry of Agriculture had identified 890,000 hectares of abandoned agricultural land and of that amount, 18% was rice land (Sahak, 1987). The Ninth Malaysian Plan (p.85) still reports 163,000 hectares of idle land in the period of 2001-2005, the highest percentage concerns the customary land category.

Reasons why the farms are abandoned can be broadly categorised into physical, economic and institutional factors. Physical conditions that make farming costly per unit of land include unsuitable soil conditions, diseases and pests, insufficient rainfall and land topography that make it relatively more difficult to use farm machinery; all of which basically points to very poor agricultural 'use-capacity'. Farmers normally stay in clusters of dwellings away from their farms. The more remote the farm is, the higher the costs of commuting and marketing for the farmer. Other factors suggested in studies by Sahak Mamat (1987), Pazim Othman (2000) and Amriah Buang (2000) include out-migration of farm labour, capital limitations regarding farm renewal, and unstable input and output prices. Farmers also face legal restrictions as far as crop choice if the land title is explicit about the type of agricultural activities allowed on the land. This inflexibility prevent farmers from responding to new agricultural needs in the market.

In locations where development speculation pressures are intensifying, poor-yielding farms are more even more vulnerable to land idling. The increasingly diverse economy creates greater off-farm employment opportunities which have lower risk compared to farming (from climate and price fluctuations). Uncertainty brought about by the prevailing rate of land development in surrounding areas fuelled speculative tendencies in the market. High **transaction costs** associated with inherited land can also cause the land to be underutilised for as long as the issues are not resolved. The problem is worsened if any of the heirs or beneficiaries is missing or is simply being uncooperative. Other constraints relating to the farmers themselves include age factor, poor attitude towards hard work innovation and investment. Figure 3.6 describes the main factors leading to land idling amongst smallholders in Malaysia and their inter-linkages.

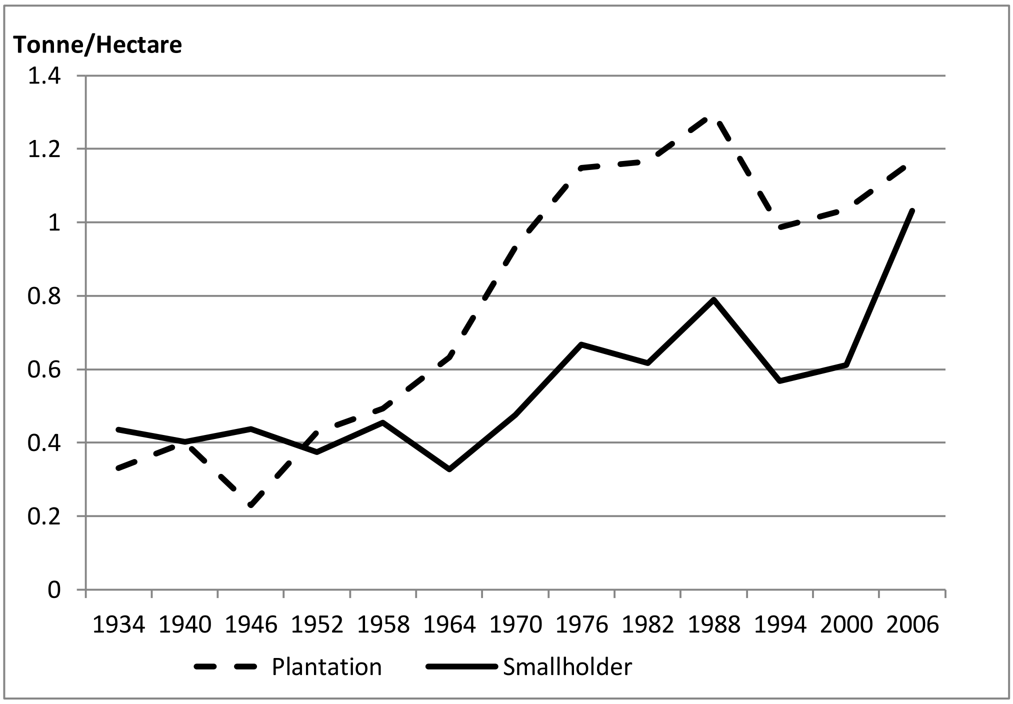
Figure 3.6 Summary of Factors Leading to Land Abandonment



Modified based on Pazim Othman (1997).

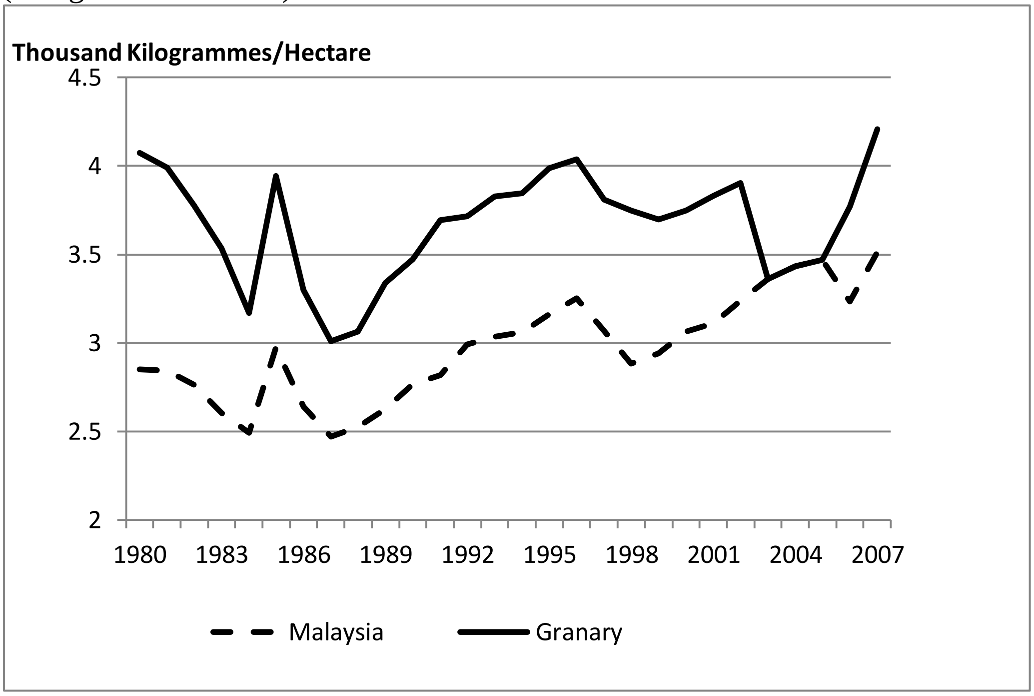
The physical and economic factors listed in the figure are responsible for relatively low rate of returns amongst small farmers; excessive and continued trend may trigger land abandonment in a number of these farms. That smallholdings are less productive per unit of land can be inferred from the disparity in yield rates as shown by Figure 3.7 for rubber and (smallholder versus plantations) and in Figure 3.8 for rice production (average farmers in the country versus farmers in the granary areas who are more organised than the rest of the rice farmers). Rice production yields in the granary areas are higher compared to average yields, although both areas display the same yield pattern over time. The two figures underscore the fact that a wide income gap exists between the smallholders and the larger agriculturalists. The lower-productivity farmers are bound to be more vulnerable to shocks in the market for output or input and hence are more likely to sell their land or leave their farm uncultivated.

Figure 3.7 Yield from Rubber Plantation and Smallholders



Source: Department of Statistics, Malaysia

Figure 3.8 Rice Yields in Granary Areas compared to National Average (Kilogramme/Hectare).



Source: Department of Statistics, Malaysia

There are several built-in preventive measures provided in the National Land Code (1965) to discourage land abandonment. Section 117 and Section 127 of the NLC allow the State to initiate forfeiture proceedings on agricultural lands left idle beyond a period of three years on grounds of a breach of the agricultural land-use conditions stated in the title. However, this law has been very rarely implemented (none that we know of) to avoid possible adverse ballot-box reactions. Section 129(a)(b)(c) have been in fact amended to replace forfeiture with "temporary possession" of the land so that the State can develop or cultivate the land or invite a third party to do so. The landowner is not obliged to pay for remedial work undertaken on the land by the third party or government. In 2001, a pilot project to consolidate fragmented land through voluntary participation was carried out by the Ministry of Agriculture in collaboration with the State of Negri Sembilan. The objective was to develop a 220 hectare tract of contiguous smaller plots of abandoned land. The combined plots involved 180 owners. Despite the extensive use of government machinery and local support, the process of obtaining landowners' consent alone took more than three months to complete. Given the same situation, it is hard to imagine a private agricultural investor being interested to embark on a similar land consolidation effort just to secure a parcel of land even if it exhibits very high use-capacity qualities.

3.3.3 Land Control Powers

Applying to change the approved land-use of a parcel from agriculture to development is sometimes necessary to facilitate land partitioning process because of the 0.4 hectares ruling. Development land is also saleable to non-nationals whereas agricultural land is not. However, the majority of farmland conversion applications are made for parcels whose highest value can be realised in an alternative use and because there are no comprehensive agricultural zoning existent, the conversion applications are not confined only to land at the urban fringes. 'Politics of development' which is popular in the early decades of independence called for wide-spread economic changes across the country to address regional growth imbalances. Land-use change is generally regarded as inevitable as average levels of income and non-agricultural demand for land rose. To see how land conversion is managed, it is useful to understand the State's main land-control devices. The first which is land title is typically granted with three types of conditions (National Land Code (NLC), 1965):

i. "Categories of land-use" which states **on the title** that the land must be used for agriculture, building, commercial or industrial use.
ii. "Express conditions" which are set out **on the title** indicating additional conditions for use and restrictions regarding ownership as deemed suitable by the State Authority. For land specified as Category 2 paddy land, express conditions may include the variety of rice, the timing of cultivation and harvest, method of irrigation and number of cropping per year.
iii. "Implied conditions" which are set out **in the NLC** to supplement the "express condition" for the land. It comprises conditions applicable to all state alienated land (e.g., the obligation to maintain boundary marks) and with respect to its land-use category (e.g., type agricultural activity allowed or prohibited on the land, limit of number of building constructed upon agricultural land lots).

The title conditions essentially became the country's first and most important land-use planning tool. The total supply of land allocated for any given use is changeable by altering the title conditions. The State Executive committee (EXCO), as the State cabinet, is the sole authorising body since land is a state matter (see Yusuf, 1989).[56] The change in categories of land-use is decided either in an ad-hoc manner or in accordance to State land-use plans, if one is complete for the area at the time.[57] To change or rescind the express conditions (and also to subdivide or amalgamate land plots), the owner must surrender the original title to the State Authority in return for a new one, where the new set of leasehold terms, express conditions and rent structure are stated. Appendix 3B shows the process of land alienation and types of restrictions in more detail. Because Malaysia is a federation of many states which are entitled to enact their own laws regarding land, the NLC was necessary to bring uniformity to the way land is regulated across the country, with respect to land tenure, registration of titles and land transactions. There are other land regulations unique to each state (Yusuf, 1989). Interestingly, Section 116 of the NLC asserts that the land title conditions should prevail over any other form of land-use controls including the planning permission system.[58] If a plot of agricultural land is located within a planned residential zone, the land's title prevails until the owner applies for a land-use change. The overriding power of the State EXCO to determine the land-use category "in the best interests of the people" has always been a subject of controversy for its lack of reliance on transparent economic and social indicators.

Another important land-control instrument is the Temporary Occupancy License (TOL). Although the original objective of approving them, i.e. to relocate people at risk of communist raids during the period of insurgency, is now irrelevant, there are still pockets of land under TOL tenure method. According to law, each TOL can be renewed up to a maximum of three times, after which the recipient can apply for a full title grant. If rejected, the land reverts to the State or is alienated to other individuals. However, in practice, the State tends to renew the licenses year after

[56] Article 74 of the Malaysian Constitution declares that land is a State matter over which the State has both legislative and executive authority. The powers of the State over land are spelt out in the NLC as per Section 11, 14, 40 to 42. Land remains a symbol of sovereignty and power of the State's Ruler/Sultanate within the Malaysian Federal system of governance.

[57] Given limited resources at the district level, changing economic conditions and the vast amount of information, consultation and training, delays in plan preparations were inevitable.

[58] Land-use planning through the planning permission system is established with the implementation of the Town and Country Planning Act 1976 (TCPA), modelled after the British TCPA 1947. Similar to NLC, the TCPA is provided for by the Federal constitution to ensure uniformity in law and policy in all of the states in Malaysia. TCPA basically operates through a licensing process and is independent of the NLC. All levels of government are required to prepare development plans (including structure plans and local plans) and carry out recognised measures of development control.

year to the same individual. This creates strong positive expectations in the licensee's mind that his application for a full title will be approved, but this is not always so. In some cases, political intervention is requested to resolve the matter and TOL remains an important vote-determining issue in any given election year.[59]

The state's power to acquire privately-owned lands via compulsory takings provision has also been subject to heated debates. The 1992 revision of the Land Acquisition Act (1960) (LAA) states that

> *... the State is empowered to acquire any land for any person or corporation for any purpose which in the opinion of the State Authority is beneficial to the economic development of Malaysia or part thereof…."(LAA S3(b))*

Naturally, there were misgivings surrounding the possibility that State can use this clause to acquire land to benefit certain quarters via the nation's 'privatisation' initiatives. The law does not adopt a procedure that allowed affected parties to object and participate in a local public inquiry 'public purpose' term. The Malaysian judiciary has traditionally been reluctant to intervene in land matters because it is perceived as under the discretion of the state executive,[60] whether with regards to acquisition or disposal of lands (Azmi Harun, 1996). Eventually, the Federal Government stepped in to pass an amendment bill in 1997 to improve transparency in government takings procedures particularly regarding the exact potential land's use and possible market value.

The above discussions regarding title conditions, TOL and government takings demonstrate how state intervention can affect land supply for competing uses and subsequently their prices. Wilcox (1978) cautioned how the "considerable latitude" allowed in the NLC can encourage haphazard and pre-mature development of land, and more importantly weakens the utility of planning as a means of land-use management. It is often argued that without adherence to a comprehensive state-wide

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[59] For example, *The Star*, 10th February 2008 (less than a month before the 12th General Election) reported that the State government finally acted to end decades of uncertainty faced by 913 TOL farmers in Perak by approving 30-year leases on the 2903 hectares of land they had been toiling on for generations without a full land title.

[60] Courts can only decide on matters relating to amount of compensation and procedures of acquisition. There was no onus on the state to define the 'public purpose' term. "Government is the sole authority to decide what is, or, what is not, a public purpose, and the decision by Government in this respect cannot be questioned by a Civil Court" (Refer to court's decision on Yew Lean Finance Development (M) Sdn Berhad v. Director of Lands & Mines, Penang (1977) 2 MLJ 45).

plan and separation of the executive and the legislature, the powers vested in the State can be easily misused. When deciding on land conversion and planning permission applications, the EXCO are not bound to follow technical board reports or public petitions, although this is encouraged.[61] The NLC also has no provisions regarding the limit States can award new land or allow land to be converted to a single person or entity. The State's tight control over land matters understates among other things, the importance of land for short and long term political gains, with the ruling party's system of patronage sometimes being extended to land distribution and development contracts in the past.

The States, in general, favour moves to spread development to the rural areas which was far lagging compared to the booming cities like Kuala Lumpur, Penang and Singapore.[62] The rural economy was badly suffering from the falling international prices for their output. The State's post-70's land policies were explicitly geared towards social and economic restructuring to prevent explosive class clashes such the one in 1969.[63] Hence, the period saw massive public infrastructure expenditure to build schools and colleges, industrial zones and better road networks in rural areas. As the transformation gained momentum, land supply for development was duly expanded to reduce overall cost of local and foreign investment in the newer sectors of the economy.

In addition, by allowing land-use changes, the State government stand to benefit from development premium payments and higher annual land tax revenues. The State was able to finance additional infrastructure in relatively less-developed areas without raising taxes from other tax constituents. Computation of development premium follows a fixed percentage of the potential market value of the land in development use and the extent of government's stake in the project, if any. In many

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61 Hence, it is not unusual to find land alienation that appears confusing. Anecdotal evidence include rice land which was eventually abandoned because soil conditions or topography that are not suitable for rice cultivation. Planting other than rice would constitute a breach of the "agricultural-rice" title conditions. Land erosion incidents are also often blamed on land decisions that allow agricultural activities on high-risk hillside areas.

62 Singapore was part of Malaysia until 1965.

63 Horii (1991) wrote about "the fundamental contradiction of Malaysian society – the concentration of economic wealth in the hands of the rich Chinese and monopoly of political power by the Malay ruling groups". He blamed the colonial capitalist economic structure which he said "perpetuated and even expanded economic inequalities among ethnic groups".

a case, if the private developer is willing to contribute public infrastructure and amenities (e.g., highway access points, town halls, schools, mosques and parks) to a new area, then the development premium charge is smaller. The total **transaction costs** for the developer from the whole process of negotiating the land transaction and development permission as well as the infrastructure built are capitalised into the developed property values, but essentially would also depend on subjective factors such as the negotiation skills, reputation and goodwill based on relationships or past project performances. Because of the large amount of negotiation and scrutiny involved, large development projects are only approved for firms with considerable reputation and capital to carry the project through. In other words, only large firms with considerable **market power** are allowed to purchase and develop the land.

3.3.4 Agrarian Reform Agencies

Given the problems of absentee landlords, co-ownership, scarce labour and scattered locations of farms, it is not difficult to imagine the challenges faced by the Ministry of Agriculture, RISDA and FELCRA in pursuing rehabilitation and consolidation of private smallholdings in the country. Generally, many of the smallholders could not participate in the schemes either because they are unable to secure proper land titles; or because the land they have been working on is co-owned; or because the land has been pledged as collateral for loans.

Whilst these constraints may not apply to land settlement schemes, the cost of establishing a new settlement area can be extremely prohibitive. Settlers are provided production, management and marketing support as well as suitable social amenities for the whole family. Because of its costs, many argue that a larger number of the poor can benefit from funds saved if FELDA'S support is limited to production and processing activities only. FELDA has yet to resolve issues regarding second and third generation settlers, who want greater independence concerning their land e.g., in deciding where to sell their output, which crop to cultivate, how to dispose their interests in the land scheme if they are no longer interested or able to continue.[64] Today, much of the farm work is subcontracted to other smaller farmers

[64] Basically, land enrolled in agrarian reform schemes cannot be sold to an outsider without permission from the managing agency. This condition is, in fact, reasonable from the collective point of view because selling to a person with different land-use plans might jeopardise the

or foreign farm labour, while the rest are done by basic machineries. Cooperative farming and mini estates models have been poorly received because of the bureaucratic and political nature of their management.

The issues mentioned here and in Section 3.2.3.2 are far from exhaustive but are sufficient to highlight the need to critically assess the role and objectives of land-related agencies. Macro and micro assumptions that justify their existence in the past should be updated so that new roles and mechanisms can be found to suit changes in the target group's demographic composition, average economic size of farms, preference for agricultural activities, risk tolerance, level of education and training, land concentration ratios, cost and availability of labour, capital requirements, industrial linkages for the output, to name a few.

In a nutshell, the government needs to make a serious attempt to engineer modern, equitable and sustainable agricultural growth models in which key components must include:

(i) proper and attractive exit options for aging or 'withdrawing' farmers; and

(ii) solution to problems faced by co-owners of inherited land.

Scattered and uneconomic agricultural parcels must re-organised and made more attractive to serious agricultural investors and farmers. New agricultural models naturally take time to show results and overcome scepticism, but are important for the future of the sector. The recent proposal (in the Ninth Malaysian Plan, 2006-2010) to establish economic corridors which promote clustering of economic activities is a step in the right direction. The corridor concept will allow for appropriate agriculture infrastructure and agro-based industries to be built on land relatively free of development pressures, as well as encourage the pooling of agriculture technology and labour resources in one place.

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operation of the scheme and other remaining participants, particularly if the plot withdrawn blocks critical access points to the scheme production area.

3.4 CONCLUSION

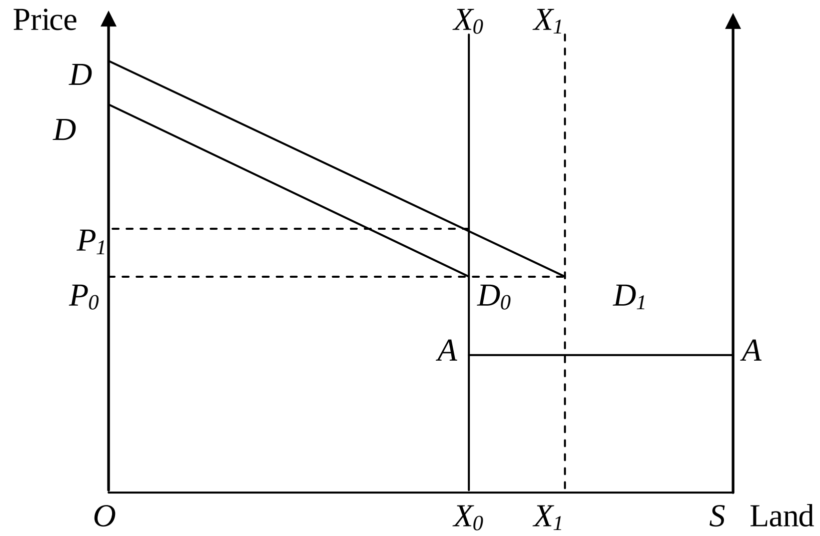
The shortage of empirical studies on agricultural land markets which incorporates institutional effects on land use and prices is testimony of the difficulty in finding suitable data to measure the effects. Although some discussions in the chapter have been mainly anecdotal, they combine well with the more factual sections to support the theoretical conclusions described in Chapter 2. The chapter began by tracing significant political and economic changes that lead to the creation of specific land laws and agencies related to agriculture and land use. Through the Torrens Land Registration system and policies, British Malaya experienced massive economic growth, mainly through fortunes made in the rubber sector. However, prevalent hardcore poverty in the rural areas compelled the newly-independent government to launch large-scale agrarian reforms including opening new lands for agriculture. More massive and in-depth socio-economic restructuring took place in the 70’s to correct the large income inequality between urban and rural dwellers. In the 80’s, after an extended period of rubber price slump, the government turned to the manufacturing sector as the new engine of growth. On the other hand, the food sector never really had a chance to take off due to cheap foreign supply and government controlled prices of the output. Reinvention of the economy in the 80s and 90s caused massive outflows of resources from the agricultural sector to booming sectors. Increasing development pressures in turn created larger expectation of land conversions i.e., land price speculation; which for reasons explained in the chapter, is not confined to urban-fringe lands.

In the second half of the chapter, we examined four specific issues associated with external influences on the land market first discussed in Chapter 2 namely, state intervention to fix land supply, transaction costs and market imperfections. Firstly, the chapter examines how the interaction between title registration and informal credit systems contributed towards encouraging **land fragmentation** and landlessness in the rural society. The way inherited land is divided is partly responsible for overall smaller average land sizes. Fragmented lands in turn enter the land market as ‘excess surplus’, as a large number of sellers seek to dispose their land regardless of market conditions. Secondly, the section examined the root causes of **land abandonment** and challenges faced by authorities to resolve it. It is quite obvious that unless a more forceful or persuasive measure is adopted to provoke landowners into action, the idle land problem will be here to stay.

Thirdly, the chapter examines how land-control devices are used to determine and change land supply. Based on the discussions, the way prices of land is affected by institutions and economic transformation can be summarised and depicted through modifications to Figure 2.4, and which is subsequently shown here as Figure 3.9. Assuming that prime land for residential and commercial needs are typically found on low-lying areas with near water routes (usually to facilitate agriculture and trade growth). The different population land needs are spread out into deeper areas eventually up to an area of land equivalent to (OX_0+SX_0); and that the government has the power to determine the quantity and area of land for specific uses i.e. housing (OX_0) and farming (SX_0). Over time, demand for housing land shifts upwards from DD_0 to DD_1 to reflect population growth and the changing economic landscape. Therefore, prices are pushed upwards and the equilibrium price of development land is found at the intersection of its supply and new demand, P_1. Further price movement upwards can be motivated by speculative activities in the market. In order to relieve some amount of these pressures, the state agrees to increase area development land increases from OX_0 to OX_1 through the approval of more land-use conversion applications.

It is quite likely that farms are now pushed to marginal lands and this in turn causes higher costs of agricultural production. If price of outputs are consistently low (due to price controls for output or foreign inflow of supplies), farming would become increasingly less attractive or viable, particularly for small farmers with limited capital resources and little protection against climate, pest and overall market risks – hence the considerably elastic nature of the demand curve for agricultural land, *AA*. The figure shows that a smaller supply of agricultural land is now available at SX_1. Without favourable changes in agriculture rates of return or assertive policies to support farming returns or preserve agricultural land, prices remain relatively unchanged even though the total hectarage of land available for agriculture falls to X_1.

Figure 3.9 Land Market with Inelastic Development and Agriculture Land Supply



Finally the section demonstrated that it is important to re-evaluate the role and effectiveness of **agrarian institutions** in helping farmers adjust to the new economic realities. Fresh approaches are needed to create and support a robust group of agriculturalists working with and without the agency's resources. We argue that the problem of low agricultural margins can be partly linked to less than optimum land ownership and use patterns. However, it can be similarly argued that the current land-ownership and use patterns are caused by low agricultural margins.

Nevertheless, the analyses in this chapter are able to bring forth several testable hypotheses. All things equal, are there significant price differentials: (i) between cultivated agricultural land and idled land?; (ii) between agricultural land with and without development potential? Another pertinent aspect that can be empirically estimated is the price impact of land-use restrictions with respect to schemes under agricultural reform programs and the Malay Reserve Land enactments. It is also possible to investigate the hypothesis that development pressure on land is not only found in urban-fringe lands but in other traditionally rural areas as a result of broad regional development policies undertaken after the 70s. The following chapter describes the sources of our data and the process of assembling the dataset used in the thesis's econometrics analysis.

APPENDIX 3A
LAND FRAGMENTATION

1. Land Transmission Via the Market

To illustrate how land fragmentation occurs through the system, we take a case where a plot of rubber land is alienated in one grant/title to Messrs. A and B, presumably relatives.[65] Let say the land is 8 hectares in size, and registered at the Land Office and is known as Lot 100. The co-proprietors can apply to break-up the land into smaller lots. Let us further assume that they have to put up the land as collateral in their business/consumer loan, but neither wants the bank to have any claim on their land over and above the loan borrowed. Assume this amount corresponds to the market value of a portion of the land, resulting in Lot 102. An application for **sub-division**[66] is approved subject to certain conditions, most notably:

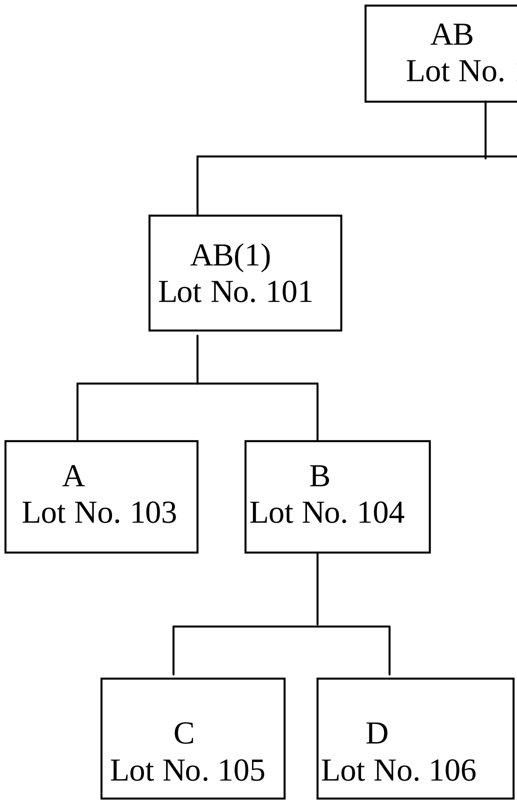
- The original plot of land is held under a final title (Lot 100).
- The effect of sub-division of agricultural land must not result in lots less than 0.4 hectares i.e., Lots 101 and 102.[67]
- All individuals with registered interests on the land must consent to the sub-division and act as co-proprietors of the resulting lots.
- Resulting plots of land have reasonable access to road, river or transportation network.

After some time, A and B decided to break up Lot 101, feeling that it could be better managed as two smaller units, or say that the two co-proprietors have had a major altercation and would like to part ways. They are unable to do anything with respect to Lot 102 because it is still charged to the bank. An application is made to the State Authority through the Land Office to obtain sole ownership of different parts of Lot 101. This process is called partitioning the land.[68] The application is submitted with a proposal drawing identifying boundaries of the new lots, subject to similar conditions

[65] Land alienation in most cases are only awarded to one person per lot of land. However, there can be joint applications for land. We adopt the latter to enable us to explain the concepts of sub-division and partition better.
[66] Section 136 - 137, NLC
[67] Section 205(3), NLC
[68] Section 140 - 142, NLC

as in the subdivision case. Now, A and B are sole owners of separate titles, Lot No. 103 and 104, respectively.

Figure 3.10 Land Subdivision and Sale



Many years passed by and B may eventually decide that he no longer wants to continue farming and desires to commence a grocery business in the village. None of his children are interested in taking over the farm from him. Furthermore, he is in need of capital to start his grocery business. So B resolved to sell his Lot 104 to outsiders. Because the rubber market was performing poorly at the time, B was unable to attract a satisfactory price for his land. It was suggested to him to apply for conversion of land status from 'agriculture' to 'building' category, as there is better demand for houses from people staying in the nearby city. To do so, he would have to engage a surveyor and other professionals to prepare an application for change in land-use category, building construction approval and so on. Consequently, Lot 104 was divided into two separate lots, Lots 105 and 106 as 'building' land to two different buyers, Messrs. C and D (Figure 3.10).

2. Land Transmission via the Inheritance System

Let us now assume A has four children, two girls and two boys. Upon his demise, all his physical and financial assets are to be distributed among his heirs according to the Muslim inheritance law. In practice, the first step is normally to identify the rightful heirs to A's assets, and secondly, assemble and quantify the value of his estate. In our example, Lot 103 is solely owned by A, while Lot 102 is partially owned. A also left some savings in the bank. After paying off creditors using the savings, the heirs will elect one person amongst them to act as administrator of A's estate. To simplify matters further, we will concentrate on lot 103, because lot 102 is still subject to a bank claim, therefore is intentionally left out from our illustration due to its complexity. The heirs are Messrs. E, F, G, H, I.

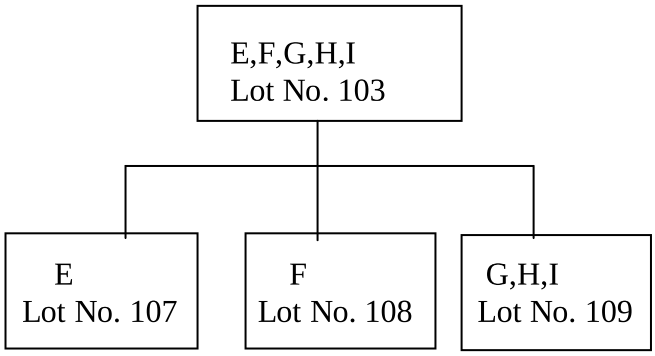
With respect to the Lot 103, there are several alternative options for them to choose from:

a) The heirs can keep the original lot intact, but have all their names and respective shares on the land registered at the Land Office. Essentially, they are co-proprietors of the land, despite not having specific sub-plots drawn for each person. The lot can be leased out and its proceeds shared according to their shares in the land. If let say, one of children continues his late father's work on the land, he would pay the other beneficiaries their respective share of the net returns from the land minus his expenses.

b) The heirs can negotiate for a settlement amongst them as to who will receive what, most preferably to allow only one person per asset, where possible. The person receiving the land must buy out the others' shares or swap shares in other assets. Some may renounce his or her claims altogether if it is very insignificant or troublesome to maintain. Thereafter, the remaining claimant will be registered as the sole owner.

c) The heirs can register their claims on the land, paving the way for partitioning to be done. Provided that one's share of the land is large enough (more than 0.4 hectares, at least) and that others consent to this withdrawal from the original plot, he or she can apply for partitioned land titles. This move will allow him/her full rights over the land. The application must be initiated by the person with the largest share of the land, which is in this case, E. The other claimants to the land can also obtain separate titles, except where their claims translate into sub-plots which are less than 0.4 hectares i.e., in the case of G, H and I. For instance, there is a total of 1 acre of land, all of which, for the sake of simplicity, have equal shares. In this case, they must remain as co-proprietor of the 1 acre, i.e., Lot 109 (Figure 3.11).

Figure 3.11 Land Partitioning



d) Even if the inherited lot of land inherited is not really small to begin with, the heirs can collectively opt to liquidate all claims on the land in return for cash, which is more easily distributed according to their respective shares. They may engage a land broker to seek interested buyers who wants to buy the land as it is. Alternatively, the beneficiaries can pool funds to undertake the process of converting the land into any of the development land category – an effort that can be worthwhile, if trends in the real estate market are positive. However, to do so, they must first have their names registered in the land registry as co-proprietors, then transfer all rights to the administrator to act as their agent in the ensuing administrative processes of land conversion and disposal. The conversion application can be submitted simultaneously with the transfer (sale) application to register the new owner of the land. In this case, the lot of land remains intact, while all beneficiaries receive their share of their inheritance in cash, refer to Figure 3.10.

There is no single legal term for conversion of land,[69] rather the law allows application to change in 'land-use category' in order to allow development to take place. The law allows for subdivision/partition and conversion applications to be made simultaneously, although separately assessed. If both are successful, a new title will be issued, indicating the new land-use category, tax rate, express and implied conditions of use and transfer and so forth. In the case of subdivided or partitioned land, the law requires that each resulting lot must have the minimum required levels of road accessibility, sewage and other infrastructure benefits.

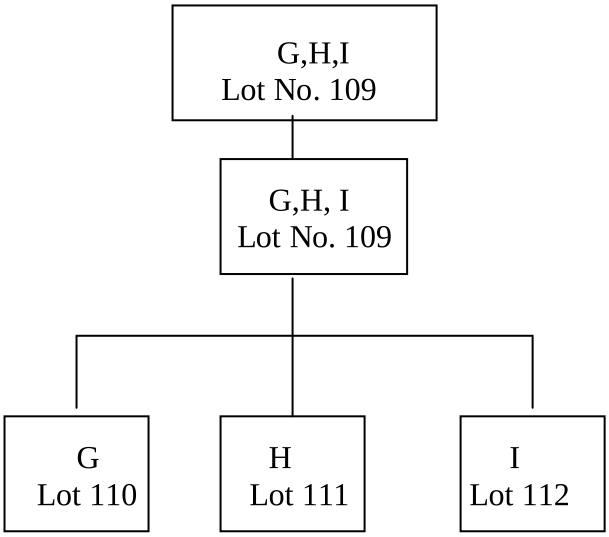
Various departments need to be consulted, in particular, the local planning authority. The application for conversion can be sent to the Land office after the local planning authority has approved site preparation and layout plans. However, only after the conversion application is approved by the Land office that the landowner will appoint his panel of consultants to draw up a construction plan for building approval. The landowner may apply for a developer's license if he intends to develop the land himself. For land development projects, the owner must demonstrate that there are land allowances made for public or open space and future road expansion and so forth as viewed appropriate. Therefore, the land is surrendered back to the State with a proposed plan that incorporates all these allocations. The state can then 're-alienate' the land to the applicant. The re-alienated land is normally smaller in total size from the original lot because of the land allowance provided.

In summary, there are two basic reasons for conversion: one is to benefit from higher prices from non-agricultural demands. This is particularly true for agricultural land at the rural-urban fringe. However, another reason for conversion is to get around the problem of co-proprietorship when partitioning is not allowed as in the case of lot 109 in the example given. However, land in non-agricultural categories can be partitioned or subdivided up to a minimum allowable area determined by the local planning authority (usual conditions regarding access, shape of land and infrastructure apply). Therefore, co-proprietors can still partition the land provided the conversion is approved. Refer to Figure 3.12. This is a very practical solution for

[69] In the simplest case where a landowner wants to convert his land aby amending the category and express conditions- then it comes under Section 124. Scenarios involving surrender and re-alienation is related to Sections 204 or 197 and 76.

problematic situations where co-proprietors cannot agree on what to do with their land. For instance, some would like to sell the land sooner than others, some might want to build their own house on the land, or maybe develop the land into a small-scale housing project.[70]

Figure 3.12 Land partition via conversion



Should the co-proprietors agree to convert land in order to secure separate titles to their own portion of land, they must be willing to share the necessary administrative costs, including costs of re-surveying, valuation, legal, drawing up detailed plans for planning permission, premium for the new land category, and so on. The premium for conversion is basically payment to the state government for administrative costs and can be seen as a one-off tax on the new land status. It ranges between 15 to 30 percent of current market value of its new intended use. Private individual sellers are subject to real property gains tax, if they sell the land in less than 6 years. Corporations selling land are required to pay the tax regardless of the period the land is held.

[70] An acre of land can normally accommodate 2 to 8 plots of housing land, and even more, if interlink houses are to be built.

APPENDIX 3B

Land Alienation Process and Types of Restrictions

Subject to the approval of the State authority, both the district and land offices can issue either a grant or a lease (both being instruments of alienation) or a short-term approval in the form of Temporary Occupational Licenses. A brief description of the different types of tenure in t he latter category is as follows:

i. Temporary Occupational License (TOL)

The license to use land is given to applicants on a short-term basis, not exceeding a period of twelve calendar months. The license must be renewed by making subsequent applications and payments. The land can be used only for pre-specified purposes[71] but because of the short-term nature of occupancy, it has generally been used for vegetable farming, aqua-farming, livestock breeding; generating valuable food supply to the population. The license is non-transferable upon the licensee's death or dissolution of his business. There can be no more than three renewals unless express permission is given by the State Authority.[72] The TOL holders can at any time apply for alienation of the land, although its approval is not automatic.

ii. Group Settlement (GS) Title

An individual participating in a group land settlement scheme prior to 1985 can request for a separate title corresponding to his share of the scheme's land upon satisfaction of certain conditions. For example, he must have worked consistently on the land for the stipulated amount of time. The land title application must be made through the GS agency, for the State Authority to approve. The State Authority can award a freehold or a leasehold title to the applicant. However, several issues relating to the GS land must be noted:

- The GS agency must be the first entity approached for offer to sell if the settler wishes to sell his land. If it shows no intention to retain the land in its scheme, then the settler can offer the land to the market.
- A GS plot cannot be transferred to a non-Malay if it is located in the Malay Reserve area, without the approval of the highest State Authority.

[71] Section 43, 65-68, NLC

[72] TOL may be issued for any purposes other than those prohibited in Section 42(2).

- A GS plot can only be registered under the names of two persons at most, at any one time. Therefore, if the original settler passes away and leaves a wife and more than one child, the settler's holding will be put under administration, whereby the GS agency will continue agricultural work on land, but will distribute net returns from land to the deceased heirs through the administrator.

Steps in the Alienation Process

At the beginning of the Torrens system's adoption, a person wanting to register his claim on a piece of land had to show that he was indeed occupying the land, afford to pay the required amount of land premium and thereafter able to pay the annual land tax. Today, occupancy is no longer an important factor considered in approving land alienation.

The grant title, which is the document of alienation, would state clearly to whom the land is alienated to, the location of the land, how much annual tax is to be paid on the land, type of lease, conditions and restrictions with regards to use and rights on the land and claims on the land. The State has unilateral rights to alienate any piece of land for a period not exceeding 99 years (leasehold) or in perpetuity.[73] The latter is only applicable when it could be established that:

a) the alienation is in favour of the federal government or government agency

b) the State Authority is satisfied that the land is intended for public purposes

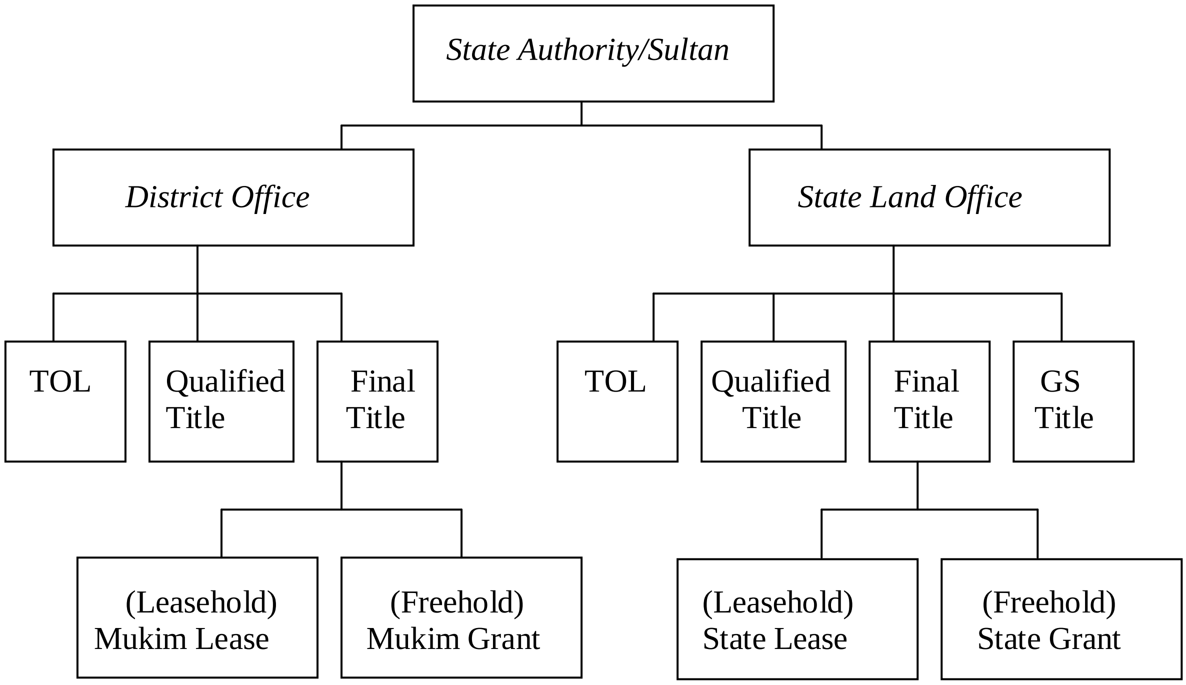
c) the State Authority is satisfied that there are special circumstances rendering such alienations appropriate[74]

In the past, a qualified title, *Hak milik Sementara*, HS(D), if land is registered at the land office, or HS(M), if registered at the district office, is issued pending the completion of official survey on the land. A final title will be produced upon further payment of premiums to state authorities. Figure 1 shows the different types of land titles issued by the State.

[73] Section 76, NLC

[74] Unfortunately, such wordings can be open to wide interpretation and lead to misuse of power. Taken together with the other two conditions, it would appear that very seldom freehold land is awarded to private individuals.

Figure 3.13 Land Alienation Process



Conditions regarding Interests on Land

Since land rights are given in the form of 'tenure', the state can impose restrictions on the right of ownership and transfer pertaining to the land. These conditions come into effect immediately upon the date the alienation is registered, and will continue to prevail, until an application to overturn them is made and approved. Failure to comply with conditions regarding interests will lead to the transfer transaction considered null and void; hence the new owners' claims will not be registered. Unless there is clear evidence of fraud or misrepresentation, they will not be compensated for taking part in the transaction. The restrictions are as follows:

- *Malay Reservation Land*:[75] not to be sold to non-Malays, although some states allow for its lease or even alienation under certain circumstances. However, in general, MRL still cannot be transferred without approval of the highest authority in the state.

[75] Article 89(6) in the Federal Constitution states that "In this Article 'Malay Reservation' means land reserved for alienation to Malays or to natives of the sate in which it lies: and Malay includes any person who, under the law of the state in which he is resident, is treated as a Malay for the purposes of the reservation of the land". Note that since state has encompassing powers on land, the Constitution reflects this by allowing varying definitions of Malay and Malay Reserve Land across the states. The NLC sections relevant to MRL are 211 and 436.

- *Bumiputra restriction*: such land not to be sold to non-*bumiputras*[76]
- *Foreign ownership restriction*: agricultural land is currently not transferable to non-nationals[77]
- *Transfer approval restriction:* certain types of land cannot be transferred or sold without the written approval of the relevant authority. For instance, transfers of plantation land greater than 40 hectares require permission from the State's Plantation Land Board.

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[76] *Bumiputra* (children of the land) refers to all Malays and indigenous people.
[77] Section 433(b), NLC

CHAPTER 4
DATA AND VARIABLE SELECTION

4.1 INTRODUCTION

Because the hedonic price model is applied to Malaysia, it is necessary to devote some discussion to the features unique to the country and subsequently how they affect the thesis's empirical approach and variable selection. The empirical literature comprises studies that estimate land price determinants either over time or across a given region. The former requires that rental from land's agricultural or alternative uses are known and a reasonably consistent and long timeseries data available. Tenanted farm in Malaysia today can be found in the rice and small-holding rubber subsector, although they are not as ubiquitous as they were in the past.[78] Basically, a person whom the state has awarded alienated land (the "grantee") has a right to let out the whole or any part of his land for a period not exceeding his state lease term. If this tenancy agreement extends for more than three years, an instrument of private 'lease' must be registered at the land office, whereas short-term tenancy arrangements (not exceeding three years) can take effect either through oral or written agreements.

There are additional reasons why a reliable and consistent data on rent values are extremely scarce for Malaysia. Rents are usually payable either in cash or in kind, based on a pre-agreed fixed quantum or percentages, the latter was more popular in the past. The monetary value of payment-in-kind, if recorded, poses comparison problems due to the highly diverse nature of land use and ownership. Even if a fixed monetary monthly or yearly rent is known, anecdotal accounts by officers in land-related authorities suggest that, its value is usually nominal and seldom reflect changing returns to land. This is mainly because in many cases, the tenants are related or well-known to their landlords. Furthermore, if a parcel of land belongs to

[78] Their numbers are declining as more landowners employ cheaper foreign labour and machineries to cultivate their lands rather than rent it to others. In 60's and 70's, many poor tenants and the landless were absorbed into government's group settlement schemes. In more recent years, the decline of tenanted farms can be attributed to increase in non-agricultural employment opportunities and out-migration.

more than one owner, change of rates seldom take place because the difficulty in obtaining regular consensus regarding rental review especially if the individual shares are insignificant.

Chapter 3 established that non-agricultural demand is an important feature of the Malaysian agricultural land market because of the economic transformation that the country undergoes to lift income levels. As a result, **agricultural rental series** alone would be far inadequate to reflect potential future income. It is well-documented when non-agricultural demand for land is strong and highly credible, typical factors that affect agricultural rent may not exert as much influence on price as they would otherwise, a point which we will return to shortly. Because a parcel's sales price represents the discounted present value of all its future rents, it follows that any changes to rent expectations is duly reflected in the price function. However, any future expected changes in asset values is not be necessarily capitalised into present rental values. As such, whilst the rent function is appropriate to represent current-period values of land, it may not be reliable to reflect changes in land asset values from potential variation in land-use (see Taylor, 2003 p. 341). Palmquist and Danielson, 1989 (p. 55) aptly summarized the distinction between land rental and land values in their footnote,

> *When people rent land, their only interest will be in the current productive capabilities of the land, although the lease may require them to protect the interests of the landowner. The value of land as an asset depends on the present value of future rents. The land may be used for different purposes in the future, so different characteristics may be relevant. These characteristics would then influence asset value but not rental value. For example, proximity of farmland to a major population centre might increase land values even though it did not increase agricultural productivity. In the same vein, a characteristic that is of value in agricultural use, such as soil productivity, may be discounted in the asset price if that characteristic is not as highly valued in some alternative use (e.g., commercial use) that is anticipated in the near future...*

In support of the above argument, Hardie, Narayan and Gardner (2001) found in their empirical study of land prices in both rural and urban counties, that responses to change in agricultural returns are inelastic and relatively uniform in both rural and urban counties; but response to non-agricultural factors is found to be more elastic and substantially greater in rural counties.

Because of the lack of usable rental data and the strong presence of non-agricultural demand in Malaysia, the thesis select to employ a cross-sectional approach for its empirical component. Recall that the Hedonic Price Model (HPM) is based on the premise that price is a function of a good's set of value-creating attributes, such that inter-parcel price variations can be traced from differences in the levels of attributes in a parcel. The process of identifying and selecting data sources to represent land's value-creating attributes proved to be as challenging, if not more, than the task of processing the data itself. Unlike in the U.S. or U.K., data on agricultural land sales is not maintained by the Department of Agriculture. After much deliberation and consultation with various departments and agencies, in the end the thesis used agricultural land sales data from the National Property Information Centre's (NAPIC) annual publication, the Property Market Report (PMR).

Section 4.2 addresses in detail the important attributes commonly employed in HPM literature for agricultural land. The discussion is later used to guide the variable selection process. Section 4.3 describes the multiple sources of data in detail, including their respective limitations and advantages. Section 4.4 describes the sequence of processes carried out to construct the dataset. The final list of dependent and explanatory variables is formally listed in Section 4.5. Finally, to help provide a picture of trends and key features of the land market, the chapter develops descriptive statistics as given Section 4.6, while Section 4.7 concludes.

4.2 HEDONIC ATTRIBUTES OF AGRICULTURAL LAND

Guided by the survey of HPM literature at the end of Chapter 2, this section identifies the most commonly documented hedonic factors in agricultural land pricing studies. The hedonic characteristics are very broadly categorised as either physical or locational attributes of land.

4.2.1. Physical/Structural Attributes

Parcel-specific characteristics determine to a large extent the production function and income-generating capacity of a parcel of land. Both natural and man-made conditions of the parcel complement each other to influence the best resource combination for the specific production objective. As such, attributes like crop yield, soil quality, elevation, irrigation investment, eligibility for government payments, climatic changes, percentage of parcel cultivated, value of structures on the land and crop-type have all been proven capitalised into agricultural land values.[79] This section will examine in detail three particularly recurrent variables with respect to physical characteristics of a parcel: parcel size, land-use restrictions and crop yield.

4.2.1.1 Parcel Size

Of the many physical characteristics of land, parcel size is the one that is most often found statistically significant in connection to price, although the direction of this relationship is unclear. Brownstone and deVany (1991) challenged the hypothesis that in absence of competing uses for land, the value of a large parcel should equal the sum of the values of its subdivided parts – such that a linear relationship between parcel price and its size exists. They argued that this is not necessarily so. Price per unit of land tends to decrease with size if buyers consider the risks to their profit margin on account of the parcel's vastness; there are bound to be parts of the land with problematic gradients or underground water source or subsurface rocks which makes construction expensive.[80] Chicoine (1981) argues that a proportional value-size relationship can theoretically exist only if the size of an agricultural parcel sold coincides with the size needed for its intended use. If parcels are larger than needed and if the surplus area adds little or no utility to buyer, the costs of subdividing the parcel will be an unnecessary burden, such that the marginal relationship between price per unit and size declines.

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[79] There is a number of studies using hedonic techniques to gauge a cut-off point of possible conversion point for remaining agricultural land. This is commonly done by estimating a hedonic function for a sample of already developed properties (for a review, please refer to Bell and Irwin, 2002). An alternative approach as adopted by Drozd and Johnson (2004), use the hedonic analysis to formulate an index of land's 'farmability' based on specific spatial (location, cropland percentage, access to markets) and physical (soil, irrigation, slope) characteristics. The farmability index is then employed to predict a cross-over point of conversion into non-agricultural use. According to the authors, a parcel whose farmability index exceeds this cross-over point is more likely to be converted since its landowners can realise higher value from subdivision and development of the parcel. However, they acknowledge that the predicted sale-conversion might not always take place, either because agents are not aware of the potential premium embedded in their land or because of prohibitive transaction costs involved.

[80] However, if the land is earmarked for development, problems arising from physical shortcomings of the parcel are not expected to deter it entirely, especially if environmental and building restrictions are lax or if the market has shown that is willing to absorb the higher costs of land development.

If the parcel is purchased with development in mind, then the cost of land subdivision extends beyond transaction costs (search, negotiate, contracting costs) to include costs of land preparation and regulatory compliance. In addition, the larger the parcel size, the larger the amount of infrastructure per unit of land is required, e.g., road access, street lighting, sewerage and so on. It is also common to set aside a sizeable portion of the land for road and open space allowances as required by land regulators. All these considerations essentially results in smaller re-saleable area, or higher costs, hence smaller profit per unit of the land overall. Fischel (see Lin and Evans, 2000 footnote p. 393) observes that the number of houses built on larger parcels could be lesser than the number of similar houses on individual smaller parcels whose aggregate area is the same as the single larger parcel. To summarise, constant or increasing returns to scale is not a given outcome in land development activities particularly if flexibility in land-use is limited or if subdivision proves to be expensive.[81]

On the other hand, literature shows that increasing returns to scale can take place particularly if the sizes of parcels for sale are generally small, the costs of land assembly can be significant. Chicoine argues that because of market imperfections and the localised nature of the urban-fringe agricultural land market, cost of combining land can be expensive. As a consequence, people are willing to pay higher prices per unit of land as parcel sizes increases.[82] Lin and Evans found empirical support for this in their study of Taiwan urban housing market. They gave two possible reasons: (i) cost of building infrastructure is built into the price; and (ii) there are constraints in land-use choices. In a typical case, the type and intensity of development of a parcel is limited by the neighbouring lands' existing use. Buyers might be forced to purchase adjacent parcel(s) to resolve or reduce issues arising from introducing new land-use for the parcel in question. To conclude, a non-linear price and size relationship would exist if there is benefit (or cost) from land subdivision (or assembly) and that the relationship depends largely on the parcel sizes in general and land-use flexibilities.

[81] As Colwell and Sirmans (1993) clarified if arbitraging is indeed in full-force, then risks from owning large (or small) parcels can be completely eliminated.

[82] The incremental values for assembling and subdividing land are commonly referred to as plattage and plottage value, respectively.

4.2.1.2 Land-use restrictions

As demonstrated in the earlier chapters, land-controls are extremely important factors in pricing considerations because of the manner they affect the current and prospective owner's subjective expectations of future rents from the land (Larkin *et al.*, 2005, Nickerson and Lynch, 2001, Plantinga and Miller, 2001). Intuitively, the price of agricultural land enrolled in a land preservation programme, for instance, would fall or at least stabilise within the affordability of pure agriculturalists, at least for an agreed period of time. If the restriction is rescinded for any reason, we can expect the hedonic price function to change on account of there being upward shifts in the supply of land attributes. However, the impact of a restriction on price (or the extent of price shift) after its repeal largely depends on how credible the restriction is perceived in the first place; and this involves public views regarding its enforcement and the overall land planning. For instance, if the market expects land-use restrictions to be alterable (for economic, social or political reasons) in the not-too-distant future, market prices might not be at levels expected for a restricted land. Therefore, it is not surprising that empirical literature is inconclusive with regard to the impact of government land control measures.

4.2.1.3 Crop yield

Parcel-specific yield or output sale values are usually gathered through agricultural surveys or farm cooperative records. However, farmers (except those in government agrarian land settlements or agricultural assistance schemes) are still able to sell their output to private mills if prices are more favourable here. This poses a problem of data leakage because such private transactions can either be unreported or under-reported in official statistics. Furthermore, if the official documents only provide **aggregate** values of land output or sales value, for instance by state, which (i) cannot be linked to productive characteristics of the parcel; and (ii) do not display much variation in its numbers over time, then there is a likely problem of correlated errors in the model. Another aspect that complicates the use of yield is the lack of homogeneity in land use in any given area. In the thesis's study area, which spans four administrative states, there are no particular principal or expansive agricultural activities that allow us to adopt specific crop information such as those available for the Corn Belt states in the U.S.

4.2.2 Locational characteristics

Locational characteristics are particularly important in that they represent non-farm attributes that may give rise to production and potential differentials. Locational characteristics are variables that describe the geographical, social and economic characteristics of neighbouring parcels or the larger area where the observed parcel is located. A critical feature of these attributes is that they are not easily reproducible by the seller/landowner. For instance, owing to a parcel's spatial position, certain attributes such as scenic vistas cannot be easily replicated in other parcels; hence its 'exclusiveness'. The more inimitable the environmental or locational attribute, the lower the price elasticity with respect to these attributes.[83] Furthermore, the marginal effect of locational characteristics on price differ in value depending on whether land is used as a factor of production (e.g., in cash crop agriculture) than when it is used as a consumption good (e.g., vacation homes, recreational space). Because an attribute's importance in a hedonic price function is highly dependent on the type of land-use intended, studying the relationship between locational attributes and its unit price will provide useful indicators of its future use. To further the discussion, several important attributes are examined in more detail.

4.2.2.1 Distance to urban centre

There are various methods adopted in the literature to employ distance measures as indicators of urbanisation pressure and market access. The methods range from a straight line distance variable between parcel and city to the more complex urban gravity index (as in Shi, Phipps and Coyler, 1996) or population-weighted distance measures (as in Hardie *et al*., 2001). The availability of GIS-based data has brought tremendous improvement in the quality and convenience of using such measures in land valuation studies. Theoretically, if unit price falls with greater distance at a declining rate instead of a constant rate, this implies that the effects of distance on price gradually lessen the more remote a parcel is. Alternatively, one can test the relationship between proximity to urban centre and unit price of land by using a reciprocal transformation of the distance variable. In any form, distance to urban amenities has been prominently featured in many studies as an important proxy (and

[83] Mollard, Rambonilaza and Vollet (2007) give an excellent description of the 'territorial anchorage' concept and why it is a critical component in price determination.

sometimes the only proxy, such as in Shonkwiler and Reynolds, 1986) for non-agricultural sources of demand for land.

4.2.2.2 Distance to transportation nodes

In land price analysis, it might be worth examining the importance of distance to major transportation access points, not least to reflect the potential cost of reaching input and/or output markets. Furthermore, if a parcel is indeed desired for future industrial or commercial use, a high degree of visibility from the highway is always a desired bonus – the owner-firm can advertise by putting up large sign boards facing the highway, as well as subtly showcase their plants or showrooms to the highway users.

4.2.2.3 Neighbouring land-use

The general purpose of introducing variables indicating neighbouring land-use into the function is to gauge the degree of land-use diversification in the parcel's area i.e., how many types of land-uses there are and how pervasive they are. Examples of variables in this category are adjacent-parcel's specific land-use, percentage of land in non-agricultural use, index of non-agricultural infrastructure and index of land fragmentation per a unit of land. The spatial arrangement of an area's diverse set of economic activities has important implications for price (see Bockstael, 1996). For instance, if development activities are scattered within a traditionally agricultural region, the customary advantages of accessibility and complementarity when different agricultural activities exists in the same location (including those relating to labour supply, machine use, storage, processing and so on) will decline and be replaced by advantages from having different types of economic activities located together.[84] Positive and negative externalities and their spatial patterns are known to affect price (Geoghegan et al., 1997). The ultimate consequence of land-use diversification is that market price of land will eventually move towards the best and highest-earning land-use. As argued earlier in the thesis, scattered and unplanned

[84] For a discussion regarding merits of accessibility and complementarity in 'economics of location', please see Lean and Goodall (p. 141).

development in the rural area is particularly hazardous to agriculture's sustainability, as it tends to encourage land speculation and land fragmentation.[85]

4.2.2.4 Demographic factors

Demographic factors feature in many land hedonic studies in the form of local **population density** and annualised rate of **population growth**. Basically, the two are used to reveal trends regarding off-farm income opportunities and overall regional economic growth. A growing population would naturally attract supplies of other economic goods and services, which in turn will attract more people to the area. Consequently, increasing demand for land either for food cultivation, or residence (rented or purchased) naturally causes price to move upwards. Palmquist and Danielson (1989) explain the difference between the two variables: population density of the district in which the parcel is located can be used to measure current population pressures, while the rate of population increase can proxy for expectations of population growth. It is normally assumed that population expansion entails greater economic diversity, which is translated into higher development expectations in the area.

The preceding list of value-contributing characteristics provides us the much needed direction for the model building task. The varied nature of attributes also serves to remind us of HPM's main advantage which is modeling flexibility. The following section describes the process of identifying appropriate and reliable data to represent the variables above, and discuss their importance for the Malaysian study.

4.3 DATA IDENTIFICATION

Our study covers a period of seven years from 2001 to 2007 encompassing four states located in the west coast of Peninsular Malaysia. The states: Selangor, Perak, Negri Sembilan and Melaka, are selected based on their relatively higher degree of non-agricultural investment and population growth compared to the rest of the country. The states are well-connected via the North-South Expressway. The land sales data come from 27 districts in the study area which involves various types of

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[85] Problems caused by diversity and land fragmentation are more pressing in the rural framework than in urban area where land-use tends to be more homogeneous. Landscape ecologists study mosaics of natural and man-made *patches* of activities and their effect on the eco-system and landscape valuation (see Geoghegan et al. 1997).

economic activities. Agriculture is one of the key economic sectors for Perak, contributing to 14.6% of its Gross Domestic Product value in 2006. Current agricultural activities include cultivation of rice, the planting of commercial crops such as oil palm, rubber and sugar cane, and the cultivation of fruits and vegetables. Selangor, Negri Sembilan and Malacca enjoys close proximity to the country's commercial and administrative capitals, Kuala Lumpur and Putrajaya respectively; and the country's main port (Klang). Main economic contributions to the GDP comes from the manufacturing and services industry, Malacca's main sector today is tourism, while Negri Sembilan continues to benefit from escalating industrial and residential land prices in Selangor and Kuala Lumpur. Malay Reservation lands and land settlement schemes are well-spread over the four states. Federal territories of Kuala Lumpur and Putrajaya are omitted, although they are in the same region since there is almost no agricultural land stock there. The following sections will offer insights on our deliberations on data sources, measurement issues, data input and processing.

Figure 4.1. Map of Malaysia

4.3.1 Property Market Reports

Our principle source of data is the Property Market Reports (PMR) published by the National Property Information Centre (NAPIC), the research arm of Valuation and

Property Management Division (VPMD), a division under the Ministry of Finance.[86] The annual publication compiles data regarding market trends categorised by type and location including agricultural land sale information: land-use, location and accessibility from main roads of a selected sample of observations. Basically, population of observations in the NAPIC database is directly obtained from the PDS 15 (Pin. 2006) form issued by Stamp Duty Department of the Inland Revenue Board.[87] The observations that eventually appear on the PMR publication are those considered sufficient and suitable to show a 'fair' market value of land which subject to the kind of attributes present. This is in line with the hedonic pricing model principle whereby price of a land parcel should correspond to the type and level of attributes of the parcel.

The PDS 15 (Pin. 2006) form concerns Section 5 of Stamp Act (1949) is used to record details regarding completed property transfers and in the computation of stamp duties[88]. However, information eventually published in the PMR only includes the title land-use category, actual activities on the parcel (if legal agricultural land, specific crop type must be mentioned: rubber, oil palm, rice (single or double cropping), coconut or cocoa, fruit cultivation or aquafarming and so on). Appendix 4A at the end of the chapter shows a sample of the PDS15 form, whilst Appendix 4B shows a sample page from the PMR report. To simplify the study, the thesis focussed

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[86] We spent a substantial amount of time to determine possible sources for land value data. The Land Office data is found unsuitable for several reasons. Firstly, the decentralisation of power over land under the Constitution (as described in Chapter 2) gave rise to slight state-based variations in land management, which needs to be accounted in a broad cross-sectional study such as ours. Secondly, in any given State, land transfers are registered under a multi-tiered system - rural land exceeding 4 hectares are registered with the state Registry office, while smaller land plots are registered at local district land offices. Because of this system of record-keeping, the process of data collection form both levels for all states (involving 31 offices altogether) would be time-consuming as well as risking inconsistency and varying cooperation levels. Thirdly, the land transfer forms used to register changes in ownership are filed separately from the land title document. Therefore, while it is possible to see who the previous and new owners are and what are the land's characteristics from the land title, transfer details e.g., amount of monies are recorded in another document maintained separately. We also made every effort to obtain land value information from the Department of Agriculture's records. They appear to have rather good data regarding crops hectarage and agricultural land-use, including information regarding rainfall and elevation. Unfortunately, there is no information regarding agricultural land values or rent, nor do they routinely incorporate price valuation questions in their agricultural surveys or census.

[87] The Inland Revenue Board Malaysia is the equivalent of HM Revenue and Customs in the United Kingdom. The form is required for all types of private transfers of land assets with or without exchange of cash.

[88] To safeguard against under-reporting sale value to save on stamp-duty, the form will include market value of the land as determined by the VPMD. Subsequently, the amount of stamp duty payable will be calculated based on the higher of the two.

on only four types of agricultural land (rubber, oil palm, rice and vacant (or idled) land) and a special category of land which is basically agricultural or rural land with positive development potential. For this, the VPMD officials employ site-visits or local information summary including neighbouring land use, local plans as well as a host of observable and unobservable features valuation officials believe may contribute to a parcel's development value.

By comparing Appendix 4A and 4B, it is shown that there is a considerable amount of information regarding the parcel and the characteristics of the buyers and sellers in the PDS(15) form which are not published in the PMR.[89] This is understandable given the purpose of the latter as a market reference document for the real-estate practitioners. It is possible to request access to VPMD database to extract other information about the parcels omitted from the PMR. There are three reasons why we did not pursue this further. Firstly, only licensed real-estate agencies and certain entities can be registered as a data user. Secondly, even if an academic researcher is eventually registered, the cost of data could be prohibitive given the large area being studied.[90] Thirdly, VPMD does not maintain a central repository of data, hence separate applications and subsequently collection of data must be done at each VPMD branch offices in the study area.[91] We would have made every effort to overcome these constraints had we not already spent a lot of time and expenses identifying potential data sources earlier.

Information about existence and value of farm or residential structures or other improvements on the parcels are not recorded even in the PDS(15). However, they are assumed to be very modest (relative to U.K. norms) for several reasons. Firstly, the law allows no more than one residential building in agricultural parcels less than

[89] Not all of the information is transferred to VPMD's database.

[90] Data for each parcel costs RM1.00, which is approximately £0.16 as at December 2009.

[91] The problems discussed here goes to explain why a wide-scale cross-sectional land price examination is rarely attempted. A recent study by Suriatini Ismail (2005), done with research grant from VPMD using branch-level data, only covered a single district, Kulai in the state of Johor. Such limited geographical and temporal focus limits the use of the study for policy inferences because single district studies often assume homogenous land type, soil quality and market participants; therefore suits real estate studies rather than economic analyses of price determinants. Interestingly, out of over 5000 property sales data Kulai, only less than 200 were usable in her regression exercise because of incomplete and inconsistent information recording. This reflects potential problems of data consistency that we will face even if we are able to access the database.

one acre. Since many of the parcels in the observation are likely to be small-holdings, we do not expect the number or value of building to be substantially important in price determination. Secondly, the custom in Malaysia is that land-owners/farmers reside in a communal village instead of on their respective farms. Thirdly, rubber, oil palm or rice processing mills usually require large capital outlays such that they are typically owned by large plantation firms or the settlement agencies. Hence, it is possible to conclude that the average parcel price per hectare is not highly influenced by the value of the owner's house or structures.

By using the PMR data instead of VPMD branch-level data, the study possibly passed up many details of the land transfer which are excluded in the PMR. They may include lease type, restrictions, transferor and transferee information and more importantly the parcels' land lot number. Without the lot number, additional information such as soil type, infrastructure, distances to amenities and so on cannot be matched with Geographic Information System (GIS) data sources accurately. There is also no information about crop planted on parcels that are categorised as developable land. Therefore, this creates a missing value problem if we are to use crop-type as an explanatory variable.

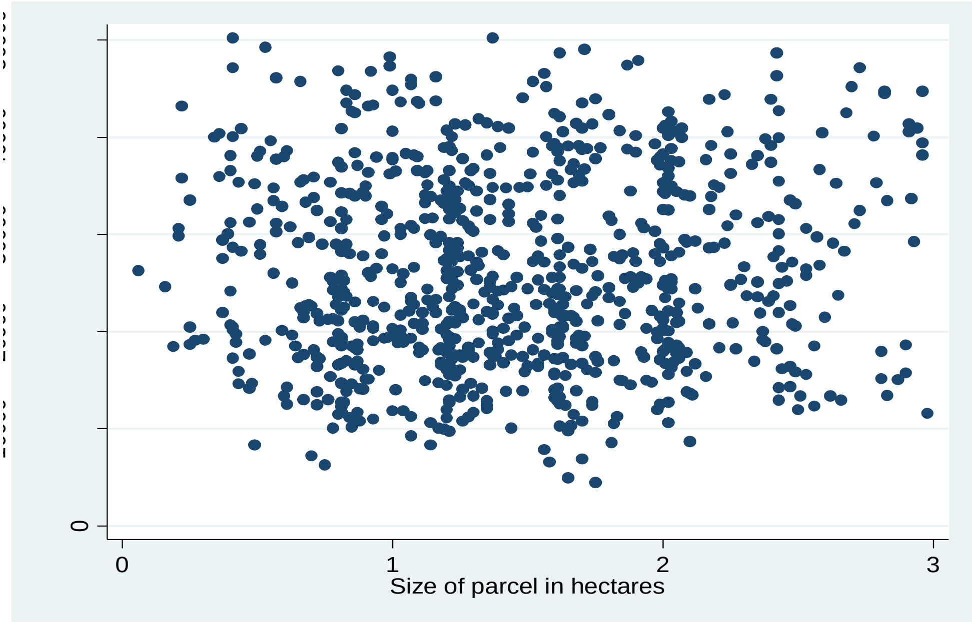
A particularly important piece of information that is not carried over to the PMR is whether a parcel is transferred as a stand-alone transaction or is part of a larger transaction involving more than one lot of land or owners. Where there is more than one person with a registered claim on a parcel of land, the law requires that the PDS15 form conveys information correspond to a single individual and his claims of the land only.[92,93] Because many observations in the dataset are recorded as under 0.4

[92] Each 'lot' of land may have one or more registered owners of a small original lot can elect an administrator amongst them and through the instrument of power of attorney, sell the land as the one lot that it is. In the event of a complete sale, each co-owner must discharge their individual claims on the land accordingly. The system also allows partial sale, subject to conditions, where (a) only some co-owners sell their interests in the land, while others retain theirs; and (b) the owner or co-owner sell only a portion of their collectively owned land and retain the rest.

[93] In the PDS(15) form, the person transferring the parcel is required to indicate if the transfer is part of a larger transaction. However, this information is not carried over to the PMR. By referring to the PMR's information alone, it is possible to infer that parcels whose 'average land area' is less than 0.4 hectares are part of a transaction for a larger plot of land. However, we cannot ascertain if other parcels in the sample are necessarily sold on its own.

in size,[94] it can be concluded that the ‘average land area’ information in the PMR does not refer to parcel size per transaction but only to each person’s share of the sold land.[95,96] Since price negotiations are likely to be more affected by the total size of land offered for sale, we are unable to use PMR’s size data to correctly infer about the relationship between parcel size and per unit price of land. A scatterplot of price and PMR’s parcel size confirmed that there is no discernible relationship between the two (Figure 4.2. and 4.3); even at other various magnifications of the data set.

Figure 4.2 Scatterplot of real price per hectare and PMR’s ‘average land area’ less than 3 hectare.

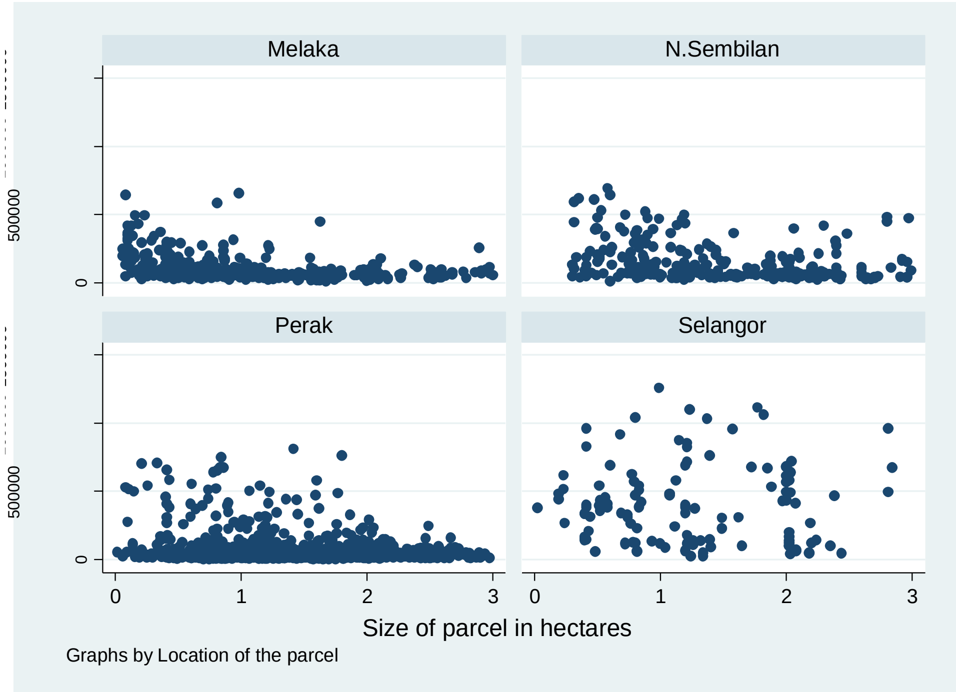


[94] Recall that Section 205(3) of the National Land Code prohibits agricultural land subdivision or partition if any of the resulting lots becomes smaller than 0.4 hectares.

[95] This is reasonable given that PDS(15) is essentially a stamp duty declaration form, completed by each party involved in a transfer and used to compute his individual stamp duty charges.

[96] Smaller parcel sizes may be the outcome of land partition exercises. The NLC allows a co-owner to initiate steps to withdraw his share of the land and have it registered solely under his name. The overall process of land partitioning can be lengthy and costly. Needless to say, buyers do not mind paying more for already-partitioned parcels (as long as the parcel size coincides with buyers’ needs). This explains why Malaysia’s estate plantations are seldom interested to enter the market for small privately-owned lands. Large companies prefer to expand their landholdings by buying from each other rather than from smallholders. If land assemble cost is as significant as the market perceive it to be, then we can expect to see a convex relationship between land’s price and size i.e., the smaller the parcel, the lower the **unit** price of land.

Figure 4.3 Scatterplot of real price per hectare and PMR's 'average land area' less than 3 hectare by state.



Nevertheless, the PMR possesses some merits over other data sources and as a whole is fairly comparable to equivalent US, and Canadian land sale databases. Firstly, it allows the use of actual price paid as the dependent variable (refer to Section 2.4.5). Secondly, because of its latitude, with respect to land types, time and geographical coverage, the PMR offers a valuable natural experiment opportunity to test many of the propositions made in this thesis earlier. Thirdly, errors and outliers are minimised because the data is already purged of non-competitive transfers such as:

i. land transfers between state and federal ministries or agencies (lease or takings)

ii. nominal price or zero-compensation transfers (gifts of land or land-swap transactions.[97,98]

iii. related-party-transactions[99] (i.e., transfers from parent company to its subsidiaries or between associated companies). Property subsidiaries of large

[97] Swap land transactions refer to which does not involve cash, rather done in exchange for another piece of land, cost of building properties or a percentage of equity as well as payment for settlement of debt. State or federal agency's request for land is usually carried out through the land alienation process (lease from state) or swap, depending on the need and location.

[98] These observations are omitted from the regression dataset for being against the HPM assumption that the land price function represents equilibrium prices for each attribute in a **competitive** setting.

[99] Related-party-transactions involving land arise mostly in instances where an agricultural company with vast land-bank disposed a portion of its land to its own property development subsidiary or an

plantation firms embark on land development projects using portions carved out from existing land banks. Whole townships have been built on plantation land e.g., Sime UEP's USJ, Bukit Jelutong in Shah Alam, Bandar Baru Bukit Raja in Klang. Guthrie (now part of the Sime Darby group), for example, also operates an expressway in Klang Valley. Plantation companies are among the largest property developers in the country.

4.3.2 Digital and Printed Maps

To augment the PMR database, variables representing the locational characteristics of a parcel are added by using simple GIS tools. Each parcel is uniquely geo-coded according to the given address or reference to the nearest identifiable location (transformation of textual data into spatial data).[100] GIS is useful to compute location-based characteristics (such as distance to urban centre) and to specify elements within a spatial unit surrounding a parcel. Distances between points on a map based on their individual geo-codes are naturally more accurate compared to distances calculated based on a centroid of a postcode area or a *mukim* the parcel is located at. Even though digital versions of the government-issued maps can be used for the geo-referencing exercise, we use a freely available geo-coding application from www.simple3uonline.com which is based on Googlemap. Government digital maps were considered but they require registration with the Mapping and Surveying Department (MSD) which produces the maps. Furthermore, the MSD maps are based on Malaysian Rectified Skew Orthomorphic (MRSO) coordinate system, whereas previous spatial econometrics work employing STATA that we plan to emulate employs the more universally-used World Geodetic System 84 (WGS84).[101]

Since it is important to identify the impact of land restrictions on sales value, the empirical model includes two types of land controls pertaining to agricultural land.

associated company in exchange for equity and/or cash. The exchange value is therefore dependent on the company's market share price and negotiations between the parties (including minority shareholders demands) and therefore although transparent, may not reflect market equilibrium accurately.

[100] Linear referencing refers to using relative positions on a road, street, rail, or river network to describe location of a point of interest.

[101] There are also various technical issues concerning the use of RSO for micro land maps, particularly when dealing with points on state geographical borders.

Parcels located within the Integrated Agricultural Development Area (IADA)[102] or Group Settlement Act schemes (GSA) are typically restricted in terms of use as well as ownership. The rate of land withdrawal from the programmes has been low in the past[103] but is expected to increase as the land's second generation settlers are not interested or are unable to continue in the programme. Another relevant land-control item is the Malay Reserve Land (MRL) enactments which bars land from being sold to non-Malays regardless of its land-use category. It is interesting to observe if the two forms of land controls i.e., GSA and MRL, have any impact on the number or type of potential buyers entering the market, *ceteris paribus* and hence, its average prices. The PMR showed inconsistencies in the reporting of land restrictions; which would result in unreliable or missing values in our data.We eventually found a solution in the form of the humble MSD's printed thematic maps. The specific series, DNMM9101, available at state level, show international, states, district and *mukim*[104] boundaries, and more importantly, MRL and GSA areas.

In fact, a series of land-quality maps (digital and printed) are also available from the Department of Agriculture (DOA), including agro-climatic maps, soil suitability map, crop suitability map and soil erosion risk map. Using digital map overlaying techniques, the DOA maps could be imposed on a base map,[105] to provide a more informative description of a district's physical and spatial characteristics. However, because the DOA's maps show aggregated agricultural characteristics of the land, they might not be as useful as expected to justify the high financial, time and bureaucratic costs incurred when obtaining individual digital maps from the various district offices involved.[106] It would be very difficult to match the various crop suitability data to each individual plot by using these maps. Very few parcels are

[102] In general, granary areas are today mainly located in IADA projects. Rice farms outside of IADA areas are individually-owned, although many farmers receive technical advice from the state's Department of Agriculture.

[103] This statement is based on anecdotal information gathered from separate discussions with RISDA, DOA and IADA officers met in the course of data identification.

[104] *Mukim* is a sub-unit of a district.

[105] For this specific purpose, we purchased a set of base maps for all four states from a private surveying institution.

[106] The cost of Malaysian government's geo-spatial data is approximately between £100 to £170 per mega byte. There are separate maps for each characteristic and there are 26 districts involved. There is no single integrated land quality variable to be used in the study to simplify the variable and avoid unnecessary loss of degree of freedom. It is in fact not possible to use a single land quality index for the diverse types of crops prominent in the Malaysian agricultural sector.

homogenous in land quality even if they are currently planted with the same crop. A single land quality measure is not available and is in fact difficult to use in a large cross-sectional study like ours. Crops like rice are not only sensitive to soil type but also rainfall pattern over the course of planting, while oil palm tree do well on peat soil. In addition, the process of integrating the maps together, particularly if they employ different land identification scale, format and projection, can be very daunting for a non GIS-specialist. Chapter 3 has also shown that the title's land-use category might not always correspond to crop-soil suitability matrices.

Roka and Palmquist (2008) noted that using soil suitability data tend to be problematic when comparing soils across vast regions, particularly when the pre-dominant crops change. Using average yield to measure soil productivity is equally problematic when there are different crops in different areas. Even Benirschka and Binkley (1994) found results for soil quality indicators to be ambiguous for the U.S. Corn Belt states. Nickerson and Lynch (2001) did not find prime soils to matter in decisions to enrol land in land preservation programmes. Madisson (2007) found that land quality grades and price relationship is inconclusive for the England and Wales hedonic study. Given that grades of land are commonly made known to prospective buyers via the sales catalogues or other less formal methods, he found that some grades are statistically significant while some are not, and that the estimated implicit prices attached to the different land grades fail to correspond with the land quality rankings. Based on the foregoing arguments and evidences, it can be concluded that whilst the land soil grading system (if available) can accurately indicate a parcel's 'use-capacity', it is not as important to indicate the parcel's economic worth or 'highest and best use'.

4.3.3 Census Publications

Population figures are derived from the 1991 and 2000 Population and Housing Census of Malaysia. Annualised population growth and population density are calculated for each parcel according to the district it is located. District's population density is based on the 2000 Census.

4.4 DATA PREPARATION

In summary, data are combined and processed according to the following steps:

4.4.1 Textual data to Digital Format

Information from the PMR was keyed into the Microsoft Excel spreadsheet. They include year, state, district, address, price per hectare, land-type (agricultural or development), crop (if agricultural land), parcel size and road frontage. The initial dataset comprised 2796 sales observations.

4.4.2 Spatial Data

Based on linear-referencing information given in the PMR, the parcel's most likely location was identified and geo-coded one at a time. Parcels for which the textual location description was too general or ambiguous are omitted. To improve accuracy, we also made use of hybrid map feature (showing both road and satellite maps of a location) to help determine if the location's current land-use corresponds to the information in the PMR:

- Agricultural land – rice (light green squares), oil palm (dark green vegetation), rubber (light green vegetation)
- Developable land – must not be located in obvious urban, water catchment or forest reserve areas.

For every one of the observation, the longitude and latitude values are then used to compute distance variables using suitable STATA programming codes.[107] Firstly, geo-codes of four cities with population over 250,000 (based on 2000 population census) are obtained. The cities are Kuala Lumpur, Ipoh, Melaka City and Seremban. The calculation of Euclidian distance, i.e., straight line distance between the parcel and its **nearest** city in kilometres, follows[108]

$$z = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

where x_1 and x_2 are longitudes and y_1 and y_2 are latitudes of the two points. The outcome, z, is converted to kilometres by multiplying it with 111 km (approximately

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[107] The codes were guided by a response Sergio Correia gave in the Statalist user forum regarding the best way to measure shortest distances between two points. The thread can be accessed from the following url, http://www.stata.com/statalist/archive/2007-01/msg00074.html

[108] Distance is calculated between two points using the respective latitude and longitude coordinates on projected maps. A planar approximation for the surface of the earth may be useful over small distances and is considered accurate for locations at the equator. Because of Malaysia's position on the equator, it is possible to assume that the study area is relatively 'flat' and therefore use the projected coordinates available as it is. The circumference of the earth at the equator is 24,901.55 miles, divided by the 360 lines that run from the North to South Pole yields physical distance between each 1 coordinate to equal 69.17 miles or 111.32 kilometres, with a small margin of error.

69 miles). The process is repeated to find the distance between a parcel and the nearest access to transportation access (major NSE interchanges) and also in the calculation of distances to 'neighbouring' parcels.

4.4.3 Land Restriction Data

Next, we use the MSD printed maps on which we flagged all of the MRL and GSA areas. If a parcel in the data is clearly within a flagged area, its restriction variable takes the value of one; otherwise, zero. However, in reality each individual lot of land might be subject to different restrictions or might have had certain restrictions lifted in the past.

At the end of these procedures the sample size is reduced to 2222. Appendix 4C shows a random excerpt from the Excel worksheet containing the final dataset. The complete set of data can be requested from the author. Despite plenty of precedents from the literature with respect to variables and methods of estimation, this section demonstrated that modeling a hedonic price function for agricultural land requires great care to achieve a depiction of the market that is as accurate as possible. Based on the array and quality of data available to us and recommendations contained in the hedonic model literature, the list of variables for our empirical study of the Malaysian agricultural land prices is presented in the following section.

4.5 VARIABLE SELECTION AND MEASUREMENT

The previous section described the variables of interest and for which data are readily available. This section is merely to reiterate the list of variables and their expected effects on average price. A summary of variable definition is provided in Table 4.1. The dependent variable in the model is Real Price per hectare of land in Ringgit Malaysia (RM), *rprice,* obtained from records in the annual Property Market Report publication. The sale values are deflated using year 2000 constant prices based on the yearly Consumer Price Index (CPI). The CPI is considered more relevant compared to other price indexes. Since the agricultural sector involves a large proportion of smallholders and that they typically employ simple input materials, it is expected that changes in consumption power of the Ringgit is more pertinent than changes in producer prices which tracks changes in prices of machineries and inputs more relevant to the manufacturing and industrial sectors. The thesis also use unit price of land instead of total price of land as the former is expected to reduce possible problems associated with heteroscedasticity.

Road frontage, *rdfnt*, is hypothesised to give positive value to parcel price, irrespective of parcel's potential use. If a parcel is under land-transfer or land-use constraint, the relevant restriction dummy variables will take the value of one. We anticipate that the more restrictions a parcel is subjected to, the less attractive it becomes and thus, the lower its unit price. We also investigate if different types of restrictions, *mrl* and *gsa*, produce different marginal impacts on price.

The proximity of the land parcel to the nearest town area, *distown,* is expected to be positively related to unit price of land. The significance of this variable is multi-fold. To agricultural buyers, it represents ease and cost of access to market for their agricultural input and output. To non-agricutural buyers, the distance variables represent locational advantage, with regards to social amenities – administrative, recreation and economic – that proximity to an urban area brings. Intuitively, the implicit price of proximity to an urban centre should be higher in areas where agricultural parcels are relatively more dominant, compared to areas where development is still in progress. Nevertheless, proximity to city centre is not positively valued if pollution, congestion or other negative urban externalities are significant. Distance from a parcel to the nearest NSE interchange, *distnse*, is expected to be important in a similar way although for slightly different reasons. NSE is the main route for transporting commodities for markets in another state or to Thailand or Singapore, as well as for shipment through Penang, Port Klang or Singapore international ports; NSE is also used by many residing in rural areas to commute to work in the larger towns or cities.

Demographic information is valuable to shed light on changes occurring in the surrounding areas of a parcel, and is often employed to signal rising non-agricultural demands on the existing overall supply of land. An important demographic indicator is population growth, *popgro*, which is hypothesised to be positively associated with land prices. Another often used indicator is population density, *popden*, which serves to reflect urban pressure in the area as more and more people opt to move out of the district or stay because higher levels of amenities or job opportunities now accessible to them.

In order to capture the effects of different land-use potentials, we include dummy variables for the five categories of land: developable agricultural land, rubber, oil palm, rice, and vacant agricultural land. The last four categories can also be broadly classified as non-developable agricultural land (*dev* = 0) in the sense that their 'highest and best' potential is still in continued agricultural use. The land-use dummies are introduced in the additive and multiplicative forms to determine structural stability across the different land-use potentials. State-based dummies are later introduced into the model to test the geographical extent of the land market.

Table 4.1 Data Description and Summary Statistics: Full Sample (n=2222)

VARIABLE	DESCRIPTION	MEAN	STD DEVIATION	MIN	MAX
rprice	Sale Value per hectare (in RM) in 2000 prices	106,028	146,490	4,753	1,254,197
rdfront	1=Parcel with Road Frontage; 0=otherwise	0.202	0.402	0	1
distown	Euclidian distance to nearest town (in km)	40.54	24.32	1.81	126.62
distnse	Euclidian distance to nearest NSE interchange (km)	21.29	18.02	0.48	83.42
popden	District's population density based on 2000 Census	228.78	303.61	13.09	2516.08
popgro	Annualised district population growth based on 1991 & 2000 Census (in %)	1.96	2.66	-0.41	13.47
gsa	If located in Group Settlement Schemes, then gsa=1; otherwise=0	0.22	0.42	0	1
mrl	If located in Malay Reserve Land areas, then mrl=1; otherwise=0	0.22	0.41	0	1
dev	If possesses development potential=1; otherwise =0	0.22	0.42	0	1
oil palm	If planted with oil palm trees=1; otherwise =0	0.27	0.44	0	1
rice	If planted with rice=1; otherwise=0	0.05	0.23	0	1
rubber	If planted with rubber trees=1; otherwise=0	0.36	0.48	0	1
vacant	If not cultivated=1; otherwise =0	0.31	0.46	0	1
melaka	If located in the state of Melaka=1; otherwise=0	0.21	0.41	0	1
n.sembilan	If located in the state of N.Sembilan=1; otherwise=0	0.17	0.37	0	1
perak	If located in the state of Perak=1; otherwise=0	0.55	0.49	0	1
selangor	If located in the state of Selangor=1; otherwise=0	0.06	0.23	0	1

4.6 DATA DESCRIPTION

This section highlights several points regarding the data assembled. The summary of statistics (Table 4.1) shows that the dependent variable, real price per hectare of land (*rprice*), has an arithmetic mean of RM107,028, and median of RM55,611(Table 4.2). The median shows the central tendency of the sample's sale price value; while the mean is, in fact, much closer to its 75th percentile value. In other words, 75 percent of the values of variable price are approximately less than the mean value.

Table 4.2 Percentile distribution of Price per hectare of land in real prices per hectare

Percentiles	*Real Price in RM*	*Percentiles*	*Real Price in RM*
1%	10,672	75%	108,588
5%	15,774	90%	267,011
10%	18,732	95%	433,676
25%	29,847	99%	705,317
50% (Median)	*55,661*	*Mean*	*107,028*

Simple state-based analysis using unit price intervals (Figure 4.4) also shows that for all states except Selangor, *rprice* distribution is highly skewed to the right. More than 85 percent of the Perak samples were sold at prices less than the sample mean while for Melaka, Negeri Sembilan and Selangor, the proportions are approximately 70, 65 and 14%, respectively. In all four types of non-developable land 90% of the samples are sold below the global mean price (Table 4.2).

Figure 4.4 Histogram showing the distribution of observations

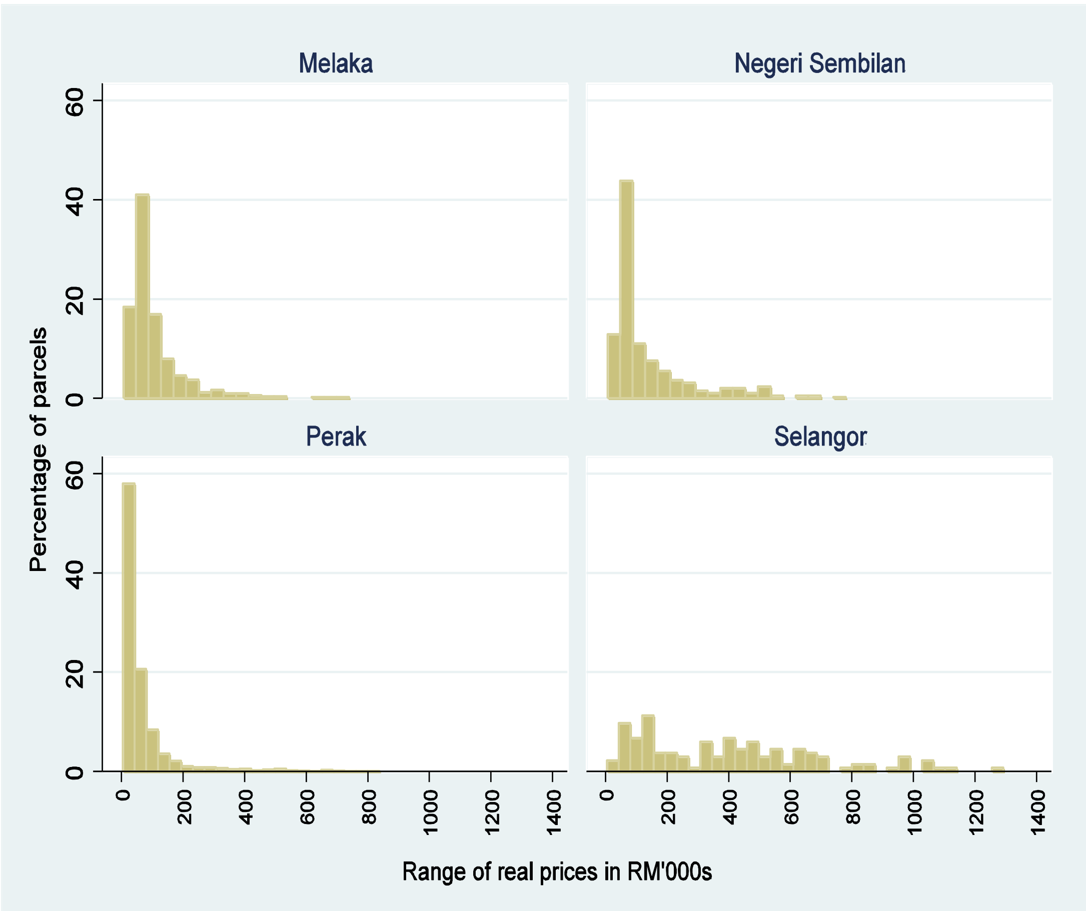

Table 4.1 also reports that the standard deviation of *rprice* for the full sample is RM146,490, which indicates a very significant dispersion across the sample. Developable parcels make up 20% of our regression sample; rice only 5% while the other three types of land contributes to 30% on average to the sample size. With respect to the parcels' geographical distribution, Perak, being the largest and the most agricultural of the four states, contributes just over half of the overall sample observations. Perak's average distance to town and NSE access points is the largest compared to the rest of the sample states. Only 15 percent of Perak samples display development potential (Table 4.3). On the other hand, more than two thirds of the Selangor samples have development potential. This is not surprising given that distances to town and highway accesses are smaller and the districts in Selangor are relatively more populated. The population growth in Selangor districts are on average five times higher than those in other states.

Table 4.3 Descriptive Statistics by State

	n	*dev*	*rprice*	*rdfront*	*distown*	*distnse*	*popden*	*popgro*
Selangor	133	0.66	399,934	0.34	17.2	11.7	683.0	10.7
Melaka	477	0.25	100,127	0.17	19.4	11.0	406.6	2.2
N.Sembilan	379	0.30	128,187	0.24	28.1	18.8	186.4	2.17
Perak	1233	0.15	70,497	1.86	38.4	27.1	123.9	0.85

From the following Table 4.4, it is fairly obvious that mean prices vary a great deal depending on development potentials of the parcels. For instance, the mean price of non-developable land in general is less than one-fifth of the mean for developable land. Although the mean area of the former is larger, close to half of the latter enjoy road frontage, which is another important explanatory variable. On average, parcels without development potential are located further from urban centres and highway access points. Additionally, the districts they are located in are sparsely populated and have slower rate of population growth.

Table 4.4 Descriptive Statistics by Development Potential

	n	*rprice*	*rdfront*	*gsa*	*mrl*	*distown*	*distnse*	*popden*	*popgro*
All	2222	106,417	0.2	0.23	0.22	40.54	21.28	228.8	1.95
Dev	1723	299,820	0.48	0.03	0.25	31.67	15.30	409.76	3.67
Non-dev	499	50,180	0.12	0.29	0.20	43.16	23.02	177.2	1.45

Among non-developable observations (Table 4.5), rice land seems to be the cheapest at an average of RM36,361. The unit price reflects low-profit margins from rice farming in Malaysia relative to other rice-producing countries in South East Asia. To promote Malaysia's self-sufficiency in rice production, the rice sector has undergone transformation and is today characterised by several forms of input subsidies as well as rural improvement programmes.

Table 4.5 Descriptive Statistics by Current Agricultural Use

	n	*rprice*	*rdfront*	*gsa*	*mrl*	*distown*	*distnse*	*popden*	*popgro*
Oil palm	462	54,365	0.13	0.31	0.08	47.15	24.76	148.54	1.19
Rice	94	36,361	0.11	0.56	0.37	59.91	17.69	183.88	1.01
Rubber	602	48,466	0.12	0.35	0.24	39.42	22.82	158.23	1.27
Vacant	543	50,985	0.12	0.17	0.24	41.14	18.34	216.70	1.95
Total	1,716	50,180	0.12	0.29	0.20	43.16	23.07	175.32	1.44

Another interesting statistic concerns vacant land. As shown in Chapter 3, land is left underutilised due a number of possible reasons: structural, economic and institutional. Where the problems (and low rates of return) persist, the landowners are usually willing to dispose the land to the market at unit prices lower than actively cultivated land. Rice and rubber land commands lower than average prices in the non-developable land categories due to low profit from price competition in the international market.

The table also shows the relative proximity of the various categories of agricultural land-use to urban centres and highway access points. On average, rice lands in the sample are nearest to highway interchanges but are relatively further from city centres. On average, oil palm parcels are generally further from cities or highways, if only slightly from the rest of the sample.

On average, land restricted under *gsa* commands very low sale price at RM43,731 compared to RM139,695 if the parcel is only *mr*l restricted (Table 4.6). The numbers hint that the effects of the different restrictions on average price are different. Parcels that are both *gsa* and *mrl* restricted fetches even lower average price i.e., RM28,574. The table shows that land settlement parcels are typically remote as they usually involve new land openings; whereas *mrl* lands are not necessarily so.

Table 4.6 Descriptive Statistics by Type of Restriction

	n	*rprice*	*rdfront*	*distown*	*distnse*	*popden*	*popgro*
GSA only	341	43,731	0.08	45.42	23.62	132.41	1.34
MRL only	315	139,695	0.22	25.74	15.19	507.22	2.99
GSA&MRL	165	28,574	0.07	66.07	40.19	76.78	0.79
Unrestricted	1401	124,330	0.24	39.68	19.85	207.45	2.02
Total	2222	106,417	0.2	40.54	21.28	228.8	1.95

4.7 CONCLUSION

The first two sections in this chapter discussed in detail explanatory variables customarily found in agricultural land hedonic pricing literature. Then the chapter described the process undertaken to identify, acquire and prepare the dataset for our hedonic pricing model estimation. We discussed the appropriateness of each source and types of data that were eventually selected in our regression model. Due to constraints in the data, it was shown that several important variables could not be included in the model such as parcel area, type of buyer and seller, tenure type, information about co-ownership and soil quality. The omission of certain variables compromises our ability to directly test effect of transaction costs and market imperfection on prices. Nevertheless, the hedonic model constructed in this chapter is promising in that it is able to incorporate both spatial and economic information to study various sub-types of agricultural land despite the data-sparse environment we started with.

The empirical model will estimate implicit prices of individual land attributes and subsequently reveal if the implicit values differ from one sub-type of land to another. The descriptive statistics section suggests that the different land-use potentials (agricultural and development) and spatial locations (as given by state where the land is located in) of land are particularly important to price variations. We should also be able to compare between vacant and cultivated agricultural land. It is hypothesised that restrictions cause unit price to fall by limiting the number of buyers and sellers in the market and that their respective impacts on price differs from one another. The aim of the empirical exercise is to explore statistical significance or correlations based on the price relationships discussed in this chapter. For achieve this end, the next chapter is devoted to describing the empirical methodology employed in the exercise.

APPENDIX 4A: THE PDS (15) FORM FOR COMPUTATION OF STAMP DUTY

PDS 15 (Pin. 2006)
(Borang Seksyen 5)

LHDN MALAYSIA

Taksiran (Pejabat Duti Setem/Pusat Khidmat Hasil) ……………………………………………………………………………………

[Borang ini hendaklah diisikan dalam lima salinan dan dihantar pada masa surat cara pindah milik iaitu borang KTN 14A/MOT, Surat Ikatan Penyerahan Hak, Borang KTN16F dan 16I dihantarkan untuk disetemkan. Menurut peruntukan di bawah Seksyen 36 Akta Setem bayaran RM10.00 kena bayar.]

Deklarasi di bawah Seksyen 5, Akta Setem 1949 berhubung dengan Pindah milik Harta Tanah

A. PIHAK-PIHAK

Pemberi Pindah milik atau Penjual	Penerima Pindah milik atau Pembeli
Nama : ………………………………………………………	Nama : ………………………………………………………
No. K/P : …………………………………………………… *Warganegara : *Syarikat Tempatan atau Syarikat Asing : No. Pendaftaran Syarikat : ……………………………………… No. Fail Cukai Pendaftaran : ………………………………… diuruskan oleh Pejabat Cawangan Hasil Dalam Negeri di …………………………………………	No. K/P : …………………………………………………… *Warganegara : *Syarikat Tempatan atau Syarikat Asing : No. Pendaftaran Syarikat : ……………………………………… No. Fail Cukai Pendaftaran : ………………………………… diuruskan oleh Pejabat Cawangan Hasil Dalam Negeri di …………………………………………
Alamat untuk Urusan : …………………………………………… …………………………………………… …………………………………………… No. Tel/Fax : Tel : ……………………… Fax : ……………………	Alamat untuk Urusan : …………………………………………… …………………………………………… …………………………………………… No. Tel/Fax : Tel : ……………………… Fax : ……………………
Sebutkan hubungan antara kedua pihak (misalnya adik beradik atau syarikat induk/anak syarikat) : ………………………………………………	
Nama, alamat dan rujukan fail peguam …………………………… (jika ada) : …………………………………………………… …………………………………………………… No. Tel/Fax : Tel : ……………………… Fax : ……………………	Nama, alamat dan rujukan fail peguam …………………………… (jika ada) : …………………………………………………… …………………………………………………… No. Tel/Fax : Tel : ……………………… Fax : ……………………
Nama Ejen Harta Tanah : ……………………………………………… No. Tel/Fax : Tel : ……………………… Fax : ……………………	Nama Ejen Harta Tanah : ……………………………………………… No. Tel/Fax : Tel : ……………………… Fax : ……………………

B. BUTIR-BUTIR PEMINDAHAN MILIK

(a) Adakah surat perjanjian jualbeli dibuat? ☐ Ya ☐ Tidak
Jika Ya, nyatakan tarikh surat perjanjian disempurnakan ……………………………………………………………………
dan lampirkan 1 salinan surat perjanjian tersebut.

(b) Tarikh surat cara pindah milik disempurnakan ……………………………………………………………………………

(c) Balasan yang dinyatakan : Ringgit Malaysia ……………………………………………………………………………

(d) Bahagian dipindah milik (misalnya semua/setengah) : Semua : ☐ Sebahagian (…… / ………… bahagian)

(e) Adakah Transaksi yang dilaksanakan oleh surat cara pindah milik ini ***membentuk** / ***tidak membentuk** sebahagian daripada transaksi yang lebih besar atau siri-siri transaksi dalam tempoh 12 bulan selepas tarikh surat cara pertama yang digunakan untuk menyempurnakan pemindahan harta ini.

☐ Ya dan Akuan Berkanun disertakan

☐ Tidak

C. BUTIR-BUTIR HAK MILIK DAN HARTA TANAH

Negeri	Daerah	Mukim / Bandar Pekan / Seksyen	No. Pelan Ukur		No. Lot / PT	Jenis dan No. Hak milik / No. Hak milik Strata
			RSS			
			CP			
Tempoh Hak milik (Kekal/Pajakan) : ………………		Tarikh Luput Pajakan : ……………………	Luas Lot : ……… Hektar (………………… Ekar)		Alamat Harta Tanah	
Nama Skim Perumahan		No. Bangunan / Blok	No. Tingkat / Aras		Luas Petak / Unit	

JENIS HARTA TANAH (*sila potong yang tidak berkenaan)

I a. TANAH KOSONG Ya / Tidak*
b. LAIN-LAIN JENIS TANAH ……………………………
(sila nyatakan seperti perlombongan, rekreasi dll.)

II. TANAH PERTANIAN*

Bil.	Jenis Tanaman	Umur	Bil.	Jenis Tanaman	Umur
a.	Getah		d.	Kelapa / Koko	
b.	Kelapa Sawit		e.	Durian	
c.	Padi	…………. kali / setahun	f.	Lain-lain	

III. TANAH DENGAN BANGUNAN*

Bil.	Jenis Bangunan	Bil. Tingkat	Bil.	Jenis Bangunan	Bil. Tingkat
a.	Rumah Teres		d.	Rumah Pangsa / Kondo	
b.	Rumah Berkembar		e.	Ruang Pejabat	
c.	Rumah Sesebuah		h.	Ruang Kompleks Beli Belah	
d.	Rumah Kedai		i.	Lain-lain	
c.	Kilang	…………. kali / setahun			

Adakah Kerajaan membuat pengambilan ke atas tanah ini? Jika ada, nyatakan tarikh dan keluasan yang telah diambil.

Tarikh : …………………… Luas diambil : ………………….. hektar (…………….. ekar)

Saya / Kami mengaku bahawa semua keterangan-keterangan yang diberi di atas adalah benar dan betul.

……………………………………………………
Tandatangan *Pemberi Pindah milik / *Penjual /
*Ejen. Jika ejen, sebutkan nama dan alamat
……………………………………………………
……………………………………………………
E. No. E ……………. No. K/P : ………………
Tarikh : ………………………

……………………………………………………
Tandatangan *Penerima Pindah milik / *Pembeli /
*Ejen. Jika ejen, sebutkan nama dan alamat
……………………………………………………
……………………………………………………
E. No. E ……………. No. K/P : ………………
Tarikh : ………………………

E. UNTUK TINDAKAN PEJABAT DUTI SETEM

Pengarah Penilaian
…………………………………………………………………………
…………………………………………………………………………
Tiga / Empat salinan borang ini dikemukakan untuk tindakan tuan.
Sesalinan surat perjanjian jualbeli *ada / *tidak disertakan.
Sessalinan surat hak milik *ada / *tidak disertakan.
Nilaian yang dikehendaki ialah nilai pasaran bagi *tanah kosong / *tanah dengan bangunan / *unit strata / *tanah dengan tanaman pada ……………………………... (tarikh surat perjanjian jualbeli disempurnakan) / ………………. (tarikh borang KTN 14A) / Surat Ikatan hak disempurnakan).

*Sila potong yang tidak berkenaan.

b.p. Timbalan Pemungut Duti Setem
Daerah :

Pejabat Setem :
Tarikh : ………………………

F. UNTUK TINDAKAN JABATAN PENILAIAN DAN PERKHIDMATAN HARTA

Tarikh :
Bil. Fail :
Pada pendapat saya nilai pasaran harta tanah ini adalah seperti berikut :-

pada ……………………… ialah RM ………………………..
pada ……………………… ialah RM ………………………..

Nilai yang dinyatakan berjumlah RM ………………………………… pada ……………………… dan ……………………… bagi harta tanah ini boleh diterima untuk maksud Duti Setem di bawah Butiran 32(a) Jadual Pertama Akta Setem 1949 sahaja.

RINGGIT MALAYSIA								
TARIKH	JUTA	RATUS RIBU	PULUH RIBU	RIBU	RATUS	PULUH	SA	SEN

…………………………………
(Tandatangan, Nama dan Cop)

APPENDIX 4B: SAMPLE PAGE FROM THE PMR PUBLICATION.

Jadual 8.30 Harga Harta Pertanian
Table Prices of Agricultural Property

District and Location	Frontage/ Interior	Average Land Area (Hectare)	Land Price (RM/Hectare) 2006	2007	% Change
RUBBER					
Seremban					
Kampung Mantin Dalam	Interior	0.92	NA	74,000	ND
Tampin					
Kampung Gedok, Off Batang Melaka	Interior	2.31	53,900	54,400	0.9
Off Km 7, Jalan Tampin/Gemas	Interior	0.81	49,400	41,000	-17.0
Batu Belang, Off KM 6, Jalan Tampin/Gemas	Interior	2.07	64,900	88,000	35.5
Off Km 3, Gemencheh Lama	Interior	1.74	NA	97,477	ND
Jempol					
Off Km 32, Jalan Bahau/Dangi	Interior	1.97	50,000	51,000	2.0
Jalan Bahau Kemayan	Road frontage	1.85	NA	97,000	ND
Km 15, Jalan Bt Kikir/Spg Pertang	Road frontage	14.98	NA	73,000	ND
Kuala Pilah					
Off Km 21, Jalan K. Pilah/Tampin	Interior	1.56	NA	60,000	ND
Jelebu					
Off Jalan Kuala Klawang/Titi	Interior		48,500 - 75,400	70,300 - 87,700	27.5
Kawasan Gagu/ Kampung Sepri	Interior		61,800 - 74,000	65,400 - 89,000	13.7
Jalan Titi/Kampung Chennah/Kenaboi	Road frontage	5.96	NA	80,600	ND
Off Jalan Titi/Kampung Chennah/Kenaboi	Interior	2.19	61,300 - 64,400	60,500 - 70,300	3.1
Jalan Kuala Klawang/Simpang Pertang	Road frontage	5.79	67,600 - 74,100	79,100	11.6
Off Jalan Kuala Klawang/Simpang Pertang	Interior	4.34	61,700 - 66,700	69,200 - 84,400	19.6
Jalan Simpang Pertang/Durian Tipus	Road frontage	2.40	NA	87,700	ND
Off Jalan Simpang Pertang/Durian Tipus	Second Layer	2.34	61,800	77,100	24.8
	Interior	2.58	44,500 - 60,900	53,500 - 74,100	21.1
OIL PALM					
Jelebu					
Off Jalan Kuala Klawang/Titi	Interior	5.66	NA	74,000	ND
Kawasan Gagu/ Kampung Sepri	Interior	1.14	NA	65,500	ND
Off Jalan Kuala Klawang/Simpang Pertang	Interior	1.96	68,000	69,200 - 79,100	9.0
Off Jalan Simpang Pertang/ Durian Tipus	Interior	2.04	45,000 - 59,000	68,000 - 79,100	41.4
Port Dickson					
Off Km 22, Jalan Port Dickson/Pasir Panjang	Interior	1.73	111,200	111,200	Stable
Off Km 26, Jalan Port Dickson/Pengkalan Kempas	Interior	2.03	95,700 - 106,200	95,700 - 106,200	Stable
Kampung Air Hitam, Off Km 28, Jalan Port Dickson/Pasir Panjang	Interior	0.60	84,700	84,700	Stable
Tampin					
Off Jalan Air Kuning/Batang Melaka	Road frontage	9.80	NA	83,400	ND
Rembau					
Kampung Ayer Melintang Off Km 6, Kota-Lubok China	Interior	3.66	NA	69,200	ND
Kota-Semerbok	Road frontage	4.10	NA	71,600	ND
Kampung Senama Baru, Off Km 27, Jalan Seremban-Tampin	Road frontage	0.94	NA	104,600	ND
Bt. 24, Kampung Baru Chengkau, Seremban-Tampin	Interior	0.95	NA	74,000	ND
Jempol					
Ladang Geddes Bahau	Second layer	2.30	NA	92,000	ND
Km 15, Jalan Bt Kikir/Spg Pertang	Road frontage	23.00	NA	93,000	ND
Kuala Pilah					
Off Km 15, Jalan Tampin/K. Pilah	Interior	8.48	NA	47,000	ND
VACANT LAND					
Port Dickson					
Off Pekan Lukut	Interior	0.51	209,000	209,000	Stable
Off Km 27, Jalan Seremban/Port Dickson	Interior	2.92	192,700	192,700	Stable
Kampung Tg. Agas, Off Km 27, Jalan Port Dickson/Tg. Agas	Interior	1.23	105,600	105,600	Stable
Off KM 26, Jalan Port Dickson/Pengkalan Kempas	Interior	1.46	97,600	97,600	Stable
Jempol					
Kampung Celogeh, Lenggeng	Interior	0.69	NA	91,000	ND
Kampung Sungai Petai, Lenggeng	Interior	0.83	NA	66,000	ND
Kampung Sungai Mahang, Lenggeng	Interior	0.92	NA	108,000	ND
Km 20.4, Jalan. Seremban/Mantin	First Layer	1.31	NA	296,000	ND
Kampung Pulau, Labu	First Layer	0.77	NA	92,000	ND

Jadual 8.31 Harga Tanah Pembangunan
Table Prices of Development Land

District and Location	Frontage/ Interior	Average Land Area (s.m.)	Land Price (RM/Hectare) 2006	2007	% Change
RESIDENTIAL DEVELOPMENT					
Seremban					
Jalan Lenggeng/Broga	First Layer	6,000	NA	1.70	ND
Off Km 29, Jalan Lenggeng/Broga	Interior	8,000	NA	10.60	ND
Kampung Che Lah, Jalan Mantin/Kajang	First Layer	4,000	NA	10.70	ND
Off Mantin Dalam	Interior	16,000	NA	7.20	ND
Off Kampung Pajam	Interior	4,000	NA	6.50	ND
Kampung Stesen, Nilai	Interior	5,000	NA	18.40	ND
Port Dickson					
Off KM 27, Jalan Seremban/Port Dickson	Road Frontage	8,000	43.10	43.10	Stable
KM 29, Jalan Seremban/Port Dickson	Road Frontage	12,000	51.90	52.00	Stable
Off KM 27, Jalan Seremban/Lukut/Sepang	Interior	5,000	24.70	25.00	Stable
Off KM 10, Jalan Port Dickson/Pasir Panjang	Interior	28,000	53.80	53.80	Stable
Off KM 10.6, Jalan Port Dickson/Pasir Panjang	Road Frontage	6,000	77.50	77.50	Stable
KM 22.8, Jalan Port Dickson/Pasir Panjang	Road Frontage	14,000	32.10	32.10	Stable
Tampin					
Kampung Batu Satu, Jalan Gemas/Pasir Besar	Interior	13,000	NA	8.60	ND
Jelebu					
Jalan Kuala Klawang - Gagu	Road Frontage	3,000	NA	15.60	ND
Jalan Kuala Klawang - Kampung Sepri	Road Frontage	7,000	NA	22.90	ND
Jalan Petaling - Gagu	Road Frontage	3,000	NA	15.60	ND
Off Jalan Petaling - Gagu	Second Layer	13,000	NA	12.30	ND
Jalan Kuala Klawang - Kampung Sepri	Road Frontage	7,000	21.10	22.90	9.4
Off Jalan Kuala Klawang - Titi	Second Layer	22,000	NA	13.20	ND
Jalan Titi - Purun	Road Frontage	9,000	NA	14.80	ND

APPENDIX 4C: RANDOM SAMPLES FROM THE ASSEMBLED DATASET IN WORKSHEET FORMAT.

Obs. ID	Price	State	District	Address	Year	Roadfrontage	developable	rubber	oilpalm	paddy	vacant	Latitude	Longitude	Distance to largest town	Distance to NSE	Population growth rate	Population density	GSA Restricted	MRL Restricted
1047	76923	Perak	Kerian	Lian Seng Estate Jalan Gula	2007	0	0	0	1	0	0	4.948499	100.564	70.21282	11.90225	0.755	172.85	0	0
1680	86500.48	Perak	Manjung	Bruas Batu Hampar	2004	0	0	0	1	0	0	4.478541	100.774	37.83567	33.08448	1.996	182.53	0	0
1608	124995	Perak	Manjung	Kampung Raja Air Hitam	2006	0	0	0	1	0	0	4.331348	100.751	48.21864	47.84057	1.996	182.53	1	0
1655	141637.4	Perak	Manjung	Ulu Licin Ulu Bruas	2005	1	0	0	1	0	0	4.452528	100.767	39.57937	35.93402	1.996	182.53	0	0
1000	26000	Perak	Kerian	Jalan Segari Pantai Remis	2007	0	0	0	1	0	0	5.31045	100.771	86.55126	32.95574	0.755	172.85	0	0
1424	71900.4	Perak	Larut Matang	Taiping Trong	2004	1	0	0	1	0	0	4.712619	100.688	46.53583	14.96415	0.505	134.99	0	0
1831	39000	Perak	Perak Tengah	Kampung Belanja Kanan	2002	0	0	0	1	0	0	4.5025	100.915	22.46278	24.01388	1.44	66.035	0	1
1969	81598.52	N.Sembilan	Port Dickson	km36 Seremban Rantau Linggi	2005	0	0	0	1	0	0	2.53564	101.981	20.62144	7.726653	2.191	192.43	1	0
1894	20978.16	Perak	Perak Tengah	Kampung Tua	2006	0	0	0	1	0	0	4.283419	100.913	40.35106	35.62664	1.44	66.035	0	0
11	41379	Melaka	Alor Gajah	Rancangan Bukit Apit	2007	0	0	0	1	0	0	2.35779	102.12	22.69933	11.76285	2.122	207.42	1	0
1961	114000	N.Sembilan	Port Dickson	Sungai Nipah	2001	1	0	0	1	0	0	2.626186	101.751	24.22738	11.86931	2.191	192.43	0	0
235	66700.37	Perak	Batang Padang	Tapak Penjara Tapah	2004	0	0	0	1	0	0	4.19166	101.274	49.59146	5.153909	0.273	58.042	0	0
1270	25398.98	Perak	Kuala Kangsar	Rancangan FELDA Lasah	2006	0	0	0	1	0	0	4.954143	101.1	39.35248	30.6165	0.259	58.9	1	0
1892	25155.99	Perak	Perak Tengah	Bota Kanan Lambor Kanan	2006	0	0	0	1	0	0	4.322447	100.902	37.32032	34.0396	1.44	66.035	1	1
1658	76396.93	Perak	Manjung	Jalan Segari Pantai Remis	2006	0	0	0	1	0	0	4.389202	100.628	56.57339	47.45113	1.996	182.53	0	0
317	53836	Perak	Hilir Perak	Kampung Chui Chak	2007	0	0	0	1	0	0	4.038248	101.174	62.97728	17.95586	-0.208	114.47	0	0
725	35833	Melaka	Jasin	Rancangan Kesang II	2002	0	0	0	1	0	0	2.328117	102.399	20.8771	10.59414	1.629	155.17	1	0
369	22400	Perak	Hilir Perak	Rancangan Attaduri	2002	0	0	0	1	0	0	4.042357	101.157	62.28688	19.20647	-0.208	114.47	1	0
839	65500	N.Sembilan	Jelebu	Gagu Kampung Sepri	2007	0	0	0	1	0	0	3.009041	102.071	34.94925	35.60357	-0.413	28.35	1	0
1731	57915	Melaka	Melaka Tengah	Kampung Bukit Nibong	2007	0	0	0	1	0	0	2.204275	102.362	11.77159	13.24988	3.506	1307.1	0	0

CHAPTER 5
EMPIRICAL METHODS

5.1 INTRODUCTION

The principle underlying HPM is that a good's overall value is simply an aggregation of the implicit value of its attributes. If two items of the same good are sold at different prices, and the two differ only by a certain amount of attribute x_1, one can compute the implicit price of x_1 from the items' price differentials, *ceteris paribus*. A basic hedonic model can take the following regression form,

$$p_i = \alpha + \beta_1 x_{1i} + ... + \beta_m x_{mi} + \varepsilon_i, \quad \text{for } i = 1, \ldots \text{I}, \qquad \text{(Eq. 5.1)}$$

where p_i is price of item i, $X = (x_1, x_2, ..., x_m)$ is a vector of the $k = 1, ..., m$ characteristics of land and β_k is the vector of regression coefficients and ε is a vector of error terms presumed to have a multivariate normal distribution, $N(0, \sigma^2 I)$. Nevertheless, this basic model must be validated and augmented in several respects to obtain a sufficiently robust description of the land price-attribute relationships.

This chapter discusses several pertinent modeling issues and methods employed to correct the model's misspecification biases. They include choice of functional form and effect of time in Section 5.2; structural stability in Section 5.3; spatial dependence in Section 5.4. Methods for model evaluation such as measures of fit and predictive performance are described in Section 5.5, while Section 5.6 present guidelines for interpretation of results. Section 5.7 concludes.

5.2 BASIC HPM SPECIFICATION ISSUES

Recall that a hedonic price equation is essentially based on equilibrium points determined by market interactions between suppliers and demanders of individual attributes. A single, constant market-clearing price $P(x_k)$ for one additional unit of attribute x_k implies that the x_k regression coefficient is linear in form. However, if the relevant attribute is not producible (at least within a reasonable time period) or if there are attributes that are jointly-produced, a linear form may not be appropriate after all (Linneman 1980, p.49 – 50) .[109] Furthermore, a constant price assumption requires that the said attribute can be costlessly repackaged for resale i.e., there must be full arbitrage possibilities in the market for reselling of the attribute (Rosen, 1974, Goodman, 1989). To illustrate the implications of less than full arbitrage, let x_a, x_b and x_c be the particular values of vector X, t is a scalar number and $t > 1$.

i. Suppose $x_a = \left(\frac{1}{t}\right) x_b$ but $p(x_a) < (\frac{1}{t}) p(x_b)$. Then it is obvious that the price of x_a is no longer constant because t units of a model offering x_a can now be acquired at less cost.

ii. Suppose $x_a < x_b < x_c$ and x_b is defined as $x_b = \delta x_a + (1-\delta) x_c$ where $0 < \delta < 1$. If the market allows that $p(x_b) > \delta p(x_a) + (1-\delta) p(x_c)$, then the utilities obtained from a model with x_b can be enjoyed by purchasing δ units of a model with x_a and $(1-\delta)$ units of a model with x_c at lower cost compared to a direct purchase of a model x_b.

The above arguments cast doubts about assuming a linear form for the hedonic function. Many researchers attempted to resolve this uncertainty by comparing the performance of a given model stated in various functional form specifications. This approach appears consistent with the recommendations made by Halvorsen and Pollakowski (1979) and Linneman (1980) i.e., when functional form is unknown, employ statistical measure to guide model selection. One commonly used method of functional form search is the Box-Cox procedure. It involves a series of transformation of the dependent and continuous independent variables whereby the transformation parameters are assumed unknown *a priori*. The general form of the Box-Cox equation can be written as

$$P^{(\theta)} = \alpha_0 + \sum_{k=1}^{m} \beta_k X_{ik}^{(\xi)} + \sum_{j=1}^{l} \gamma_j Z_{ij} \qquad \text{(Eq. 5.2)}$$

[109] Example of joint-production of attributes in agricultural land context: a flat natural landscape could provide the land with positive scenic value as well as lower the cost of machine use (either for grazing, cropping or real estate development).

where $P^{(\theta)}$ is the vector of transformed prices, $X^{(\zeta)}$ is the vector of transformed continuous explanatory variables and Z is the vector of untransformed dummy variables, θ is the power transformation factor on the dependent variable and ζ is the power transformation factor on k^{th} independent variable. The error terms in the Box-Cox hedonic function are assumed normal and independently distributed with mean μ and a constant variance, σ^2. By maximising a log-likelihood function associated with Eq.5.2 which is written as follows,

$$L = (\theta - 1)\sum_{i=1}^{n} \ln P - \frac{n}{2}\ln(2\pi) - \frac{n}{2}\ln(\sigma^2) - \frac{1}{2\sigma^2}(P^{(\theta)} - X^{(\xi)}\beta_1 + Z\beta_2)'(P^{(\theta)} - X^{(\xi)}\beta_1 + Z\beta_2)$$

we are able to estimate the μ, σ_2, β_1 and β_2 coefficients. The maximum values of the log-likelihood functions are then used to test the significance of the transformation parameter in the unrestricted model. For instance, the test statistic employed to determine the confidence intervals for ζ is

$$L_{\max}(\xi) - L_{\max}(\hat{\xi}) < \frac{1}{2}\chi^2, \alpha \qquad \text{(Eq. 5.3)}$$

where ζ is the restricted lambda, $\hat{\xi}$ is the unrestricted lambda, L_{max} is the value of the log-likelihood function associated with each model, and α is the specified level of significance (Halvorsen and Pollawoski, 1985). The same procedure is applicable to derive a confidence interval for θ.

The general unrestricted forms of the dependent and explanatory variables are as follows,

$$P^{(\theta)} = \begin{cases} \dfrac{P^{(\theta)} - 1}{\theta}, & \theta \neq 0 \\ \ln P & \theta \to 0 \end{cases} \qquad X^{(\xi)} = \begin{cases} \dfrac{X^{(\xi)} - 1}{\lambda}, & \lambda \neq 0 \\ \ln X & \lambda \to 0 \end{cases}$$

It can be easily seen that a simple linear form of a variable is the result of θ or ζ taking the value of 1 while the square root form is the outcome if θ or ζ is 0.5. On the other hand, a log transformation is recommended if θ or ζ approaches zero. It can be shown by an application of L'Hopital's rule that if the power transformation factor on an independent variable, for instance, is continuous around 0, its functional form would approach the natural log form,

$$\lim_{\xi \to 0} \frac{x^{\xi} - 1}{\lambda} = \lim_{\xi \to 0} \frac{d\left(x^{\xi} - 1\right)/\, d\xi}{1} = \lim_{\xi \to 0} x^{\xi} \text{ x} \ln x = \ln x$$

Despite its statistical appeal, the Box-Cox procedure to search for the correct functional form has been subject to several criticisms. Cassel and Mendelsohn (1985) argued that the best fit criterion does not always lead to more accurate estimates of implicit prices; whereas the fundamental use of HPM is to uncover the most reliable estimates of implicit values for attributes of interest. Consider a Box-Cox flexible form for a price function with two explanatory variables and an interaction term,

$$\frac{\left(P^{\theta} - 1\right)}{\theta} = b_0 + b_1\left(\frac{X_1^{\xi} - 1}{\xi}\right) + b_2\left(\frac{X_2^{\xi} - 1}{\xi}\right) + b_3\left(\frac{X_1^{\xi} - 1}{\xi}\right)\left(\frac{X_2^{\xi} - 1}{\xi}\right)$$

where P is the value of a good and X is its k^{th} attribute. The implicit price of X_1 is derived from the first order condition with respect to X_1,

$$P_{X_1} \equiv \frac{\partial P}{\partial X_1} = P^{(1-\alpha)} X_1^{(\beta-1)}\left(b_1 + b_3\left(\frac{\mathrm{X}_2^{\beta} - 1}{\beta}\right)\right)$$

which is not only difficult to use but the estimate is also less efficient in that the variance around the parameter tends to be larger. By logical extension, the more explanatory variables are employed in the model, the bigger the loss in efficiency.

Another limitation of the flexible-form function concerns the problem of prediction bias. For instance, if the *price* is log-transformed but the researcher is interested in the predicted price in original monetary scale. Retransformation by calculating the exponential understates the true predicted price because the mean of predicted log of price is not the same as log of mean of predicted prices, $E(\log P) \neq \log[E(P)]$. The standard error of the prediction, $\exp\{E(u)\}$ must not be left unaccounted. If u is assumed to be normally distributed, $u_i \sim N\left(0, \sigma^2\right)$, then with some manipulation, it is possible to obtain[110] $\exp\{E(u)\} = \exp(0.5\sigma^2)$. By setting $w = \log P$ and $y = P$, the predicted price can be computed from,

$$\hat{y}_i = \exp(\hat{w}) * \exp(\hat{\sigma}^2 / 2)$$

One practical limitation of using the Box-Cox procedure is that power transformations are only applicable to continuous explanatory and dependent variables, whereas hedonic models are known to have a high number of discrete variables as regressors. Even then, continuous variables with negative or zero values cannot be easily log or square-transformed, the only solution is to drop the problematic observations from the sample (a move that many researchers try to avoid at all costs). In addition, the Box Cox procedure may suggest different power transformation factors for different variables, which increases the complexity of the model. Therefore in many studies, it is common to see that all continuous independent variables are assumed employ the same power transformation factor.

Essentially, if the Box-Cox procedure is employed, it is imperative that the functional form recommendations are weighed carefully via a sound knowledge of real-world relationships between the dependent and explanatory variables. One reliable rule-of-thumb is that coefficient signs must conform to theory and expected rate of change and elasticity. Many authors recommend simpler and more reliable functional forms such as the semi-log or double-log forms, with judicious use of interaction terms. Cropper, Deck and McConnell (1988) found using a simulation study that the Box-Cox flexible form is more reliable only when an equation is specified correctly, otherwise simpler functional forms might just do. Kuminoff, Parmeter and Pope (2009) found in another simulation exercise that simpler linear specifications outperform more flexible functional forms when spatial fixed effect variables are included in the model. Hidano (2002, p.70) argued that use of Box-Cox flexible form is not advisable when estimated coefficients are unstable.

[110] Its mathematical derivation can be found in Wooldridge (2006) and Green (2008, p.100 and p. 996).

The main advantage of simpler functional forms is that they are able to accommodate non-linearity while keeping it easy for researchers to interpret estimated coefficients. By non-linearity, the model implies that the price of an additional unit of a specific attribute depends on the quantity already in supply, and sometimes on the quantities of other attributes (Goodman, 1989). A log-log model, for instance, is particularly convenient when variables are invariant to scaling. Since continuous variables often have very wide quantitative ranges, use of logs can help reduce the range that is empirically tested and cause the regression to be less sensitive to outliers. Log-transformation of the dependent variable is particularly useful in reducing the occurrence of heteroscedastic errors which is commonplace in cross-sectional studies.

If data spans a number of years, it is necessary to test if parameter estimates are constant over time.[111] Therefore, to formally test for time effect in the hedonic model, we executed the following steps. Firstly, the nominal price data is adjusted for inflation by dividing it with a suitable price deflator. Then real price is regressed on a set of time dummy variables (to differentiate the year a sale is recorded) and other explanatory variables. The basic regression model price function in Eq.5.1 is rewritten to create a hedonic price index,

$$p_i^t = \alpha^t + \delta D_i^t + \sum_{k=1}^{m} \beta_k^t x_{ik} + \varepsilon_i^t \qquad \text{(Eq.5.3)}$$

where D_i^t is the dummy variable for each year and $t = 0$ is the selected base period. If parameter values are indeed stable throughout the study period, then $\beta_k^0 = \beta_k^1 = \beta_k^s$ for all periods $t = 1,...,s$ and independent variable $k = 1,...,m$. If the dependent variable, price, is in logs, the estimated year dummy coefficients, $\hat{\delta}_t$, needs to be re-transformed to its natural scale before a price ratio can be computed (de Haan, 2004).[112] Predicted prices in

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[111] The examination of time effect on implicit prices of attributes is particularly important in evaluating effectiveness of public programmes, where results of the before-and-after analysis must reflect other ongoing changes in the economy, possibly affecting estimation results.

[112] Because we are interested in the ratio of price of one year to another, it is not necessary to factor in the standard error of prediction as in 4.13. The reason is because both predicted prices emerge from the same regression, therefore both would be adjusted by the same value of $\exp\{E(u)\}$.

the base year is given by $\hat{p}_i^0 = \exp\left(\hat{\alpha} + \sum_{k=1}^{m} \hat{\beta}_k x_{ik}\right)$ and in the subsequent period, t =1, is given by $\hat{p}_i^1 = \exp\left(\hat{\alpha} + \hat{\delta}_i^1 + \sum_{k=1}^{m} \hat{\beta}_k x_{ik}\right)$ and so on; such that the exponent of the individual year-dummy coefficients, $\hat{\delta}_t$, directly yields a quality-adjusted measure of price change in year t compared to the base year. For instance, the hedonic price index of year 1 (base year = 0) is simply,

$$\exp(\hat{\delta}) = \hat{p}_i^1 / \hat{p}_i^0 \qquad \text{for all } i \qquad \text{(Eq.5.4)}$$

By computing the hedonic (attribute-adjusted) price index for each year in the data, a researcher can verify if there are macro-economic forces influencing prices **other** than inflation. If so, suitable adjustments to the model can be made including introducing a dummy variable to distinguish clearly marked periods of time.

Because the HPM approach assumes constant implicit prices over all observations in the data, it is sensible to test for structural stability more comprehensively. Failure to accurately account for heterogeneity in the market amounts to model misspecification in the form of omission of a relevant variable. Market segmentation basically implies that participants in different sub-markets interact only amongst themselves such that the equilibrium condition in each sub-market indicates different shadow prices for the same attribute in a good (Goodman and Thibodeau, 1998). Methods to determine the appropriateness of disaggregation is discussed in the next section.

5.3 STRUCTURAL STABILITY

If there are reasons to believe that a good can be differentiated into smaller unique categories, the researcher is responsible to establish whether the model can be improved by incorporating the differentiating factor. Secondly, he must seek to uncover the true implicit prices such that each category of the good can be described by its own unique hedonic price equation. In principle, statistically determined delineation of sub-markets can be evidenced by statistically significant shifts in the model intercept, functional form or slopes. The mean or covariance and variance structures differ from one market segment to another such that there are clustered error variances, denoted as $Var[\varepsilon_i] = \sigma_r^2$, where $r=1, 2,..., s$ is the number of submarkets operating simultaneously. The null hypothesis of coefficient stability is usually tested using the standard Chow test. However, this approach is unable to indicate precisely which of the variable(s) is different in its effect on price, the extent of the difference or whether the difference is statistically significant after all. Furthermore, as Taylor (2003) and Kennedy (1996) cautioned:

i. It is difficult to ascertain if the standard F-tests are statistically significant because of data segmentation or because of other model misspecification errors;
ii. F-tests are also likely to reject aggregation in large samples (see Ohta and Griclich, 1975, 1979);
iii. Although the standard F-test identifies significant differences in attribute prices, it is not capable of assessing the importance of these differences. Neither does the Tiao and Goldberger (1964) test to compare individual coefficients across different submarkets. Variations in relatively unimportant variables could yield statistically significant Chow test.
iv. If large numbers of explanatory variables are included in the model (which is a norm in HPM), it is very likely that many of the estimated coefficients will emerge unstable.
v. A separate sub-sample regression involves smaller number of observations; which leads to less plausible estimates because variation in the same submarket is usually smaller, not to mention the loss of efficiency from smaller degrees of freedom.

These are among the handful of issues to consider when opting for a disaggregated estimation of the data.[113] One powerful approach to analyse structural stability is by

[113] There is also the issue of whether the *a priori* division of the market corresponds to actual market division. Several authors employs sophisticated statistical methods of deriving functional sub-markets which include factor analysis, principal-component and cluster analysis. Bourassa *et al*. (1999 in Wilhemsson, 2004) developed a statistical technique to identify housing geographical sub-markets by combining principal-component and cluster analyses. The principal-component analysis is used to extract a number of factors from the original variables. The factor scores are then used in the cluster analysis using different clustering procedure to create sub-markets based on individual housing attributes (including price) and neighbourhood characteristics, rather than spatial location. They show

using an interaction model whereby the intercept and all slopes are allowed to vary across sub-markets. In an interaction model, the estimated effect of a given attribute varies linearly i.e., it is **conditional** upon the grouping (or sub-market) it belongs to; therefore the focus of analysis now shifts from hypothesis testing of estimated **coefficients** to hypothesis testing of estimated **effects** of regressor as the grouping variable takes on different values.

The general form of the simple linear interactive model is given as

$$P = \alpha_0 + \alpha_1 Z + \sum_{k=1}^{m} \beta_k x_{ik} + \sum_{k=1}^{m} \gamma_k \left(Z x_{ik} \right) + \varepsilon_i \qquad \text{(Eq.5.5)}$$

where Z is the variable which represents non-overlapping sub-markets. It is also called the moderating factor because it modifies the effects variable x_k has on P according the group it represents. For example, if there are two sub-markets, observations with $Z = 1$ belongs to a group that displays the differentiating factor, Z, while those with $Z = 0$ does not.

The constituent effect of x_k, given by β_k, stands for partial effect of x_k on price when $Z = 0$. The estimated value of β_k, no longer represents the "average" or the "main" effect of x_k over **all** observations in the sample, rather only the average effect of x_k within its specific group of observations. It follows that the standard error of estimates in the interactive model is also conditional in that they reflect an estimate's precision when the estimate refers to the relevant specific sub-market. In this case, standard errors for β_k

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that hedonic analysis using the attribute-based sub-market approach shows better goodness-of-fit compared to one with administrative sub-markets. Wilhelmsson employs Ward approximation in his cluster analysis of the hedonic OLS residuals, with the assumption that the error term is spatially dependent. Data are divided into separate sub-samples according to the value and sign of the error term. The resulting geographical clusters are then introduced as sub-market dummies in the second OLS estimation of the hedonic equation. Functional sub-markets created through this method appear to pick up the influences of neighbourhood characteristics that are not observable and quantified and thus, able to reduce spatial dependency and increase model's predictive performance. However, the method is only feasible where there is a large dataset. Additionally, the number of sub-markets may be high particularly when the number of explanatory variables used in the hedonic function increases. Wilhelmsson also found that sub-markets may overlap; an observation can belong to zero, one or two sub-markets.

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refer to uncertainty associated with the estimates for the group where $Z = 0$.[114] The coefficient γ_k represents the **difference** in effects of x_k when Z is 1 compared to when Z is null, but it is not the actual effect of x_k when $Z = 1$. Correspondingly, the standard error of γ_k indicates the level uncertainty associated with the **gap** between the groups' x_k effect on price (but says nothing about the estimate of x_k when $Z = 1$).[115]

The linear interaction model is flexible in that it can be used to test various sources of market heterogeneity. For instance, the thesis argued that land's future use prospect is a fundamental consideration in pricing such that development-motivated agents appear to interact in a separate market from agricultural-motivated agents. To corroborate this hypothesis, development potentials can be incorporated as the moderating factor to test the structural stability of the hedonic pooled equation.

Another common application of the interaction model is the testing of the geographical extent of a market. If variations in a hedonic model's coefficients are ascribable to the observation's absolute location, then the market is said to be spatially heterogeneous (see Anselin, 1988 p. 119). For instance, Cavailhes and Wavresky (2003) used a random-effects model to detect spatial heterogeneity across French communes, although in general, prices are largely influenced by agricultural returns and future land prospects. Wilhemsson (2004) argues that functional submarkets can be useful to compensate for omitted or unmeasurable neighbourhood characteristics. Patton and McErlean (2003) suggest that separate coefficients for each sub-market can be estimated using a spatial regime model, which is essentially an interaction model but takes the following form,[116]

$$P_i = \sum_{r=1}^{s} \alpha_r + \sum_{k=1}^{m} \sum_{r=1}^{s} \beta_{kr} x_{kri} + \varepsilon_i, \quad \text{for } i=1,\ldots\text{I}, \qquad \text{(Eq.5.6)}$$

where *r=1, 2,…, s* submarkets.

[114] Standard errors for β_k are usually large because of multicolinearity which exists with the use of product terms. However, the multicollinearity arises because there is insufficient information in the data to estimate the model parameters correctly. The interaction model's value is in showing the distinct marginal effects a regressor has on the dependent variable (see Brambor *et al*. 2005).

[115] Kam and Franzese (2007) provide a thorough exposition regarding modeling and interpreting interactive hypotheses.

[116] Anselin (1988, p. 129) provides a brief summary and commentary of alternative procedures to account for spatial variation including switching regressions and spatial adaptive filtering process.

Heterogeneity in a market such as land could very well arise from more than one source. To the extent that various aspects of heterogeneity are reflected in measurement errors, they may result in heteroscedasticity (Anselin, 1988). However, to test the full extent of market segmentation would require a large dataset with sufficient variation in time, attributes and space and complex formulation of multi-level effects. When constrained by sample size, the researcher would do well to focus on **the** most critical source heterogeneity i.e., one that if accounted correctly could better 'protect' the estimation from heteroscedastic errors.

The basic HPM framework essentially assumes independent observations, which is why hedonic functions are usually estimated using the standard classical linear regression model. However, since land is a spatial product, there is always a possibility of interdependence among observations that is due to their relative geographic locations.[117] The next section describes the special models used to address autocorrelations or biases introduced by interactions between observations in the same geographical 'neighbourhood.

5.4 SPATIAL DEPENDENCIES

For each observation *i*, there is a number of *j* neighbours which can exert influence over *i*'s outcome or response. This interdependence can be formally stated as $cov(y_i|x_i, y_j|x_j) \neq 0$ where y_i and y_j are observations on a random variable at locations *i* and *j* (see Fulcher, 2004). As a result, a non-zero covariance between observations could still exist even after controlling for differences in attributes. The basic hedonic model can be corrected to account for spatial interactions by incorporating either a lagged dependent variable, or lagged explanatory variables, or correlated error terms. We describe spatial lag and spatial error dependence and their respective sources in turn in the following section.

[117] Correlation over space is relatively more complicated than correlation in time series because there is no natural ordering in space as there is in time. Furthermore, spatial autocorrelation can occur as a two dimension problem – time and space.

5.4.1 Types of Spatial Dependence

5.4.1.1 Spatial Error Dependence

Spatial error dependence simply refers to the existence of patterns in the regression error terms. It is based on the assumption that there is one or more omitted variable in the hedonic price equation and that the omitted variable(s) has a spatial pattern. The error dependence may also originate via an aggregation bias in the data, for example, the use of neighbourhood or regional proxies as opposed to the spatial unit of observations under consideration[118] (see Kim, Phipps and Anselin, 2003), Anselin and Bera, 1998). As a result, there are likely to be measurement errors; and errors in one location are also likely to spill over to other locations. In a regression context, this would lead to non-spherical error-covariance. Inferences using the standard t and F statistics would be misleading although parameter estimates remain unbiased. Because OLS assumption of independent, $E\lfloor u_i u_j \rfloor = 0$, and homoscedastic residuals are violated, the method is no longer appropriate to estimate the empirical function.

5.4.1.2 Spatial Lag Dependence

Spatial lag dependence occurs when there is interdependence of the dependent variable across observations as a result of the observations' locations with respect to each other. The price of an observation i is partly determined by prices of j observations spatially related to it within a certain 'neighbourhood' definition. In other words, the selling price of a parcel most likely echoes the price of the adjacent land or the prevailing land in the same area. In extreme cases, the use of prevailing local price totally replaces an assessment of aggregate value of plot attributes.

It is obvious that spatially-adjusted models will need to express at the outset how 'neighbours' are defined. A researcher should clarify the parameter values that he feels is able to capture this particular collection of observations that are potentially influential

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[118] Another potential source of aggregation bias, which is unrelated to spatial effects, can come from the use of economic data as explanatory variable for transactions in the same time period.

simply because of their relative location to a particular observation *i*. Consequently, this extent of 'neighbourhood' is formally expressed in a spatial weight matrix.

5.4.2 Spatial Weight Matrix

A spatial weight matrix, **W**, describes the researcher's assumptions or understanding about the spatial interaction structure among observations in his data.[119] The ij^{th} element of the matrix **W**, represents the assumed or known *a priori* spatial relationship between i^{th} and j^{th} observation that corresponds to the perceived impact on the empirical function.[120] In a binary spatial weight definition, the elements in **W** will equal one for *i,j* pairs that falls into pre-defined groups of observations considered neighbours. In a non-binary distance-based spatial weight matrix, elements w_{ij} can either be the absolute or inverse distance between the i^{th} and j^{th} observation. Hypothetically, the further the distance, the less influence a parcel's price would impose on the price of another parcel sold in the same period (Bell and Bockstael, 2000). This follows Tobler's first law of geography, "*...everything is related to everything else, but near things are more related than distant things...* (1970).

One very popular type of spatial weight matrix is distance decay spatial weights, generally expressed as

$$w_{ij} = \begin{cases} 0, & \text{if } d_{ij} \le lb \text{ or } d_{ij} > ub \\ 1/d_{ij}^{f} & \text{if } lb \le d_{ij} \le ub \end{cases} \qquad \text{(Eq.5.7)}$$

where *(i, j)* denotes the location pair, d_{ij} denotes the Eucladian distance between locations *i* and *j*, *lb* denotes the lower bound of the specified distance for a 'neighbourhood' to exist, *ub* is its upper bound and *f* denotes a positive friction parameter. For inverse-squared distances (f = 2), the weights decline at an increasing rate

[119] One other method of modeling spatial autocorrelation which is geostatistically-based is kriging. The method involves expressing the elements of the variance-covariance matrix as a 'direct function of a small number of parameters and one or more exogenous variables. However, it is quite impossible to estimate an N x N covariance terms from cross-sectional data. That and a number of other estimation and identification problems made kriging less suitable for hedonic models using non-panel data (see Anselin and Bera 1998, Dubin, 1998, Anselin 2001).

[120] Anselin (1988) argued that the structure of spatial dependence incorporated in the spatial weight matrix should be chosen judiciously to reflect relevant notions to the model's aim which is to test potential influence, rather than reflecting an ad hoc description of spatial pattern.

as parcels are farther apart. Intuitively, the narrower the upper and lower bounds specified, the smaller the expected spatial dependence because the extent of the neighbourhood is somewhat truncated. Distance weights are generally computationally intensive because it is a full matrix with zero elements only on the diagonal. For these reasons, distance-based spatial weights are more suitable for smaller sample sizes or when used on sub-sets of data.

Another common type of spatial weight matrix is the *m*-order nearest neighbours matrix.[121] If *j* is one of the *m* nearest neighbours to *i* therefore, $w_{ij} = 1$; otherwise $w_{ij} = 0$. The extent of a neighbourhood can again be controlled by restricting the value of *m*. The resulting matrix is sparse because only *m* nearest neighbours provide the non-zero elements in the matrix. Sparse matrix calculations require much less computer memory and storage space (Le Sage, 1998). Another benefit is that the researcher will not face the problem of having 'islands' or observations with no neighbours (Anselin and Bera 1998). Bucholtz (2004, in Cotteleer, 2007) states that matrices based on a specific number of nearest neighbours have an advantage over other weighting matrices because the hypothesised spatial influence that observations have on each other will not change if the matrix is row-standardised.

In row-standardised spatial matrices, the normalized weight matrix, $\tilde{\mathrm{W}}$, is structured as follows,

$$\tilde{w}_{ij} = \left(1 / \sum_{j=1}^{N} \left| w_{ij} \right| \right) w_{ij} \qquad \text{(Eq.5.8)}$$

Row-standardisation is generally favoured in the literature because it allows a better comparison between models and data, facilitates the maximum likelihood estimation of spatial models and so on and so forth (see Cotteleer, 2007). However, several authors including Wang and Ready (2005) noted that by row-standardising, weights based on the absolute distance to neighbours for each row are now re-scaled to ensure that their sum

[121] The other common spatial weight matrix is the contiguity matrix. The matrix only allow contiguous neighbours to affect each other and hence, is usually applied when observational unit is aggregated (known boundaries). Its *(i,j)* elements is positive if i^{th} and j^{th} observations have a common boundary and zero otherwise.

is unity, to the extent of distorting actual spatial relationships between observations. This happens because the number and/or density of neighbours for each spatial observation are generally not the same. Table 1 illustrates this concept of “distance effect”. Both observations A and B are assumed to have the same number of neighbours and the total impact of neighbours across observation are both equal to one as a result of row-standardisation. It is quite obvious that A’s neighbourhood is relatively sparser; on the other hand, all of B’s neighbours are located nearby at approximately the same distance. Spatial weights for each neighbour are computed using distance-decay functions and row-standardisation given in Eq. 5.7 an 5.8, respectively. Due to row-standardisation, A’s first neighbour is weighted 0.4, while B’s is weighted only 0.2 despite both being the same distance from their respective base observations. A’s third neighbour which is located twice as far as B’s neighbour are accorded the same spatial weight value.[122] The table demonstrates how remote neighbours of one observation can enjoy the same weight as closer neighbours for another observation.

Table 1. Example of “distance effect” and “number effect” due to row-standardisation (Spatial weights are given in brackets)

Observation	Neighbour 1	Neighbour 2	Neighbour 3	Neighbour 4	Neighbour 5	Total Weights
A	2 km *(0.4)*	4 km *(0.2)*	4 km *(0.2)*	8 km *(0.1)*	8 km *(0.1)*	*(1.0)*
B	2 km *(0.2)*	2 km *(0.2)*	2 km *(0.2)*	2 km *(0.2)*	2 km *(0.2)*	*(1.0)*
C	2 km *(0.5)*	2 km *(0.5)*	2 km *(0.5)*	-	-	*(1.5)*
D	2 km *(0.5)*	2 km *(0.5)*	2 km *(0.5)*	2 km *(0.5)*	2 km *(0.5)*	*(2.5)*

Nevertheless, Wang and Ready also noted that by **not** row-standardising the spatial weight matrix, units with more neighbours might attract higher price-premium than those with fewer neighbours, *ceteris paribus*. Therefore, the total effects of neighbours can be influenced by the number of neighbours an observation has within the specified

[122] An important implication of “distance effect” is that the resulting spatial weights matrix is no longer symmetric, hence makes computation of test statistics relatively more complicated. Similar types of distortions can be found where further neighbours of observations with few neighbours have higher weights than closer neighbours of observation with many more neighbours.

boundaries. Compare the total effects of neighbours on C who has only two neighbours as opposed to D who has five neighbours. All neighbours are located at the same distance away from the respective observations. The total neighbourhood effects are 1.5 for C and 2.5 for D. This unintentional result is called the “number effect”. We agree with Wang and Ready that between the two effects, the number effect is potentially more damaging than the distance effect in a spatial lag model, because here, the total spill-over of prices could multiply as the number of neighbours increases. On the other hand, the number effect is not as serious in a spatial error model because magnitude of errors cannot be affected by the number of neighbours a unit has.

Researchers are often advised to pay as much attention to the complex art of spatial weight formulation as they would to model estimation. They should consider the results of tests detecting spatial dependencies to help answer (i) whether including spatial dependencies improves model specifications and performance; and (ii) whether the model results are sensitive to spatial weight matrices adopted. Bell and Bockstael (2000) compared the Generalised Method of Moments to maximum likelihood estimation methods of the spatial model and found that estimated coefficients are more sensitive to spatial weight choice than the estimation method. Upon the determination of the spatial weight matrix most suitable for the data, there are various ways to model the two types of spatial dependencies into the hedonic model. They are discussed in the following section.

5.4.3 Types of Spatial Model

5.4.3.1 Spatial Error Correction Model (SEC)

To formalise the structure of the error covariance, it is assumed that the errors follow a first order Markov process (Bernischka and Binkley, 1994). The basic hedonic function can be extended to include a spatially autoregressive process in the error term

$$\mathbf{y} = \mathbf{X\beta} + \mathbf{u} \quad \text{where} \quad \mathbf{u} = \lambda\mathbf{Wu} + \boldsymbol{\varepsilon} \quad \text{and} \quad \varepsilon \sim \mathrm{N}(0, \sigma^2 \mathrm{I}) \qquad \text{(Eq.5.9)}$$

where $\mathbf{y}$ is a $(n \times 1)$ vector of dependent variables, $\mathbf{X}$ a $(n \times k)$ matrix of explanatory variables, $\boldsymbol{\beta}$ is a $(n \times 1)$ vector of parameters, λ is the spatial scalar autocorrelation coefficient, **W** is the (n x n) spatial weight matrix**,** **u** is the vector of spatially correlated error terms, and **ε** is the vector of uncorrelated error term. The product of **W** and **u** is a vector with weighted averages of errors in neighbouring observations. The spatial autoregression coefficient, λ, indicates the correlation between parcel i's error and a composite of the errors of its neighbours. The classic linear regression function is a special case where λ is zero (Bernirschka and Binkley, 1994). Solving for **u** and **y** gives us,

$$\mathbf{u} = (\mathbf{I} - \lambda\mathbf{W})^{-1}\boldsymbol{\varepsilon} \qquad \text{(Eq.5.10)}$$

$$\mathbf{y} = \mathbf{X}\boldsymbol{\beta} + (\mathbf{I} - \lambda\mathbf{W})^{-1}\boldsymbol{\varepsilon} \qquad \text{(Eq.5.11)}$$

whereas the variance-covariance matrix is as follows

$$E[\mathbf{uu}'] = \sigma^2(\mathbf{I} - \lambda\mathbf{W})^{-1}(\mathbf{I} - \lambda\mathbf{W}')^{-1} \qquad \text{(Eq.5.12)}$$

According to Dubin (1998), the variance matrix above does not have constants as its diagonal elements. The off-diagonal elements of the variance-covariance matrix exhibit patterns of spatial dependence. If **ε** is independent and identically distributed with finite variance σ^2, the spatial error process can be written as

$$\Omega(|\lambda) = \left[(\mathbf{I} - \lambda\mathbf{W})^{-1}(\mathbf{I} - \lambda\mathbf{W}')^{-1}\right] \qquad \text{(Eq.5.13)}$$

Accordingly, under the assumption of normality, the log likelihood function is

$$L = -\frac{1}{2}\ln|\Omega(\lambda)| - \frac{1}{2}\ln(2\pi) - \frac{1}{2}\ln\sigma^2 - \frac{(\mathbf{y} - \mathbf{X}\boldsymbol{\beta})'\Omega(\lambda)^{-1}(\mathbf{y} - \mathbf{X}\boldsymbol{\beta})}{2\sigma^2} \qquad \text{(Eq.5.14)}$$

Maximising the log likelihood function with respect to σ^2 and β yields the generalised least square (GLS) results (Anselin and Bera, 1998)

$$\hat{\sigma}^2 = \frac{\mathbf{u}'\mathbf{u}}{n}$$
$$\hat{\beta} = \left[\mathbf{X}'\Omega(\lambda)\mathbf{X}\right]^{-1}\mathbf{X}'\Omega(\lambda)^{-1}\mathbf{y} \qquad \text{(Eq.5.15)}$$

where $\mathbf{u} = (\mathbf{y} - \mathbf{X}\boldsymbol{\beta})(\mathbf{I} - \lambda\mathbf{W})$. However, a consistent estimator for λ cannot be obtained from the OLS residuals and therefore the standard two-step Feasible Generalised Least Squares (FGLS) approach cannot be applied. Instead, the estimator for λ must be obtained from an explicit maximisation of a concentrated likelihood function obtained by substituting 5.15 into 5.14,

$$L_C = -\frac{1}{2}\ln|\Omega(\lambda)| - \frac{1}{2}\ln(2\pi) - \frac{1}{2}\ln\left(\frac{\mathbf{u}'\mathbf{u}}{n}\right) - \frac{n}{2} \qquad \text{(Eq.5.16)}$$

which is used to find an estimate of the spatial error coeffecient, λ.

5.4.3.2 Spatial Autoregressive Model (SAR)

This spatial autoregressive process can be formalised and added as an extension of the basic hedonic model to obtain,

$$\mathbf{y} = \mathbf{X\beta} + \rho\mathbf{Wy} + \boldsymbol{\varepsilon} \qquad \text{(Eq.5.17)}$$

where ρ is a scalar autoregressive parameter and $\boldsymbol{\varepsilon}$ is as usual, distributed according to $\varepsilon \sim N(0,\sigma^2 I)$[123]. It is easy to see that the basic hedonic model is a special case where $\rho = 0$. Technically, the spatial lagged dependent variable, **Wy,** is an endogenous variable in that it is always correlated with the error term, $\boldsymbol{\varepsilon}_i$ as well as the error terms at all j locations.[124] Disregarding spatial lag dependence amounts to omitting a valuable explanatory variable. For these reasons, estimations of the model by OLS method would produce biased results and subsequently cause misleading inferences to be made (Anselin, 1995). The correct method of estimation is either maximum likelihood or instrumental variables techniques depending on the error structure. Solving the spatial lag model for **y** and **ε** gives us,

$$\mathbf{y} = (\mathbf{I} - \rho\mathbf{W})^{-1}\mathbf{X\beta} + (\mathbf{I} - \rho\mathbf{W})^{-1}\boldsymbol{\varepsilon} \qquad \text{(Eq.5.18)}$$

$$\boldsymbol{\varepsilon} = (\mathbf{I} - \rho\mathbf{W})\mathbf{y} - \mathbf{X\beta} \qquad \text{(Eq.5.19)}$$

Accordingly, the variance-covariance matrix is given by,

$$E[\boldsymbol{\varepsilon\varepsilon}'] = \sigma^2(\mathbf{I} - \rho\mathbf{W})^{-1}(\mathbf{I} - \rho\mathbf{W}')^{-1} = \Omega(\rho) \qquad \text{(Eq.5.20)}$$

whereby this variance matrix is full, since in principle, each location is correlated with all other locations (Anselin and Bera, 1998). Under the assumption of normality, the log likelihood function takes the form

[123] The spatial lag model is also referred to as the mixed regressive, spatially autoregressive model (Anselin, 1988).

[124] From Eq. 5.17, it can be seen that the spatial lag term **Wy** is correlated with the disturbances even when the latter are independent and identically distributed; whereas the time-series lag variable is not.

$$L = \ln|\mathbf{I}-\rho\mathbf{W}| - \frac{N}{2}\ln(2\pi) - \frac{N}{2}\ln\sigma^2 - \frac{[(\mathbf{I}-\rho\mathbf{W})\mathbf{y}-\mathbf{X\beta}]'[(\mathbf{I}-\rho\mathbf{W})\mathbf{y}-\mathbf{X\beta}]}{2\sigma^2} \quad \text{(Eq.5.21)}$$

Maximising 5.21 with respect to σ^2 and β yields the following maximum-likelihood estimates

$$\hat{\sigma}^2 = \frac{[(\mathbf{I}-\rho\mathbf{W})\mathbf{y}-\mathbf{X}\hat{\beta}]'[(\mathbf{I}-\rho\mathbf{W})\mathbf{y}-\mathbf{X}\hat{\beta}]}{N} \quad \text{(Eq.5.22)}$$
$$\hat{\beta} = (\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'(\mathbf{I}-\rho\mathbf{W})$$

both of which can be substituted into the log-likelihood function in Eq. 5.21 to obtain a maximum likelihood estimate of the spatial lag coefficient, ρ.

5.4.3.3 Spatial Durbin Model (SDM)

The spatial lag model only considers spatial lag pertaining to the dependent variable i.e., influence from price of neighbouring observations. If there are reasons to suspect that an observation is also affected by the explanatory variables of neighbouring observations, then the spatial Durbin or spatial common factor model is more appropriate (Anselin, 1988). A set of spatially-lagged explanatory variables is added into the model in Eq. 5.17,

$$\mathbf{y} = \rho\mathbf{W}\mathbf{y} + \mathbf{X}\boldsymbol{\beta}_1 + \rho\mathbf{W}\mathbf{X}\boldsymbol{\beta}_2 + \boldsymbol{\varepsilon} \quad \text{(Eq.5.23)}$$

Le Sage and Pace (2009) demonstrated that the presence of omitted variables in the spatial error model will lead to the true data generating process being that is associated with the spatial Durbin model. They argued that the use of a spatial Durbin specification helps protect against omitted variable bias. It was also shown that the spatial Durbin model nests both spatial lag and spatial error models and it can be concluded that the spatial Durbin is the only model that will produce unbiased coefficient estimates under most data generating processes.

5.4.3.4 General Spatial Model (SAC)

The general spatial model basically incorporates the spatial error term into the spatially lag dependent model and therefore considered to be a higher order model. The model allows for the two types of dependences to be estimated together. A different weight matrix may be specified for each of the spatial dependence processes if it is believed that a different set of neighbours exert influence through the spatial lag than through the spatial error. For instance, the spatial lag matrix, $\mathbf{W_1}$, may be limited to those parcels sold earlier in time compared to the observation, while the spatial error weight matrix, $\mathbf{W_2}$, does not have similar constraints. The general spatial model can be written as,

$$\mathbf{y} = \rho \mathbf{W}_1 \mathbf{y} + \mathbf{X}\boldsymbol{\beta} + \mathbf{u} \qquad \text{(Eq.5.24)}$$

where

$$\mathbf{u} = \lambda \mathbf{W}_2 \mathbf{u} + \boldsymbol{\varepsilon} \quad \text{and} \quad \boldsymbol{\varepsilon} \sim \mathrm{N}\left(0, \sigma^2 \mathrm{I}\right)$$

Combining the two spatial processes in one expression yields,

$$\mathbf{y} = \rho \mathbf{W}_1 \mathbf{y} + \lambda \mathbf{W}_2 \mathbf{y} - \rho\lambda \mathbf{W}_1 \mathbf{W}_2 \mathbf{y} + \mathbf{X}\boldsymbol{\beta} - \lambda \mathbf{W}_2 \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon} \qquad \text{(Eq.5.25)}$$

A number of statistical tests have been developed to ascertain the necessity of accounting for spatial interactions in a dataset. The tests provide initial guidance on the types of spatial dependence present, which can be validated by comparing actual model performance. We briefly describe the statistical foundations for tests applied in our study in the next section.

5.4.4 Specification Tests and Model Selection

Basically, the tests to detect spatial dependence employ pre-specified spatial weight matrix and OLS regression residuals, explained further below.

5.4.4.1 Moran's I

The most commonly used specification test for spatial autocorrelation is *Moran's I.* It is a spatial analogue to Pearson's correlation coefficient and is defined as follows:

$$\mathbf{I} = (N / S_o)\left(\mathbf{e}'\mathbf{W}\mathbf{e}/\mathbf{e}'\mathbf{e}\right) \qquad \text{(Eq.5.26)}$$

where $S_o = \sum_i \sum_j w_{ij}$, a standardisation factor that corresponds to the sum of the weights for the non-zero cross-products, $\mathbf{e}$ is the vector of OLS residuals, and $\mathbf{W}$ is the spatial weight matrix of the size (n x n). If spatial weights are row-standardised weights, then

$S_o = N$. The hypothesis of no spatial correlation is rejected if *Moran's I* is larger than the critical value (Anselin 1988, 1999). The *Moran I* statistics has a standard normal distribution, takes on values between -1 (strong negative correlation) and +1 (strong positive correlation). Under the null hypothesis of no spatial autocorrelation, *Moran's I* value is *-1/((N – 1)* and converges to zero as *N* increases. The test, however, does not indicate any specific types of spatial dependence.

5.4.4.2 Lagrange Multiplier test[125]

The standard Lagrange Multiplier (LM) test for spatial error dependence model where the null hypothesis is value of $\lambda = 0$, while the LM test for spatial lag dependence model tests the null hypothesis that $\rho = 0$.

The LM-error test takes the form,

$$\mathrm{LM}_{\mathrm{err}} = \left[\mathbf{e}'\mathbf{W}\mathbf{e}/\left(\mathbf{e}'\mathbf{e}/N\right)\right]^2 / \left[\mathrm{tr}\left(\mathbf{W}^2 + \mathbf{W}'\mathbf{W}\right)\right] \qquad \text{(Eq.5.27)}$$

The LM-lag test takes the form,

$$\mathrm{LM}_{\mathrm{lag}} = \left[\mathbf{e}'\mathbf{W}\mathbf{y}/\left(\mathbf{e}'\mathbf{e}/N\right)\right]^2 / \mathbf{D} \qquad \text{(Eq.5.28)}$$

where $\mathbf{D} = \left[\left(\mathbf{WX\beta}\right)'\left(\mathbf{I} - \mathbf{X}\left(\mathbf{X}'\mathbf{X}\right)^{-1}\mathbf{X}'\right)\left(\mathbf{WX\beta}\right)/\boldsymbol{\sigma}^2\right] + \mathrm{tr}\left(\mathbf{W}^2 + \mathbf{W}'\mathbf{W}\right)$.

Both tests have an asymptotic $\chi^2(1)$ distribution. These tests basically compare the OLS model with the specific spatial model type but not between the spatial models themselves. The test against one spatial model still has some power against the other. As such, we could obtain significant results for both types of spatial dependence although only one is actually present. Anselin recommends that in such an event, it is necessary to consider their robust forms. The robust LM test is a two-way test accounting for the presence of both types of spatial dependence.[126] If only one robust LM statistics is

[125] Although the Likelihood-Ratio or Wald tests are asymptotically equivalent to the LM tests, the two are relatively more cumbersome to implement as they require the estimation of the alternative model.

[126] The robust tests are multidirectional in that they include correction factors to account for the presence of the other type of spatial effect i.e., we can test for spatial error dependence in the presence of a spatially lagged dependent variable and vice versa. Their mathematical derivation as well as that of other multidirectional tests can be found in Anselin *et al*., (1996).

significant, that model should be chosen; if both robust LM are highly significant, the model with the larger test statistic value is favoured. However, since the power of the Robust LM test is less than that of the standard LM tests when only one of the two types of spatial dependence is present, the former needs to be used in conjunction with the latter.[127]

Anselin noted that in applied econometrics work, heteroscedasticity is likely to be present. Therefore, it is useful to be able to test for residual spatial autocorrelation in the presence of heteroscedasticity, without having to specify its precise form. He applied the Davidson and MacKinnon (DM) test procedure to extend the spatial LM tests in an instrumental variable framework. The test now involves testing a null hypothesis τ = 0, whereby:

$$\begin{aligned} H_0 &: \mathbf{y} = \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\mu} \\ H_1 &: \mathbf{y} = \mathbf{X}\boldsymbol{\beta} + \mathbf{S}\boldsymbol{\tau} + \boldsymbol{\mu} \end{aligned} \qquad \text{(Eq.5.29)}$$

where **S** is a (*n x r*) matrix, $\boldsymbol{\tau}$ is a *(r x 1)* column of parameters and $\boldsymbol{\mu}$ is an independent but heteroscedastic error term with $\mathbf{E}\left[(\boldsymbol{\mu}_1)^2\right] = \sigma_1^2$, bounded for all *i*.

The test statistic for the spatial lag model is written as

$$\mathbf{DM_1} = \mathbf{y'MZ}\left(\mathbf{Z'M\Omega(u)MZ}\right)^{-1}\mathbf{Z'My} \sim \boldsymbol{\chi}^2\mathbf{(R)} \qquad \text{(Eq.5.30)}$$

where the projection matrix $\mathbf{M} = \mathbf{I} - \mathbf{X}\left(\mathbf{X'X}\right)^{-1}\mathbf{X'}$, and Ω(u) is a diagonal matrix with the squared OLS residuals. However, no actual IV estimation is necessary. The test is equivalent to N minus the sum of squared residuals in an auxiliary regression of

$$\boldsymbol{\iota} = \mathbf{U.M.S}\boldsymbol{\tau} + \text{errors} \qquad \text{(Eq.5.31)}$$

where $\boldsymbol{\iota}$ is a vector of ones, and **U** is a diagonal matrix of OLS residuals. The test for spatial error in the presence of heteroscedasticty can be expressed using the spatial Durbin form,

$$H_1 : \mathbf{y} = \lambda\mathbf{Wy} + \mathbf{X}\boldsymbol{\beta}_1 + \lambda\mathbf{WX}\boldsymbol{\beta}_2 + \boldsymbol{\mu} \qquad \text{(Eq.5.32)}$$

[127] Kelejian and Robinson (1998) developed an alternative multidirectional test for the same purpose. It is generally suggested that an estimator using instrumental variables or the generalised-methods-of-moments to estimate the parameters of cross-sectional data with heteroscedastic errors and spatial dependence.

To allow estimation (see Anselin, 1988 p.114), the unrestricted model is re-writen in a non-linear form,

$$\mathbf{y} = f(\boldsymbol{\beta}, \boldsymbol{\lambda}) + \boldsymbol{\mu}$$

where the relevant partial derivatives are :

$$\partial f / \partial \beta = \mathbf{X} - \boldsymbol{\lambda}\mathbf{WX} \qquad \text{(Eq.5.33)}$$

$$\partial f / \partial \lambda = \mathbf{Wy} - \mathbf{WX}\boldsymbol{\beta}$$

An extension of the DM results to this case yields the test statistic,

$$\mathbf{DM}_{NIV} = (\mathbf{y} - f)' \mathbf{MPF}(\lambda) \left[F(\lambda)' \mathbf{PM\Omega(u)MPF}(\lambda)^{-1} F(\lambda)' \mathbf{PM} \sim \boldsymbol{\chi}^2\mathbf{(R)} \right] \qquad \text{(Eq.5.34)}$$

where **(y – f)** is the OLS residuals, **Ω(u)** us a diagonal matrix of squared residuals, **M** is the projection matrix and **P** is a matrix of instruments with the following definitions,

$$\mathbf{M} = \mathbf{I} - \mathbf{PF}(\boldsymbol{\beta}) \left[\mathbf{F}(\boldsymbol{\beta})' \mathbf{PF}(\boldsymbol{\beta}) \right]^{-1} \mathbf{F}(\boldsymbol{\beta})' \mathbf{P} \qquad \text{(Eq.5.35)}$$

$$\mathbf{P} = \mathbf{Q}(\mathbf{Q}'\mathbf{Q})^{-1}\mathbf{Q}'$$

The auxiliary regression is of the form,

$$\boldsymbol{\iota} = \mathbf{U.M.P.F(}\lambda\mathbf{)}\boldsymbol{\tau} + \text{error} \qquad \text{(Eq.5.36)}$$

where **ι** is a vector of ones, and **U** is a diagonal matrix of OLS residuals as before, **MPF**(λ) are the residuals in a regression of **PF**(λ) on **PF**(β) i.e., matrices of the partial derivatives shown earlier in Eq. 5.35.

5.5 MODEL SELECTION

Overall, model selection is based on the LM-tests for spatial lag and spatial error models, significance of the estimated ρ and λ values in the spatial regression models and the value of log-likelihoods. The closer ρ is to 1, the larger the lagged effects of neighbouring units' dependent variable, provided that the coefficient is significant. The best model should display appropriate signs of explanatory variables, significant coefficients, residual normality and a high log-likelihood value. The use of R-squared values to compare goodness of fit across models is no longer suitable because spatial models estimates are derived by ML or IV methods (see Anselin, 1988 p. 243). With the former, the more appropriate measure of fit is the maximised log-likelihood or a squared correlation between predicted and observed values. Additional measures of fit that allow direct comparisons between models are information-based criteria, such as the well-known Aikaike Information Criterion (AIC) and the Schwartz Information Criterion (SIC). Both measures use the likelihood function in conjunction with the number of independent variables to discriminate between models. With respect to this, the AIC criteria is defined as

$$\mathrm{AIC} = -2.L + q(K) \qquad \text{(Eq.5.37)}$$

where L is the maximised log likelihood value, K is the number of unknown parameters of the model and q is a correction or penalty factor for the number of parameters. The model with the lowest AIC or SIC values are preferred. However, as often reminded, any comparison and eventual 'best' model selections are conditional on the specification of the model and choice of spatial weights.

Nevertheless, there are researchers like Gao *et. al* (2006) who suggest a useful way to objectively test the significance of spatial relationships and model suitability is to scrutinise the prediction power of the competing models. If a spatial model does not outperform the standard linear model, then we can accept the estimation results of the simple model as sufficiently robust and represents the data well. Comparisons of the competing models' predictive ability are best done using in-sample or out-sample observations. There are several numerical cross-validation criteria which can be summarised as follows:

Mean of squares of prediction errors: $\frac{1}{n}\sum\left(y_i - \hat{y}_i\right)^2$ (Eq. 5.38)

Mean of absolute errors: $\frac{1}{n}\sum\left|y_i - \hat{y}_i\right|^2$ (Eq. 5.39)

Average error rate[128]: $\frac{1}{n}\sum\frac{\left|y_i - \hat{y}_i\right|^2}{y_i}$ (Eq. 5.40)

[128] As a guide, Gao *et al.* (2006) recommends that if the mean is larger than the median, the mean is a better predictor.

where y_i and $\hat{y}_i$ denote the observed and predicted dependent variables, respectively. The smaller the values of these measures, the better the model. Upon deciding on the best model to use in estimating our hedonic function, the logical next step is to examine the marginal values of each regressor to obtain the implicit prices of the attributes.

5.6 IMPLICIT PRICES

A fundamental extension of empirical prediction exercise is to isolate the price effect of a change in any particular attribute is changed, *ceteris paribus*. The change in log of price is essentially given as price elasticity of the good associated with one unit change in the attribute. The marginal or implicit value of an attribute can be easily inferred from the partial price elasticity of the good with respect to this attribute. Subsequently, the predicted price of the good at specified levels of attributes (median or mean) can be computed. If the dependent variable is in logs, then special care has to be taken to re-transform the predicted log effects to its original scale, as described earlier in the chapter. This section demonstrates the considerations usually taken when interpreting the marginal effects from the estimated coefficients, β_k, in different model specifications:

i. In a price model where x_k and P are both log-transformed, the marginal effects are found by expanding the derivative,

$$\beta_k = \frac{\partial \ln P}{\partial \ln x_k} = \frac{\partial P}{P} / \frac{\partial x_k}{x} \qquad \text{(Eq 5.41)}$$

whereby the final transformation directly provides the familiar price elasticity measure. The coefficients of log regressors measure the percentage change in price associated with a 1 percent change in x_k. A positive (negative) coefficient estimate means that price response is in the same (opposite) direction as the associated change in the explanatory variable's value. The variables are assumed to display constant elasticity throughout the sample[129]. Eq. 5.41 can then be

[129] It is entirely possible to compute elasticity at several different price points, rather than just at the mean or median observation, in order to test the assumption of constant elasticity. An alternative technique would be to convert the log-log model into a linear specification following the form:

manipulated to yield the predicted effect of a unit change in x_k at a given level of x_k and Price,

$$\frac{\partial \mathrm{P}}{\partial x_k} = \frac{\hat{\beta}_k}{\bar{x}_k}\overline{\mathrm{P}} \qquad \text{(Eq. 5.42)}$$

ii. If the attribute x_k is a continuous variable that is not log-transformed, the β_k coefficient gives the semi-elasticity measure of relative change in price associated with one unit change in the value of the regressor x_k, such that

$$\beta_k = \frac{\partial \ln P}{\partial x_k} = \left(\frac{\partial \mathrm{P}}{\mathrm{P}}\right)\left(\frac{1}{\partial x_k}\right) \qquad \text{(Eq. 5.43)}$$

Upon rearranging the terms, the predicted effect of a unit change in x_k is

$$\frac{\partial \mathrm{P}}{\partial x_k} = \hat{\beta}_k \overline{P} \qquad \text{(Eq.5.44)}$$

iii. If the attribute x_k is a dummy variable, the calculation of the price effect is slightly more elaborate. *If* $x_k = 1$, the antilog of the coefficient minus one will show the percentage price difference associated with the characteristic's presence (as in Gujerati, p.321[130])

$$\frac{\partial P}{\partial x_k} = \exp\left(\hat{\beta}_k\right) - 1 \qquad \text{(Eq.5.45)}$$

The predicted change in price associated with the characteristic can be obtained by rearranging the preceding expression,

$$\frac{\partial P}{\partial x_k} = \partial P = \left[\exp\left(\hat{\beta}_k\right) - 1\right]\overline{P} \qquad \text{since } \partial x_k = 1 \qquad \text{(Eq.5.46)}$$

iv. When interaction terms are employed to examine the **conditional effect** of a regressor on the dependent variable, the calculation of marginal effects is slightly

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$y = \alpha_0 + \alpha_1 x_k + u$; and compute $\frac{\partial \ln(f)}{\partial \ln x}$ at any value of x. However, because of the highly mixed types of functional forms in the thesis's model, as well as visual confirmation from a scatterplot of the dependent variable, *lprice*, against the respective log independent variables, we find no evidence to suggest a varying elasticity nature for any of them.

[130] Based on Halvorsen and Palmquist (1980).

different[131,132]. Both the coefficients of the constituent variable and the product term provide the regressor's total effect on the dependent variable, all else constant. For instance, if the dependent variable is in logs but the regressor is not, then partial elasticity is given by

$$\frac{\partial \ln P}{\partial x_k} = \beta_k + \gamma_k z \qquad \text{(Eq.5.57)}$$

whereby coefficient γ_k indicates how much the effect of x_k on log of P changes as z takes on different values. the expression can be simplified as

$$\eta_k = \beta_k + \gamma_k z \qquad \text{(Eq.5.58)}$$

where η_k the partial elasticity of price with respect to variable x_k.

v. In a spatial error model, the marginal implicit price is not expected to be different from the standard linear model simply because there are no changes in parameter estimates, only smaller or larger standard error of the estimates. Thus, if only spatial errors are detected, one can still use OLS estimates above to compute implicit prices without making any modifications.

vi. However, in the presence of spatial lag dependence, recalculations of partial elasticity and predicted implicit prices are necessary. Consider the simple spatial lag model in Eq. 5.17 where a statistically significant positive value of the spatial autoregressive coefficient, ρ, implies that prices of neighbouring parcels tend to

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131 Marginal effects computation can be quite involved as compounded variable transformations are adopted. For instance, if an independent variable enters the price function as a log and quadratic log form. Assuming other factors are constant, a quadratic and log predictor's coefficient is the derivative of the variable written from the function $\ln \text{Price} = \beta_0 + \beta_1 \ln x_k + \beta_2 \ln x_k^2 + ... + u$ will appear as $\frac{\partial \ln \text{Price}}{\partial x_k} = \beta_1 + 2\beta_2 x_k$. Rearranging the terms gives us the effect of a unit change in the regressor on price as $\partial \text{ Price} = \frac{\beta_1 + 2\beta_2 \ln x_k}{x_k} \text{Price}$ where β_2 is the coefficient for the quadratic term of the variable. If for instance, its log term is negative and its quadratic log term positive, than we can say that **the elasticity**, not the magnitude, of the regressor varies as the variable increases beyond a certain value i.e., we have decreasing and later increasing percentage changes.

132 The interaction model approach is used to achieve our goal of modeling structural stability in the market. Effects of an independent variable vary linearly depending on values of other independent variables (or in this case, group membership).

"spill over" on the price of the observed parcel. For this reason, Kim *et al.* (2003) in Patton and McErlean (2004) express the partial differentiation of the spatial lag function with respect to attribute x_k as follows:

$$\frac{\partial P}{\partial x_k} = \begin{bmatrix} \partial P_1/\partial x_{1k}, \partial P_1/\partial x_{2k}, ..., \partial P_1/\partial x_{nk} \\ \partial P_2/\partial x_{1k}, \partial P_2/\partial x_{2k}, ..., \partial P_2/\partial x_{nk} \\ \\ \partial P_n/\partial x_{1k}, \partial P_n/\partial x_{2k}, ..., \partial P_n/\partial x_{nk} \end{bmatrix} \quad \text{(Eq.5.49)}$$

The matrix indicates that the price of a particular parcel, P_1 (first row of the matrix) is directly influenced by marginal changes in attribute x_k in location 1 as well as changes in x_k that occurred in neighbouring parcels i.e., x_{2k}, x_{3k},..., x_{nk}. If the spatial lag model follows a semi-log specification, marginal prices must be recalculated matrix as follows

$$\frac{\partial \ln P}{\partial x_k} = \begin{bmatrix} \partial \ln P_1/\partial x_{1k}, \partial \ln P_1/\partial x_{2k}, ..., \partial \ln P_1/\partial x_{nk} \\ \partial \ln P_2/\partial x_{1k}, \partial \ln P_2/\partial x_{2k}, ..., \partial \ln P_2/\partial x_{nk} \\ \\ \partial \ln P_n/\partial x_{1k}, \partial \ln P_n/\partial x_{2k}, ..., \partial \ln P_n/\partial x_{nk} \end{bmatrix} \quad \text{(Eq.5.50)}$$

Both matrices show that the coefficient estimate in an OLS model in the presence of spatial lag effect tends to over-value the impact of the regressor x_k on price - because there are indirect influences attributable to x_k coming from neighbouring units that are not accounted accordingly. Therefore, Patton and McErlean argue that even if parameter estimates from spatial models vary very slightly from OLS estimates, this will not guarantee that the difference in marginal effects is also very small.

The effect of a unit change in x_k induced at every parcel location in P_i is called the spatial multiplier; its value given by the sum of each row of the inverse matrix of row standardised spatial weight matrix or $1/(1-\rho)$. This spatial lag multiplier is introduced into the matrix as $\mathbf{A} = [\mathbf{I} - \rho\mathbf{W}]^{-1}$. Hence, a partial derivative Jacobian matrix showing elasticity of price in the semi-log model with respect to x_k can be re-written in a simpler manner as follows:

$$\frac{\partial \ln P}{\partial x_k} = \begin{bmatrix} \left(\beta_k \cdot a_{11} \cdot P_1 / \partial x_{1k}\right), \left(\beta_k \cdot a_{12} \cdot P_1 / \partial x_{2k}\right) \left(\beta_k \cdot a_{1n} \cdot P_1 / \partial x_{nk}\right) \\ \left(\beta_k \cdot a_{21} \cdot P_2 / \partial x_{1k}\right), \left(\beta_k \cdot a_{22} \cdot P_2 / \partial x_{2k}\right) \left(\beta_k \cdot a_{2n} \cdot P_2 / \partial x_{nk}\right) \\ \\ \left(\beta_k \cdot a_{n1} \cdot P_n / \partial x_{1k}\right), \left(\beta_k \cdot a_{n2} \cdot P_n / \partial x_{2k}\right) \left(\beta_k \cdot a_{nn} \cdot P_n / \partial x_{nk}\right) \end{bmatrix} \quad \text{(Eq.5.51)}$$

$$= \beta_k A \left(\frac{P}{x_k} \right)$$

The matrix's diagonal elements represent the direct or own effects of x_k on price, while its off-diagonal elements represent the indirect/cross-effect coming from x_k changes in neighbouring units.

As shown above, the accurate marginal effects of any given attribute on price, ME_{x_k}, when x_k is not log-transformed can be derived simply by factoring in the spatial lag effect which is given by A, as shown in Eq. 5.51 above or $\partial P = \left\lfloor \exp\left(\hat{\beta}_k\right) - 1 \right\rfloor A\overline{P}$ if x_k is a dummy variable. However, partial differentiation with respect to a log-transformed x_k variable requires that a specific value of x_k is introduced into the matrix. Usually the sample mean, $\bar{x}_k$ is used but this is no longer appropriate because in the presence of spatial lag, the mean values of x_k in other locations are also important to price. Because they are not the same ($\bar{x}_{1k} \neq \bar{x}_{2k} \neq \bar{x}_{3k} ... \neq \bar{x}_{nk}$), it is easy to see that Eq. 5.42 which shows the relevant predicted implicit price calculation cannot be modified to reflect the spatial lag process.

Kim *et al*. (2003) calculated the marginal effects of land attributes on its price from the OLS and the spatial lag estimation and found the resulting marginal effects to be almost similar. Patton and McErlean concluded that although there is ample room for new empirical evidence comparing the marginal effects between standard and spatial models, it may be the case that the overall impact of spatial lag dependency on marginal implicit value of attributes is small. A researcher faced with a log spatial autoregressive specification would have to consider if adjustments suggested are worth the extra computational burden. If the aim of the model is to seek very accurate point estimates, then this extension is indispensible. Otherwise, the OLS partial elasticities and predicted implicit prices can be sufficiently useful as a guide to policy assessment or market analysis.

In fact, debate continues whether spatial econometrics is indeed an essential feature of HPM. Mueller and Loomis's (2008) paper is among the handful of research investigating the importance and consistency of spatial influence in hedonic price models. They found that the degree of bias observed in estimated traditional HPM coefficients may not be as large[133] or damaging as often thought, in the sense that biased empirical estimates is not likely to cause severe economic losses from policy-targetting that is 'off' because of resulting model misspecification. Even if a spatial specification is fully adopted, Wilhelmsson (2002) argued that the choice of spatial structure will affect the interpretation of parameters for variables that are correlated with it. It is also difficult to agree on a single utilisable degree of bias because there are vastly contrasting magnitudes of the spatial bias found in different studies for the same geographical region. In particular, location-based variables have been found to be helpful in precluding spatial error dependence because the higher the amount of spatial information included in the model, the smaller the risk of omitted variable bias, thus, the smaller the degree of spatial dependencies among the error terms.

5.7 CONCLUSION

The thesis's empirical component attempts to add to the literature concerning land market price determinants through the application of Hedonic Pricing models. However, because of its ad hoc nature, the process of model selection essentially involves evaluating alternative models to find one that best subscribes to reason (market realities) and the available data. Models are tested and in an iterative manner, they are either improved or replaced with better models. In this chapter, we described various model improvement techniques including the Box-Cox functional form search procedure,

[133] For example, Patton and McEarlean found the degree of spatial lag bias to be very small in their study of Northern Ireland agricultural land market. They also found inconclusive evidence of spatial heterogeneity unless spatial lag dependence is accounted for, the reason for this was not given.

hedonic price index calculations, interaction model to model structural stability, spatial econometrics to explicitly incorporate the effects of space into the model and statistical and empirical model evaluation methods to guide model selection.

CHAPTER 6
ESTIMATION RESULTS

6.1 INTRODUCTION

This empirical work attempts to add to the strand of literature regarding land market determinants using the hedonic pricing model (HPM) approach. The underlying principle of the hedonic pricing approach is simply that a good's overall value should be an aggregation of the values of its attributes. Since it is impossible to capture each and every value-generating attribute of land, an alternative is to incorporate a variable that can describe its overall value, which in absence of state control, should reflect the land's 'highest and best' use-potential. Prior empirical studies employed survey or assessed values of land which inherently accounts for differences in potential, whilst others employ actual transaction values that do not explicitly indicate land potential. The data employed in this study is unique in that it provides both actual transaction prices and the 'highest and best' use-potential of each parcel. It is therefore possible to test directly if the marginal or implicit price of a given attribute is different according land's highest potential use; and subsequently, measure the extent of that difference. The thesis also seeks to ascertain the type and extent of influence an observation's location has on its price. The inclusion of a spatial perspective in the model is necessary since uncorrected spatial biases could produce misleading inferences regarding the impact of changes in attributes on price.

This chapter is structured in such a way that is parallel to Chapter 5 which described the statistical foundations of the methods employed in this study. The chapter continues by outlining a basic empirical model that best suits the Malaysian agricultural land market and data availability. The model is tested using the full set observations and thereafter, evaluated accordingly. Section 6.3 addresses the issue of market heterogeneity i.e., structural stability of the estimated basic price function by accounting for different sources of data grouping. Tests for spatial dependence using smaller sub-types of land are given in Section 6.4. Interpretation of empirical estimates and substantive analyses are provided in Section 6.5 while Section 6.6 concludes.

6.2 BASIC HEDONIC MODEL

The key relationships concerning price determinants can be presented in an estimable format based on a general hedonic regression model (from Eq. 5.2) as

$$P_i^{(\theta)} = \alpha_{0i} + \sum_{j=1}^{k} \beta_j X_{ij}^{(\xi)} + \sum_{m=1}^{n} \beta_m X_{im} + \varepsilon_i \qquad \text{(Eq. 6.1)}$$

where the model contains $k = 1,2,3,...,l$ continuous variables and $m = 1,2,3,...,n$ qualitative variables, representing different attributes of the i^{th} land sales observation; β_k and β_m are vectors of regression coefficients and ε is a vector of error terms presumed to have a multivariate normal distribution, $N(0, \sigma^2 I)$.

Using the selected dependent and independent variables described in Chapter 4, the basic regression equation is as follows[134]

$$\begin{aligned} P = \alpha + \beta_1 rdfront + \beta_2 gsa + \beta_3 mrl + \beta_4 popgro + \beta_5 popden \\ + \beta_6 distown + \beta_7 distnse + \varepsilon \end{aligned} \qquad \text{(Eq. 6.2)}$$

The dependent variable in the model is Real Price per hectare of land in Ringgit Malaysia (RM), *rprice*. The explanatory variables include *rdfnt*, a dummy to indicate if the parcel has road frontage advantage, *gsa* and *mrl*, dummies to indicate group settlement lands or Malay Reserve restrictions, respectively. Demographic indicators such as population growth and population density are measured as *popgro* and *popden* respectively; while distances between an observed land parcel to the nearest major city and the nearest highway access point are given by *distown* and *distnse* respectively.

In order to capture the effects of different land-use potentials, we include dummy variables for the five categories of land: developable agricultural land, rubber, oil palm, rice, and vacant agricultural land. The last four categories can also be broadly classified as non-developable agricultural land (*dev* = 0) in the sense that their 'highest and best' potential is still in continued agricultural use. The land-use dummies are introduced in the additive and multiplicative forms to determine structural stability across the different

[134] All the empirical tasks are undertaken using Stata Statistical Sofware (Stata, 2009).

land-use potentials. State-based dummies are later introduced into the model to test the geographical extent of the land market.

To evaluate the appropriateness of the model, various diagnostic tests (as explained in Chapter 5) are performed and their results are discussed in the following sub-sections:

6.2.1 Pairwise Correlation

Prior to performing the estimation procedure, it is perhaps useful to investigate pairwise correlations between three pairs of "similar" explanatory variables in the model. It is found that the restriction variables, *gsa* and *mrl* are only weakly correlated with each other (correlation coefficient = 0.145); whilst the demographic indicator variables, *popgro* and *popden* as well as distance-based variables, *distown* and *distnse*, register correlation coefficients of 0.584 and 0.604, respectively. Although for the latter two, their pair-wise correlations are greater than 50%, it was decided to retain and review the issue again after the estimation procedure. In general, the dependent variable, price is highly correlated with all variables in the model except *distown* and *distnse.*

6.2.2 Functional Form

The choice of functional form of the model is addressed first through the Box-Cox search procedure. It involves a series of transformation of the dependent and continuous independent variables. The procedure was performed in two stages. First, the transformations involve only the dependent variable. Secondly, only the continuous independent variables are subject to transformations; where to simplify the process, it is assumed that ζ is the same for all independent variables (see Green, 2008 p.296). This incremental approach is useful in determining which transformation combination will provide the most significant improvement to the estimation results. The approach also helps us avoid transforming variables unnecessarily or choosing the wrong type of transformation for the respective types of variables.

The limited functional form search revealed that for the dependent variable, the unconstrained $\hat{\theta}$ value is - 0.1549 when the full sample is utilised (Table 6.1a). The null hypothesis of θ= 1, is soundly rejected (Chi-square value 4382.5), which implies that the linear form of the dependent variable is not appropriate. The null hypothesis of θ= 0, which suggests a log-linear form, is also rejected (smaller Chi-square value i.e. 80.7). However, when the same procedure is applied on data sub-sets (four states and two land-use potentials), the overall results favour accepting the null hypothesis compared to the alternative. Transforming the dependent variable by taking the natural log of price has been shown to be quite common in hedonic land price literature such as Chicoine (1981), Dunford *et al.* (1985), Elad *et al.* (1984), Shonkwiler and Reynolds (1986), Isgin and Forster (2006), Nickerson and Lynch (2001), Patton and McErlean (2003) and Cotteleer (2007). With respect to the continuous explanatory variables, Table 6.1b demonstrates that the λ values estimated on full sample and its sub-sets almost in all instances recommend log-transformations of the continuous regressors.[135]

Table 6.1a Results of the Box-Cox Search Procedure on the Dependent Variable

Sample	$\hat{\theta}$	Chi-Square Values		Decision*	
		$\theta = 0$	$\theta = 1$	$H_0{:}\theta = 0$	$H_0{:}\theta = 1$
Full Sample	-0.1549	80.65	4382.48	Reject	Reject
Melaka	-0.0952	4.22	605.80	Accept	Reject
N.Sembilan	-0.1902	15.71	571.17	Reject	Reject
Perak	-0.0441	3.78	2734.83	Accept	Reject
Selangor	0.0931	1.47	92.54	Accept	Reject
Development	0.1256	15.67	750.76	Reject	Reject
Agricultural	-0.0660	1.06	278.06	Accept	Reject

*at 5% level of confidence

Table 6.1b Results of the Box-Cox Search Procedure on Continuous Independent Variables

Sample	Value of $\hat{\xi}$	Chi-Square Values		Decision*	
		$\zeta = 0$	$\zeta = 1$	H_0: $\zeta = 0$	H_0: $\zeta = 1$
Full Sample	0.0237	0.06	78.26	Accept	Reject
Melaka	-0.3216	0.93	7.67	Accept	Reject
N.Sembilan	-0.3430	0.72	6.56	Accept	Reject
Perak	-3.7644	-2.32	9.63	Accept	Reject
Selangor	-1.5604	7.67	13.540	Reject	Reject
Development	0.1223	1.93	51.53	Accept	Reject
Agricultural	0.3433	1.09	0.74	Accept	Accept

*at 5% level of confidence

[135] Other types of sub-groupings are also tested, the results are omitted but points to the same conclusion.

Overall, the Box-Cox search procedure provides empirical support for a double log specification to test the Malaysian data. A non-linear model makes more sense as it allows the implicit values of attributes to vary according to the level of other attributes. For instance, value of road frontage should logically be different depending on whether a parcel is near a major urban hub or not. To summarise the conclusions from this exercise: (i) log-transformed variables in the model are *price*, *distown*, *distnse*, and *popden*; and (ii) the variable representing population growth, *popgro*, is not transformed because it takes negative values for a number of observations and dropping them simply because of their negative *popgro* values would seem inappropriate.[136]

Other possible transformations of the continuous regressors are attempted, for instance, the Box-Cox search procedure is also tested for H_0: $\zeta = -1$. The transformed variable would represent a distance decay function which is expected to be positively related to price. Upon application, the test failed to reject the null hypothesis in only one out of the seven subsamples tested. This led to the conclusion that the inverse form is not appropriate for the model's continuous regressors. Although this reciprocal transformation produces higher adjusted R^2 values in the pooled basic model estimation, it is not able to outperform models employing log-transformation of the distance variables when additional data identification variables are added. Furthermore, the log-transformed variables are relatively easier to interpret because they can directly provide the elasticity of price with respect a particular explanatory variable in question. The visual relationships between the log forms of *distown* and *price* as well as between the log forms of *distnse* and *price* are shown in Figure 6.1a and 1b, respectively. We found very little evidence of curvature in the two graphs, therefore it is possible to rule out a quadratic transformation for the two logs of distance variables[137].

[136] It is not possible to add 1 to the percentage value mainly because this does not ensure proportionate increase across all observations.
[137] In these two graphs plotting log of price against log of distance variables, other variables' effects are not controlled.

Figure 6.1a Scatterplot of *lprice* against *ldistown*

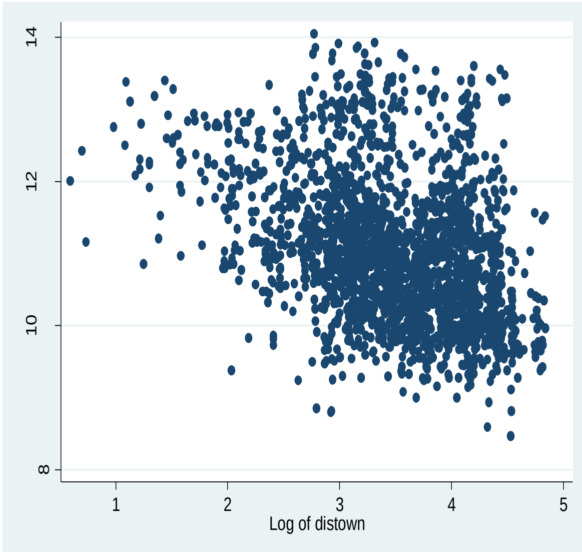
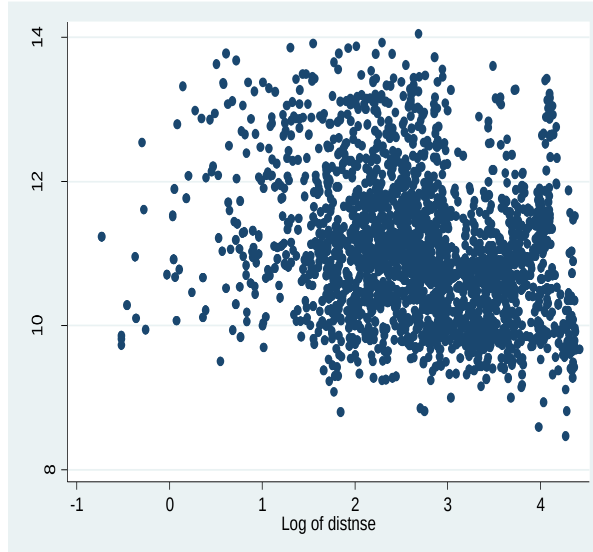


Figure 6.1b Scatterplot of *lprice* against *ldistnse*



Following the conclusions above, the chapter's hedonic model adopts a non-linear transcendental price function written as

$$P_i = \beta_0 \sum_{k=1}^{l} X_{ik}^{\beta k} \exp\left(\sum_{n=1}^{m} \beta_n X_{i,n} \right) \qquad \text{(Eq. 6.3)}$$

where the model contains $k = 1,2,3,\ldots,l$ continuous variables and $n = 1,2,3,\ldots,m$ dummy variables representing different attributes of the i^{th} land parcel; β_k and β_n are the vectors of regression coefficients and ε is a vector of error terms presumed to have a multivariate normal distribution, $N(0,\sigma^2 I)$. A linearised version of the model can be easily given by a mixed log function,

$$\ln P_i = \ln \beta_0 + \sum_{k=1}^{l} \beta_k \ln X_{ik} + \sum_{n=1}^{m} \beta_n X_{in} + \varepsilon_i \qquad \text{(Eq. 6.4)}$$

6.2.3 Model Estimation Results

This section revisits the issue of possible colinearity between certain variables which is first investigated in Section 6.2.1. The basic regression model is regressed to test the null hypothesis of equality of coefficients for the following pairs; $H_0 : \beta_{gsa} = \beta_{mrl}$, $H_0 : \beta_{lpopden} = \beta_{popgro}$ and $H_0 : \beta_{ldistown} = \beta_{ldistnse}$. Interestingly, all three hypotheses are soundly rejected. This shows that we were right in our decision to retain the pairs for their separate effects on the dependent variable.

The model is then regressed several more times using different specifications to find the best fit for the data (Table 6.2).[138] The only variable that did not contribute to general model fit is *ldistnse,* whereby the adjusted *R*-squared (R^2) value of Model 6 is exactly equal to Model 1 i.e., the larger model. The variable is also not significant in four out of the six models estimated. This implies that proximity to NSE access points is immaterial in deciding price. The reason could be related to the fact that Malaysia's highway network is highly extensive particularly in the region studied, such that its impact on land price is not often appreciable. For instance, there are 13 interchanges (not including the Sg. Besi exit to Kuala Lumpur city) along the NSE from Melaka to Kuala Lumpur, on a stretch of only 130 kilometers. Similarly, there are 23 interchanges between Kuala Lumpur (commencing at Bukit Lanjan) to Bukit Merah, north of Perak i.e., which is merely 265.3 kilometers away.[139] The variable, *ldistnse*, is dropped from the model from this point onwards. All other variables are individually statistically significant and are stable with respect to coefficient values and signs. The adjusted R^2 of Model 6 is 0.5096, which is reasonably high for a study using cross-section data.

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[138] The linear model was regressed although not included in the table. Adjusted R^2 was 0.3971, much lower than the log model; and two out of the seven regressors were not statistically significant.

[139] Calculations are made using a comprehensive map of the NSE, "Discover Malaysia with PLUS: Peninsular Malaysia Map", published by PLUS Expressway Berhad, the operator of NSE highway. Base map for this document is obtained from MSD.

Table 6.2 Estimation Results of the Basic Hedonic function

VARIABLES	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)
rdfnt	0.84***	0.90***	0.84***	0.87***	0.83***	0.84***	0.83***
	(0.041)	(0.042)	(0.041)	(0.042)	(0.042)	(0.041)	(0.041)
Gsa	-0.37***	-	-0.39***	-0.36***	-0.45***	-0.38***	-0.39***
	(0.033)		(0.032)	(0.035)	(0.034)	(0.033)	(0.032)
Mrl	-0.11***	-0.17***	-	-0.09*	-0.13***	-0.12***	-0.08*
	(0.034)	(0.034)		(0.038)	(0.034)	(0.033)	(0.033)
popgro	0.12***	0.11***	0.11***	-	0.15***	0.12***	0.12***
	(0.008)	(0.008)	(0.008)		(0.008)	(0.008)	(0.008)
lpopden	0.21***	0.25***	0.21***	0.37***	-	0.21***	0.25***
	(0.020)	(0.020)	(0.020)	(0.021)		(0.020)	(0.018)
ldistnse	-0.02	-0.03	-0.03	-0.02	-0.04*	-	-0.05*
	(0.020)	(0.021)	(0.020)	(0.021)	(0.020)		(0.019)
ldistown	-0.13***	-0.16***	-0.12***	-0.16***	-0.25***	-0.14***	-
	(0.031)	(0.031)	(0.030)	(0.033)	(0.028)	(0.029)	
Constant	10.23***	10.08***	10.16***	9.77***	11.69***	10.20***	9.64***
	(0.175)	(0.181)	(0.174)	(0.188)	(0.099)	(0.170)	(0.113)
Observations	2222	2222	2222	2222	2222	2222	2222
R^2	0.5111	0.4897	0.5090	0.4464	0.4872	0.5109	0.5062
Adj. R^2	0.5096	0.4884	0.5077	0.4449	0.4858	0.5096	0.5049

Robust standard errors in parentheses.
*** p<0.001, ** p<0.01, * p<0.05
The dependent variable is log of price, *lprice*.

All explanatory variables show the expected signs and are individually and jointly statistically significant. Holding other attributes constant, parcels with roadfrontage or those located in highly populated, high growth districts or in sites nearer to large cities generally command higher price premiums. On the other hand, parcels which are subjected to any of the two forms of land-restrictions, *gsa* and *mrl* draw lower prices in the market. A more elaborate and substantive interpretation of estimation results is deferred until the end of the chapter to allow the following sections to focus on model building and validation.

6.2.4 Model Diagnostics

Model 6 is subsequently subjected to several standard specification tests. The Ramsey RESET test whereby the null hypothesis of no specification error is rejected ($F_{3,\ 2212}$ =

15.90). The standard Breusch-Pagan test for heteroscedasticity is also significant (χ^2 = 55.37). Since one possible source of heteroscedastic errors is the presence of outliers, it is useful to refer to the residuals against fitted values plot (Figure 6.2). The graph does not indicate extreme outlier points;[140] only 16 out 2222 (less than 1 % of the sample) observations have residuals greater than or smaller than |2|. Upon closer inspection, the model over-predicted *lprice* of four parcels located in high-growth districts but which were idle at the time of sale and have poor development potential; and under-predicted *lprice* of fourteen parcels located in low-growth districts but showed high development potential – all of which seems acceptable. Dropping the problematic observations did not seem to help resolve the issue of heteroscedasticity either (χ^2 = 48.44).[141] Because of the aforementioned reasons, these observations are not omitted from the regression sample. Nevertheless, Table 6.2 only reports heteroscedasticity-robust standard errors.

In addition, multi-collinearity is tested using the familiar variance-inflating factor (VIF) test, which measures the speed with which variances and covariances increase for each regressor due to existence of linear relationships between the regressors. The VIF mean value is 1.39, indicating very low degree (or non-existence) of collinearity. The residuals are rather normally distributed as shown by its kernel density plot (Figure 6.3). Hence, it can be accepted that the model residuals are close to a normal distribution.

[140] An outlier is defined as an observation with a “large residual” relative to other observations – hence the point has a large vertical distance from the estimated regression line. The removal of such points can dramatically affect the regression estimate as well as its goodness-of-fit. However, researchers are cautioned that automatic rejection of these points is only be justifiable if there is evidence of error in recording (Fox, 1997 in Gujerati, 2003).

[141] Adjusted R^2 of the model without outliers increased to 0.5353.

Figure 6.2 Residuals versus Fitted Values

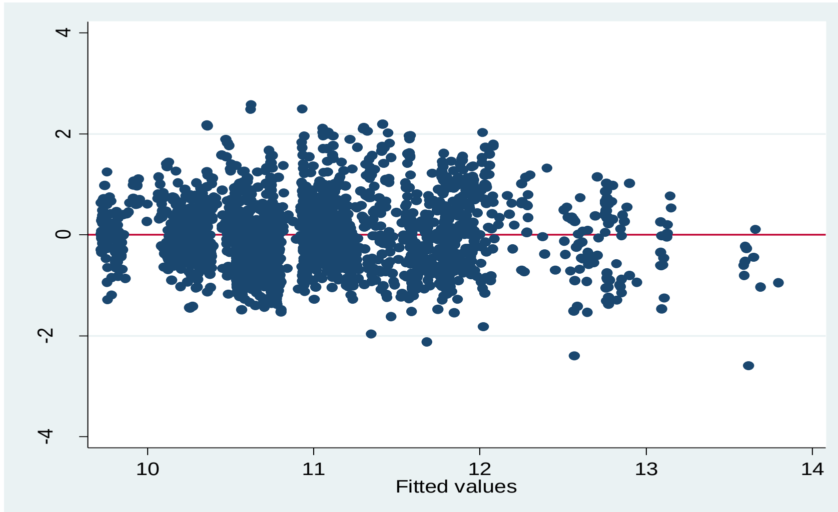
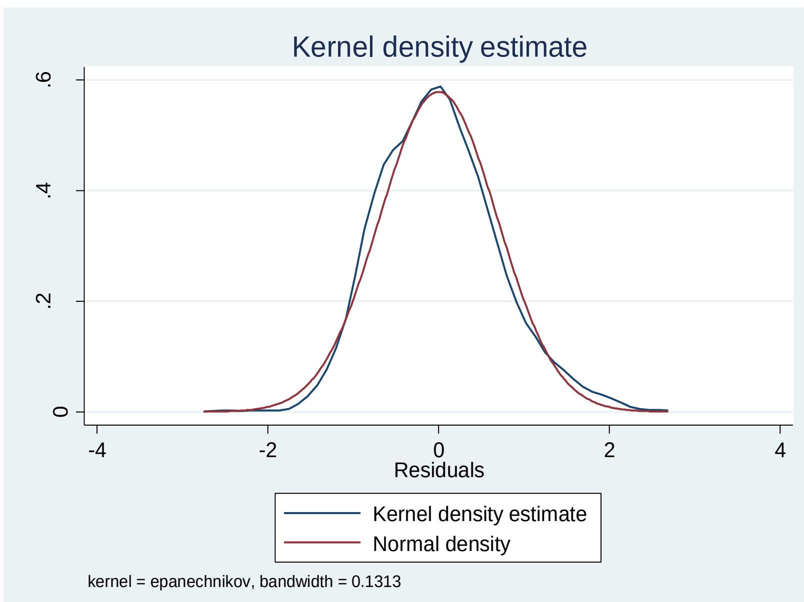


Figure 6.3 Kernel density estimate of Residuals



6.2.5 Time Effect

It is a conventional practice to add year dummy variables in models using cross-sectional data to account for uncontrolled effects of changes in the general economy over time. The price data, which spans a period of seven years from 2001 to 2007, is already adjusted for inflation (2000=100 Consumer Price Index). By including year dummy variables, the extended regression model is as follows,

$$\log P = \alpha + \beta_1 rdfront + \beta_2 gsa + \beta_3 mrl + \beta_4 popgro + \beta_5 lpopden + \beta_6 ldistown + \sum_{t=2}^{7} \beta_{7|t} year + \varepsilon \qquad \text{(Eq. 6.5)}$$

where the reference year is by default the earliest year in the sample, 2001. As shown in Table 6. 3, individual year dummies, other than 2007, were not statistically significant, although their joint-significance tests showed that $\sum_{t=2}^{7} \beta_{7|t} year$ as a whole were considerably influential in determining price (*p*-value = 0.0016). This finding lead to the conclusion that price is to a large extent stable throughout the study period, **except** in 2007; which explains why its year dummy is statistically significant when others are not. In other words, time trend is still present despite using CPI-adjusted prices and that the trend is most obvious for 2007.

To corroborate this hypothesis, yearly hedonic price indices using Eq. 6.4 are computed and presented graphically in Figure 6.4. It can be seen that 2007 is clearly the year that the price trend changed the most. Hence, it is concluded that it would make for a more efficient and parsimonious model if only a single binary dummy variable, *year7*, is created to differentiate year 2007 from the rest of the period, instead of having six year dummies in the model for each different year. Table 6.3 shows the estimation results of the basic model with *year7* dummy. The new variable *year7* is indeed negative and statistically significant. The adjusted R^2 is higher in the simpler model, 0.5143, while all the other regressors maintained their respective coefficients and standard error values.

Figure 6.4 Attribute-adjusted Land Price Index (2000=100)

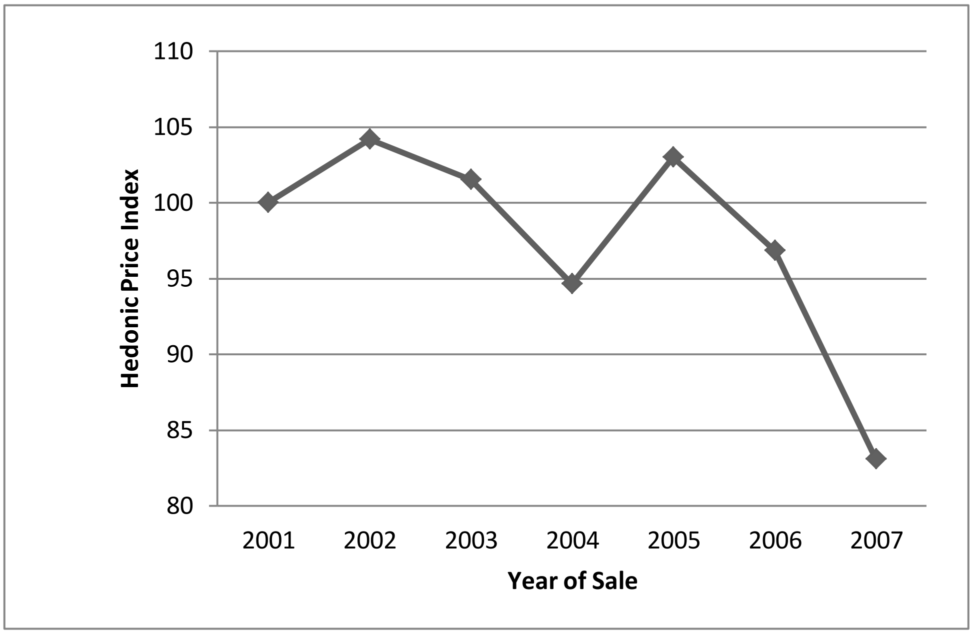


Table 6.3 Estimation Results of Model with Year of Sale dummies

Model with Individual Year Dummies			Model with *year7* Dummy		
VARIABLES	Parameter Estimates	Robust Std. Errors	VARIABLES	Parameter Estimates	Robust Std. Errors
rdfnt	0.84***	(0.041)	*rdfnt*	0.84***	(0.041)
gsa	-0.37***	(0.032)	*gsa*	-0.37***	(0.032)
mrl	-0.13***	(0.033)	*mrl*	-0.13***	(0.033)
lpopden	0.21***	(0.019)	*lpopden*	0.21***	(0.019)
popgro	0.12***	(0.008)	*popgro*	0.12***	(0.008)
ldistown	-0.14***	(0.029)	*ldistown*	-0.14***	(0.029)
year_2	0.03	(0.067)			
year_3	0.01	(0.063)			
year_4	-0.05	(0.061)			
year_5	0.03	(0.058)			
year_6	-0.03	(0.058)			
year_7	-0.18**	(0.057)	*year_7*	-0.18***	(0.036)
constant	10.22***	(0.175)	*Constant*	10.23***	(0.169)
Observations	2222		Observations	2222	
R^2	0.5165		R^2	0.5158	
Adj. R^2	0.5139		*Adj.* R^2	0.5143	
Breusch-Pagan χ^2	56.69		Breusch-Pagan χ^2	58.24	
Jacques-Bera χ^2	59.21		Jacques-Bera χ^2	60.67	
AIC	4653.5		AIC	4646.9	
SIC	4727.7		SIC	4692.6	

Dependent variable is log of real price per hectare.
Robust standard errors in parentheses (*** p<0.001, ** p<0.01, * p<0.05).

The basic hedonic model estimated in this section assumes that attributes display a constant effect on the dependent variable, *lprice*. The Breusch-Pagan White's test for heteroscedasticity continues to be highly statistically significant. Diagnostic tests suggest that residual variances are not constant. This is most likely because of model misspecifications and in a cross-sectional study, often involves the model's failure to account for possible group-specific effects. If so, there are cross-correlations among residuals leading to consistent but inefficient OLS estimates. By adding more explanatory variables that can effectively address data groupings, the model performance is expected to improve. At the same time, more information about the nature and extent of segmentation of the Malaysian agricultural land market can be discovered.

6.3 STRUCTURAL STABILITY

The purpose of this section is to formally test whether the price-attribute relationship estimated in the preceding section is stable over different groups of observations. Techniques to investigate the two potential sources of heterogeneity in the land sales data which are: (i) spatial location of the observation and (ii) land-use potential, follows the description given in Section 5.3.

6.3.1 Spatial Heterogeneity

It is generally held that estimating a single implicit price over the entire market is inappropriate if

(i) buyers and sellers are neither able nor interested to participate in more than one local market, and

(ii) local markets differ in terms of their supply and demand (see Freeman, 1989).

A prospective buyer might limit his search area either because for some reason, he is partial to the location; or that he finds positive externalities from activities already undertaken there; and/or simply because he does not want to bear additional search costs to extend his search area. Land market in any given localised area is usually thin causing the market to work on fairly scarce information (Elad *et al.*, 1994). However, information about **local** land's characteristics is abundant because parcels in the same locality are usually homogenous such that a buyer can easily obtain a reasonably good knowledge regarding a parcel even without inspecting it. As a result, buyers are more confident to buy land in an area familiar to them rather than incur costs obtaining information about land in areas new to them. This manner of market behaviour tends to propagate the existence of localised markets. However, the exact extent of the local market is impossible to observe directly. One commonly used method is to segmenting the market according to administrative boundaries but this is usually only justifiable if there are deep-rooted differences between regions on account of different tax and institutional structures or economic growth paths.[142]

Supporters of unsegmented market or those that favour the 'greater' land market hypothesis argue that suppliers and demanders tend to flow across geographic locations so as to arbitrage all price differences in different locations. Palmquist (1989) describes three circumstances where the single market model for agricultural land is likely to occur: (i) if the crop cultivated is traded in national and international markets, such that one can find an integrated land market throughout all regions; (ii) all regions have similar land and agricultural policies; and (iii) market agents do not display particular regional preferences. As a consequence, market disaggregation is neither justifiable nor statistically valid. In other words, the local sample merely represents a random sample of the greater market and that the estimated regression results can be applied to the entire area.

In order to test this hypothesis of geographical or spatial heterogeneity in the Malaysian data, the sample is partitioned into two regions involving all four states covered in the study.[143] Central region is represented by Selangor, Melaka and Negri Sembilan - all

[142] Xu, 1990; Elad *et al.,* 1994; and Kennedy *et al.*, 1997 are amongst a large number of studies that estimate separate hedonic price functions for different sub-market determined along administrative or topography schemes.

[143] Spatially segmented models also frequently suffer from smaller degrees of freedom because of their smaller and imbalanced sample size. This problem can be avoided if the partition be based on conomic and physical structure of the states, rather than follow political delineation of state or districts.

three are small but highly industrialised and more densely populated than the state of Perak (Table 6.4). This northern state is set distinctly apart from the rest in that it has a vast land stock. In addition, Perak is rich in natural resources, less heavily populated and more importantly, has continued to retain agriculture as one of the key drivers of its economic growth. Table 6.4 reveals that the average price of agricultural land in the Central region is more than twice as expensive as in Perak. Because of higher urbanisation pressures in the Central region, distances between the parcels and an urban centre are relatively shorter on average. Perak has a higher percentage of *gsa* parcels but the Central region has more *mrl* parcels. Given its considerable expanse of land, it is not surprising that many large remaining agrarian settlement schemes are still in operation in Perak.

The spatial regime model which is specified following Eq. 5.5 is essentially an interaction model where a *central* dummy is introduced and interacted with all land attributes in the basic hedonic model. The joint hypothesis that the central region is the same as Perak (the reference category) yields F-statistics$_{8,2206}$ = 18.11, and is therefore soundly rejected. Table 6.5 shows the calculated estimates of the marginal effects of the regressors by region. All the explanatory variables are significant in both groups except *ldistown* and *year7*. Impact of roadfrontage on price is smaller in the Central region and that the price reduction effect is significant. The effects of the two restrictions and population density are constant across the two regions. Population growth, distance to urban centres and year of sale are significantly different across the two regions. The model is unable to reject heteroscedasticity (χ^2 = 59.62). The null hypothesis of normality in residuals is also soundly rejected (χ^2 = 110.9). Overall, the spatial regime model does not contribute to the basic model's explanatory power or model adequacy as expected. Hence, in the following section, we turn to examine land-use potential as a potential source of market heterogeneity.

Table 6.4 Comparison of Descriptive Statistics by Spatial Distribution

Mean Values	*All (n=2222)*	*Central (n=989)*	*Perak (n=1233)*
*price (RM)**	117,553	166,851	78,010
popgro (%)	1.96	3.34	0.85
popden (person/km sq.)	228.71	359.40	123.89
distown (km)	40.54	24.26	53.61
rdfnt=1	0.20 *(n=450)*	0.22 *(n=220)*	0.19 *(n=230)*
gsa = 1	0.23 *(n=506)*	0.15 *(n=144)*	0.29 *(n=362)*
mrl=1	0.22 *(n=480)*	0.26 *(n=258)*	0.18 *(n=222)*
year7=1	0.19 *(n=429)*	0.13 *(n=132)*	0.24 *(n=297)*

**price* refers to real price per hectare.

Table 6.5 Partial Elasticities from the Spatial Regime Model

Segments	Perak		Central	
VARIABLES	Parameter Estimate, η_k	Robust Standard Errors	Parameter Estimate, η_k	Robust Standard Errors
central			1.33***	(0.390)
Constant	9.46***	(0.210)		
rdfnt	1.01***	(0.062)	0.62***	(0.052)
gsa	-0.36***	(0.042)	-0.39***	(0.044)
mrl	-0.14**	(0.054)	-0.11*	(0.049)
popgro	0.26***	(0.033)	0.10***	(0.009)
lpopden	0.18***	(0.024)	0.14***	(0.041)
ldistown	0.04	(0.044)	-0.14**	(0.052)
year7	-0.15***	(0.045)	-0.08	(0.059)
Observations		2222		
R^2		0.5422		
Adj. R^2		0.5391		
Breusch-Pagan χ^2		59.62 (*p-value* = 0.000)		
Jacques-Bera χ^2		110.9 (*p-value* = 0.000)		
AIC		4538.4		
SIC		4629.7		

Dependent variable is log of real price per hectare.
Robust standard errors in parentheses (*** p<0.001, ** p<0.01, * p<0.05).

6.3.2 Land-Use Potential

When land is capable of more than one use and the market is relatively free, price performs the role of rationing scarce land supply among competing **uses** instead of among competing **individuals** buying the land for the same use. This means that the overall price of a parcel represents the capitalised value of the parcel's numerous attributes which is in turn dependent on the type of activity and period of time the buyer expects to utilise the land as well as the amount he expects to receive upon its disposal. Therefore, any study of land price should attempt to uncover the extent to which impact of land attributes differ when the land's perceived 'highest and best use' varies (1986, p. 12).[144] Ultimately, this section seeks to understand how attributes affect land prices and whether there should be different price functions for different groups of land, whereby one is valid only within its own sub-market segment but is not relevant in other sub-markets. Sample questions include:

i. Does use-potential matter to price generally?
ii. Does the value of road frontage, if any, depend upon the type of activity foreseeable for the land?
iii. Which of the two types of restrictions affect price more in the two categories of land? What is the extent of the difference?
iv. Is the linear relationship between price and *ldistown* stable across all categories of land-use potential?
v. Is population pressure more important to certain activities than to others?
vi. Is the lower price trend in year 2007 a common phenomenon for all types of land?

As described in the data chapter, the Malaysian agricultural land sales data comes neatly partitioned into two broad categories: (i) parcels perceived as having fairly good development potential, and (ii) parcels deemed to have negligible or zero development potential. The former is purchased on the **assumption** that permission will be granted to

[144] Land's 'use-capacity' and 'highest and best use' changes over time as opportunities and shifts in the economy, land legislation and human perception take place.

change land-use conditions sometime in the future (which is shown in Chapter 3 to be relatively common given the government's slant towards wide-spread development growth). On the other hand, parcels in the latter category are in fact more valuable in their respective current agricultural use than in development use. It can be deduced that their "highest and best" potential-use continues to be agricultural, at least within the foreseeable future. A particularly noteworthy category of land concerns uncultivated agricultural land with no development potential. Hence, inter-group comparison is executed via the introduction of a set of dummy variables into the model: *dev*, *oilpalm*, *rice*, *rubber* and *vacant*. The dummies take on the value of one to indicate the highest land-use potential of the parcel and zero where it does not. Since the purpose of the exercise is to identify separate price functions for different land-use potentials, the dummies are interacted with all land attributes in the basic model. The empirical function is thus extended as an interaction model as in Eq.5.5 of the methods chapter.

The estimated interaction or "conditional effects" model displays far greater explanatory power compared to the basic or "constant effects" model i.e., a jump from 0.5143 to 0.7331 in the Adjusted R^2 (Table 6.6). This proves that including land's use-potential can enhance the description of land's price-attribute relationship. The reference category in this regression is *oilpalm*.[145] The model also displays marked improvement in terms of the homoscedasticity (χ^2 = 4.10) and normality of residuals tests (χ^2 = 6.24); both null hypotheses cannot be rejected at the 5% significance level. We know that data heterogeneity can be reflected in the model as measurement errors (omission of relevant variables), and consequently this will cause the model to produce high chi-squared test statistics in the Breusch-Pagan/Cook-Weisberg test for heteroscedasticity. By accounting for land-potential, it appears that this problem is effectively addressed. Information criteria, AIC and BIC values are much smaller in the model with land-use dummies than in the spatial regime model, further solidifying the former's superiority in describing the Malaysian market. The correlation coefficient between actual and fitted values of land price (in RM) is 0.8073, which is quite satisfactory.

[145] The standard errors of the estimate for potential-use dummies are large because of insufficient number of observations with all dummy attributes equal to zero.

All land attributes in the model are mostly statistically significant in each category of land's potential-use and display the expected signs. An exception is rice land category, in which only three out of seven explanatory variables are statistically significant. It appears that a model which incorporates land's potential-use is far more accurate in explaining market heterogeneity than a model which incorporates spatial locations, notwithstanding inherent statistical differences found between the land markets in the central region and Perak.

In summary, the section established that land's potential-use is critical in determining the conditional effects of a discrete change in the level of attributes; and therefore yields the final preferred specification of the price function for Malaysia. This knowledge has far-reaching consequences in benefit-loss assessment and future agricultural policy strategies, a subject which will be revisited in subsequent discussions. Prior to that, it is important to investigate if there are other forms of specification biases in the hedonic model. One that is particularly relevant is spatial dependences between observations in the model. For instance, the price of one parcel might be influenced by the prices of similar parcels, especially if the other parcels are located nearby. The following section explores this type of price lag and one other form of dependence brought by the spatial relationship between sales of land in the same category.

Table 6.6 Partial Elasticities from Interaction Model Estimation with Land's Potential-Use Grouping

	OilPalm		Rice		Rubber		Vacant		Developable	
VARIABLES	Parameter Estimate	Robust Standard Errors	Parameter Estimate, η_k	Robust Standard Errors	Parameter Estimate, η_k	Robust Standard Errors	Parameter Estimate, η_k	Robust Standard Errors	Parameter Estimate, η_k	Robust Standard Errors
dev	-0.70***	(0.168)								
rice	0.24	(0.775)								
rubber	-0.77	(0.413)								
vacant	-0.28***	(0.075)								
constant	10.81***	(0.304)								
rdfnt	0.35***	(0.061)	0.44**	(0.164)	0.49***	(0.047)	0.41***	(0.072)	0.27***	(0.048)
gsa	-0.20***	(0.056)	-0.06	(0.089)	-0.10*	(0.044)	-0.27***	(0.075)	-0.70***	(0.167)
mrl	-0.36***	(0.075)	-0.07	(0.073)	-0.13**	(0.045)	-0.13*	(0.055)	-0.26***	(0.051)
popgro	0.13***	(0.028)	0.21***	(0.033)	0.13***	(0.025)	0.07***	(0.009)	0.07***	(0.007)
lpopden	0.12**	(0.042)	-0.02	(0.102)	0.16***	(0.032)	0.15***	(0.030)	0.13***	(0.034)
ldistown	-0.20***	(0.057)	-0.19*	(0.086)	-0.09	(0.049)	-0.16***	(0.050)	0.09*	(0.039)
year7	-0.15**	(0.052)	0.01	(0.103)	-0.13*	(0.052)	-0.19***	(0.056)	-0.31***	(0.069)
Observations					2222					
R^2					0.7387					
Adj. R^2					0.7331					
Breusch-Pagan χ^2					4.10 (*p-value* = 0.0430)					
Jacques-Bera χ^2					6.236 (*p-value*=0.0442)					
AIC					3347.85					
SIC					3576.10					

Dependent variable is log of real price per hectare.
Robust standard errors in parentheses (*** p<0.001, ** p<0.01, * p<0.05).

6.4 SPATIAL DEPENDENCE

In the last two decades, HPM studies are increasingly veered towards incorporating a spatial outlook in their modeling approaches (among them Pace and Gilley (1997), Kim, Phipps, Anselin (2003), Bell and Bockstael 2000, Madisson 2007, Basu and Thibodeau (1998), Maddison (2002), Patton and McErlean (2004) and Cotteleer *et al*. (2007)). Although spatial dependency analyses have long been ubiquitous in housing market studies, it only began to garner attention in agricultural land studies through works by Patton and McEarlean (2004), Maddison (2007) and Cotteleer (2207). It has since been an important feature of cross-sectional land price studies.

Land prices are believed to be particularly susceptible to spatial patterns. Spatial **error** dependence may arise when the hedonic function fails to capture all relevant (productive and locational) attributes of a parcel that could contribute to the changes in price. In addition, market participants are thought to be highly influenced by sales of comparable parcels within the same area, more so if market-depth is limited. As a result of this price "echoing" or **lag**, land transactions in the same geographical space are not really independent of each other. Spatial lag dependence is believed to be prevalent in situations where information on parcel's attributes is imperfect and costly. As a result, similar agricultural parcels are usually lumped together as a single homogenous commodity; its price taken from the 'average' of the particular class of land (Taff, 1999). As more and more sales are priced using this method, the market is predisposed to'circularity of price-setting' (Patton and McErlean, 2004). Such biases are further strengthened by the market's over-reliance on informal (word-of-mouth) or formal (local real estate brokers and appraisers) market guides; where price is largely guided by the 'nearest and more recent comparable sales' principle (Can, 1992). If there is indeed such structural spatial interaction in the market, one might be interested in finding its degree and then control for it in order to be able to arrive at the ''true'' effect of the explanatory variables on price.

The spatial model estimation requires that spatial weight matrixes to be pre-determined. To avoid very large spatial matrices which could hamper computational efficiency, the sample is divided according to a previously established discriminating factor i.e., land use-potential. Overall, the resulting matrices are still large, except rice which has less than 100 observations. It is impossible to segment the sample further (for instance according to year of sale or region) as this would result in some very small segment sizes and imbalanced distribution of observations. Furthermore, in previous sections, it was already shown that the varying effects of explanatory variables on price over time could be sufficiently accounted in the model through the inclusion of *year7* dummy, whereas the varying effect of spatial regions has been proven to be weaker compared to potential-uses. The following discussion describes the thesis's spatial weight matrices, tests and results of the standard and spatial models previously outlined in Chapter 5.

6.4.1 Spatial Weight Matrices

Since the actual spatial relationship between observations in the sample is unknown, three different spatial weight matrices are employed in this analysis of spatial dependencies. They are defined as follows:

6.4.1.1 Inverse distance-squared matrix, row-standardised

Inverse distance-squared decay function gives low weightings to observations further from each other since spatial dependence is expected to be smaller.[146] In this thesis, a cut-off point is selected for the 'neighbourhood' effect to be zero after approximately 11 kilometers.[147] This is considered sensible in the economic sense as well because it is likely that prospective buyers do not make comparisons if the parcel is further than 10 kilometer radius of the parcel they are interested in.[148] The matrix is written as

W1: $W_{ij} = 1/d_{ij}^2$ if d_{ij}^2 < 11.1 kilometers, 0 if otherwise,

[146] Goldsmith (2004) (in Wang and Ready, 2005) argues that a distance-based weights matrix is not feasible for rural studies as lot size may vary greatly in rural areas. Typically, one will find a small number of neighbours for larger-sized lots in the rural areas as compared to a high number of neighbours for smaller sized lots in the urban areas. In this dataset, there are no variables related to lot size, but for reasons stated earlier, it can be assumed that the bulk of the transactions involve smallholdings, hence the issue raised by Goldsmith is not relevant for this thesis.

[147] There is no simple method to determine actual boundaries of a 'neighbourhood'. Some researchers adopt administrative boundaries e.g.,districts. However, this approach may be problematic if district sizes vary considerably.

[148] If parcels sold in an area are generally large or that the volume of transaction is extremely low, it is very likely that the resultant matrix be very sparse. This is one reason why too many levels of segmentation should not be imposed on the data.

6.4.1.2 Inverse distance-squared matrix, non row-standarised

In the methodogical section, it is highlighted that row-standardisation of the spatial matrix would result in alterations of the actual spatial relationship specifically through the "distance effect". To safeguard against the possible loss of accuracy, the analysis is then conducted with unstandardised version of the same spatial matrix above. The matrix is written as

W2: $W_{ij} = 1/d_{ij}^2$ if $d_{ij}^2 < 11$ kilometers, 0 if otherwise.

6.4.1.3 Nearest neighbour binary matrix

Binary neighbours gives a value of one if the other parcel is located within a pre-specificed distance from parcel *i*, and 0 if otherwise. To determine the nearest neighbours, the distance for these potential neighbours are ordered from smallest to largest, and observations with the *x* smallest distances are designated as the nearest neighbour of a particular observation. The cut-off number of neighbours for this thesis is arbitrarily set at 5. The matrix can be written as

W3: $W_{ij} = 1$ if five nearest neighbour, 0 if otherwise.

6.4.2 Detecting Spatial Dependence

The Moran and Spatial Lagrange Multiplier tests procedures are conducted using all three spatial weight matrices described above for each of the five sub-groups. The Likelihood Ratio tests and LM tests are conditional upon the assumption that the error term is normally distributed. It is very obvious from Table 6.7 that **W2** spatial matrix is incompetent to describe any form of spatial dependence. Therefore, the use the non row-standardised matrix is not continued hereafter. On the other hand, both **W1** and **W3** offer the same conclusion in all sub-samples i.e., based on the robust LM results, all groups except developable and rice display spatial lag dependence. The problem in rice could be because there are insufficient observations that can allow spatial effects to be revealed. On the other hand, it could also be that there is indeed no spatial dependence at all in that sub-category of land. In cases involving other types of land, the Moran's I statistics are all significant. Statistically significant LM-error and robust LM-error test statistics indicate that spatial error is an important feature of the data. Overall, this series of test results have led to the conclusion that the appropriate model to fit the data used is the spatial error model.

Table 6.7 Test of Spatial Dependencies

Sub-sample	Tests	W1: inverse-distance^2 row standardised		W2: inverse-distance^2 unstandardised		W3: five nearest neighbours	
		Statistic	*p-value*	Statistic	*p-value*	Statistic	*p-value*
Development (n=506)	Moran's_I	7.58	0.0000	0.75	0.4532	11.05	0.0000
	LM_Error	53.61	0.0000	0.48	0.4895	109.83	0.0000
	Robust_LM_Error	0.57	0.4520	0.41	0.5226	2.06	0.1510
	LM_Lag	55.34	0.0000	0.76	0.3844	114.87	0.0000
	Robust_LM_Lag	2.30	0.1295	0.69	0.4069	7.10	0.0077
Oil Palm (n=462)	Moran's_I	7.46	0.0000	1.4	0.1610	12.06	0.0000
	LM_Error	51.81	0.0000	1.97	0.1609	132.76	0.0000
	Robust_LM_Error	1.25	0.2645	2.3	0.1293	3.93	0.0475
	LM_Lag	67.08	0.0000	2.75	0.0975	141.28	0.0000
	Robust_LM_Lag	16.51	0.0000	3.08	0.0792	12.45	0.0004
Rice (n=94)	Moran's_I	0.49	0.6238	0.04	0.9716	0.73	0.4671
	LM_Error	0.00	0.9823	0.00	0.9772	0.01	0.9345
	Robust_LM_Error	1.46	0.2273	0.00	0.9845	2.35	0.1251
	LM_Lag	0.18	0.6750	0.04	0.8447	0.97	0.3246
	Robust_LM_Lag	1.63	0.2013	0.04	0.8455	3.32	0.0686
Rubber (n=623)	Moran's_I	10.36	0.0000	0.76	0.4477	13.82	0.0000
	LM_Error	101.49	0.0000	0.55	0.4579	176.52	0.0000
	Robust_LM_Error	1.49	0.2220	0.46	0.4991	1.98	0.1596
	LM_Lag	129.02	0.0000	1.22	0.2690	197.61	0.0000
	Robust_LM_Lag	29.02	0.0000	1.13	0.2883	23.07	0.0000
Vacant (n=537)	Moran's_I	7.75	0.0000	0.31	0.7546	10.63	0.0000
	LM_Error	55.44	0.0000	0.09	0.7611	102.29	0.0000
	Robust_LM_Error	0.01	0.9124	0.16	0.686	3.91	0.0480
	LM_Lag	65.38	0.0000	1.77	0.1828	105.38	0.0000
	Robust_LM_Lag	9.95	0.0016	1.85	0.1743	7.01	0.0081

6.4.3 Basic and Spatial Model Regressions

Since both **W1** and **W3** gave similar test conclusions, the analysis is continued with only **W1,** which is the inverse distance squared row-standardised spatial weight matrix. The estimation results from standard OLS and spatial models (estimated using Maximum Likelihood method) are shown according to land categories in Tables 6.8 through 6.12. Although the LM test results above appear to point towards a spatial error model for all land categories barring rice, all four spatial models are tested along with the OLS regression: Spatial Error Correction Model (SEC), Spatial Autoregressive Model (SAR), Spatial Durbin Model (SDM) and the General Spatial Model (SAC).

An important assumption of the spatial model is that there are no other sources of model misspecification, such as heteroscedasticity, and this is confirmed by the respective Breusch-Pagan chi-square statistics in the table. The results show that except for rice category, the null hypothesis of homogeneous variance cannot be rejected at the 10 % level. Hence, it can be concluded that heteroscedasticity is no longer present in the group regressions and that the only misspecification error is in the form of spatial bias.

By partitioning the data into five groups, each regression is executed using smaller sample sizes, which meant smaller degrees of freedom. Naturally, there are repercussions from this decision, for instance, squared correlation coefficient is always high, particularly where SDM is concerned. This is because in SDM, the number of regressors is doubled through the addition of spatially lagged dependent and independent variables. The squared correlation coefficient does not correct for number of regressors, hence making it less effective as a model performance criteria. In addition, it is also observed that in all of the SDM regressions, the Wald tests on coefficient of lagged independent variables are always significant, even though the individual parameter variables are in most cases not.

With respect to developable parcels (Table 6.8), Wald and likelihood ratio test on λ are statistically significant in the SEC model, so is ρ in the SAR model. Spatially lagged X variables are not individually significant except *ldistown* and *lpopden*, which are both only weakly significant. In the SAC model that simultaneously tests for both types of dependence, ρ is no longer significant. The AIC and BIC measures also show that the SEC is superior to others although it can be noted that it does not always give the smallest standard deviations of the coefficients among all models.

Within the oil palm land category (Table 6.9), λ is statistically significant in the SEC model, as is ρ in the SAR model. The SDM results show that spatially lagged X variables are generally not individually significant except for *ldistown* and *lpopden* again. In the SAC, λ is strongly significant. However, the AIC and BIC measures indicate that the SAR is better compared to others in describing the group's price function and gives smaller standard deviations in all of the coefficients i.e., more efficient estimates. Based on this model, estimated ρ indicates that a 1 % increase in average nearby oil palm parcel price will lead to a 0.38 % increase in the observed price of the observed oil palm parcel.

Table 6.8 Results of OLS and Spatial Regressions on Developable sub-sample

VARIABLES	OLS	ML-SEC	ML-SAR	ML-SDM	ML-SAC
rdfnt	0.27***	0.29***	0.27***	0.28***	0.29***
	(0.048)	(0.046)	(0.044)	(0.044)	(0.046)
gsa	-0.70***	-0.62	-0.58***	-0.46**	-0.63
	(0.167)	(0.359)	(0.153)	(0.172)	(0.353)
mrl	-0.27***	-0.21***	-0.20***	-0.16*	-0.20**
	(0.051)	(0.059)	(0.049)	(0.061)	(0.062)
popgro	0.07***	0.07***	0.05***	0.03	0.08***
	(0.007)	(0.010)	(0.007)	(0.033)	(0.015)
lpopden	0.13***	0.11*	0.10**	0.06	0.11*
	(0.034)	(0.046)	(0.034)	(0.077)	(0.049)
ldistown	0.09*	0.06	0.05	-0.29	0.06
	(0.039)	(0.052)	(0.037)	(0.176)	(0.058)
year7	-0.32***	-0.29***	-0.28***	-0.30***	-0.28***
	(0.069)	(0.059)	(0.068)	(0.071)	(0.061)
wx_rdfnt	-	-	-	-0.16*	-
				(0.076)	
wx_gsa	-	-	-	-13.20	-
				(9.515)	
wx_mrl	-	-	-	-0.04	-
				(0.080)	
wx_popgro	-	-	-	0.02	-
				(0.034)	
wx_lpopden	-	-	-	0.02	-
				(0.092)	
wx_ldistown	-	-	-	0.39*	-
				(0.193)	
wx_year7	-	-	-	0.02	-
				(0.091)	
Constant	11.14***	11.30***	7.34***	7.29***	12.66***
	(0.273)	(0.358)	(0.618)	(0.636)	(2.169)
rho	-	-	0.34***	0.34***	-0.11
			(0.048)	(0.050)	(0.173)
lambda	-	0.36***	-	-	0.45**
		(0.046)			(0.144)
R^2 / Squared Correlation	0.321	0.319	0.324	0.347	0.315
Breusch-Pagan χ^2	0.38				
Log likelihood	-402.23	-375.96	-376.08	-369.74	-375.82
AIC	820.46	771.92	772.15	773.48	773.64
SIC	854.27	814.18	814.42	845.32	820.13

Table 6.9 Results of OLS and Spatial Regressions on Oil Palm sub-sample

VARIABLES	OLS	ML-SEC	ML-SAR	ML-SDM	ML-SAC
rdfnt	0.35***	0.33***	0.32***	0.33***	0.29***
	(0.061)	(0.065)	(0.059)	(0.058)	(0.062)
gsa	-0.20***	-0.18***	-0.16**	-0.16**	-0.16***
	(0.056)	(0.052)	(0.051)	(0.054)	(0.050)
mrl	-0.36***	-0.32***	-0.31***	-0.33***	-0.30***
	(0.075)	(0.084)	(0.069)	(0.073)	(0.081)
popgro	0.13***	0.11***	0.09***	0.03	0.11***
	(0.028)	(0.022)	(0.023)	(0.039)	(0.024)
lpopden	0.12**	0.15**	0.10**	0.25**	0.18**
	(0.042)	(0.049)	(0.037)	(0.080)	(0.057)
ldistown	-0.20***	-0.14*	-0.11*	0.30	-0.09
	(0.057)	(0.069)	(0.055)	(0.166)	(0.094)
year7	-0.15**	-0.10	-0.12*	-0.12*	-0.07
	(0.052)	(0.052)	(0.049)	(0.049)	(0.048)
wx_rdfnt	-	-	-	-0.09	-
				(0.112)	
wx_gsa	-	-	-	0.01	-
				(0.090)	
wx_mrl	-	-	-	0.04	-
				(0.144)	
wx_popgro	-	-	-	0.12	-
				(0.076)	
wx_lpopden	-	-	-	-0.24*	-
				(0.112)	
wx_ldistown	-	-	-	-0.48*	-
				(0.192)	
wx_year7	-	-	-	-0.14	-
				(0.089)	
Constant	10.81***	10.48***	6.52***	7.58***	13.61***
	(0.304)	(0.386)	(0.701)	(0.766)	(1.338)
rho	-	-	0.38***	0.34***	-0.32*
			(0.055)	(0.060)	(0.130)
lambda	-	0.41***	-	-	0.67***
		(0.053)			(0.089)
R^2 / Squared Correlation	0.356	0.354	0.380	0.412	0.325
Breusch-Pagan χ^2	1.25				
Log likelihood	-331.35	-306.13	-302.43	-294.67	-305.34
AIC	678.69	632.27	624.83	623.35	632.67
SIC	711.77	673.63	666.19	693.65	678.16

In the rice group regressions (Table 6.10), the results confirmed conclusions drawn from the LM spatial tests – they are unable to uncover any form of spatial effects. Both λ and ρ are statistically not significant in all specifications. The smallest AIC and BIC values belong to the OLS model. Accordingly, it can be concluded that for the rice land category, the OLS model is sufficiently robust to estimate the effects of regressors on price and that no spatial adjustments are necessary.

As for the rubber land category (Table 6.11), λ is statistically significant in the SEC model, as is ρ in the SAR model. Spatially lagged X variables are generally not individually significant except for *ldistown* and *popgro*. In the SAC regression, both types of dependence coefficients are statistically significant but the effect of neighbour prices is negative rather than positive. The AIC measure points in favour of the SDM while BIC supports the SAC model. The SAC also yields the smallest standard deviations in all of the coefficients except *rdfnt*. Based on the SAR model, the estimated ρ indicates that a 1 % increase in average nearby parcel price will lead to a 0.45 % increase in the observed price of a rubber parcel.

The vacant land group (Table 6.12) shows similar results as the rubber land category whereby λ is statistically significant in the SEC model, as is ρ in the SAR model. In the SAC model, both types of dependence coefficients are statistically significant but the effect of neighbouring parcel prices is negative rather than positive again. Spatially lagged X variables are generally not individually significant except for *ldistown* and *year7*. The AIC measure points in favour of the SAC model while BIC supports the SAR Model. It is the SAC model that yields the smallest standard deviations in all of its coefficients.

Table 6.10 Results of OLS and Spatial Regressions on Rice sub-sample

VARIABLES	OLS	ML-SEC	ML-SAR	ML-SDM	ML-SAC
rdfnt	0.44*	0.44***	0.44**	0.47**	0.43***
	(0.170)	(0.108)	(0.163)	(0.159)	(0.104)
gsa	-0.07	-0.07	-0.07	-0.07	-0.08
	(0.092)	(0.076)	(0.089)	(0.096)	(0.078)
mrl	-0.07	-0.07	-0.07	-0.13	-0.09
	(0.076)	(0.077)	(0.074)	(0.084)	(0.079)
popgro	0.21***	0.21***	0.22***	0.26	0.25***
	(0.034)	(0.046)	(0.044)	(0.289)	(0.071)
lpopden	-0.02	-0.02	-0.02	0.04	-0.01
	(0.106)	(0.058)	(0.104)	(0.216)	(0.062)
ldistown	-0.19*	-0.19**	-0.20*	-0.14	-0.22**
	(0.089)	(0.068)	(0.084)	(0.157)	(0.079)
year7	0.01	0.01	0.01	-0.03	0.00
	(0.107)	(0.090)	(0.102)	(0.091)	(0.087)
wx_rdfnt	-	-	-	0.00	-
				(0.143)	
wx_gsa	-	-	-	-0.13	-
				(0.115)	
wx_mrl	-	-	-	0.33**	-
				(0.116)	
wx_popgro	-	-	-	-0.03	-
				(0.301)	
wx_lpopden	-	-	-	-0.23	-
				(0.245)	
wx_ldistown	-	-	-	0.02	-
				(0.168)	
wx_year7	-	-	-	-0.02	-
				(0.134)	
Constant	11.05***	11.05***	11.58***	11.60***	13.43***
	(0.738)	(0.459)	(1.497)	(1.345)	(2.283)
rho	-	-	-0.05	-0.00	-0.23
			(0.110)	(0.124)	(0.212)
lambda	-	0.00	-	-	0.22
		(0.132)			(0.224)
R^2 / Squared Correlation	0.493	0.493	0.495	0.547	0.502
Breusch-Pagan χ^2	11.51				
Log likelihood	-23.74	-23.74	-23.65	-18.41	-23.26
AIC	63.488	67.487	67.302	70.817	68.527
SIC	83.834	92.920	92.735	114.053	96.504

Table 6.11 Results of OLS and Spatial Regressions on Rubber sub-sample

VARIABLES	OLS	ML-SEC	ML-SAR	ML-SDM	ML-SAC
rdfnt	0.49***	0.45***	0.46***	0.46***	0.41***
	(0.047)	(0.053)	(0.041)	(0.044)	(0.052)
gsa	-0.10*	-0.11**	-0.09*	-0.11**	-0.08*
	(0.044)	(0.042)	(0.039)	(0.039)	(0.034)
mrl	-0.13**	-0.10*	-0.11*	-0.10*	-0.10**
	(0.046)	(0.046)	(0.041)	(0.047)	(0.036)
popgro	0.13***	0.09***	0.10***	0.07**	0.09***
	(0.025)	(0.024)	(0.016)	(0.023)	(0.016)
lpopden	0.16***	0.16***	0.09**	0.08	0.06*
	(0.033)	(0.039)	(0.028)	(0.064)	(0.024)
ldistown	-0.09	-0.07	-0.02	0.33*	-0.01
	(0.049)	(0.060)	(0.043)	(0.142)	(0.031)
year7	-0.13*	-0.07	-0.08	-0.08	-0.08
	(0.052)	(0.047)	(0.048)	(0.048)	(0.045)
wx_rdfnt	-	-	-	-0.05	-
				(0.089)	
wx_gsa	-	-	-	0.09	-
				(0.063)	
wx_mrl	-	-	-	-0.09	-
				(0.070)	
wx_popgro	-	-	-	0.10*	-
				(0.042)	
wx_lpopden	-	-	-	-0.04	-
				(0.077)	
wx_ldistown	-	-	-	-0.43*	-
				(0.171)	
wx_year7	-	-	-	-0.10	-
				(0.085)	
Constant	10.03***	10.00***	5.44***	6.31***	3.92***
	(0.279)	(0.327)	(0.505)	(0.608)	(0.554)
rho	-	-	0.45***	0.40***	0.60***
			(0.040)	(0.046)	(0.052)
lambda	-	0.46***	-	-	-0.27**
		(0.042)			(0.090)
R^2 / Squared Correlation	0.416	0.413	0.441	0.477	0.446
Breusch-Pagan χ^2	2.68				
Log likelihood	-413.14	-364.37	-355.94	-346.12	-352.69
AIC	842.28	748.75	731.87	726.24	727.36
SIC	877.76	793.09	776.21	801.63	776.15

Table 6.12 Results of OLS and Spatial Regressions on Vacant sub-sample

VARIABLES	OLS	ML-SEC	ML-SAR	ML-SDM	ML-SAC
rdfnt	0.41***	0.41***	0.41***	0.39***	0.36***
	(0.072)	(0.069)	(0.069)	(0.068)	(0.069)
gsa	-0.28***	-0.24***	-0.22**	-0.21**	-0.19**
	(0.075)	(0.068)	(0.071)	(0.072)	(0.060)
mrl	-0.13*	-0.16**	-0.14**	-0.17**	-0.11*
	(0.055)	(0.058)	(0.052)	(0.053)	(0.047)
popgro	0.07***	0.07***	0.05***	0.06	0.03***
	(0.009)	(0.014)	(0.009)	(0.035)	(0.008)
lpopden	0.15***	0.16***	0.11***	0.11*	0.08**
	(0.030)	(0.038)	(0.029)	(0.052)	(0.025)
ldistown	-0.16**	-0.14*	-0.10*	0.21	-0.07*
	(0.050)	(0.058)	(0.047)	(0.135)	(0.034)
year7	-0.20***	-0.14**	-0.16**	-0.15**	-0.15**
	(0.056)	(0.053)	(0.052)	(0.052)	(0.050)
wx_rdfnt	-	-	-	-0.21	-
				(0.140)	
wx_gsa	-	-	-	-0.09	-
				(0.138)	
wx_mrl	-	-	-	0.13	-
				(0.089)	
wx_popgro	-	-	-	-0.01	-
				(0.042)	
wx_lpopden	-	-	-	-0.03	-
				(0.069)	
wx_ldistown	-	-	-	-0.39*	-
				(0.160)	
wx_year7	-	-	-	-0.20*	-
				(0.100)	
Constant	10.41***	10.28***	6.60***	7.40***	4.46***
	(0.285)	(0.324)	(0.549)	(0.623)	(0.685)
rho	-	-	0.36***	0.32***	0.57***
			(0.045)	(0.048)	(0.063)
lambda	-	0.37***	-	-	-0.32**
		(0.049)			(0.099)
R^2 / Squared Correlation	0.411	0.409	0.421	0.454	0.424
Breusch-Pagan χ^2	0.80				
Log likelihood	-438.35	-413.46	-410.50	-402.50	-407.38
AIC	892.71	846.92	841.01	839.00	836.76
SIC	927.00	889.78	883.87	911.86	883.91

As the above series of results show, the selection of the ‘best’ model using the recommended statistical measures is hardly a straightforward affair. Despite the LM tests indicating a spatial error process for almost all sub-groups, individual regression results gave varying results. For the oil palm, rubber and vacant categories, better model fits can be achieved in other spatial models such as SAR or SAC. These ambiguous results could be contributed by weak assumptions, further unknown model misspecifications as well as reduced degrees of freedom.

As for additional evidence regarding the type and extent of spatial biases, the literature recommends that the predictive ability of the four competing models be compared. In this study, this method of empirical evaluation is primarily done by examining in-sample prediction errors. The estimated regression model is imposed on approximately 20% of the sample to obtain predicted values of the dependent variable, log of price. The predicted log of price is duly transformed to its natural scale (recommended in Section 5.2 regarding functional form). The resulting pairs of predicted and actual prices are subsequently used to generate prediction errors for the respective models and samples. The procedure is then repeated for each model and each parcel group. Since rice has not shown traces of spatial influence in both the LM detection tests as well as spatial model regressions, rice category is omitted from this cross-validation exercise. Therefore, the exercise involves twelve cases coming from four land categories (developable, oil palm, rubber and vacant) and three models each (OLS, ML-Spatial Error and ML-Spatial Lag). Three numerical criteria used are as described in Section 5.5 with respect to model selection methods: Mean Squared Errror (MSE), Mean Absolute Error (MAE) and Average Error Rate (AER).

Table 6.13 demonstrates that the study's hedonic specification is fairly competent in predicting the dependent variable. The MSE and MAE values are all under 0.5, while the AER is less than 5%. With respect to model comparisons, in all but two cases, the ML-Spatial Lag model produces the lowest outcome. The two exceptions are MAE and AER for vacant parcels in which the OLS model appeared to surpass both spatial models. Overall, the reduction in prediction errors through the use of spatial models is not as substantial as expected considering the amount of effort taken to perform the adjustments.[149] It is not very likely that an out-sample prediction endeavour would bring about different conclusions regarding model selection either.

Table 6.13 Comparison of Models using Numerical Criteria

Mean Squared Error : $\frac{1}{n}\sum(y_i - \hat{y}_i)^2$				
Model	Developable	Oil palm	Rubber	Vacant
OLS	0.3032	0.2256	0.2361	0.3289
ML-Spatial Error	0.3024	0.2251	0.2554	0.3323
ML-Spatial Lag	0.2953	0.2215	0.2293	0.3232
Mean Absolute Error : $\frac{1}{n}\sum\lvert y_i - \hat{y}_i\rvert$				
Model	Developable	Oil palm	Rubber	Vacant
OLS	0.4356	0.3898	0.3888	0.4639
ML-Spatial Error	0.4348	0.3924	0.4081	0.4669
ML-Spatial Lag	0.4266	0.3887	0.3807	0.4677
Average Error Rate: $\frac{1}{n}\sum\frac{\lvert y_i - \hat{y}_i\rvert}{y_i}$				
Model	Developable	Oil palm	Rubber	Vacant
OLS	0.0357	0.0375	0.0393	0.0464
ML-Spatial Error	0.0356	0.0378	0.0414	0.0468
ML-Spatial Lag	0.0349	0.0374	0.0385	0.0467

6.4.4 Spatial Bias and Implicit Prices of Land Attributes

It is interesting to note that although coefficient estimates and signs are generally stable across the competing models, in land categories where the spatial lag model is superior, the coefficients are relatively smaller than the corresponding coefficients in the OLS model (oil palm, rubber and vacant).[150] This suggests that the OLS coefficients could be overstating the impact of regressors on the dependent variable i.e., the implicit prices of land attributes.[151] In other words, the presence of spatial effects, with the exception of rice lands, requires us to consider the OLS estimates as

[149] Gao *et al.* (2006) arrived at the same conclusion in his cross-validation exercise of OLS, spatial dependency and geographically weighted regression models.

[150] OLS coefficients are not found to be different in the developable land group (where spatial error is more appropriate) or the rice group (where neither types of spatial bias are found).

[151] Section 6 in Chapter 5 also demonstrates that even if OLS and spatial lag model's parameter estimates are exactly the same, this does not guarantee that marginal effects would equal each other.

‘upper bound’ values of the variables effects. As shown in Section 5.6, a spatial lag multiplier, $1/(1\text{-}\rho)$ can be computed to gauge the degree of bias. For each of the aforementioned three categories of land, the calculation of the multiplier yields 1.613, 1.818 and 1.563, respectively. It follows that to correct for spatial lag bias, partial elasticity of price with respect to each regressor should be deflated by the corresponding spatial multiplier value. However, because the multiplier values tend to be rather large, this move would result in downward corrections that give way to very small estimate values, in fact much smaller than the ones suggested in the spatial lag model itself, or in any other spatial model.

To illustrate, if OLS coefficient for *year7* in the vacant land regression (Table 6.12) is 0.20, then the spatial-lag-adjusted coefficient would be 0.20/1.563 = 0.13, which is smaller than the spatial lag model estimate of 0.16. This lack of convergence prevents unreserved and meaningful valuations regarding the true degree of the spatial lag bias. Furthermore, as shown in the methodological section, the spatial-lag adjustment to predict effect on real price (instead of log of price) is not easily performed on log-transformed independent variables, whereas there are two of them in the model. Hence, the overall situation is one where spatial-lag-adjusted implicit prices are only conceivable for one part of the model and are not computable for the rest of the model.

In summary, since there is no firm agreement in the first place between (i) the LM-tests, (ii) model regression outputs and (iii) the predictive cross-validation exercise regarding the type and degree of spatial dependence present in the three relevant groups, the decision to correct for spatial bias needs to be considered carefully. We are also concerned with the fact that the recommended multiplier values are considerably large such that resulting substantive inferences could vary a great deal from those gained from the traditional hedonic model. Perhaps at the end of the day, it is important to remember that spatial models are usually adopted for exploratory purposes i.e. to see if there are biases in the estimation results from the observations’ spatial relationships between each other. If eventually it is found that the spatial bias magnitude is less than convincing or turns out to be ambiguous, then it is perhaps best to revert to standard models results as upper bounds to the impact of variables. Therefore, the thesis's subsequent discussion regarding substantive differences between categories of land use-potentials will employ OLS estimates of elasticity and predicted price effect, bearing in mind that spatial biases might be present in at least four out of the five categories tested for spatial autocorrelation.

6.5 DISCUSSION

This section provides a substantive analysis based on the results obtained in the empirical estimations above. Since market segmentation is best explained by using the 'highest and best use' concept, subsequent discussions will only refer to estimation results presented in Table 6.6. To provide a background for this analysis, the table of descriptive statistics from Section 4.6 is reconstructed to mirror the estimated model results in Table 6.6 in segmenting the data according to the five land-use potentials. The first row in Table 6.14 below shows that average prices amongst agricultural-potential groups do not vary by a large amount, between RM36,361 to RM54,365. Anecdotal evidence suggest that oil palm land are able to garner relatively better prices compared to land with other agricultural potentials, primarily because oil palm trees planted in the country are mostly still productive as the sector is relatively new, compared to rubber. A large majority of rubber parcels have mature trees, and require substantial re-investment costs for land clearing and replanting.

The summary statistics also show that parcels with development potential are on average at least six times higher than the agricultural-potential categories. They tend to be located in fast-growing districts with relatively high population density. Developable parcels are on average, located much closer to urban centres at 31.67 km. Close to half of the developable parcels have road frontage, compared to only an average of 12% in non-developable categories. It is also evident that the distribution of observations is highly disproportionate with respect to the *gsa* restriction – less than 1 % in the developable land category but at least 17% in the other categories. Whilst this gives valid concerns about the use of its parameter estimate for policy assessments, the inclusion could nonetheless provide useful impressions regarding direction of effects.

Oil palm and rubber parcels are typically located in remote districts (distances to nearest major town are 47.15 and 39.42 km respectively) with sparse population while population growth are only 1.2% and 1.27% respectively. Oil palm and rubber planting are either undertaken as large projects or are part of a greater agrarian programme, hence their locations in large pockets of undeveloped land, whereas vacant and rice parcels can be found nearer to other centres of economic activities and human dwellings.

Table 6.14 Comparison of Descriptive Statistics by Land Potential-Use Distribution

Mean Values	*Developable (n = 506)*	*Oil Palm (n=462)*	*Rice (n=94)*	*Rubber (n=623)*	*Vacant (n=537)*
*price (RM)**	328,827	54,365.78	36,361.60	48,466.52	50,985.62
popgro (%)	3.67	1.20	1.01	1.27	1.95
popden (person/km sq.)	409.76	148.55	183.88	158.23	216.70
distown (km)	31.67	47.15	59.91	39.42	41.14
rdfnt=1	0.48 *(n=244)*	0.13 *(n=61)*	0.11 *(n=10)*	0.12 *(n=73)*	0.12 *(n=62)*
gsa = 1	0.004 *(n=2)*	0.31 *(n=143)*	0.56 *(n=53)*	0.35 *(n=215)*	0.17 *(n=93)*
mrl=1	0.26 *(n=130)*	0.08 *(n=39)*	0.37 *(n=35)*	0.24 *(n=149)*	0.24 *(n=127)*
year7=1	0.18 *(n=93)*	0.22 *(n=102)*	0.18 *(n=17)*	0.15 *(n=94)*	0.23 *(n=123)*

**price* refers to real price per hectare.

Next, estimates from Table 6.6 earlier is brought forth to help construct a more informative table showing **conditional** marginal effects using partial elasticity estimates obtained for each variable. The calculations of marginal implicit prices and their respective interpretations follow the guidelines presented in Section 5.6 in the methodology chapter. Tables 6.15a and 6.15b show the conditional marginal effects of discrete and continuous independent variables on land price. The t-statistics show that all of the variables in the model are statistically significant in almost all sub-groups of land $(\eta_k \neq 0)$. For better clarity, discussions henceforth correspond to two types of land attributes as they are presented in the model: dummy variables and continuous variables.

Table 6.15a Marginal Effect of Dummy Variables on Price.

Attri-butes	Use-Potential	Partial Elasticity* η_k	Marginal Effect** ME_{x_k}	Robust Standard Errors	t-statistics	p-value	95% Confidence Interval	
gsa	*developable*	-0.705	-50.58	0.168	-4.21	0.0000	-1.0334	-0.3763
	oilpalm	-0.196	-17.77	0.056	-3.48	0.0010	-0.3059	-0.0853
	rice	-0.066	-6.39	0.089	-0.74	0.4570	-0.2398	0.1078
	rubber	-0.105	-9.95	0.044	-2.37	0.0180	-0.1917	-0.0180
	vacant	-0.278	-24.31	0.075	-3.69	0.0000	-0.4263	-0.1306
mrl	*developable*	-0.268	-23.48	0.051	-5.27	0.0000	-0.3672	-0.1679
	oilpalm	-0.364	-30.49	0.075	-4.85	0.0000	-0.5107	-0.2166
	rice	-0.069	-6.63	0.073	-0.94	0.3500	-0.2125	0.0752
	rubber	-0.135	-12.59	0.046	-2.95	0.0030	-0.2241	-0.0451
	vacant	-0.134	-12.51	0.055	-2.44	0.0150	-0.2411	-0.0262
rdfnt	*developable*	0.269	30.89	0.048	5.62	0.0000	0.1752	0.3632
	oilpalm	0.346	41.31	0.061	5.71	0.0000	0.2271	0.4645
	rice	0.437	54.88	0.164	2.66	0.0080	0.1152	0.7598
	rubber	0.494	63.84	0.047	10.47	0.0000	0.4012	0.5862
	vacant	0.407	50.20	0.072	5.65	0.0000	0.2657	0.5479
year7	*developable*	-0.319	-27.30	0.069	-4.6	0.0000	-0.4548	-0.1829
	oilpalm	-0.146	-13.55	0.052	-2.79	0.0050	-0.2478	-0.0433
	rice	0.008	0.78	0.103	0.08	0.9400	-0.1940	0.2096
	rubber	-0.132	-12.39	0.052	-2.55	0.0110	-0.2341	-0.0305
	vacant	-0.198	-17.95	0.056	-3.51	0.0000	-0.3084	-0.0873

*Partial Elasticity (from Eq. 5.58): $\eta_k = \beta_k + \gamma_k z_d$ where z_d refers to the various land categories.
**Marginal Effects for dummy variables follow Eq. 5.55:

$$ME_{x_k} = \frac{\partial P}{\partial x_k} = \partial P = \left[\exp(\hat{\eta}_k) - 1\right]$$

6.5.1 Impact of Land Restrictions

Partial elasticity of *gsa* variable is considerably different between developable and the four non-developable land categories. The η_k is as high as 0.705 for developable land but ranges from 0.066 to 0.278 in the non-developable groups. In terms of price discount attributable to *gsa*, vacant land registers a price shortfall of 24%, while the smallest and only insignificant effect is seen in rice parcels with 6.4%. Developable land category registers an almost 51% price reduction due to *gsa*, all else constant. However, taking into consideration the number of developable land with *gsa* status is only 2 out of 506, this should be viewed with some caution. Nevertheless, the results collectively indicate that sales restriction in government agrarian schemes does indeed lower the prices even after accounting for other characteristics of land.

The effect of *mrl* on rice land is the smallest and the only one that is insignificant. Price of *mrl*-restricted land is about 23% cheaper if the land has development potential. It appears that whilst the restriction does have an adverse effect on price, though not very substantially. The probable reason is because *mrl* does not restrict development use of the land, only that the land must be held in Malay interests, compared to *gsa* which explicitly blocks non-agricultural use and outsider interests in the land. With respect to oil palm parcels, the *mrl* effect is larger than the effect of *gsa*.

Overall, the estimates confirm that state intervention does indeed affect land values and that different policies have different impacts on prices. To provide visual comparisons of partial elasticity of price with respect to the two variables, the respective η_x values are visually depicted along with 95% confidence intervals in Figure 6.5 and 6.6. If the effect of a variable differ significantly between groups, their confidence intervals should not appear to overlap (this is seen in Figure 6.5 for *gsa* whilst the opposite is observed for *mrl* in Figure 6.6.).

Figure 6.5 Partial Elasticity of Price with respect to *gsa*, with 95 % CI

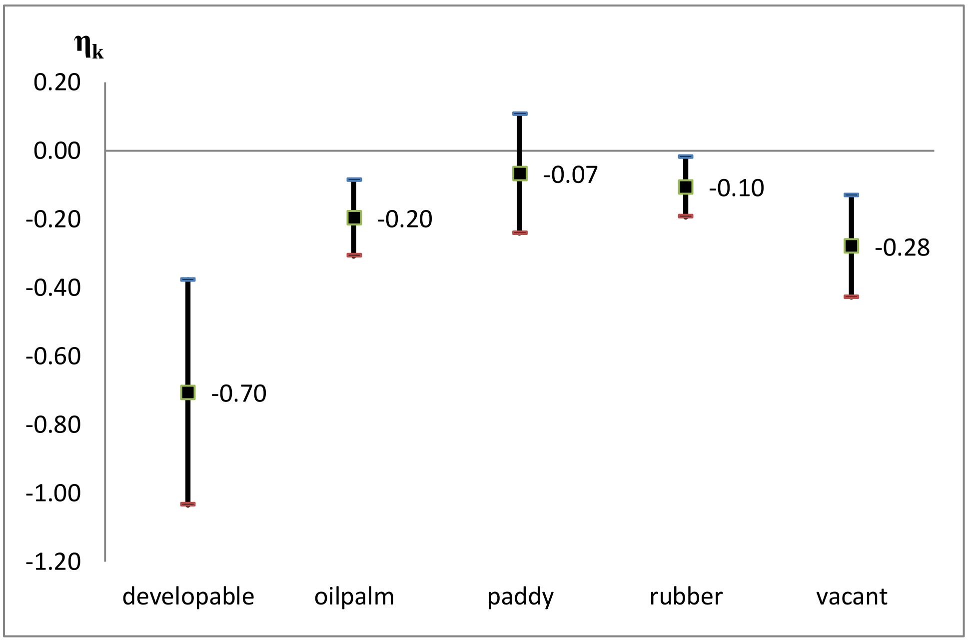
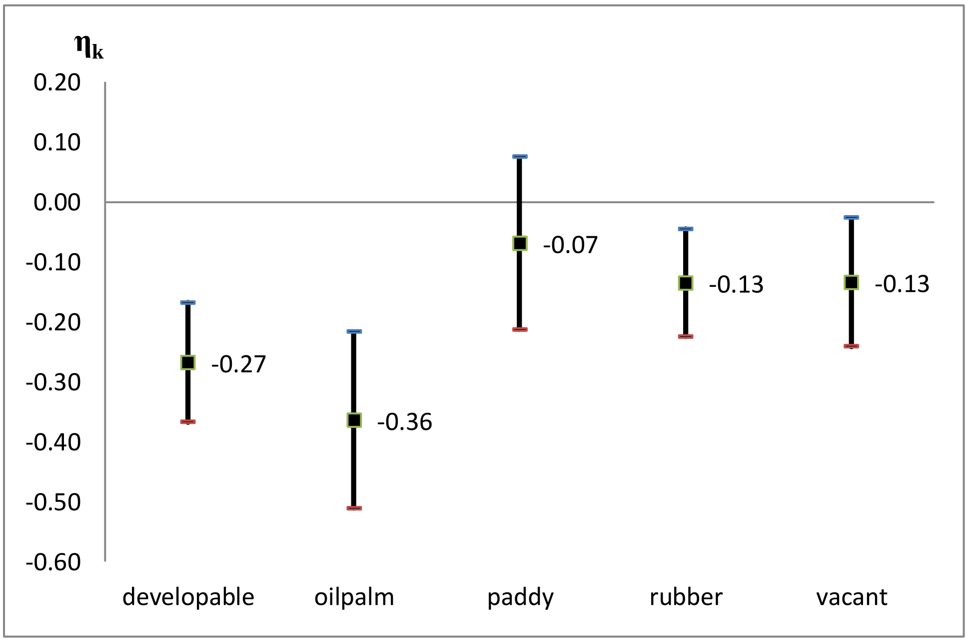


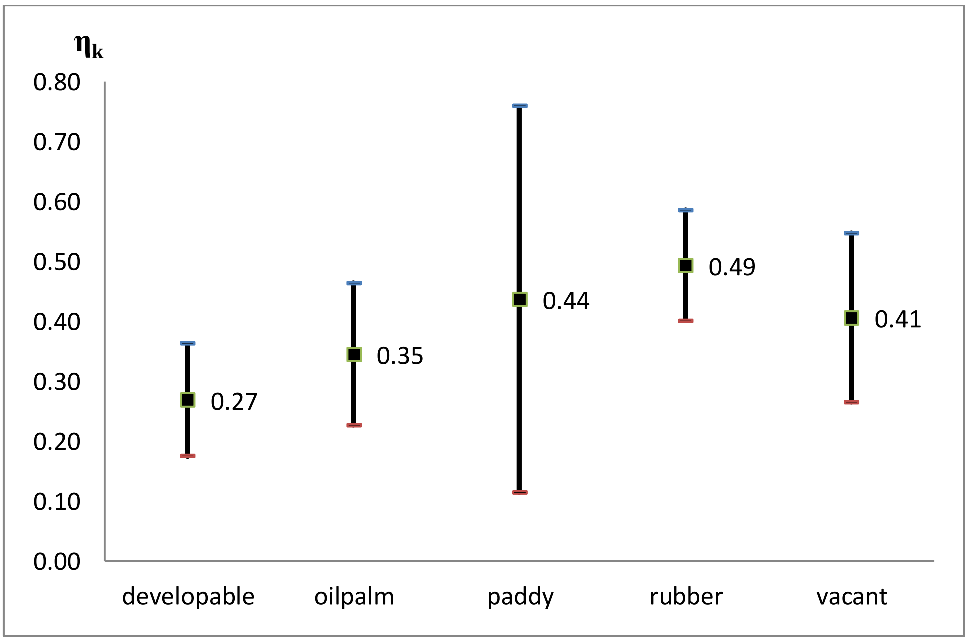
Figure 6.6 Partial Elasticity of Price with respect to *mrl*, with 95 % CI



6.5.2 Impact of Road-Frontage

Parcels are normally considered to have some degree of locational advantage if they face the road, regardless of its potential use. The estimation results appear to support this hypothesis. In all categories, the results indicate positive and significant impact on price from having road-frontage. Nevertheless, it is interesting to note that the impact of *rdfnt* is smaller in developable land, 30.8% compared to non-developable land categories where it is capable of inducing premiums amounting between 41% to 64% of the price. Elasticity of price with respect to road-frontage is largest for rubber and rice land i.e., land typically located in more remote areas compared to others. The results appear to indicate that road access advantage is relatively more highly valued among non-developable agricultural land. This could be because parcels with road frontage are usually few and far between in the Malaysian rural context such that if the attribute is present in a parcel, its price could be significantly different. A quick look at Table 6.6 will show that on average, only 12% of the non-developable parcels enjoy road frontage compared to 48% of developable parcels.

Figure 6.7 Partial Elasticity of Price with respect to *rdfnt*, with 95 % CI



6.5.3. Impact of Year of Sale

As shown in Section 6.2.5, yearly price index of land fell substantially following dramatic oil and steel price shock in 2007. Malaysia as one of the largest producers of palm oil was expected to gain from the bullish commodity market trends because of biodiesel production potential in the oil palm industry. Rising oil prices meant immediate and dramatic increase in fertiliser and transportation costs, which many were ill-prepared for, especially if the oil palm or rubber trees are not harvestable yet and capital reserves are small. In fact, the impact of higher production costs was felt across the board for all agriculturalists, but more so by the smallholders. Table 6.15a shows that with the exception of rice, agricultural-potential land suffered reductions in price between 12 to 18 % in the year 2007 compared to other years in the study.

Developable land suffered a larger price markdown in 2007 i.e., 27% (also see Figure 6.8). Erratic changes in prices of steel and oil sent the property sector into an uncertain state. Many developers were forced to reschedule or revise their land acquisition plans as costs of production increases. In some cases, firms liquidated portions of their land banks to finance existing debts or diversify their income-generating activities. Falling interests in land acquisitions could also be attributed to worries regarding the sub-prime crisis, although this was in its early stages in 2007 (South-East Asian countries were later found not to be very adversely affected). The general markets (particularly lending institutions) at the time became more cautious and tight with their real estate spending and loans, and this is clearly shown by the drop in demand for land with development potential.

Figure 6.8 Partial Elasticity of Price with respect to *year7*, with 95 % CI

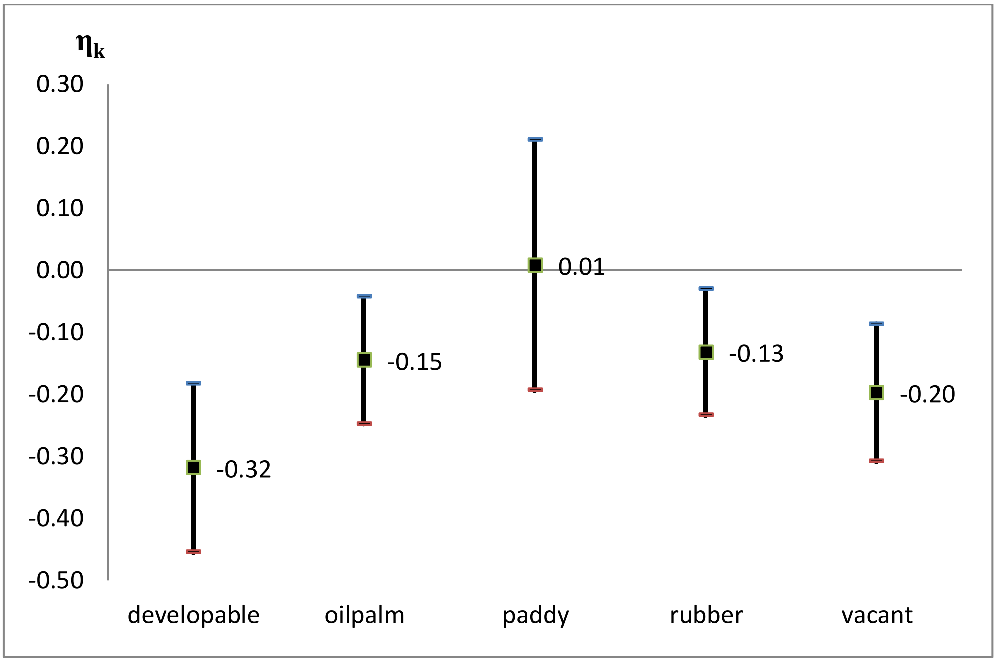


Table 6.15b shows the **conditional** marginal effects using partial elasticity estimates obtained for each continuous explanatory variable. The calculations of marginal implicit prices and their respective interpretations follow the guidelines presented in

Section 5.6 in the methodology chapter. The t-statistics show that all the continuous variables are statistically significant in almost all sub-groups of land $(\eta_k \neq 0)$.

Table 6.15b Price Elasticity with respect to Continuous Independent Variables

List of Attribute	Develop-ment Potential	Marginal Effect/ Elasticity* η_k	Robust Standard Errors	t-statistics	p-value	95% Confidence Interval	
popgro	*developable*	0.068	0.007	10.07	0.0000	0.0545	0.0808
	oilpalm	0.127	0.028	4.55	0.0000	0.0724	0.1821
	rice	0.207	0.033	6.24	0.0000	0.1420	0.2721
	rubber	0.131	0.025	5.22	0.0000	0.0817	0.1800
	vacant	0.070	0.009	8.04	0.0000	0.0527	0.0867
lpopden	*developable*	0.133	0.034	3.87	0.0000	0.0657	0.2007
	oilpalm	0.124	0.042	2.96	0.0030	0.0419	0.2056
	rice	-0.018	0.103	-0.17	0.8630	-0.2188	0.1834
	rubber	0.164	0.033	5.02	0.0000	0.0996	0.2275
	vacant	0.149	0.030	4.92	0.0000	0.0894	0.2077
ldistown	*developable*	0.087	0.039	2.24	0.0250	0.0107	0.1624
	oilpalm	-0.202	0.057	-3.53	0.0000	-0.3136	-0.0897
	rice	-0.194	0.086	-2.26	0.0240	-0.3623	-0.0257
	rubber	-0.086	0.049	-1.77	0.0780	-0.1826	0.0096
	vacant	-0.165	0.050	-3.28	0.0010	-0.2628	-0.0663

*Elasticity (Eq. 5.58): $\eta_k = \beta_k + \gamma_k z_d$ where z_d refers to land groups.

6.5.4 Impact of Population Pressure

The partial elasticities of *popgro* and *lpopden* basically confirm the hypothesis that population pressures cause agricultural land prices to rise rather than fall. The only non-significant outcome concerns *lpopden* in the rice category, which also happens to be negatively signed. In other categories, a 10% increase in the district's population is associated with 0.7 to 1.3% increases in price; whereas a 10% increase in population density is linked to a 1.2 to 1.6% increases in price. Interestingly, as Figures 6.9 and 6.10 attest, the marginal impacts of population growth and population density are fairly constant across all categories of land, of course save for rice. This is actually quite remarkable given that the average population growth and density for developable land are more than twice as high as non-developable land (recall Table 6.7). That the effects of demographic variables on price are positive but fairly indistinguishable across development potential shows that both the agricultural and development sectors thrive equally well on the increased market potential for output and labour brought about by the higher population growth and density. Although the percentage of effects appears to be very small and similar, it is worth remembering that the quantum of changes (if calculated at the categories' respective mean or median prices) are distinctively different from one another.

Figure 6.9 Marginal Effects of Price with respect to *popgro*, with 95 % CI

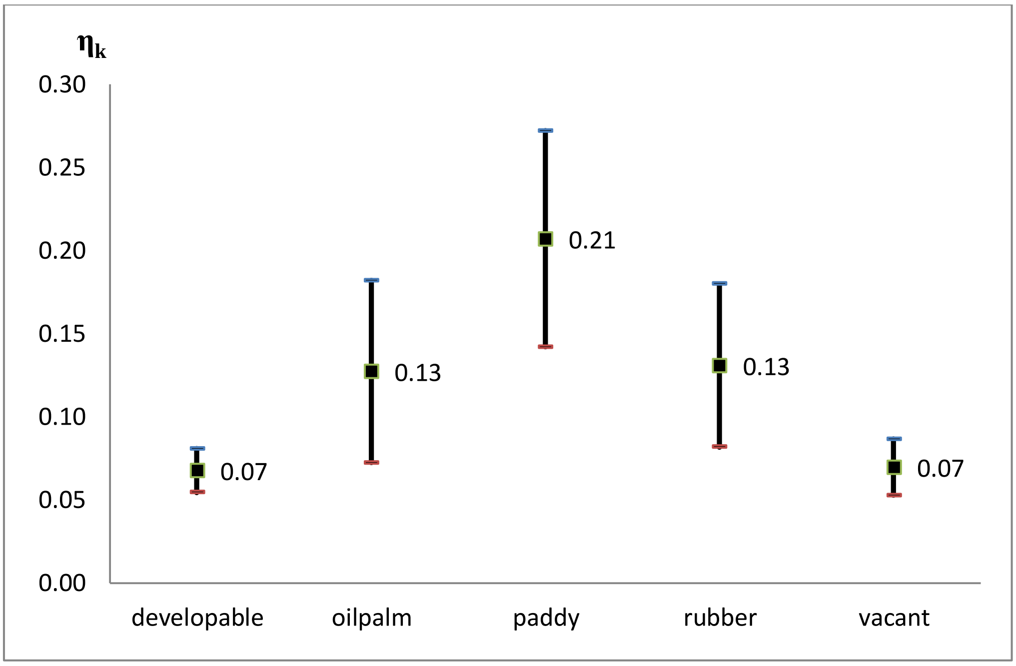
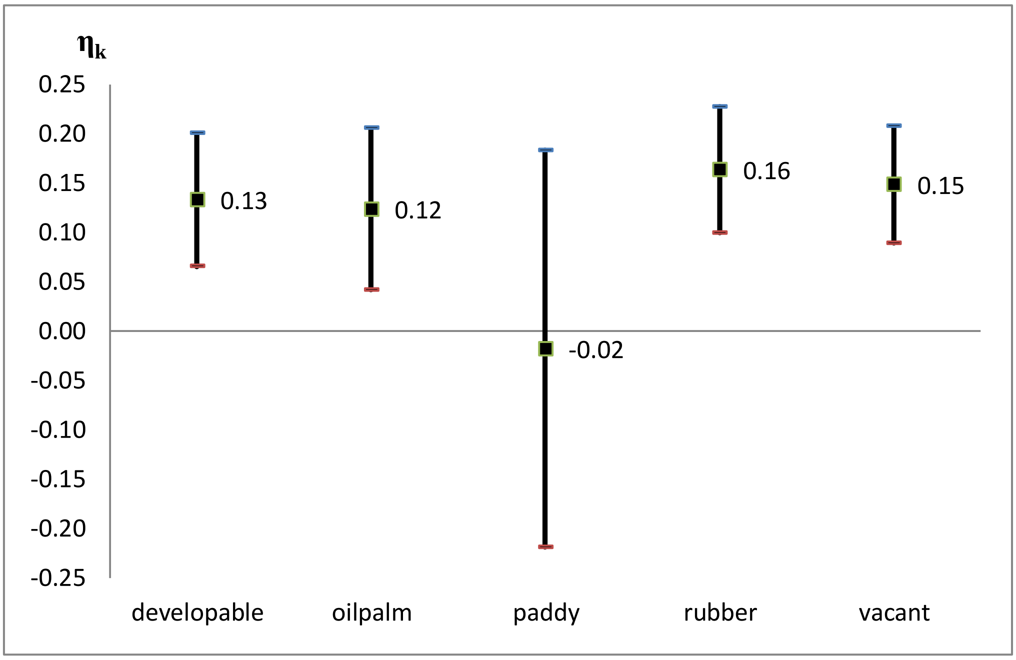


Figure 6.10 Marginal Effect of Price with respect to *lpopden*, with 95 % CI



6.5.5 Impact of Distance to Urban Centres

Regardless of potential use, parcels are generally assumed to have some degree of locational advantage, hence higher prices, if the parcels are located near urban amenities. This is validated by the results in Table 6.15b in which the elasticity of price with respect to *ldistown* variable is negative in all four agricultural-potential groups, although it is not statistically significant for rubber and rice land categories, ranging from 0.6 to 0.9% for every 10% increase in the distance to the nearest urban centre. Hence, it is possible to conclude that proximity to market is desirable more or less in the same degree for all agricultural categories. Agricultural buyers are willing to pay high prices for parcels nearer to cities in order to gain from broader market access and more efficient transportation costs. The findings support earlier studies that show impact of location is often much larger in regions with sparse development and relatively low land values.

In the developable land category, price is found to be positively related to distance to the nearest urban centre; which indicates that the further the developable parcel is, the higher the price per unit, all else constant. Development-motivated land buyers appear willing to pay more for land in lower-density areas, physically separated from existing population hubs for their development intentions.[152] This finding appears to indicate a pattern of land development that is not necessary linked to urban fringes. This is not particularly strange for the Malaysian context, but we nevertheless discuss several important reasons for this apparently diffused pattern of development:

(i) To reduce population pressure in major cities, many initiatives have been established to develop land in new areas which are traditionally greenfields i.e., new land is alienated by the state to be developed by a private firm in a public-private partnership arrangement.[153] This measure falls under 'planned development' framework of initiatives of the government as opposed to 'ad hoc' development approvals seen in other areas. The framework may include public expenditure to build colleges, better road networks and commercial or industrial zones in the area. Most of these new projects are designed to be self-contained in that all facilities of a complete town is available for residents to enjoy without having to go to the city. As the popularity of these **new low-density townships** projects increases, private firms are gradually more ready to embark on similar ventures on their own by purchasing privately-owned agricultural land. The new town grows as sufficiently high critical mass of population, new and improved road infrastructure is quickly made available, which in turn promotes further growth in the area and its surroundings.

(ii) Certain parcels of land at the urban fringes could be withheld from development due to various market or institutional reasons including speculation, high transaction costs, missing or uncooperative owners and so forth. As a result, development is forced to "leap-frog" to other places away from the cities.[154]

(iii) Good quality and extensive highway networks in Malaysia provide excellent connections between these outlying development areas with the more traditional urban and employment centres. New technology lowers the cost of

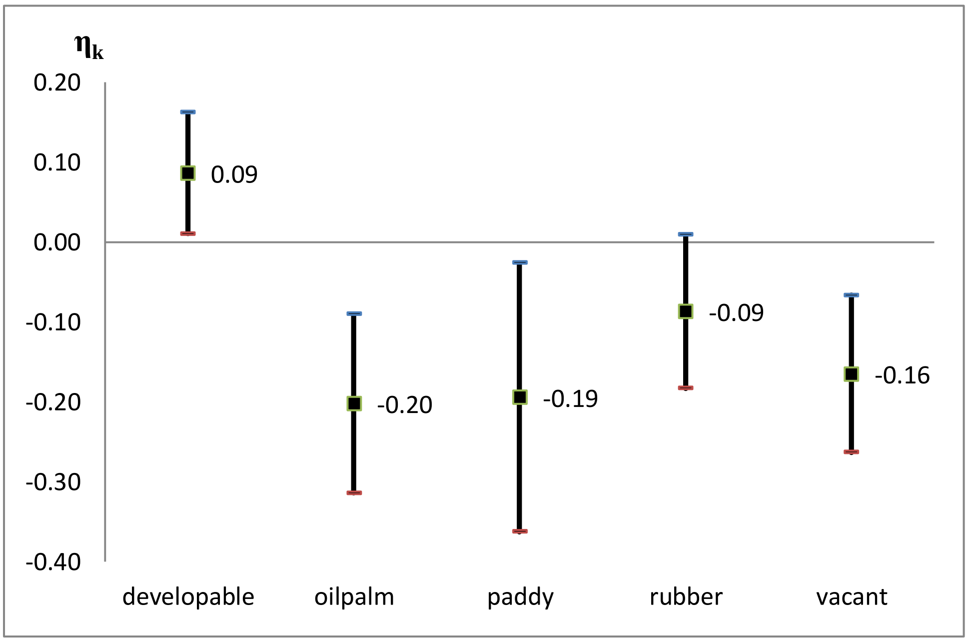
[152] Increasing proportion of low-density development in sub-urban and outlying areas is driven by household's preference for low-density residential (Gordon and Richardson in Carrion-Flores and Irwin, 2004).

[153] Cost of acquiring lands designated for these public-private development projects do not appear in the thesis data, because they are confidential. Some might involve transfer of interests rather than cash.

[154] Discontinuous development or leapfrog development is also explained briefly by Gordon and Richardson in Carrion-Flores and Irwin, (2004).

communication and transportation. People are no longer averse to commuting 'long' distance to work. Land areas along the highway enjoy high growth prospects, where there are numerous interchanges and a widening network of feeder and tributary road construction which encourages growth in and around the area.

Figure 6.11 Marginal Effect of Price with respect to *ldistown* with 95 % CI



6.5.6 Mean Predicted Price

To wrap up the regression analysis, a hypothetical baseline parcel is formulated and defined as one that is without roadfrontage (*rdfnt* = 0), restrictions (*gsa* = 0 and *mrl* = 0), located at a distance from a major city equivalent to the sample mean of *ldistown* and in a district with the median observed *popgro* and *lpopden* values.[155] Table 6.16 shows the average price (from Table 6.14) and predicted baseline price for each category of land.

The predicted price for an average baseline parcel which has development potential is RM229,297, which means that there is a substantial net premium of RM175,447

[155] The baseline median *popgro* is 1.44, median *lpopden* is 5.044541 and mean *ldistown* values is 3.500646. Other characteristics are held constant for all categories: *rdfnt* = 0; *gsa* = 0; *mrl* = 0; and *year7* = 0.

over the average predicted price of land without development potential. The predicted oil palm's baseline parcel is RM68,413; rice, RM44,796; rubber, RM52,631, and a vacant baseline parcel costs RM49,558. The mean predicted prices are all higher than the respective average prices in the sample except for developable and vacant land.

Table 6.16 Comparison of Mean Price and Predicted Baseline Price by Land-Use Potential

Category of Land by Land-use Potential	Mean Price per Unit (RM)	Predicted Baseline Parcel Price per unit (RM)
Developable	328,827	229,297
Oilpalm	54,365	62,254
Rice	36,361	44,796
Rubber	48,466	52,631
Vacant	50,985	49,558

Predicted mean price for land with rice potential is the lowest in all five groups at RM44,796, underscoring the weak return potential from rice cultivation in Malaysia. In the analyses earlier, rice land has been particularly outstanding in that many of the attributes are not statistically significant or that the coefficients display different signs than the rest. Tables 6.15 and 6.15b show that variables such as *gsa, mrl, lpopden* and *year7* are not statistically significant in the rice land category results. In fact, it is in the rice sub-sector that the impacts of restrictions are the smallest. This is probably because most of the rice lands are either enrolled or founded **within** the country agrarian land programmes, such that the parcels are likely to have one or both types of restrictions (as seen in the high percentages of the category having *gsa* or *mrl* restriction in Table 6.14).

Even if the rice parcels are not restricted land, landowners still rely heavily on government's incentives to enhance production yields. Rice maintains relatively much of its historical and cultural significance not to mention, importance to national food security, hence the high level of public interest in the sector. The retail ceiling price of domestically-produced rice is typically set lower than imported rice prices but does not exceed a level by which ordinary people can afford to purchase it. The variety of rice planted in Malaysia are mostly not considered premium or niche such as India's basmathi or the Japanese rice, hence the demand for Malaysian rice is not particularly inelastic. These factors might explain why the margin of profit for local farmers is characteristically narrow. Even though rice farmers are able to purchase seeds and certain quality of fertilisers at government-subsidised prices, other changes in costs of production (particularly for labour and machinery) are neither subsidised nor passed on to the consumers. It is useful to also note that there are no direct payments to landowners on account of their rice land holding, therefore none can be capitalised into price. Recall that in the colonial land reform process i.e. introduction of Torrens land registration system, the Malays peasants are allowed to register their existing farm and dwelling lands which were naturally small given that there are no special interests or allocations for capitalistic holding of land amongst the farmers. Over time, these already small parcels of land are further divided to different owners through the peasant credit and inheritance land transmission mechanisms. The combination of these economic and structural characteristics of the paddy land causes it to be less sought after among agriculturally-motivated buyers.

It is also interesting that compared to the other three agricultural-potential lands, there was no significant price effects in 2007 for rice (in Table 6.15a, the t-statistics for *year7* for rice land is 0.08). It is also remarkable that marginal effect on price is actually positive for *year7*, meaning that in this year, the price of rice land moved upwards whilst the price of other types of land fell miserably. Prime rice land i.e., one with fully operating water system is scarce because generally Malaysia does not get enough rain to support double-harvests in a year. Acute shortage of rice during the global food crisis in 2007/2008 has re-created interests in rice farming and food self-sufficiency goals of the country and these factors may have fuelled the surge in demand for land during the year.

The second lowest predicted baseline parcel price belongs to vacant land at RM49,558. Recall that the vacant category is largely made up of agricultural parcels with very little development potential, which means that their speculative values can be assumed limited. There is a number of additional reasons for the relatively poor value of vacant land: (i) there are no productive agricultural investments on the land at the time of sale most likely because of structural and economic deficits of the land; (ii) there are probably co-ownership issues that force the land to be left uncultivated and sold at lower than competitive prices; and (iii) most probably the size of the parcel is small compared to rubber or oil palm plots, although small-scale agricultural activities can still be carried out on the land. The more detailed explanation should correspond with earlier descriptions regarding the effects of transaction costs on land price (in Chapter 2) and issues of land fragmentation and abandonment (in Chapter 3).

6.6 CONCLUSION

The estimation results show that agricultural land prices are higher in the presence of factors that create positive and perceptible development prospects. Although these factors may not be fully captured or measured in the model, the PMR's categorisation of land according to land use-potentials has proven to be particularly useful in explaining price variations for the Malaysian data. The overall results adequately uphold the main hypothesis, that 'highest and best use' consideration is critical for pricing agricultural land in a relatively flexible land supply system where the state is willing to approve change of land-use title conditions to support wider-based development programmes and economic structural transformation. Evidence from this chapter show that mean price of developable agricultural land far exceeds the mean price of like-to-like parcels without development potential i.e. by more than two times the latter's average value.

The results also revealed that *gsa* status adversely affect market prices for land up to more than one-third of the price. This shows that the market for land from government agrarian schemes are still characterised by limited supply and limited demand, hence the low sale values. In reality, wholesale disposal of a settlement scheme i.e., via land takings or direct purchase by developers is far more practical to both buyers and sellers, because of the communal nature of the farm's composition.[156]

Another interesting finding is that developable parcel values fall with proximity to existing major cities. This validates an earlier hypothesis, that because of the country's rural development strategies, industrial and commercial growth is detected

[156] A recent example is the disposal of Negri Sembilan's FELDA Labu Sendayan to private firms to develop surburban Seremban area.

in non-typical areas, and triggers the creation of new population centres. House buyers are more inclined to pay higher prices for houses in low-density residential areas, possibly to avoid congestion and crowding in cities (often amounting reduction of net welfare), and to take advantage of quality road infrastructure connecting the rural area to the cities. That the effects of population density and growth are small, albeit positive also shows that land development is scattered and not necessarily confined to the urban fringes.

The results indicate that the land market is not particularly differentiable simply by the parcel's geographical location (spatial heterogeneity). There are also no firm conclusions with respect to the type of spatial biases in the study's hedonic estimation (spatial dependence). Although the detection tests, regressions and predictive errors all indicate that some form of spatial bias is present, the type and extent are not conclusive. In fact, the debate still continues whether spatial dimensions are indispensible in HPM studies and how do they affect the policy-making decisions. It is very difficult to agree on a utilisable degree of bias for policy analysis of the implicit value of land characteristics or programmes, because the results of spatial models are very sensitive to the type of spatial weight matrix, upper bounds of 'neighbourhood' and so forth, which is decided by the researchers. Nevertheless, because of the lack of clear evidence of spatial dependence from the chapter's spatial econometrics exercise, estimates from the standard classical model were used to establish the elasticity of prices with respect to the various explanatory variables to represent the marginal implicit values of land attributes.

CHAPTER 7
REAL OPTION AND AGRICULTURAL LAND

7.1 INTRODUCTION

The empirical results obtained in the previous chapter showed that Malaysian agricultural land can be best differentiated by its potential land-use. Agricultural land is in fact always open to a great number of potential non-agricultural investments including those relating to real estate, highways, mineral exploration, high-technology industrial plants, military complexes and so forth, consistent with what Berry (1979) describes as the ‘impermanence syndrome’ with respect to land-use. The value of this flexibility is inevitably capitalised in its price and it follows that the more fluid the conditions in the economy (from wider economic prospects and/or relatively less restrictive land-use controls), the greater the value of this flexibility. It is argued that uncertainty in future returns on land lead to the difference between the conventional present value of land in its current use and its sales value. A useful analytical perspective that incorporates opportunistic purchasing behaviour encouraged by the many uncertainties in future land returns can perhaps be found in the Real Option (RO) theory. In finance, an option is a derivative whose value is dependent upon the value of another asset (which is called the underlying asset e.g. stocks, bonds, commodities, currencies and indexes) as well as fluctuations in the value of the underlying asset.

It is well-accepted that investments in land typically involve large initiatives that are spread over a period of time. The project begins with the acquisition of undeveloped (in this application, agricultural) land to allow the buyer a right, but not an obligation, to make follow-on investments that will maximise potential returns from the land in the future. Hence, land represents the **option** to profit from its highest and best potential use. Alternatively, if the market prospects for its potential use turn out to be less promising than initially thought, the landowner (i.e., the option holder) has the **option** to either defer the follow-on investments or terminate the project entirely by disposing the land to another party.

It is worth mentioning that the option exists not only for a change in land use (agricultural to development). Even if land is acquired as an agricultural investment (agricultural to agricultural), yet unknown possibilities such as cost-reducing technologies, free trade agreements involving agricultural exports, new biotechnology or pharmaceutical potentials could give its buyer opportunities to make considerable future gains in the future. In addition, land provides excellent **hedging** benefits particularly against inflation. Ownership of land automatically creates an option on the real purchasing power of money as a hedge against the erosion of its nominal purchasing power. In general, both buyers and sellers of land are aware of the speculative and hedging appeals of land, hence they are built into its valuation. This is basically the reason land prices appear to deviate from its capitalised return from its current use.

Hence, it should be fitting to conclude the analysis on the determinants of agricultural land price by examining the concept, nature and types of RO behaviour observed in its market. We first explore the literature on capital investment to explain the theoretical concepts of the real options approach in Section 7.2 where sources and determinants of real options value in agricultural land are discussed in detail. In Section 7.3, a hypothetical case of land development investment is discussed to illustrate the numerical valuation of option in land. The case will eventually be extended to show the different types of option embedded in land and their respective computed values. Section 7.4 describes the methods and results introduced in this study to corroborate RO behaviour in Malaysian agricultural land market. The chapter ends with a summary of points in Section 7.5, followed by two appendices focusing on: (i) the issue of land idling as a form of strategic decision and; (ii) the binomial model formula.

7.2 REAL OPTION THEORY

Option pricing theory was developed based on seminal papers by Black and Scholes (1973) and Merton (1973) and Cox and Ross (1976). It is basically a concept of pricing financial securities and is eventually extended to pricing 'real' assets which exhibit option-like features. The term "Real Options" was first discussed and named by Myers (1977) and has since been an important consideration in capital-budgeting decisions. In summary, a real option represents the value to a firm of having the flexibility to **accept, reject, or postpone** additional investment. Certain investment decisions made early in the project give rise to follow-on opportunities that are wealth-creating, although the precise nature of opportunities or benefits associated are not yet known at the time of sale (Pike and Neale, 2003). The RO outlook encourages a 'wait and see' approach to investment and is valuable in the project design stage (Bowman and Moskowitz, 2001).

Today the RO approach is widely applied to analyse corporate investment decisions for example those relating to acquisition of internet innovations, license for oil exploration and brand names.[157] For example, by investing in a particular R&D facility, the investor secures the option to acquire future patents and products emerging from the facility (see Grenadier and Weiss, 1997). Investments in novel internet applications, such as the Facebook, provide the investor access to future advertisement revenues. Gibson and Schwartz (1989) and Paddock, Siegel, and Smith (1988) show that firms compete for offshore petroleum leases which will give them exploration and extraction rights in the future, even though the value of the mineral deposits are still indefinite at the time.

Titman (1985) and Williams (1991) are the first to apply the RO perspective to value real estate development on vacant urban land. Titman applies a discrete-time setting to show that the value of vacant developable land is a call option and that its price tends to rise as uncertainty on future prices increases. Williams (1991) adopts a continuous-time modelling approach to show how stochastic evolution of construction costs can affect the optimal date of construction or abandonment and density of a real estate development project. Quigg (1993) claims to provide the first empirical application of an RO pricing model in which prices were found to reflect an average of 6% premium above intrinsic value of would-be developed properties attributable to the **option to wait** that developers enjoy.[158] Yamazaki (2001) used standard deviation of daily changes of real estate sector's stock prices to proxy uncertainty in values of developed properties. His model incorporates both time-

[157] For an excellent review of the different kinds of investment problems that have been modeled using the Real Options approach, please see Lander and Pinches (1998).

[158] Wang (2001) points out two limitations of Quigg's work. Firstly, the influence of development scale on total building prices and total construction cost is ignored. Secondly, her estimation of the completed property value using historical data is questionable given the very diverse structure and site characteristics of the properties.

series economic data and cross-sectional observations of 4,368 Tokyo land parcels sold between 1985 and 2000. The findings show that uncertainty in final output price has a substantial effect on undeveloped land prices. Gillen (2006) used a hedonic pricing model to construct an index that measures the impact of changes in construction restrictions on land prices. When building restrictions in downtown Philadelphia were withdrawn, the value of the **option to expand** the original property significantly increased. Ooi *et al.* (2006) found evidence in a Singaporean study that if a sale precludes holding land for speculative and development purposes (such as in the Government Land Sale scheme), option values embedded in the land, as given by flexibility in timing, density and marketability of the property, would become almost non-existent. As such, the land's market value will approach its intrinsic value. Cunningham's (2006) study of Seattle metropolitan real estate using a hazard model found that price uncertainties reduces land development; one standard deviation increase in price uncertainty reduces the hazard of development by 11.3 percent and raises the value of vacant land evaluated at median lot price by 1.6 percent, although this could be as high as 9.1 percent the closer the parcel is to an urban centre. This result appears to support the link between uncertainty and value of land.

The RO concept has only been extended to agricultural land pricing recently and the literature remains sparse. Platinga, Lubowski and Stavins (2002) used panel data of U.S. counties to capture the effects of uncertainty in future land rents on farmland prices. Variance of annual changes in population density is used to proxy the uncertainty factor. They found that the marginal effect of population change variance is positive and significant; this suggests that option values are somehow capitalised into land prices. Capozza and Sick's (1994) model shows that when development rents are riskier, the option value and therefore, the 'hurdle' price of developable agricultural land will rise.[159] Towe, Nickerson and Bockstael (2005) found that by having the option to participate in land preservation programmes such as 'Purchase of Development Rights' in the U.S., landowners typically delay land development by about six years. In their hazard model for land conversion, the authors show that the

[159] Their model demonstrated that a greater rate of change in development rents implies larger future returns to developed land, and this is capitalised into the current land price. In other words, higher variance in development rent shocks increases the option value associated with delaying the irreversible land conversion decision.

greater the variance of returns to development, the slower land conversions will take place for parcels with all but the highest use-capacities. Isgin and Forster (2006) use sample survey data to determine if the rate of land use conversion of neighbouring parcels, local population growth, distances to metropolitan areas, and local population density can significantly affect real option values of farm real estate. Since agricultural land has multiple potential uses, and that the intended use is unclear prior to sales, they follow Shonkwiler and Reynolds (1986) in introducing qualitative variables into the hedonic model to account for various probable development outcomes. Although they did not attempt to measure the option value directly, they found that the development potential and distance to an urban area increases the option value of land. To sum up, the concept of RO allows the land price researcher to model uncertainty in future economic returns from the land, particularly if the land has alternative potential uses. The following section is dedicated to explain the theoretical foundations of the RO framework and its application to agricultural land.

7.2.1 Fundamental Concepts

In order to understand options in real assets, it is useful to distinguish it from its cousins, under the term financial options. In finance, a **call option** gives its holder the right to purchase an underlying security (share of a stock, index, interest rates) at a certain exercise price upon or before a specific date. In the real options context, a strategic asset is considered a call option because it gives its holder the right to stake his claim or make a transaction on another asset, which is called the **underlying asset;** by paying a specified exercise price, on or before an expiration date.[160] Price paid to purchase a parcel of land is payment made to acquire the call option on an underlying asset. Say that the land is purchased for its housing development potential. The underlying asset value is the final value of completed residential properties, V. The exercise price here is the cost of construction, I. The payoff or profit to the investor is the difference between the price of the underlying asset and the option's exercise price or $(V - I)$. Realistically, in addition to the land acquisition and production costs, the investor bears the standard transaction costs, land-holding

[160] In financial derivatives literature, an option is a contract that gives the purchaser the right to enter into another contract within a specified period of time. An option is called a derivative because it is a contract on another contract. A good introduction to financial options can be found in Hull (1991) and Alexander (2008).

costs, which may include interests on capital tied-up to the project, as well as waiting costs prior to the start of revenue inflow. The time to the option's expiration, *T*, can be specified, by which the option holder must choose to carry out the construction or let the option lapse. It is possible to find *T* if the planning permission approval document, as an option agreement for example, specifies the approval's validity period.

If the final value of the project exceeds that of the cost of acquiring and developing the land $(V > I)$, the option is said to be 'in-the-money'; it means that there are positive returns to the overall investment. The minimum value of an option is called its intrinsic value which is the value the investor receives from exercising the option (Chance, 1999). For example, say that a project's 'best' potential revenue is RM170K, and the cost of the relevant project is RM140K. If the price of land is RM20K, then the logical move would be to purchase the land. The option is in-the-money since there is positive net return of RM10K from the overall project. If many investors detect the same profit prospect, the market demand for land would be pushed up, until the price reaches RM30K, where it is no longer profitable to purchase the option for the purpose of this project. Hence, the minimum value of the call option which is in-the-money is RM30K.

The maximum possible value of the option is simply the value of its underlying asset, because logically, undeveloped land cannot sell for more than the output of its 'highest and best-use'. This is true even if exercise cost is zero. If land does not have any perceivable maturity date (none imposed by local building laws or competition in the market), the investor can look to gain from future price increases in the underlying asset for as long as he cares to keep the land. There is no incentive to exercise the option early.[161] This observation is often summed up in the expression "An American call is worth more alive than dead" (Figlewski *et al.*, 1990, p. 33). If for any reason the investor elects to forgo waiting and decides to exercise early (e.g., by commencing construction), the investor is said to have 'killed' the option. This lost option is an opportunity cost that should count as one of the costs of investment.

[161] Additionally, since the investor does not receive any payment from the project before it is fully completed, there is less reason for the investor to exercise her option early.

The RO perspective gives valuable insights on firm behaviour when faced with dis-investment decisions. Many firms choose to bear large and ongoing losses for as long possible, rather than shut down operations and sell the assets as options. By 'terminating the option' in this manner, a firm would have incurred not only irreversible loss of tangible capital but also future profit opportunities. The relationship between RO and land idling behaviour is discussed in greater detail Appendix 7A.

If the final value of the project is less than the cost of acquiring and developing the land *($V < I$),* the option is said to be 'out-of-the-money'. However, an option can never have a negative value simply because the holder cannot be forced to exercise it. Therefore, the minimum value of an option that is out-of-the-money is zero. This is why the RO theory holds that the investor has limited liability or limited 'downside' risks, because the value of the option-bearing asset is never zero even if the option is worthless. The more active the secondary market for the asset is, the better the prospect of finding a buyer for the asset. In the case of land as an option-bearing asset, if there were very minimal improvement or fixtures added to it, the land can be relatively easy to dispose. On the other hand, land with specific structures built will pose problems of indivisibility and rehabilitation costs to accommodate other uses i.e. the problem of asset fixity. In any case, it is useful to note that the decision to terminate a project does not mean the investor has failed or erred in his earlier decision to purchase the option asset. Instead, this decision to divest could be optimal in the interest of the overall investment portfolio.

The price of a call option asset normally exceeds the asset's intrinsic value i.e. the discounted value of its future returns based on today's use. The difference between the price and the intrinsic value is called the time or speculative value of the call. It reflects what investors are willing to pay for the flexibility to gain more profit i.e., the time and space to resolve uncertainties and accomplish the optimal course of action. Interestingly, the market often confuses the value of flexibility to invest and the value of the investment. Having the flexibility to do something does not guarantee that it will be done. If the investor quantifies the option value to include the potential **value of a fully completed project** rather than the **value of the**

opportunity to undertake the project, the reservation price of the land is often far higher than the land's intrinsic value (Bowman and Moskowitz, 2001).

As the literature review implies, not all assets exhibit RO qualities. Dixit and Pindyck (1996) describe factors that give rise to RO in a given asset. From here, it is possible to gauge the appropriateness of describing agricultural land as a real option asset.

7.2.2 Real Option Features in an Investment

7.2.2.1 Irreversibility

Irreversibility of investment refers to the situation in which when one buys an asset, the initial cost of investment is at least partially sunk if the project is abandoned at a later point in time. For instance, residential development on a previously agricultural land is considered irreversible because of the high cost and amount of time needed to rehabilitate and prepare the land for agriculture again. Hence, the decision to exercise the option to develop must be weighed very carefully. It is often wise for the investor to wait for reliable signals in deciding the optimal type, density and timing of development before incurring follow-on investments in the project.

7.2.2.2 Uncertainty

If there is a range of possible alternative land-uses, an astute landowner/investor will normally try to anticipate probability of profit or loss outcomes from each land-use (Harvey, 1996, Titman, 1985, Forster, 2006, Riddiough *et al.*, 1997, Dixit and Pindyck 1995, Plantinga *et al.*, 1998, Isgin and Forster, 2006).[162] This involves assessing various sources of uncertainty including (i) uncertainty over future values of the project, which in turn is dependent on the demand and supply of the final assets from the project;[163] (ii) uncertainty over transaction costs and efficiency of

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[162] The general assumption is that market demand is exogenous. Nevertheless, in reality there are many steps that investors can pursue to manage market expectations and outcomes whether by themselves or in concert with other firms in the industry. Another important assumption is that quality, reliable and comprehensive information can be gathered at fairly low-cost. Otherwise, the argument that delays allows for better strategic decisions would not hold much value.

[163] Ogawa and Suzuki (2000) decompose demand uncertainty into three components: aggregate, industry-wide and firm-specific. The aggregate uncertainty is represented by the standard deviation of the rate of change on exchange rate. The industry-wide uncertainty the standard deviation of the rate of change on the production index by industry is used. Finally, the firm-specific uncertainty is given by the residual of the regression relating individual uncertainty to aggregate and industry-

production, which are especially important for projects that take time to build and provide returns; (iii) uncertainty over interest rates trends and its effect on capital costs; and (iv) uncertainty over availability of financing, regulatory requirements, legal conditions of use or interest, taxation rates and so forth; many of which are beyond the investor's control.

In an option framework, the higher the level of uncertainty means the higher the value of the option. This is because larger uncertainties increase the potential positive payoffs from the option, while potential losses remain limited. This explains why an option-based approach is especially attractive in situations where margins from an investment are particularly unstable or volatile. Studies have found that uncertainty has had an adverse effect on investment levels; firms either wait for better signals from the market or invest conservatively. A case-study of Enron natural gas plants in two U.S. states shows the firm deals with uncertainty regarding future margins by choosing a low-capital strategy (build less expensive plants although they would require higher operating costs). Enron is able to meet current levels of demands and at the same time, is well-positioned to benefit from windfall gains should demand rise substantially (Coy, 1999). The option-based perspective can also be observed in agricultural land ownership: investors purchase land in spite of its very poor or negative agricultural-use PV because it permits them to quickly adjust supply levels when the need arises. In any case, there is always positive market demand for undeveloped agricultural land, regardless of the current income flow. As a matter of fact, it is not surprising to see agricultural land prices equilibrate at prices and quantities that defy local and current conventions.

7.2.2.3 Flexibility in the timing of the second-stage investment

The value of land as a strategic option asset only exists if there is flexibility in the timing of the follow-on investment. Because the land conversion bears so much uncertainty and is irreversible, the investor should carefully weigh the benefits of investing today against the benefits of waiting for new market signals on the

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wide uncertainty. However, they find that the last component has the smallest effect on investment, hence can be ignored. If the whole economy is affected, then there will be relatively more limited opportunities to dispose of the asset; hence narrowing the investor's option to abandon it, as compared to firm-specific shocks or even industry-wide slump.

desirability or timing of the project.[164] It follows that the longer the time to expiration, the more flexibility an investor has and therefore the higher the price of the option. Dixit and Pindyck's (1996) model show that greater project uncertainties typically encourage longer delay. In sum, the higher the degree of irreversibility and uncertainty, the larger the opportunity costs of investing now rather than later, the greater will be the incentive for the investor to wait before going ahead with the second-stage investment.

The price of the option asset should logically reflect the extent of its option-creating values above. The list of factors that affect the value of real option with respect to land are summarised as follows.

7.2.3 Determinants of Real Option Value

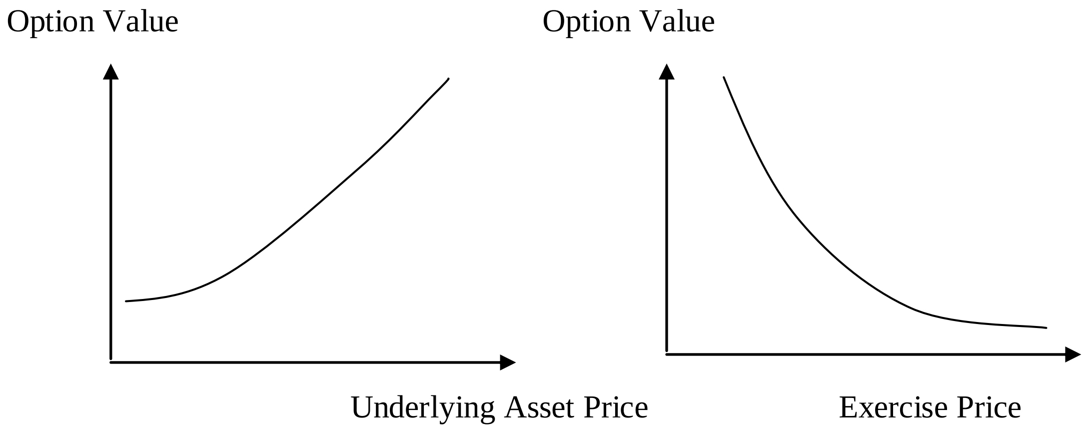
7.2.3.1 The exercise price and the current price of the final asset.

As shown earlier, profit from holding an option is positive as long as the final asset price exceeds the option's exercise price. If the exercise cost is broadened to include the cost of land acquisition and its subsequent development, then all else being equal, the option increases in value as price of final developed property, *V*, rises or as exercise costs, *I*, falls. This implies that the optimal time to exercise the option is simply the time when the difference between the final project value and exercise cost is expected to be highest, taking into account the time expected to complete the project. The more likely the land is expected to represent a 'deep-in-the-money' option, the higher the value of the land. The explanation above implies that for the case of land, its value which is represented by the value of the option here changes as expectations regarding costs and returns for the final resulting project (underlying asset). This in no way contradicts the principles behind the Net Present Value formula and indeed RO theory only provides an interpretation to the expectations component in the NPV framework. It also follows that where RO perspective is relatively more useful in circumstances where changes in market expectations are continuously on-going compare to where there are constraints that restrict changes and consequently result in lower levels of speculation activities. Figure 7.1 below

[164] Granted, there are many strategic advantages of investing immediately, for instance to pre-empt competition or to minimise foregone cash flows arising from the project's delay. Alternatively, the developer has a duty or has made a commitment to the authorities to develop the land within a stipulated amount of time after the land acquisition.

shows the effects of final asset price and exercise price on an option's value, respectively.

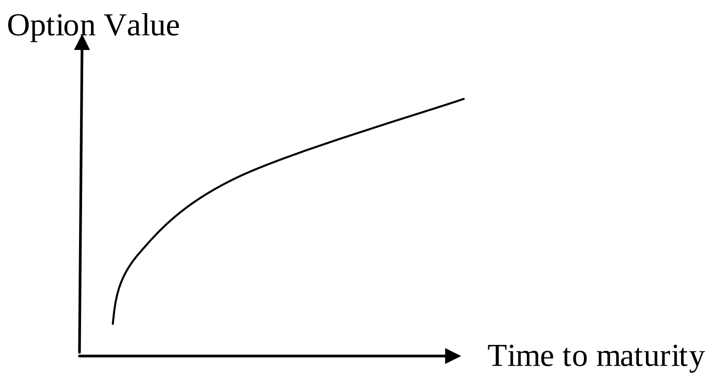
Figure 7.1 Relationship between Option Value and (a) Underlying Asset Price; (b) Exercise Price



7.2.3.2 Time to Expiration

The longer the period the investor is allowed by law to commence construction or conversion of the land, the more information he can accumulate to ensure that he is exercising his option only when it is most advantageous for him to do so (Figure 7.2). Furthermore, the value of an option should increase because the PV of follow-on capital investment becomes smaller as *T* increases. An option's time-value decays with the passage of time i.e., it approaches zero at expiry, *T*. However, where there is no perceivable expiry date, then it makes sense for the investor to wait for as long as he can (Pike and Neale, 2003); i.e. subject to his capital costs and other relevant constraints.

Figure 7.2 Relationship between Option Price and Time to Maturity



7.2.3.3 Degree of uncertainty

All things equal, a project with a relatively higher degree of uncertainty should have a more valuable growth option. The reason is because the market assumed that higher the dispersion of potential payoff, the greater the magnitude of gains realisable by exercising the option at the highest level of *V*. While this may not seem likely to apply to small farmers incapable of absorbing short term shocks, the argument may better suit opportunistic buyers with deep pockets, high risk tolerance and a longer time horizon. If final asset prices fall, the developer losses is limited to the loss incurred from disposing the land at prices lower than its acquisition price; which is avoidable if sold at a time when the land market is normal. The investor's risks are substantially diminished with the existence of an option as compared to without it. It follows that the value of an option depends on the extent of asymmetry between potential gains if price increases and potential losses if prices falls.

7.2.3.4 Interest rate

In the standard PV formula, higher interest rates lower the PV of future returns from the final completed asset. However, in an RO perspective, a higher discount rate also means that the PV of future capital costs of exercising the option is lower as well. If the net effect is positive, the overall PV of the project should still be relatively higher compared to PV in the standard formula. As a consequence, higher interest rates have the effect of encouraging greater investments in call option assets such as land, and this in turn eventually pushes its equilibrium price upwards.

7.2.3.5 Degree of Market Competition

The higher the degree of monopolistic power an investing firm has, the more time the firm has to exercise its options and the more power it has over market supply (see Williams, 1993, Grenadier, 2002, Luerhman, 1998, Pike and Neale, 2003). In other words, in a highly concentrated market, the effect of option-based decisions on equilibrium prices and quantities are substantially larger than usual. William's optimal investment timing model assumes that for a given level of demand, investors will exercise their options simultaneously with proportional shares. However, a more likely scenario in the real estate sector is that each developer exercises her options when demand reaches a certain level. They do not wait for others or follow a certain proportional ratio. As a result, there could be an oversupply in the market.

Shared ownership of an option instrument in the form of licenses, grants or land leases, implies less valuable rights for each individual firm. This is because the likely competition can erode the profit advantages of the investment. Suitable examples include government's awards of land leases to several firms to develop a large designated area, or internet broadband licenses to several firms to cover the same population base and mineral exploration rights over a given area.

7.2.3.6 Effect of Government Land Regulations

An option to invest can disappear abruptly when the growth opportunities the option promises are no longer available. For instance, a parcel of land will continue to hold an option value only as long as the land stays foreseeably free of encumbrances for development. Land-use or ownership controls have the effect of suppressing land values by curtailing the value of option intrinsic to the land (Riddiough, 1997). Other examples of state-imposed regulations include a no-conversion rule or government land takings. Recall that developers who purchase agricultural land are doing so presuming that approval for land-use change can be attainable, cost-efficient and complete. The smaller the assurance that the land-use change request can be granted, the smaller the option value of the land. The impact of delays must also be considered as there could be major changes in input prices in the mean time. Negotiations with the planning authority, the financing providers (banks) and community panels can be extensive and lengthy.

Identifying the factors influencing real option's value is not as complicated as measuring the value itself. For the latter task, we introduce the basic theoretical valuation methods for real options and subsequently provide numerical illustrations for valuing land's real option on land.

7.3 OPTION VALUATION:NUMERICAL EXAMPLE

In the classic financial option-pricing model, an underlying asset is assumed tradable (e.g.,stocks, bonds or indexes). Therefore, it is possible to construct a hedged portfolio that will eliminate almost all investment risks (Ross, 1976, Cox and Ross, 1976). This can be done by maintaining a long position in the asset and a short position in the option. A long position in the asset means that the investor buys a security with the expectation that the asset will rise in value, whereas a short position in the option entitles the investor the right (not the obligation) to sell the asset to the market at a specified price.[165] The overall effect is that the investor is able to do away with investment risks by purchasing an option to hedge his investment against a price decline.

With respect to *real* assets, risks in an investment project are hedged away by dynamically trading a perfectly correlated single asset security or an equivalent portfolio of marketed securities that share the same payoff probability as the project. The existence of this "twin asset" allows the investor to calculate the fair value that would prevail if the project was indeed 'tradable' in the market. For commodities or assets for which future markets exist, the twin asset's value can simply be taken from future or forward prices of the commodity.[166] In land development projects, its market-traded twin asset is usually identified from public-listed firms with development projects which are similar in nature. An important assumption is that the value of the "twin asset" is perfectly correlated with the value of the real project under consideration. Essentially, this means that they both inherit the same risk profiles i.e., they are affected by the same underlying sources of uncertainty (Hull, 2003, p. 256).

Because of the perfect hedging possibilities described above, investors in the RO framework adopt a 'risk-neutral valuation' of expected future payoffs from an investment. For the researcher, this means that there is no need to determine the risk-adjusted discount rate preferred by the investor. Instead, the rate of interest is selected by referring to the "twin asset" to provide essential market information about investment risks and returns.

To illustrate, assume that there are only two state variables.[167] Each year, the value of the final asset, *V*, either goes up as V^u or down as V^d according to a given percentage

[165] The statement refers exclusively to a put option contract. A put option contract gives its buyer the right to sell at a specific price.

[166] Futures prices are the expected trading price at the maturity of a futures contract. Futures prices have been particularly useful in the valuation of natural resource options (e.g.,petroleum, tin, copper).

[167] This numerical example follows Trigeorgis's (1987) implementation of the binomial valuation method for a hypothetical case involving mineral exploration and extraction rights.

with a probability ratio, *p*. Shown below is a decision tree indicating the project's values, *V*, with the two possible paths that *V* could take at one time interval. An additional simplifying assumption is that the risk-free interest rate is constant, and individuals may borrow or lend as much as they wish at this rate. In this one-period analysis, the gross value of the completed project, *V*, and the price of its twin asset, *S*, move over the next period, as follows:

$$
\begin{tikzcd}
 & V^u \; (p) \\
V \arrow[ur] \arrow[dr] & \\
 & V^d \; (1\text{-}p)
\end{tikzcd}
\qquad\qquad
\begin{tikzcd}
 & S^u \; (p) \\
S \arrow[ur] \arrow[dr] & \\
 & S^d \; (1\text{-}p)
\end{tikzcd}
$$

In the traditional present value formula, the present value of the project, V_0, is dependent on the actual probability, *p,* and the expected risk-adjusted rate of return *k*. Since the outcome is uncertain, V_0, can be expressed as follows,

$$
\begin{aligned}
V_0 &= E(V_1)/(1+k) \\
&= \frac{\left[pV^{u+} + (1-p)V^d\right]}{(1+k)}
\end{aligned}
\qquad \text{(Eq. 7.1)}
$$

In the RO approach, the value of a call option, denoted as *C*, moves in a manner that is positively correlated with the movements in its underlying asset, *V* or its twin, *S* (recall Figure 7.1a). The higher the value of final asset and its twin, the higher is the value of the option. Instead of actual probability, the approach uses risk-neutral probabilities, p', i.e., the probability that the expected value of returns, discounted today at a risk-free interest rate equals the asset's current market value,

$$
p' = \frac{\left[(1+r)S - S^d\right]}{(S^u - S^d)} \qquad \text{(Eq. 7.2)}
$$

Having identified the main parameters in an option valuation framework, the chapter proceeds with a simple land development example to explain the computations of various types of options embedded in undeveloped agricultural land.

Assume that a proposal has been made for a new public university campus to be constructed within the next 5-year economic plan, at a particular site say, in Perak. However, since the project is still at the proposal stage and will be entirely funded by the Federal government, the State's 'offer' of the campus site can only be taken up after considering comprehensive development plans drawn for the whole country (and competitive lobbying from politicians in other states). This is where the element of uncertainty emerges – the project might be shifted to another site or delayed to another time if more urgent uses of funds arises.

Nevertheless, if the project goes to plan, investors can anticipate that there will be a strong demand for housing properties. However, in order to secure the opportunity to make considerable gains from the prospective housing project, an investor must move first to secure suitable a parcel of land (adjacent or nearby parcel with relatively good access to the tentative campus site). For simplicity, it shall be assumed that once constructed, all units of properties will be sold and no follow-on investment is needed.

The housing project has a realisable sales value, V, of say, either RM170K or RM60K, depending on the realisation of the university project. If it is assumed that the market for houses are efficient, then the two outcomes have equal probability (p=0.5).[168] Let S be the listed stock price of an identical development project which plays the role of the 'twin asset'; and is assumed to have a spot price of RM15. The value of the twin asset can change to RM25.5K (an increase of 70%) or to RM9K (a decrease of 40%), depending on housing market profitability current outlook. Finally, because both the project and its twin security are perfectly correlated, presumably they would share the same expected rate of return, k and risk-free interest rate, r, which are assumed to be 15%[169] and 4% respectively. To help find the project's present value at the beginning i.e., when the investment decision is being considered, V_0, the land development decision tree is presented as follows,

168 In an efficient market where prices follow a random walk, i.e., price changes are unpredictable simply because agents in a market react to information as it surfaces rather than follow a predicted line based on past movements of the price. Therefore, price changes occur independently of each other and consequently, proportional changes in asset prices in a short period of time are normally distributed.

169 The discount rate is estimated by using Capital Asset Pricing Model (CAPM) for the project; which for the sake of simplicity, it is assumed that readers are familiar with CAPM and will accept the value as given.

$$\begin{array}{ccc} & & (170,\ 25.5) \\ & \nearrow & (V^u,\ S^u) \\ (V_0,\ 15) & & \\ (V_0,\ S_0) & \searrow & (60,\ 9) \\ & & (V^d,\ S^d) \end{array}$$

Because the gross project value, V, is exactly proportional to the twin asset's price, S, the former also increases by 70 percent or fall by 40 percent for each period and with probability, $p = 0.5$. Hence, the present value of the project's final asset, V_0, can be obtained via the standard NPV formula by working backwards following Eq. 7.1 above. Substituting the relevant values of p and k yields $V_0 = \frac{[(0.5\times170)+(0.5\times60)]}{(1+0.15)} = 100K$. Whereas, in the RO formula, the risk-neutral probability, p', is computed according to Eq. 7.2, where $p' = [(1.04\times15)-9]/(25.5-9) = 0.4$. Substituting the relevant values of risk-free interest rate, r and risk-neutral probability, p' into Eq. 7.1 will yield

$$\mathrm{V}_0 = \frac{[(0.4\times170)+(0.6\times60)]}{(1+0.04)} = 100K.$$

It is not a coincidence that the outcomes of both NPV and the RO methods are the same. The aim of the exercise is to illustrate that in the RO approach, the valuation of an asset does not depend on the investor's risk averseness (not that they do not have any), reflected in k. Rather, the RO method relies heavily on the assumption that a suitable twin asset can be found; and this will enable the investor to undertake a risk-neutral valuation approach in which a risk-free interest rate is used as the discounting rate instead. It is also not important in RO, to know the probability of an outcome for the price of underlying asset, p, because it can be inferred from the volatility of the twin asset's price in a risk-neutral setting.

Having established the basis for risk-neutral valuation in real option, the thesis moves on to the process of determining an option's value. Since an option is priced relative to the value of its underlying asset, V, the present value of an option, C_0, can be expressed in a similar manner,

$$C_0 = \frac{\left[p'C^u + (1-p')C^d\right]}{(1+r)} \qquad \text{(Eq. 7.3)}$$

Using this basic formulation, it is possible to evaluate the different types of options in an asset (Trigeorgis, 1995).[170] To complete the parameters of the model, assume that the cost of construction computed at the beginning of the investment period, I_0, is RM105K.

7.3.1 Option to Defer (Timing Option)

The value of an option to defer comes from two sources: (i) the time value of money on the deferred investment amount; and (ii) the flexibility given by the option to partake in 'good' outcomes and evade 'bad' outcomes (Luehrman (1998). Theory recommends that it is better to defer the project for as long as possible to maximise the difference between the underlying asset value and the option's exercise cost, unless the payoff from keeping the option clearly continues to be negative, in which case the option becomes worthless. Therefore, the value of a timing option is the difference between the final asset's value and the exercise price, or zero, whichever is greater,

$$\max (V- I_0, 0). \qquad \text{(Eq. 7.4)}$$

At the beginning of the investment, the expected future value of the construction cost at the end of Year 1 is $I_1 = 105(1+0.04) = 109.2K$. The local building laws require that construction must commence within one year of its land-use change approval. To correspond to probabilities that final asset value, V, can go up or down, the probable option price, C, can be computed based on Eq. 7.3,

$$C^u = \max(V^u - I_1, 0) = \max\left[170 - 109.2, 0\right] = 60.8\text{K}$$
$$C^d = \max(V^d - I_1, 0) = \max\left[60 - 109.2, 0\right] = 0$$

which yields the timing option's present value as

$C_0 = \dfrac{\left[p'E^u + (1-p')E^d\right]}{(1+r)} = \dfrac{\left[(0.4 \times 60.8) + (0.6 \times 0)\right]}{(1+0.04)} = 23.38\,\%$ of the project's present value, V_0, which was computed as RM100K earlier.

[170] There have been many studies with regards to the net value of interacting options on the same asset (compounding options). Intuitively, valuing each option separately and then summing them together will lead to overstating the value of the project. However, for the purpose of this section, this issue is not deliberated.

7.3.2 Option to Expand (Growth Option)

Say that new information emerges to indicate that certain planning and land control regulations will be relaxed, or that a major competitor intends to withdraw from the market, or a new market for cheaper input opens domestically and so on. As a result, the profit from the project is expected to be higher than initially expected. The investor might be persuaded to expand the scale of his development project. This can be done by incurring a follow-up investment, I_E. The right to expand is in fact a call option to acquire an additional x percent of the value of the basic project, V, by paying I_E as the option's exercise price. The value of a growth option is derived from the difference between the additional revenue from the increased production scale, xV, and the additional investment incurred to finance the expansion, or zero, whichever is greater. The latter occurs when such profitable expansion prospect is non-existent. Hence, the price of a growth option can be expressed as

$$\max (xV - I_E, 0) \qquad \text{(Eq. 7.5)}$$

The overall project value is now the value of the basic project's final asset plus the value of the option to expand, $[V_0 + \max (xV - I_E, 0)]$.

Therefore, if this investor is considering to expand the scale of development by 50%, (x = 0.5) by making an additional investment outlay of I_E = 40K, the price of this option is,

$$C^+ = \max(xV^u - I_E, 0) = \max\left[0.5(170) - 40, 0\right] = 45K$$
$$C^- = \max(xV^d - I_E, 0) = \max\left[0.5(60) - 40, 0\right] = 0$$

Rational decisions for the investor are: if margin of profit from the project increases, expand; otherwise, stick to the initial project scale. Together, the two probable states will give the growth option value,

$$C_0 = \frac{\left[p'E^u + (1-p')E^d\right]}{(1+r)} = \frac{\left[(0.4\times 45) + (0.6\times 0)\right]}{(1+0.04)} = 17.31\%$$ of the completed project's present value, V_0.

7.3.3 Option to Contract (Downsizing Option)

Should market conditions weaken after the option (land) is already purchased, an investor can decide to reduce the scale of development by c percent. By doing so he is able to save some amount of the planned investment outlay, I_C. In the land development example, this might involve downwards adjustment of the project's density or reduction in the range of structures planned. The flexibility to mitigate loss is actually a call option in itself whereby the exercise price is given by I_C. The downsizing option's value is either the difference between the investment savings and the loss of revenue from scaling down, *cV,* or zero, whichever is greater,

$$\max\ (I_C - cV, 0) \qquad \text{(Eq. 7.6)}$$

Essentially, the overall investment value is the value of the basic project's final asset plus the value of the option to contract, $[V_0 + \max\ (I_C - cV, 0)]$.

Let's say the decision to scale-down production by 50 percent, $x = -0.5$, will save the project's variable cost expenditure by RM32K. The value of this option is therefore,

$$C^u = \max(I_C - 0.5V^u, 0) = \max\left[32 - 0.5(170), 0\right] = 0$$
$$C^d = \max(I_C - 0.5V^d, 0) = \max\left[0, 32 - 0.5(60)\right] = 2$$

Together, the two probable states give the option to contract its present value $C_0 = \dfrac{\left[p'E^u + (1-p')E^d\right]}{(1+r)} = \dfrac{\left[(0.4\times 0) + (0.6\times 2)\right]}{(1+0.04)} = 1.15\,\%$ of the overall project's present value, V_0.

7.3.4 Option to Abandon

If the option value of holding land is so severely or permanently diminished by unfavourable market trends or changes in regulatory controls, the investor can opt to abandon the project entirely. He may recoup some portion of his capital outlay through the sale of the project's assets, including land. The option to abandon the project for the assets' salvage value is in effect a call option on the final asset value, *V*. Its exercise price is the salvage or best alternative use value of the option asset, *A*. Of course, if there are no compelling signs calling for the project's premature termination, the option to abandon must not be exercised. Therefore, the abandonment option's value can be summarised as either the difference between option asset's salvage value and the final project value or zero, whichever is greater,

$$\max\ (A-V, 0) \qquad \text{(Eq. 7.7)}$$

where the new overall project value incorporating the option to abandon will be $[V_0 + \max\ (A-V, 0)]$.

Let's say the project's asset value at its best alternative use is *A*, (which does not necessarily have a risk and return profile that is perfectly correlated with the project); and that *V* and *A* moves over time in the following manner:

$$\begin{tikzcd}[row sep=small] & (170, 153) \\ & (V^u, A^u) \\ (100, 90) \arrow[uur] \arrow[ddr] & \\ & (60, 72) \\ & (V^d, A^d) \end{tikzcd}$$

Based on the tree diagram, the probable values of the abandonment option are,

$$C^u = \max(A^u - V^+, 0) = \max(153 - 170, 0) = 0$$
$$C^d = \max(A^d - V^-, 0) = \max(72 - 60, 0) = 12\ \text{K}$$

In combination, present value of the option to abandon can be stated as

$C_0 = \dfrac{[p'E^u + (1-p')E^d]}{(1+r)} = \dfrac{[(0.4\times 0)+(0.6\times 12)]}{(1+0.04)} = 6.92\,\%$ of the overall completed value of the project, V_0.

Appendix 7B and 7C summarises a two-period binomial pricing model and decision path using an example of land development project, respectively. The numerical example which shows asset price movements over a single period can also be easily extended to incorporate other parameterisations such as a larger number of asset price paths (or time steps) as well as multiple assets considerations (see Figlewski, 1990 and Detemple, 2006).[171] In addition, other assumptions can be made about the stochastic process followed by the final asset value, V_0, and its distribution. Basically, the Binomial Option-Pricing Model (BOPM), as it is formally called, maps out all feasible alternative actions and their respective probabilities in order to calculate the present value of any given option on an underlying asset (see Trigeorgis 1987, Trigeorgis and Mason, 2004, Trigeorgis 1991 for more on the use of decision trees in various option decisions).

In modern finance applications, theoretical valuations of option prices are derived using various methods such as continuous-time models (based on Black-Scholes, 1973), finite-difference schemes and Monte Carlo simulations. Continuous-time

[171] The method was first introduced by Cox, Ross and Rubinstein in 1979.

model, normally assume that underlying asset prices change only by infinitesimal increments in each step and that the changes follow well-defined processes such as the Geometric Brownian Motion.[172] The Black-Scholes equation for the price of a European option is given as follows,

$$C_t = S_t N(d) - e^{-r\tau} XN(d - \sigma\sqrt{t}) \qquad \text{(Eq. 7.8)}$$

where S is the price of the underlying asset, X is the exercise price, τ is time to maturity, $N(\cdot)$ is the cumulative standard normal distribution function and $d \equiv \left(\sigma\sqrt{\tau}\right)^{-1}\left[\log(S_t / X) + (r + 0.5\sigma^2)\tau\right]$. The model assumes that the underlying asset can be bought and sold freely in the market, is perfectly divisible and does not pay dividends.[173] In addition, the option is firmly European i.e., it must be exercised at its expiration date, T. It also requires that the volatility of the final asset price is known and constant and that asset price is allowed to move to any one of a large number of prices at any finite period of time. The rate of return on the underlying asset is assumed to follow a lognormal distribution.

Many of the assumptions in the continuous-time models do not hold in the case of a real option. Changes in underlying asset prices are typically discontinuous and the volatility changes randomly throughout the life of the investment. Hence, it is very difficult to ascertain the ‘correct’ stochastic process for V over time. There is also the possibility of lagged effects between cash inflows and underlying asset values at each time unit, which would cause reliability issues with respect to the model’s results. There are also transaction costs and taxes on the option and underlying assets to be considered. Moreover, in many cases, the expiration period for the option, T, may be infinity. The Black-Scholes model is not capable of pricing American call options; and real options are very similar to a perpetual American call option. It is also important to recognise that there can be multiple sources of uncertainty for real options, rather than just the price of the underlying asset in the case of financial options (recall Section 7.2.2.2). To utilise models such as Black-Scholes for real

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[172] One popular approach is to use past variances of the underlying asset values and its forecasts to predict future variances. This is the essence of the Autoregressive Conditional Heteroskedasticity (ARCH) time-series model (see Lensink *et al.*, 2001).

[173] The model’s origin can be found in Black, F. and Scholes, M., “The Pricing of Options and Corporate Liabilities”, Journal of Political Economy, May-June 1973 (81):637-659 and Merton, R.C., “Theory of Rational Option Pricing”, Bell Journal of Economics and Management Science, Spring 1973(4):141-183.

options, the various sources of uncertainty must be modeled in such a way that they are treated as one (see Myers and Majd, 1990).

In short, real option valuation does not easily permit the derivation of a closed-form solution as one shown in Eq. 7.8 above.[174] The valuation of real options is therefore performed through binomial tree methods instead and it is indeed the preferred method used by professional option traders (Chance, 1999). Nevertheless, it can be seen that taking BOPM's limiting case (where all parameter values are known and similar), as smaller and smaller price changes take place over shorter and shorter intervals, one should arrive at exactly the same outcome as the Black-Scholes formula. In other words, the binomial model is considered a special case of the Black-Scholes model, but one that is easier to understand and to manipulate (Filewski *et al.*, 1990 p. 81).

7.4 REAL OPTIONS IN THE MALAYSIAN LAND MARKET

The binomial option-pricing model described above is only applicable when valuing options in a single option asset and a single underlying project at a time, for which the underlying asset price, the strike price, time to expiration, risk-free rate of interest are observable and can be easily substituted into the formulas. The data used in the thesis comprise a large number of heterogeneous option assets (land) which came from a number of years for which the value of the respective underlying assets are not known. However, it is still possible to prove that agricultural land has real-options features and the market agents adhere to real-options rationales. This is done by formulating certain testable hypotheses drawn from the theoretical discussions in the chapter particularly with respect to relationships between option price and final asset value, or between option price and uncertainty as described in Sections 7.2.3.1 and 7.2.3.3.

We also take into consideration that there are substantial differences in price structure between land with pure agricultural potential and development potential.

[174] See Bowman and Moskowitz (2001) and Lander and Pinches (1998) for a more elaborate discussion on issues relating to the suitability of option-based pricing for land.

Chapter 6 has shown that market delineation on the basis of use-potential is more informative and significant in explaining prices compared to the segmentation based on spatial distribution. Whilst it is intuitively easy to see that real-options is present in developable agricultural land values; it would be interesting to see if the real-options effect is also noticeable in land with no or little development potential as well. Acquiring land as an option asset for agricultural expansion projects is usually part of long-term hedging strategies to prepare for commodity or food price increases. As the prospect of higher food and commodity prices become more likely by the day, it would be imprudent to disregard possibility of RO behavior in the agricultural sector. To summarise, two separate hypotheses can be tested independently:

(i) in any given period of time, the price of agricultural land with positive development prospect is positively correlated with the final developed property value; and
(ii) in any given period of time, the price of an option on agricultural land with zero or minimal development prospect is positively correlated with agricultural project value.

This first set of hypothesis is very much in line with the Ricardian argument that demand for land is derived from demand of its output. A more interesting set of hypothesis concerns the relationship between uncertainty and option-bearing asset value. As shown earlier in the chapter, a project with a relatively higher degree of uncertainty should have a more valuable growth option, *ceteris paribus*. This is because a higher dispersion of potential payoff promises greater realisable gains, but limits the liability at the option asset resalable value. Hence, it is appropriate to suggest an additional set of hypotheses concerning land price and volatility of final asset values:

(iii) in any given period of time, the price of an option on agricultural land with positive development prospect is positively correlated with volatility in the final developed property value; and
(iv) in any given period of time, the price of an option on agricultural land with zero or minimal development prospect is positively correlated with volatility in agricultural project value.

Rejection of the first two null hypotheses implies that the market for land is not linked to the market for its final output; whereas rejection of the third and fourth hypotheses indicates that uncertainty in final output value does not affect land prices, i.e., landowners are not fully appreciative of the extent of the asymmetry between potential gains if prices increase and potential losses if prices fall.

We resolve the problem of unobserved underlying asset value and volatility by exploiting information from the domestic stock market with respect to the relevant economic activities. For example, it is possible to link average land price with property stock market index as a proxy for the final project value. An obvious advantage of using stock market data is its availability and consistency of reporting for any number of years. Hence, stock market data is commonly used in financial analyses as an efficient portfolio analysis tool. The data can be easily manipulated to match low or high frequency data requirements and its continuous nature allows the computation of volatility to be made. To represent the value of the underlying asset, the stock market sectoral index is preferable over the stock of a single representative firm. This is mainly because the former provides a convenient means to capture most, if not all, random influences and movements of input and output prices relevant to the sector over time, without biases in the form of firm size, location, capital and leverage structure, corporate diversification strategies and so forth.

The data on land price spans only 7 years, and since only the year of transaction is known, we are able to extract only 7 observations in all. The following sections describe how data limitations are dealt with and what methods are employed to carry out the analysis.

7.4.1 Data

The number of observations is increased by extending the sample period to 13 years i.e., from 1995 to 2007. However, because of the large number of observations, i.e., involving 8,456 land sales, both land with and without development potential in the four states of Malaysia for the period, we are not able to supplement the PMR data with information from other sources (e.g.,geo-coding, *gsa* and *mrl* status determination and so on) as this would have required a great number of additional man-hours to execute. As a consequence, the resulting hedonic model is substantially smaller because some attributes in the earlier hedonic models are now no longer included. In addition, tests or adjustments for spatial dependence are also absent since there are no geo-codes available to identify an observation. Because Chapter 6 has shown that the rice sector is unique in various respects, rice parcels are omitted from the non-developable land category. Also omitted are observations from state of Perak. These omissions are made to ensure constant effect of attributes over the new sample and as a result, the dataset has only 5,928 observations. The remaining data is then divided into only two categories: developable and non-developable land. Recall that the former includes all sales of agricultural and rural land which have not been approved for development uses but possess positive non-agricultural potential.

Since the non-developable sample data is dominated by primary plantation crops i.e., rubber and oil palm (78% of non-developable land observations), it is reasonable to use the Kuala Lumpur Plantation sector index (KLPLN) in the Bursa Malaysia to represent the agricultural sector. For developable land analysis, the Kuala Lumpur Property sector index (KLPRP) is chosen over the Kuala Lumpur Construction sector index (KLCN) because the PMR data reveals that housing development is the most prevalent type of development potential. The KLPRP and KLPLN are naturally different in market capitalisation size, average volume of traded shares and number of listed counters. Based on the indexes' composition as of May 2009, there were 40 listed companies in KLPLN and 88 in the KLPRP. However, the sectors' market capitalisations in the Main Board, for example as of 31 March 2004 were MYR36.530 million and MYR 36.22 million respectively, which indicates that the two sectors share approximately the same degree of market presence.[175] Combined, firms in the two sectors make up the largest group of landowners in the country.

It is noted that due to economies-of-scale in their production, public-listed companies in either sectors typically deal in large tracts of land either through the open market or through state alienation applications. Even if the sample data is in fact dominated by smallholdings, this is not expected to diminish the index's usefulness because

[175] All Bursa Malaysia Indexes are weighted by market capitalisation. Both indexes share the same base year, 1970 i.e., were started in 1970. The Index computation is as follows:

$$\frac{\text{Current Aggregate Market Capitalisation}}{\text{Base Aggregate Market Capitalisation}} \text{x} 100$$

factors influencing profits affect all firms irrespective of size in the same way. The daily closing value of the two market indexes are sourced from the Bloomberg financial portal. Note that KLPLN and KLPRP were not strongly correlated with each other (their linear correlation coefficient over the period is 0.3691).

7.4.2 Variable Construction and Discussion

In order to test the hypotheses stated earlier in the section, it is necessary to derive suitable time series to represent the main variables in the relationships investigated. They are: (i) time series to show agricultural land price trends must be derived from the new dataset, preferably one for each category of land; (ii) corresponding time series to represent the sectoral indexes price levels; and (iii) corresponding time series to represent the sectoral indexes' volatility. The first two can be combined to give a suitable measure of correlation over time to test the relationship between price of an option and the price of its underlying asset; while the first and the third variables are used to test the relationship between price of option and volatility in the price of the underlying asset.

7.4.2.1 Land Price Index: HPI_d and HPI_{nd}

In order to compare land price and the market indexes, we first have to find a way to construct a time-series for land price. Among the many methods available, the most basic is a price index derived from the "average" prices of land transacted each year or by other price comparison techniques such as "linking" or "overlap pricing" (Boskin, 1996 in Brachinger, 2003). However, the "average" price approach is considered inappropriate mainly because the method does not account for inter-unit variations in a given good, which is particularly important in the context of a heterogenous good such as land.

Since the land sales dataset involves very heterogeneous parcels, a more appropriate alternative would be the hedonic price index, which was first described by Griliches in 1961. By controlling the level of attributes in a given hedonic function, a reliable and practical measure of "average" **price change** between two periods can be obtained. The method for deriving the index has already been demonstrated in the study's hedonic price model building chapter earlier (Chapter 5). There are basically two broad types of hedonic models available to construct price indexes. They both require that a hedonic price function is estimated as the first step in the process.[176] Next, a base year is determined. To obtain time-dummy hedonic index such as the one produced in Chapter 6, price changes are computed from differences in the intercept values that represent different time units; whereas implicit values of attributes (slopes) are assumed constant over time. The other type of hedonic index, characteristic chain price index, applies estimated coefficients to a standard parcel to construct price indexes (Can and Megbolugbe 1997).[177] Since the number of hedonic attributes in the model is very small, the second method is not likely to produce very different time trends. Furthermore, the time-dummy approach is relatively easier to implement. The adjusted hedonic function with time-dummy variables appear as follows[178]

$$\ln p_i^t = \alpha^t + \delta D_i^t + \sum_{k=1}^{K} \beta_k^t z_{ik} + \varepsilon_i^t \qquad \text{(Eq. 7.9)}$$

where D_i^t is the dummy variable for each time period, that is $\beta_k^0 = \beta_k^1 = \beta_k$ for all periods *k = 1,...,K.*. The exponent of the individual year-dummy coefficients, $\hat{\delta}_t$, directly yields a quality-adjusted measure of price change in year *t* compared to the base year. The actual regression function is,

$$\log P_{ijt} = \alpha_{jt} + \delta D_i^t + \beta_{1ijt} rdfnt + \beta_{2ijt} mrl + \beta_{3ijt} state + \beta_{4ijt} use + \varepsilon_{ijt}$$

which is estimated twice, once for each category of land. The estimation for non-developable land includes an additional dummy variable set, *use,* to control for type of agricultural activity on the land. From the developable land regression, exponents of the time dummy coefficients, and $\hat{\delta}_d$ are extracted to calculate a price index, HPI_d; and from the non-developable regression, the estimated time-dummy coefficients, $\hat{\delta}_{nd}$ are used to obtain HPI_{nd} (Table 7.1).

176 Regardless of the method, the accuracy and precision of the resulting hedonic indexes will be affected by a number of factors including the selection of characteristics, the functional form of the price function, behavioural assumptions both on the parameter vectors and the random error terms and the econometric approaches used to estimate the parameters. These issues have been dealt with in the previous section.

177 The Laspeyres, Paasche, Adjacent Period Price indexes are included under this approach.

178 Triplett (2004) describes other methods of estimating hedonic price indexes such as the hedonic imputation method and the hedonic quality adjustment method, which are not relevant to the study's specific research needs.

Table 7.1 Quality-adjusted price index using the time-dummy approach

Year	$\hat{\delta}_d$	exp $\hat{\delta}$	*HPI* HPI_d (2000 =100)	HPI_d % Change	$\hat{\delta}_{nd}$	exp $\hat{\delta}$	HPI_{nd} (2000 =100)	HPI_{nd} % Change	CPI (2000 =100)	*CPI* % Change
1993	0.000	100.00	26.89	41.80	0.000	100	46.10	5.40	79.82	3.72
1994	0.349	141.80	38.14	34.03	0.053	105.40	48.59	19.08	82.79	3.41
1995	0.642	190.05	51.11	-7.99	0.227	125.51	57.86	9.22	85.61	3.47
1996	0.559	174.87	47.03	42.53	0.315	137.09	63.20	26.00	88.58	2.72
1997	0.913	249.23	67.03	7.87	0.547	172.73	79.63	-6.64	90.99	5.29
1998	0.989	268.84	72.31	17.94	0.478	161.26	74.34	6.86	95.80	2.82
1999	1.154	317.08	85.28	17.26	0.544	172.31	79.44	25.89	98.5	1.52
2000	**1.313**	**371.82**	**100**	**-32.49**	**0.774**	**216.92**	**100**	**-8.09**	**100**	**1.40**
2001	0.920	251.01	67.51	16.41	0.690	199.37	91.91	-0.54	101.4	1.78
2002	1.072	292.19	78.58	30.40	0.685	198.30	91.41	13.68	103.2	1.16
2003	1.338	381.01	102.47	5.80	0.813	225.43	103.92	-1.73	104.4	1.44
2004	1.394	403.11	108.42	-34.56	0.795	221.53	102.13	1.85	105.9	3.02
2005	0.970	263.80	70.95	15.24	0.814	225.63	104.02	4.46	109.1	3.59
2006	1.112	303.99	81.76	-4.47	0.857	235.71	108.66	3.36	113.02	2.03
2007	1.066	290.42	78.11	41.80	0.891	243.64	112.32	5.40	115.31	3.72

The reference year in the regressions is 1993, the first year in the new land sales dataset. Subsequently, the base year is changed to 2000 to enable an easier comparison between the two *HPI's* and the Consumer Price Index (CPI). The year-on-year percentage changes are then computed (columns in grey). The table shows that changes in both the *HPI*'s are consistently larger than the CPI, which implies that land prices are more volatile than the general price levels. We also note that HPI_d registers larger changes than HPI_{nd} in virtually all of the years in the sample. The greatest change in HPI_d occurred in 1996, the year just before the currency crisis, where the average price of developable land increased by 42.53% from the year before. The largest drop was seen in 2004, when price fell by more than 34%. Overall, HPI_d shows a positive time trend although inter-year changes are not consistent. HPI_{nd} also shows a positive time trend over the years with relatively smaller year-on-year changes. The largest rise in price is also registered in 1996 (+26%), which was trailed by an immediate drop of 6.64% in the following year.

7.4.2.2 Annualised Average Index Price: *avgKLPLN* and *avgKLPRP*

Because the historical land sales data are recorded according to the year they occurred, the market index variables must be matched accordingly. Therefore, the daily closing prices of the sectoral indexes are transformed into average monthly and subsequently, average yearly data, *avgKLPRP* and *avgKLPLN* to suit the time unit used by the land price indexes. Table 7.2 lists the resulting annualised average index price for both sectors. The KLPRP has largely been bullish prior to 1997, but fell 65% to merely 696 points at the height of the currency crisis in 1997. The index remained under 1,000 points in the period after that before it finally showed a revival in 2006 following large fiscal stimulus injected into the sector and economy as a whole. On the other hand, KLPLN did not suffer as dramatically as KLPRP, mainly because the currency depreciation had led to more attractive commodity export prices, which in turn brought greater volumes of trade and profit. The *avgKLPRP* fell only slightly (36%) in 1997 but continued to register index levels greater than 1,400 points in the following period. Note that the effect of the food and commodity crisis in 2006, which is shown by the rise in *avgKLPRP* to reach levels in excess of 5,900 points.

Table 7.2 Annualised Average Index Price of KLPRP and KLPLN

Year	*avgKLPRP*	*avgKLPLN*
1993	1,881.505	1,563.926
1994	2,731.527	2,794.964
1995	2,450.78	2,794.835
1996	2,003.32	2,674.788
1997	696.1	1,699.262
1998	919.74	1,638.355
1999	994.86	1,755.681
2000	586.06	1,423.415
2001	629.14	1,841.257
2002	624.9	1,928.818
2003	757.44	2,351.405
2004	620.51	2,525.409
2005	591.48	3,413.903
2006	1,008.63	5,963.375
2007	2,332.48	2,553.339

7.4.2.3 Annualised Index Volatility: $\hat{\sigma}_{KLPRP}$ and $\hat{\sigma}_{KLPLN}$

The task of computing the volatility of the indexes, $\hat{\sigma}_{KLPRP}$ and $\hat{\sigma}_{KLPLN}$, is considerably more elaborate than the preceding two variables. Volatility is described as the standard deviation of the annualised percentage return on the underlying asset. In principle, there are two approaches to estimate volatility: historical volatility and implied volatility. The latter is not suitable for this analysis because it requires the application of Black-Scholes or other formal option pricing models. Historical volatility is computed for each sectoral index, whereby the daily closing prices are denoted as S_i for i^{th} day, where $i=1,...n$, in a calendar year. Computation of annualised volatility, $\hat{\sigma}$, follows Merton (1980) (in Chance, 2004; Baum, 2006) where the steps are summarised as follows:

(i) Compute relative price, $\left(\frac{S_i}{S_{i-1}}\right)$

(ii) Calculate logarithmic rate of return on daily index price, u_i , where $u_i = \ln\left(\frac{S_i}{S_{i-1}}\right)$

(iii) Calculate average or expected value of the daily return for the calendar year, $\bar{u}$; and its error sum of squares, $(u_i - \bar{u})^2$ for each i

(iv) Calculate its standard deviation, $s = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(u_i - \bar{u})^2}$

(v) Use s to compute $\hat{\sigma}$ which is the annualised volatility using $\hat{\sigma} = s\sqrt{\tau}$, where τ is number of trading days in the respective years.[179]

Table 7.3 shows both the annualised average price and annualised volatility of the two sectoral indexes. This is done to emphasise the standard relationship between stock market prices and volatility. A quick scan down the table will show that volatility falls during the state of low index values and increase during the state of high index values. This relationship is observed for both KLPRP and KLPLN and

[179] In general, there is no direct relationship between volatilities of different time units. However, to match the study's yearly sales date, the 'square root of time' rule is applied to find annual volatility from daily closing prices of respective indexes. One important pre-condition for the rule's application, the price series must follow random walk, Brownian motion or geometric Brownian motion. In other words, the series must be free of serial correlation or other types of dependencies.

holds throughout the entire sample period. It basically means that price variations (and, in relation to that, the degree of market activity) are typically higher when the market is up compared to when the market is down.

Table 7.3 Annualised Average Index Price and Annualised Volatility of KLPLN and KLPRP

Year	KLPRP		KLPLN	
	avgKLPRP	$\hat{\sigma}_{KLPRP}$	*avgKLPLN*	$\hat{\sigma}_{KLPLN}$
1993	1,881.505	223,158	1,563.926	245,442
1994	2,731.527	84,631	2,794.964	81,447
1995	2,450.78	43,884	2,794.835	31,118
1996	2,003.32	43,443	2,674.788	41,724
1997	696.1	178,550	1,699.262	102,695
1998	919.74	2,729	1,638.355	715
1999	994.86	31,786	1,755.681	15,297
2000	586.06	23,620	1,423.415	15,775
2001	629.14	354	1,841.257	14,650
2002	624.9	6,477	1,928.818	23,735
2003	757.44	21,262	2,351.405	35,705
2004	620.51	3,639	2,525.409	20,732
2005	591.48	18,958	3,413.903	38,163
2006	1,008.63	17,249	5,963.375	151,720
2007	2,332.48	20,051	2,553.339	217,856

7.4.3 Correlation Analysis

Since the relevant time-series have been assembled, it is now possible to implement simple correlation analyses to test the four hypotheses set out earlier. Correlation analysis is a powerful tool used to measure the strength of a relationship between two series of data, x and y. The correlation coefficient can vary between +1 (perfect positive correlation) and -1 (perfect negative correlation).

Linear correlation, which is calculated over the whole sample period, is useful to indicate long term interdependence between *HPI*'s and the market indexes. Table 7.4a shows that developable land price index, HPI_d , is negatively correlated with the price of developed property, which is proxied by *avgKLPRP*, (-0.7471). The correlation is also negative against a lagged one year *avgKLPRP*. Both correlation values are high and negatively signed, which could lead to the conclusion that price of land moves in significantly different direction as profitability in property development.

On the other hand, the hedonic price index for non-developable land, HPI_{nd}, appears to be positively correlated with the average value of the plantation sector index, *avgKLPLN* (Table 7.4b). This correlation is greater at 0.3161 than the correlation between HPI_{nd}, with a one-year lagged *avgKLPLN*, which is 0.2636. The two figures might be used to indicate that over the 13-year period, values of agricultural land perceived to be more suitable for continued farming uses follows the trend in the plantation sector profitability (because of the positive sign) but the association is rather weak (because the coefficient of correlation is approximately only 0.3). Nevertheless, there is a strong drawback of using the linear correlation measure to test relationships between time series. The size of the correlation coefficient very strongly depends on the length of the sample period and the particular period tested. Different correlation coefficients would emerge if the period tested is shorter versus longer; and also if the sample period happens to be relatively stable or erratic. Thus, these statistics are not really reliable to measure accurate association over time.

Table 7.4a Linear Correlation Coefficients: Developable Land Category

	HPI_d	*avgKLPRP*	*lagKLPRP*
HPI_d	1		
avgKLPRP	-0.7471	1	
lagKLPRP	-0.5866	0.7775	1

Table 7.4b Linear Correlation Coefficients: Non-Developable Land Category

	HPI_{nd}	*avgKLPLN*	*lagKLPLN*
HPI_{nd}	1		
avgKLPLN	0.3161	1	
lagKLPLN	0.2636	0.7146	1

For an alternative measure of correlation, the use of a moving estimation window is recommended. A moving correlation is measured from the ratio of covariance of the two series and their standard deviations, $r_{xy} = \dfrac{s_{xy}}{s_x s_y}$ where s_{xy} is the covariance of x

and y with respect to the determined time period. Moving correlation between HPI_d and *avgKLPRP* and between HPI_{nd} and *avgKLPLN* are denoted as MC_d and MC_{nd} respectively. By adopting a moving correlation analysis, these specific questions can be examined more effectively:

(i) how the correlation changes over time?

(ii) if there are positive time trends for the correlation and volatility of the underlying asset? and

(iii) what is the relationship between correlation and volatility?

In this exercise, the length of the moving window is three years. Recall that the study's sample period covers 15 years, therefore, correlation coefficient can be derived for only 13 years (Table 7.5). For the most part of the sample period, the *HPI*'s are positively correlated with the average prices of their respective market indexes ($MC > 0$), although the strength of the relationship varies from time to time.

Table 7.5 Moving Correlation Coefficients, MC_d and MC_{nd}

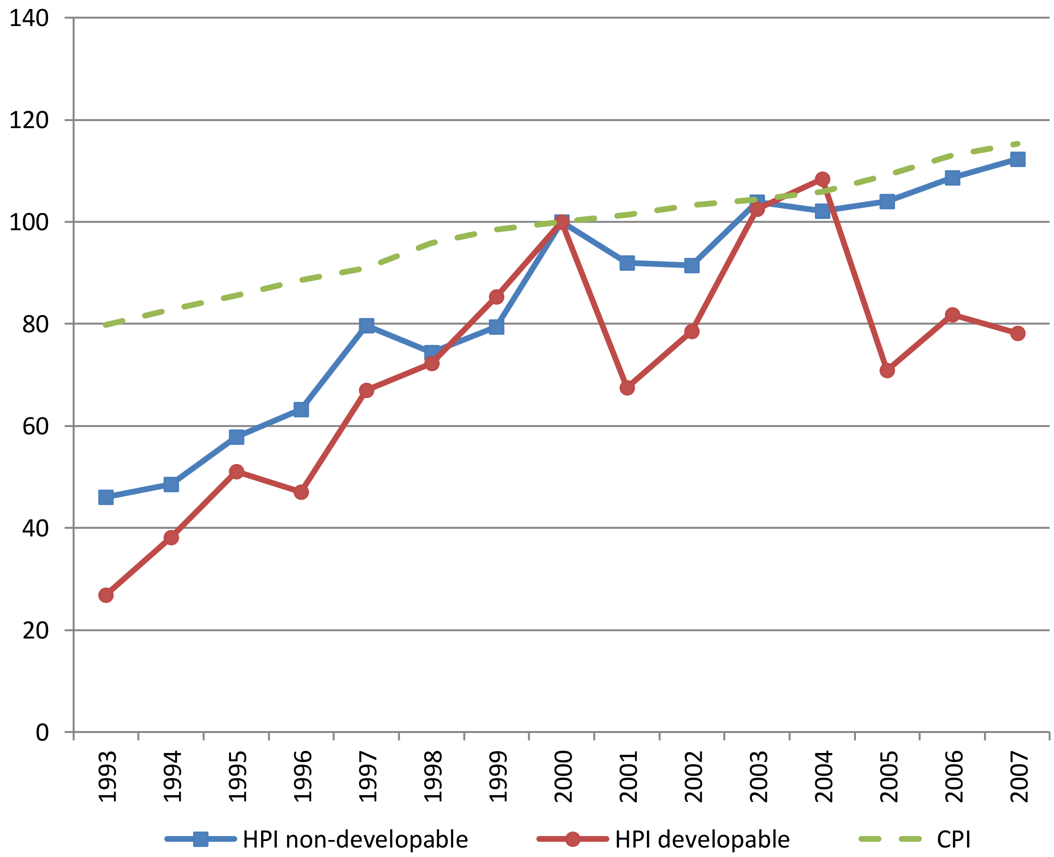
Year	MC_d	MC_{nd}
	HPI_d versus *avgKLPRP*	HPI_{nd} versus *avgKLPLN*
1995	0.495036	0.513776
1996	-0.9998	-0.15392
1997	-0.99797	0.238581
1998	-0.82534	-0.2982
1999	-0.60354	0.481947
2000	0.950495	0.742152
2001	0.956518	0.231093
2002	0.969975	0.273123
2003	0.681019	0.606069
2004	0.632638	0.524481
2005	0.644288	-0.18792
2006	0.901068	0.991324
2007	0.122645	0.942727

In order to provide a simple but more direct analysis of RO behaviour in the agricultural land market, relevant information from Tables 7.1, 7.3 and 7.5 are re-presented below, this time in visual forms.

7.4.4 Correlation Analysis by Category of Land

Figure 7.3 shows both the developable and non-developable land hedonic price indexes and CPI movements. As noted above, both indexes follow a positive time trend, and HPI_d exhibits greater volatility than HPI_{nd} over the years. The graph support the notion that the price of developable land follows a speculative trend that very strongly coincides with the country's property bubble and currency overvaluation prior to 1998.[180] The index fell again from 2004 onwards as a consequence of global economic slowdown. However, it must be noted since the lines show index trends, they cannot be used to compare which of the two *HPI*'s has a higher average price.

Figure 7.3 Time dummy land price indexes and CPI



[180] The property bubble was fuelled by strong investment demand from foreign individuals. One of the changes introduced post-crisis is to restrict foreign ownership of landed residential properties.

7.4.4.1 Developable Land

As shown by Figure 7.4, the KLPRP over the period between 1993 and 2008 appears to display a random walk type of movements - fluctuations in different periods are independent of each other.[181] In Figure 7.5, the category's moving correlation coefficient, MC_d, is depicted on the primary axis. The graph's secondary axis shows volatility of the KLPRP, $\hat{\sigma}_{KLPRP}$, as a dashed line.

[181] This is consistent with the trends indicated by *avgKLPRP* in Table 7.2 earlier.

Figure 7.4 Daily price series for Kuala Lumpur Property Index: January 1993 – 2008

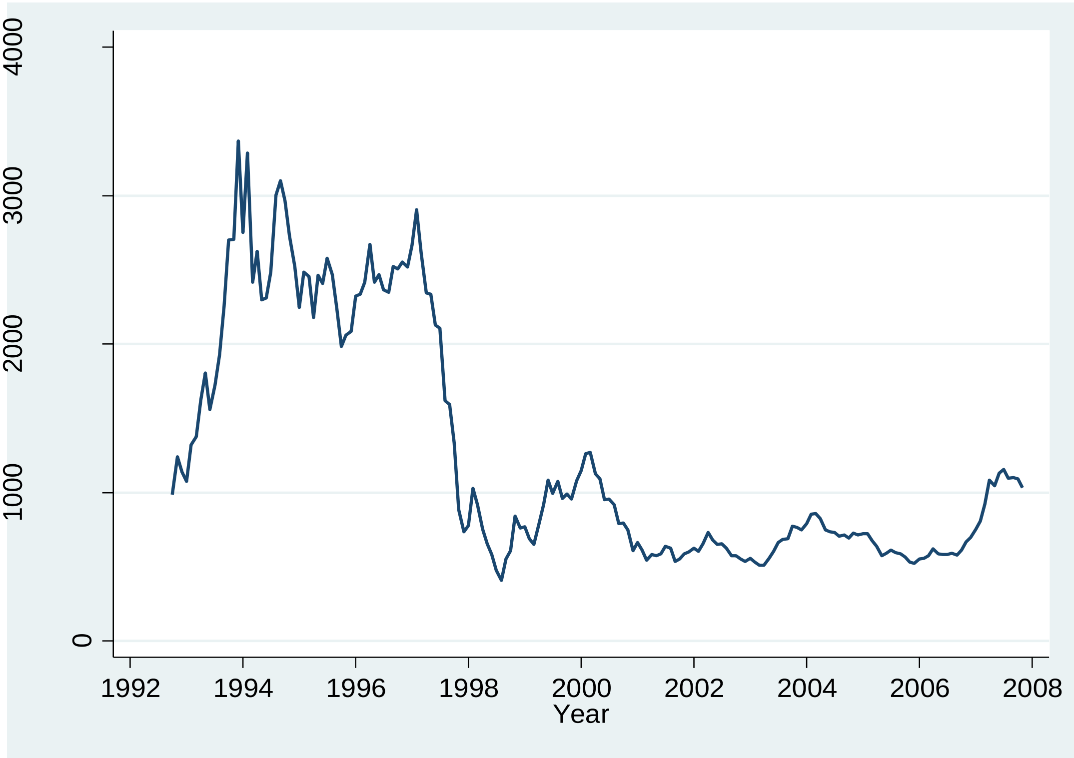
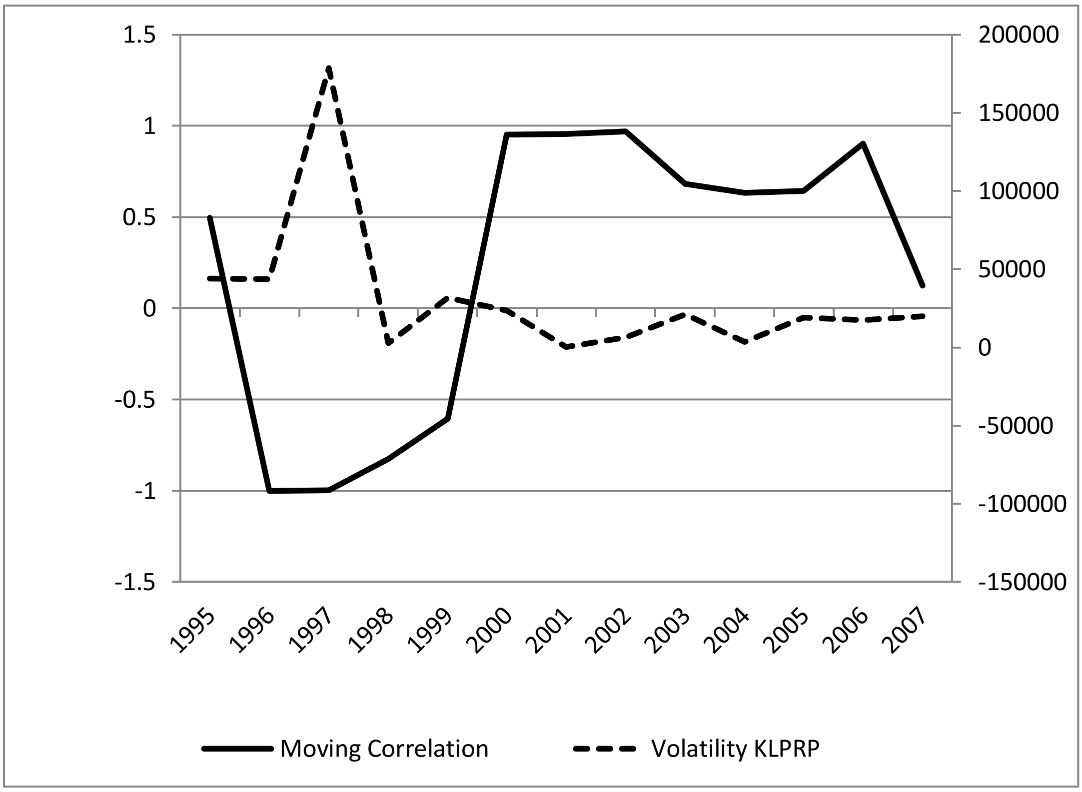


Figure 7.5 Moving Correlation, MC_d, and Annualised Volatility, $\hat{\sigma}_{KLPRP}$



It is possible to distinguish two distinct sub-periods in the graphs above based on the values of MC_d. The first sub-period lies in the short period 1994-1999, where MC_d, is generally negative.[182] In absolute terms, the MC_d are very high in this sub-period, averaging -0.85665 over the six year period. By comparing Figures 7.3, 7.4 and 7.5, it is apparent that this period coincides with the interval when KLPRP is up but HPI_d is only slowly increasing. Logically, a bullish KLPRP would encourage higher expectations of increasing future prices of developed properties. Land developers are motivated to secure new parcels of land as speculation interest in development builds. This is consistent with market behaviour motivated by the **option to defer** and **option to expand**. Indeed, Figure 7.3 shows a rising HPI_d during the period, despite starting from a relatively low point. The negative MC_d correlation coefficient is due to the fact that the KLPRP (Figure 7.4) was moving erratically but slightly downwards when the HPI_d was climbing up. The graphs also shows that volatility of the index, $\hat{\sigma}_{KLPRP}$, soared along with HPI_d. This supports the hypothesis that in any given period of time, the price of an option on developable land rises with uncertainty in the final developed property value. In other words, in periods of high volatility, land prices move to follow an unusually active and bullish property market as closely as possible.[183]

On the other hand, in the more prominent sub-period post-1999 when KLPRP is relatively weak, HPI_d is consistently positively correlated with *avgKLPRP*; as shown by positive values of MC_d. Because the KLPRP is consistently low, expectations regarding developed property prices became relatively muted, so much so that there is less pressure in the land market. As shown in Figure 7.3, the HPI_d appear to move in a slightly downward long-term trend. The pattern shows support for the hypothesis that price of an option on developable land is positively correlated with price of the final developed property value. Although MC_d is generally positive, its magnitude is relatively smaller ($MC_d < 0.7$) compared to the period when the property market is up. This provides an additional observation: the impact of KLPRP on land prices is smaller when the market is down compared to when the market is up. It is also noted that volatility, $\hat{\sigma}_{KLPRP}$, fell significantly during this period. Once again, proof is found

[182] Year 1994 is included because each point refers to a three-year moving correlation.
[183] It is already established in Section 7.4.3.2 that price volatility is high when the market is up and that this relationship applies in most contexts.

that the price of an option on developable land is positively influenced by uncertainty in the final developed property value.

7.4.4.2 Non-Developable Land

The two graphs used in the analysis for non-developable land are Figures 7.6 and Figures 7.7. Figure 7.6 shows that the movement of KLPLN over the period of 1993–2008 appears to follow long-term trends. KLPLN was not as adversely affected by the 1997 crisis as KLPRP was, but rose dramatically from 2006 onwards as a consequence of the 2006/2008 commodity crisis. Figure 7.7 shows the moving correlation coefficient, MC_{nd}, depicted on the primary axis. The graph's secondary axis shows volatility of the KLPLN, $\hat{\sigma}_{KLPLN}$, shown as the dashed line.

Figure 7.6 Daily price series for Kuala Lumpur Plantation Index: 1993 – 2008

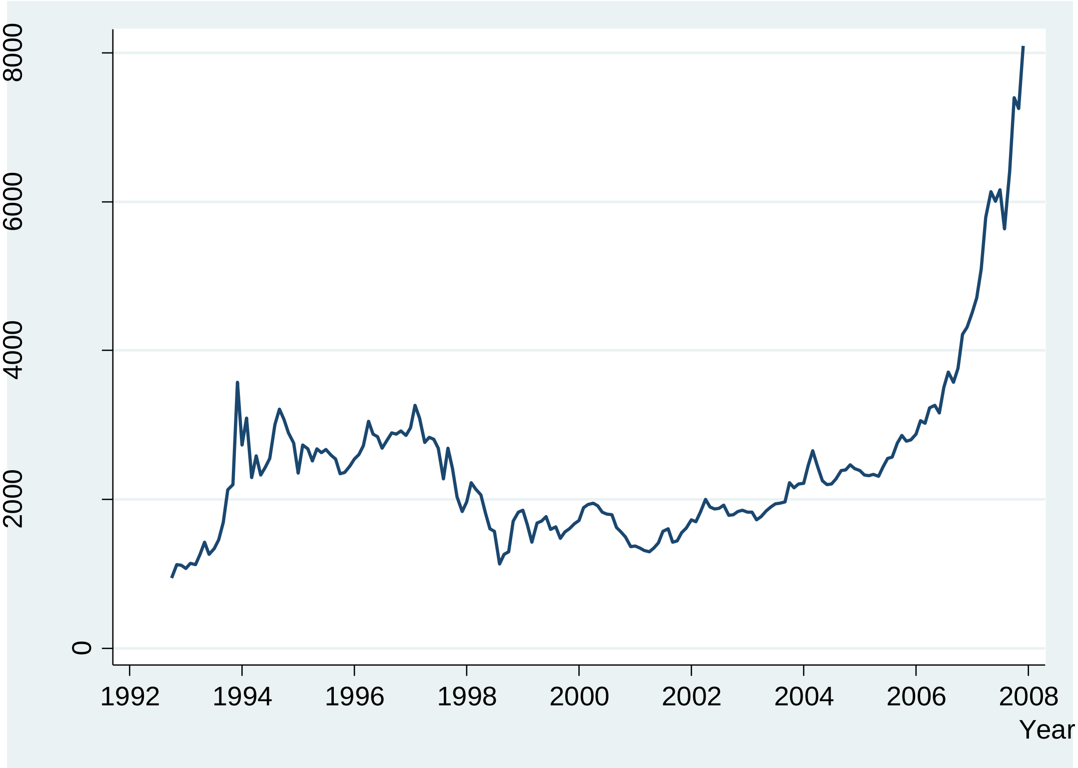
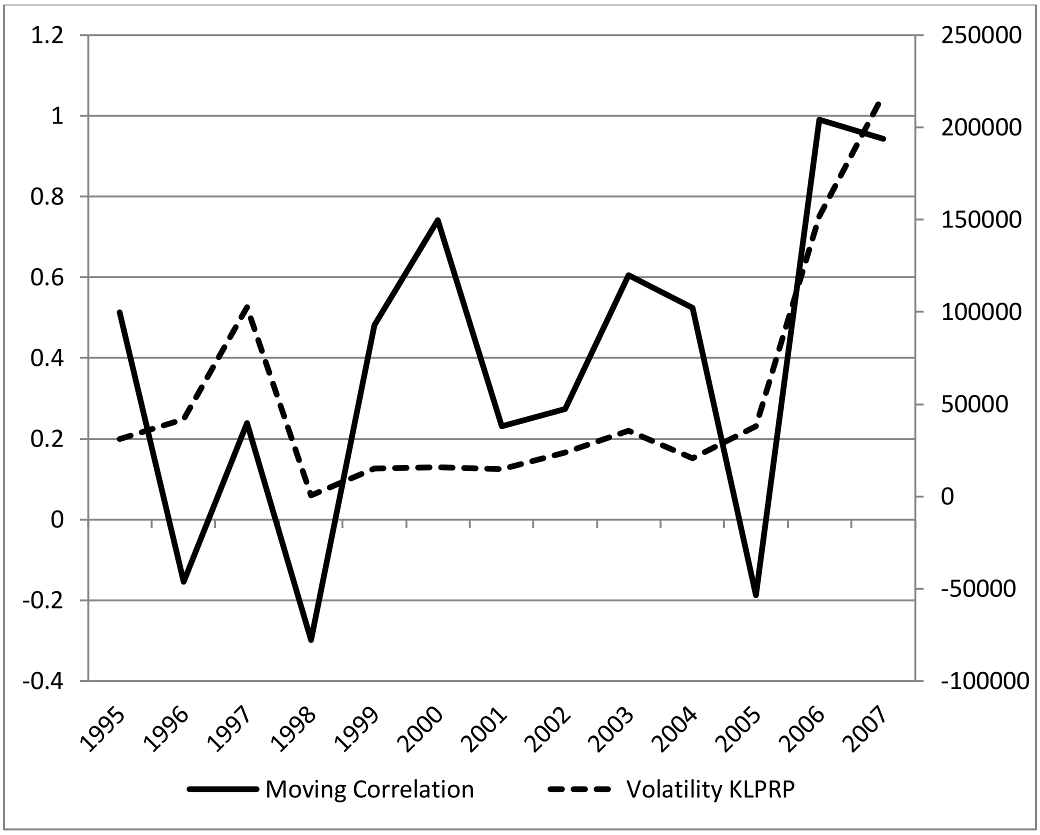


Figure 7.7 Moving Correlation, MC_{nd}, and Annualised Volatility, $\hat{\sigma}_{KLPLN}$.



Although the moving correlation coefficient, MC_{nd} , is negative for several short spells of time i.e., in the three-year periods, 1994-1996, 1996-1998 and 2003-2005 (refer to Table 7.4 for validation); Figure 7.6 suggests that the study's analysis will be less complicated to comprehend if the whole sample period is divided into three: before 1998, between 1998 and 2006 and after 2006. The relationships between the important variables described in each period can be cross-checked with the relevant tables and figures above. For simplicity, they are summarised and presented in Table 7.6 below.

Table 7.6 Comparison between three sub-periods

Sub-Period	HPI_{nd}	**KLPLN**	MC_{nd}	$\hat{\sigma}_{KLPLN}$
Before 1998	low but increasing rapidly	up but moving slightly downwards	mainly negative but small in magnitude[184]	fairly high
1999-2006	relatively higher but increasing more slowly	relatively down but moving sideways	positive but still relatively small in magnitude	low and stable
After 2006	increases	rises dramatically	positive and very large magnitudes	high

In the first sub-period, the effect of KLPLN is not very evident on HPI_{nd}. This is indicated by the small absolute value of MC_{nd} in Table 7.5 (MC_{nd} < 0.5). The negative signs in some of the points is inevitable, since HPI_{nd} was increasing whereas KLPLN was only moving sideways and slightly downwards. The small MC_{nd} is also seen in the second sub-period (where the mean MC_{nd} is +0.467), although as land prices reach higher levels, HPI_{nd} now moves in the same direction as the plantation market index; providing evidence that non-developable land prices are indeed somewhat driven by agricultural profit prospects. It is interesting to note that as KLPLN softens, the HPI_{nd} registers a slower rate of increase. Finally, in the last sub-period, as KLPLN reaches new heights, and displayed greater volatility, MC_{nd} values indicate that HPI_{nd} and *avgKLPRLN* was almost perfectly correlated (MC_{nd} > 0.94). Broadly speaking, it is possible to conclude from the evidences here that price of an

[184] This is because the first moving correlation coefficient involves two earlier years, 1993 and 1994 which do not appear in the table.

option on non-developable land is also positively correlated with the price of the final agricultural project value.

Comparison between columns showing HPI_{nd} and $\hat{\sigma}_{KLPLN}$ in the same table appears to show a positive relationship between land price and uncertainty in agricultural project profitability. Prior to 1998, $\hat{\sigma}_{KLPLN}$ is high corresponding to increasing price of land given by a rising HPI_{nd}. Between the years 1998 and 2006, reduced pressure in the land market is matched with lower levels of volatility in the KLPLN. In the final sub-period, land prices continued with a strong positive trend to correspond with higher volatility in the agricultural index prices. These observations provide support for the hypothesis that price of an option on non-developable land is moves in tandem and in the same direction as uncertainty in the price of the final agricultural project value.

To summarise, the section has shown that price of land as an option-bearing asset is positively related to the price of the underlying asset and its volatility. It can be subsequently deduced that agricultural land is (at the very least) partly purchased for its real-options features. In simpler terms, land price is driven by its speculative and hedging importance, which in turn is influenced by the price of its expected future output and the volatility of that output's price. An equally important finding is that the said conclusion holds regardless of whether the land exhibits development or pure agricultural use-potential.

7.5 CONCLUSION

Given the uncertainty brought by the ease of land conversions, it can be argued that the real option approach is particularly useful to explain agricultural land values. The thesis's empirical work in this chapter attempts to add to the literature concerning real options in land on its future use. The chapter began by establishing general principles and concepts that relate to Real Option and then subsequently discusses the motivation and use of the RO theory to explain price of land. Land is viewed as a call option on future outputs of the land either in development or agricultural use. Numerical examples for each type of real option embedded in land are given. The compounded effect of the various types of real options is not explored in this thesis due to its complicated nature, and indeed this remains an advanced subject in financial options literature. Theoretical discussions in the chapter identified four factors that are particularly important to real option valuation: and this helped set up the analysis of real options in the Malaysian land market.

To prepare a suitable time series data set, first two yearly hedonic land price indexes was computed using the time-dummy approach, one for each category of land: developable and non-developable. Next, average yearly prices and volatility of sectoral stock market indexes were computed for the property and plantation sector. The three were then utilised to test the hypothesis that (i) land price is positively correlated to the price of underlying asset; and (ii) land price is positively related to uncertainty in the price of the underlying asset. The analyses carried out separately for the two categories of land showed support of the hypotheses. The moving correlation analysis demonstrated that the impact of the correlation between land price and its underlying asset differ depending on whether the price of the underlying asset was high or low at the time.

Nevertheless, the techniques and results in this study are far from sophisticated. The hedonic land price index is sensitive to functional form specifications, omitted variables and so forth, while the moving correlation coefficient is sensitive to the length of the moving-window period. In other words, the results from this correlation analysis are only as good as the assumptions used to construct the time-series. This constitutes the biggest challenge in performing a correlation analysis on a real option asset compared to a financial option asset. Furthermore, our analysis did not in any way offer to measure the option value in land prices. This is basically because the time-series is too short to make statistically reliable estimates using the conventional empirical techniques. However, to the best of our knowledge, this is the first attempt to directly test the relationship between land price and market index as a proxy for the value of the underlying asset using aggregated data over an extended period of time.

APPENDIX 7A

LAND IDLING AS A STRATEGIC BEHAVIOUR

One of the most attractive features of the real option approach is that it recognises abandonment of a project as a viable alternative that must be contemplated from the beginning. Williams (1991, p. 191) states if the costs of carrying an undeveloped property exceeds its operating revenues, then the landowner has an incentive to abandon the asset. However, there are exceptional circumstances in which abandonment will not occur. According to Turvey (2002), a special case of RO pertaining to a behavioural characteristic called hysteresis might bear different results.[185] An example of the phenomena in financial markets is the belief that a reduction in the price of a traded security will be followed eventually by a rise in its value. The result of this form of hysteresis is that there would be some amount of hesitation to immediately dispose the security simply because its price is on a downward trend. If investors assume that the drop is temporary and that its long term prospects outweigh current holding losses, the market will observe some form of a zone of inactivity i.e., no selling and no additional buying.

Consequently, Turvey suggests that keeping land idle is probably a result of hysteresis similar to the phenomenon observed in financial markets. With respect to agricultural land, if landowners believe that land prices will eventually turn around at some point soon, they will increase their reservation offer prices. As this behaviour spreads, supply constraints will emerge to push prices upwards. This tends to happen despite the lack of perceptible increase in current income flows from the land, or its productivity. Ultimately, the belief that land prices will move upwards becomes a self-fulfilling prophecy. He writes (p. 6),

"*Under the conventional present value rule negative cashflows will result in an asset with no value, yet in agriculture we do not observe zero-valued land assets. Even*

[185] Turvey gives another example from international finance literature pertaining to irreversible investments. In periods of large exchange rate fluctuations, firms' decisions to exit(enter) into foreign markets are not necessarily reversed even when the exchange rate returns are highly unfavourable because they do not expect that over or undervalued exchange rates will prevail very long in a flexible exchange rate system. This implies that a firm's real option value continues to be unaffected even when the market is uncertain. Ansic and Pugh (1999) argued that a firm's exit decision is determined not only by its current trading position, but also by the expected value of remaining in the market. This is because if they decide exit the market now, they are aware that they are also forgoing any opportunity to increase its future value. Dixit (1992) also discussed how hysteresis influences investment timing and abandonment of a discrete investment project but in a more general framework.

land taken out of production because of low productivity will be put into production if prices rise to some trigger level. One can view marginal costs as the strike price on an option to produce agricultural commodities. When prices fall below marginal costs, production is abandoned. But there is always the possibility that price will rise at some future date so the option to produce has value. With this option in place land has value in excess of its present value, which is why we do not observe landowners accepting zero-valued bids for farmland, even when that land generates no cash flow. Likewise, when prices are above marginal costs and productive land has a positive present value we still do not observe land being sold at its present value bid price, even with growth expectations included."

The fact that landowners elect to keep their valuable land vacant or underdeveloped for prolonged periods of time suggests that vacant land is more flexible and valuable to agents in the land market than current market price (see for example, Yamazaki, 2001). Landowners stand to gain by "keeping the option alive" as long as they can, until personal circumstances or the law forces them to utilise or transfer the land to other agents (private or public). In short, landowners who view future uncertainties with an options perspective tend to delay the supply of land to the market. If the revenue from land's current agricultural activity is insufficient to sustain production, the land is left idle; although this operational decision is open to continuous revision. In the option-based framework, the rationale for keeping land idle can also be observed in the phenomenon of land-banking, where firms buy up land stocks for future instead of current use. In the mean time, the land may be unused or underused while waiting for more information to come forth or a higher offer for the land to materialise. An astute investor can build valuable agricultural land stock by either buying directly from private individual landowners or by acquiring another agricultural firm with substantial assets. It is suggested that the behavior is also a natural extension of the landowner's hedging strategy. For instance, a rubber plantation firm stocks up on additional rubber land when the commodity market for rubber is particularly weak. This opportunistic behaviour ensures that the firm has a head start in delivering market supply when prices are restored to better levels, compared to firms which had failed to strategise similarly.

APPENDIX 7B
BINOMIAL OPTION PRICING MODEL[186]

C = Call option price
V = Value of underlying asset or final project
I = Exercise price or cost of investment
T = Time to maturity of the option
r = risk-free interest rate
σ^2 = Volatility of underlying asset price
u = upward movement in underlying asset price
d = downward movement in underlying asset price
p' = risk-neutral probability

Table 7.7 List of Formulas

	One-Period Binomial Model	Two-Period Binomial Model
Underlying Asset Price	$V_u = V(1+u)$ $V_d = V(1+d)$	$V_{u^2} = V(1+u)^2$ $V_{d^2} = V(1+d)^2$ $V_{ud} = V(1+u)(1+d)$ where $p' = \frac{r-d}{u-d}$
Real Option Price	$C_u = \text{Max}[V(1+u)-I,0]$ $C_d = \text{Max}[0,V(1+d)-I]$ $C = \frac{p'C_u + (1-p')C_d}{1+r}$	$C_{u^2} = \text{Max}[V(1+u)^2-I,0]$ $C_{d^2} = \text{Max}[0,V(1+d)^2-I]$ $C_{ud} = \text{Max}[0,V(1+u)(1+d)-I]$ $C_u = \frac{p'C_{u^2} + (1-p')C_{ud}}{1+r}$ $C_d = \frac{p'C_{ud} + (1-p')C_{d^2}}{1+r}$ $C = \frac{p'C_u + (1-p')C_d}{1+r}$ where $p' = \frac{r-d}{u-d}$

[186] Adjusted from Chance, 1999 and Trigeorgis, 1987, to suit real options notations used in the thesis.

APPENDIX 7C

INVESTMENT IN AGRICULTURAL LAND : A TWO-PERIOD DECISION TREE

<table>
<tr><th>T=0 Buyer Expects Profitable Investment</th><th>Discover Market Or Technological Conditions</th><th>Decision At T=1</th><th>Discover Market Or Technological Conditions</th><th>Decision At T=2</th><th>Realised Profit (From Sale of Final Asset)</th></tr>
<tr><td rowspan="5">Purchase LAND
=
Purchase an option</td><td rowspan="2">As favourable</td><td rowspan="2">Build</td><td>Favourable</td><td>option to expand</td><td rowspan="2">Sale price –
(option price + total exercise price)</td></tr>
<tr><td>Not as favourable</td><td>option to contract</td></tr>
<tr><td rowspan="3">Not as favourable</td><td rowspan="2">option to delay</td><td>Favourable</td><td>Build</td><td>Sale price – (option price + total exercise price)</td></tr>
<tr><td>Not as favourable</td><td>option to dispose</td><td>Sale price – option price</td></tr>
<tr><td>option to dispose</td><td>-</td><td>-</td><td>Sale price – option price</td></tr>
</table>

CHAPTER 8
CONCLUSIONS

8.1 INTRODUCTION

Land prices are influenced by the direction and rate of structural changes in an economy, as resources are shifted from the 'old' to various possible 'newer' economic sectors. It follows that (i) the faster the rate of change and/or (ii) the wider the range of potential changes, the greater will be the incentive to make opportunistic purchases of land as a key asset to unlock future profits. At the same time, various institutional structures are at work to support (or impede) this outflow of land resource from one sector to another; and in certain cases could cause land to be used or traded inefficiently. The thesis presents a comprehensive analysis that combines both a study of development and institutional effects on agricultural land prices using Malaysia land sales data from one of its fastest-growing region. Three distinct but interrelated approaches are adopted: institutional analysis, empirical estimation of a hedonic price function to uncover implicit values of land attributes and finally a moving correlation analysis to uncover effects of uncertainty on land values over time.

In practice, it is generally impossible for buyers and sellers to employ a single market price for a good as heterogeneous as land. Each parcel of land exhibits a unique combination of attributes such that its valuation should essentially be a function of the quantity and value of the different attributes present in the combination. This is the premise of the Hedonic Price Model (HPM). Note that the hedonic approach to valuing individual attributes of a good is simply an extension of the NPV principles of asset valuation in that the implicit price of a specific attribute represents the discounted present value of future benefits of having the attribute present in the land.

When land is capable of more than one use and the market is relatively free, price performs the role of rationing scarce land supply among competing uses instead of among competing individuals buying the land for the same use. Accordingly the implicit price of land attributes would vary according to the attribute's importance in the respective uses. Therefore, the overall price of a parcel must ultimately depend on (i) the type of activity intended; (ii) period of time the buyer expects to hole the land and; (iii) the amount he expects to receive upon its disposal. The thesis has shown that grouping the data according to its highest and best-use potential was able to improve model performance far exceeding classification based on regional locations. Despite the initial difficulties of identifying and constructing variables from the data available, the thesis has been able to develop a reasonably large dataset comprising 2222 land sales observations from a period of 7 years from four states in the west coast of Malaysia. The dataset is then extended to incorporate a longer time period so that another level of analysis can be performed. In the second exercise, a moving correlation study is carried out separately for different highest and best use potentials to find out whether price of land is influenced by the level of volatility in its expected output value.

The main findings of the thesis are discussed in accordance to four sets of research questions stated in Chapter 1. In Section 8.3, the chapter discusses the overall policy impact and outlook for agricultural land. Section 8.4 draws attention to the limitations of this study and provides some suggestions to carry the research to new levels. Section 8.5 provides some final remarks.

8.2 SUMMARY OF KEY FINDINGS AND POLICY IMPLICATIONS

8.2.1 Development Demand and Institutional Effects

How do institutional factors affect land prices and quantity of land exchanged? More precisely, how do land controls affect the quantity and stability of land stock for agricultural and development uses? What are the ways transaction costs in land acquisition and use affect market participation and outcome? How does imbalance in the market power between sellers and buyers affect prices?

In Chapter 2, we explored the type and nature of institutional effects theoretically by focussing on land controls, transaction costs and market imperfection. Changes in supply and demand elasticity (slopes) and positions (intercepts) brought about by these institutional factors would cause the market to deviate from its competitive equilibrium. The model began with a simple economy with a single land-use (assuming that the population settlement began as an agricultural one) such that demand for land is entirely determined by demand for its output. As the economy undergoes structural transformation, resulting competition for land is solved in the market through the ‘law of one price’ (Figure 2.2), i.e. in the absence of transaction costs and government intervention, competitive markets will equalise the price of similar parcels regardless of buyer or seller’s intended use. The quantities of land for competing uses are ultimately determined by the slope and position of the respective land demand curves; which are in turn determined by their respective output prices.

If the government intervenes to fix supply of land for competing uses through imposing land-use controls, the result is **segmented markets**. Scarcity rents within each segment promote upward slopping supply curves; while respective profit prospects dictates the elasticity of the segments’ demand curves. It is quite likely that as the economy diversifies, farms are now pushed to marginal lands (poor ‘use-capacity’ in agriculture) and this in turn causes higher costs of agricultural production. If price of outputs are consistently low (due to price controls or influx of cheap foreign imports), farming will become less attractive or viable, particularly for small farmers with limited capital resources and little protection against climate, pest and overall market risks. The market would observe a considerably elastic demand for agricultural land. Importantly, a substantial gap between development and agricultural land prices would persist even though supply of agricultural land is increasingly smaller.

The power of determining land use lies in the State government through various instruments concerning land alienation approvals, land title condition changes, zoning, easement and the planning permission system. For Malaysia, the earliest and the most dominant land control until today remains to be the land title documents. Through land-use change approvals, government is able to change the overall quantity of land in various uses. If the state authorities appears not particularly averse to land-use changes i.e. from agriculture to development, it is quite likely that the market will act as if the land controls are indeed 'flexible' or not credible. As a result, legally designated agricultural land may be priced according to their future development potential rather than the current use activity.[187] The Property Market Report which is the primary source of our land sales data provides clear categorisation of land according to its **'highest and best use'** potential which was particularly helpful for testing the above notion and consequently help us estimate the extent that average prices differ across the various highest and best-use potentials. The regression analysis (in Chapter 6) confirmed that there is indeed a large gap between land with development potential and those without, even though both most of the land share the same legal categorisation i.e. agricultural land. In fact, developable agricultural land registered predicted baseline parcel price which is almost 4.4 times higher than the average of the other land categories. Table 6.16 is reproduced here to facilitate comparison.

Table 6.16 Comparison of Mean Price and Predicted Baseline Price by Land-Use Potential

Category of Land by Land-use Potential	Mean Price per Unit (RM)	Predicted Baseline Parcel Price per unit (RM)
Developable	328,827	229,297
Oilpalm	54,365	62,254
Rice	36,361	44,796
Rubber	48,466	52,631
Vacant	50,985	49,558

The thesis found strong empirical evidence that other forms of sales and land-use restrictions have succeeded in keeping price relatively low. **Malay Reserve Land** (MRL) enactments were introduced to curb outflow of land from the Malay peasants to non-Malay middlemen or investors. Land cultivated under **Group Settlement Acts** (GSA) are subject to conditions in the relevant collective agreements. With respect to GSA lands, the caveats normally include conditions regarding crop-type, sales restriction, inheritance and so forth, all aimed to ensure efficient and smooth running of the farming scheme as a whole. Farmland subjected to these two restrictions are

[187] In pursuit of broader development objectives, higher state revenues and in some cases, certain forms of political gains, the State has been quite open with respect to allowing land-use changes. Where is possible lack of transparency and adherence to a wider land-use perspective (i.e., comprehensive regional planning), the land-control system can produce highly scattered and inefficient pockets of developments which in turn create unwarranted development expectations for the nearby areas.

generally relatively free of speculative and consequently, conversion pressures. This may suggest that they provide effective ways to protect agricultural land hectarage, although it can be argued that the typical low price may have as much to do with the lands' remote locations as it does with the caveats they are subjected to. Nevertheless, in the estimation results, the effect of *mrl* and *gsa* are found to be different from each other (Table 6.15a): largest price discount on account of *gsa* are seen in developable (-50.8%) and vacant land (-24.3%) categories whilst the largest price price effect on account of *mrl* are observed in developable (-23.5%) and palm oil land (-30.5%) categories. The differences most likely correspond to how severe market participation for these lands is limited on account of the restrictions. For instance, GSA schemes might initially only allow prospective buyers from the same scheme or that the land to be purchased by the scheme's management agency itself or a person or body approved by the agency; [188] whereas *mrl* land can only be purchased by anyone as long as he is a Malay or represents Malay interests. Still, in both types of land, even if landowners are keen to sell their land, lack of potential buyers maybe one reason why market prices are usually low.

Chapter 3 also shed light on why landholdings amongst the Malays are typically small. The land registration system introduced by the British produced land titles to the Malays according to the area of land they were actively occupying and cultivating at the time; whereas foreign investors were given titles of large tracts of unoccupied land to stimulate a capitalist economy based on the lucrative rubber market. In other words, the land policies at the time created two separate classes of landowners: the large plantations and the smallholders. Over time, the latter group's land-per-person ratio became smaller as (i) some fractions of land were lost through informal credit systems or (ii) when the land is passed from one generation to the next. Consequences from land fragmentation and complex co-ownership structures are partly responsible for the farm abandonment

[188] In reality, wholesale disposal of a settlement scheme i.e., via land takings or direct purchase by developers is far more practical to both buyers and sellers, because of the nature of the farm's composition. A recent example is the disposal of Negri Sembilan's FELDA Labu Sendayan to private firms to develop surburban Seremban area.

trends in the country.[189] Grossly uneconomic farm size (arising from continuous land fragmentation), particularly those on marginal lands, usually entail very little surplus accumulation for productivity improvements or crop substitution in the future. Wide gaps in yield per unit of land between smallholders and larger agriculturalists (Figures 3.7 and 3.8 for rice and rubber subsectors respectively) underscore the fact that smallholders are particularly vulnerable to shocks in the input and output market, and thus are more likely to abandon their land or sell to the market when adverse margins persist (particularly when alternative income opportunities are now abundant in the new economic sectors). As a result, the market may be saturated with many landowners of small parcels of land relative to the number of buyers wanting the lands. The thesis also described how complex co-ownership issues can sometimes prevent farming on the land altogether. Transaction costs (over and above the standard costs associated with land division or land assemble) to deal with unprofitable and so-called 'problematic' landholdings have the effect of creating individual inertia that prevents agents from transacting as much of the assets as they would like in that period or even forever; i.e. the market cannot reallocate land efficiently. Landowners or co-landowners may be forced to release their land earlier than necessary to 'unload' problematic holdings and move on. This will induce the supply curve of land to shift rightward. On the other hand, buyers may refrain from 'problematic' land parcels even if it is economically sized if they expect substantial delay and complications in securing full rights to the land. As a result, the market would eventually equilibrate at lower than competitive prices. From the empirical regression carried out in Chapter 6, the negative effect of **transaction costs** and **excess surplus** on prices can be inferred from 'vacant' land's relatively lower mean and predicted baseline parcel prices i.e. second lowest after rice land (refer to Table 6.16 shown above).[190]

[189] Section 3.3.2 discussed structural, economic and institutional factors leading to land abandonment in more detail. Some issues why rate of return in agriculture is low is also given in the preceding paragraphs concerning gap between agriculture and development land prices.

[190] The vacant category in the empirical model is basically made up of idle agricultural parcels which have very little development potential i.e. their speculative values can be assumed limited.

8.2.2 Other Key Attributes

Are prices generally stable over the study period? How does proximity to major cities affect land prices?

The **year 2007** proved to be a major milestone for the land market as the commodity crisis and financial market uncertainties peaked. Prices of developable parcels sold in the year falls by a large percentage (-27.30%) compared to non-developable parcels (which dropped between 12 and 17%). With respect to developable agricultural land, their prices are probably affected by erratic changes in the price of steel and oil and overall credit providers' wariness about the real nature and effect of the sub-prime crisis which was only beginning to surface at the time. The relatively smaller effect of 2007 on price of non-developable agricultural land is because increases in fertiliser and transportation costs (which affected all farmers across the board) was probably offset by increasing volumes of sale of the affected commodities. However, there were no significant price effects in 2007 for rice (in Table 6.15a). It is also remarkable that for paddy lands, marginal effect on price is actually positive for *year7* (approximately +0.8%), meaning that in this year, whilst the mean price of other types of land fell, price of rice land increases. Nonetheless, the uncertainties caused by sudden spike in international rice prices forced the society to re-assess the country's stock of land resources devoted to food production and consequently this episode witnessed a (very small) surge in demand for rice land.

Another interesting finding of the empirical exercise is that proximity to a major urban centre is not valued as highly as expected for land with development potential. In fact the further the developable parcel is from a large city, the higher its price per hectare. We have shown that because of the country's deliberate strategies to spread development and reduce some population pressure in the cities, new industrial and commercial growth areas are established in non-typical locations (previously greenbelt areas). This trend eventually triggered greater preference for new low-density townships which eventually became a very lucrative business opportunity particularly for plantation companies to capitalise on their large land stock. House buyers are more inclined to pay higher prices for houses in low-density residential areas, possibly to avoid congestion and crowding in cities and to take advantage of quality road infrastructure that connects the rural areas to major cities. The finding basically suggests that land development in Malaysia is indeed **scattered** and not necessarily confined to the urban fringes. This leap-frogging pattern of development can also be linked to the shortage of available or purchasable land at the urban fringes or high costs of land assembly, whether because of institutional constraints or development speculation.

8.2.3 Spatial Influences on Price

Are land prices influenced by the land's spatial distribution over different regions? How can spatial interaction between observations be modelled? What is the degree of spatial bias in the data?

A **spatial heterogeneity** model was estimated and the results show that there are significant differences in implicit values of attributes between the highly industrialised states of Selangor, Negri Sembilan and Melaka and the less industrialised and larger state of Perak. This might imply that agents in the market are not relatively free to move from one region to another to meet excess surplus and demand situations. However, the disaggregation exercise did very little to uncover group-effects. The model is unable to reject heteroscedasticity ($\chi^2 = 59.62$). The null hypothesis of normality in residuals is also soundly rejected ($\chi^2 = 110.9$). Overall, the spatial regime model does not contribute to the basic model's explanatory power or model adequacy as expected and was not pursued further.

Because of land's spatial nature, it is often argued that the basic hedonic model must be adjusted to correct for spatial interactions between observations. This can be done by incorporating either a lagged dependent variable, or lagged explanatory variables, or correlated error terms. There are two types of spatial biases. **Spatial error dependence** refers to the existence of patterns in the regression error terms. It is based on the assumption that there is one or more omitted variable in the hedonic price function and that the omitted variable(s) has a spatial pattern. The error dependence may also originate via an aggregation bias in the data. **Spatial lag dependence** occurs when there is interdependence of the dependent variable across observations as a result of the parcels' individual locations with respect to each other. The selling price of a parcel might echo the price of an adjacent or nearby land because buyers have limited information about the parcel's attributes such that they use recent sales of land in the neighbourhood to guide their valuations.

However, the spatial econometrics exercise carried out in section 5.4 was not conclusive. Although the individual detection tests, regression results and predictive error analyses indicate that some form of spatial bias is present, each gave conflicting suggestions on the exact type and extent (Tables 6.7 through to 6.12). Even if our results are not ambiguous, there is still the issue regarding the usability of spatial multipliers to adjust the OLS estimated parameters. This is because spatial autocorrelation tests and coefficients are very sensitive to the spatial weight matrix specifications; such that researchers may derive different outcomes on the same set of data when using different weight matrices. Hence, we conclude that since there is some amount of spatial bias present in our regression model but the degree is not clearly obvious, the OLS estimates should be considered as upper bounds for the derivation of implicit prices of land attributes.

8.2.4 Real Options

Can land speculation, land banking and land idling be explained by the land's role as an asset that provides opportunities for future returns in higher use?

The estimated hedonic price function clearly indicated that Malaysian agricultural land is differentiable by its 'highest and best' potential land-use. In the context of an economy characterised by structural transformation, rapid growth rates and a rather 'lenient' land-control system, there are plenty of potential non-agricultural investments available for the land. This promotes the notion of 'impermanence syndrome' (Berry, 1979) which basically means that the market believes that land would continuously shift to its 'highest and best' use. Both landowners and prospective buyers are aware of the flexibility in land-use and assume optimistic positions with respect to future returns, by virtue of the (expected) continuous high rate of economic growth. It follows that the more fluid the conditions in the economy (which represents higher firm, industry and economic risks to potential profit), the greater will be the value of land's flexibility. Such positive expectations about future could be translate into market price that is higher than the conventional discounted present value of land in its current use. One analytical approach that incorporates such optimistic or speculative purchasing behaviour into its explanation of price is the Real Option (RO) theory. In finance, an option is a derivative whose value is dependent upon the **value** of another asset (which is called the underlying asset e.g. stocks, bonds, commodities, currencies and indexes) as well as **fluctuations** in the value of the underlying asset. Because of derivatives are basically driven by uncertainties, it is possible to find derivatives based on things like the number of days with rainfall in a season, or amount of catches from the sea and so forth. Basically, the value of a derivative is nil if uncertainty is somewhat limited but high if uncertainty is also high i.e. the return is unpredictable and possibly quite volatile.

There are several important characteristics of land that lends itself well to be the options theory. Firstly, land purchase essentially represents a large investment which could create opportunities to make larger investments (and therefore a substantial amount of profit) in the future. The underlying asset that motivates land's purchase can be almost anything really: real estate, private industry or commercial centre etc.. The investment project is usually undertaken in stages i.e. spread out over a period of time upon reaching certain minimum optimal conditions or 'hurdles' for each stage. Secondly, the nature of the investment involves large sunk costs and a high degree of asset specificity, such that reversing the investment would be costly, if not impossible. Thirdly, whether this profit is realisable or not and its quantum are subject to various sources of market and non-market uncertainties and therefore cannot be accurately determined at the time land is purchased. Fourthly, potential profit from the future possible investment appears larger than the potential loss from not making the investment, particularly since land can always be re-sold and its value can never be zero. Fifthly, there are individuals with high risk tolerance in the market who are willing to purchase the land, despite its price being higher that its present value in current use in exchange, for the rights to make large profits from its underlying asset. In short, buying land is not merely about buying an asset cheap and selling high (which might be a pure land speculator's terms of reference), but there is actually an underlying asset to be realised and purchase of land is a pre-condition for that to happen. The optimal time to exercise the option is simply the time when the difference between the underlying asset value and the investment cost is expected to be highest, taking into account time needed to complete the project. The more likely the land is expected to represent a 'deep-in-the-money' option, the higher its market value. Higher levels of uncertainties increase the potential positive payoff from owning and exercising the option; whilst potential loss remains limited. To summarise, in land, there is various types of implicit call 'options' on the underlying asset. By owning land, the investor secures the right, but not the obligation, to **make, postpone, expand or reject** follow-on investments that will maximise the investors potential benefits from holding the land.

In Section 7.4, a moving correlation analysis is performed to find evidence of relationships between annual hedonic price index and (i) value of an underlying asset, which is of course, hardly exclusive to the RO theory; and (ii) volatility in returns from the underlying asset. Our land market data is already neatly categorised into parcels with and without development potential and the OLS regression results confirmed that this method of grouping is particularly useful in explaining price differences. Hence, separate hedonic price indexes are constructed for developable and non-developable lands using a larger set of data covering 15 years instead of 7 for the OLS hedonic function estimation. As a proxy for the underlying asset value, the annualised average value of the stock market index is used.

Whilst it is easy to imagine buying land today for opportunities to develop it later, the real option explanation applies equally well for cases of land purchased for future agricultural investment. There are ample (though not yet correctly estimated) profit-expansion opportunities in the future from cost-reducing technologies, free trade agreements involving agricultural exports, new biotechnology or pharmaceutical use for agricultural produce. Current trends of increasing agricultural commodity prices and greater interests in bio-fuel production feed expectations of greater rates of returns from agriculture. Hence, we argue that the hypothesised relationships between price of land and (i) the value and (ii) uncertainty associated with its underlying asset hold for both development and agricultural future use of land. The annual hedonic price index for developable land was found positively related to prices of the **property sectoral stock market index** and its volatility; whilst the non-developable land hedonic price index was positively related to the **plantation sectoral stock market index** prices and its volatility (Section 7.4.4). In addition, the RO theory was able to give a formal structure to the problem of land abandonment on speculative grounds (as opposed to structural and institutional basis land abandonment) by showing that the period of inactivity may actually correspond to an optimal behaviour for investors with uncertainties. When profits are down but there are positive probabilities of returning to favourable levels, farmers would rather cease operations temporarily rather than dispose the land, provided that its holding costs are low and there are other income sources available in the meantime.

8.3 POLICY EVALUATION

The information gathered from analyses in the thesis can hopefully be used to help evaluate past and existing policies and institutions. At the very least, it might direct us to ask the right questions pertaining to the courses that present land and agricultural policies appear to be taking. This section extends the findings and observations from the institutional and empirical analysis of the thesis into the realm of policy implications.

8.3.1 Agricultural Land Preservation

Figures 3.3 through to 3.5 suggest that unless replaced by reserve state land, the overall quantity of agricultural hectarage in Malaysia is **declining**. Various factors have been identified in the thesis as contributing to this trend, both economic and institutional. Because of the high rate of economic growth and competition for land resources from non-agricultural sectors, parcels of farmland with 'developable' characteristics are inevitably subject to speculative pressures in the market. There is very little visible effort by the state to protect agricultural land hectarage. On the other hand, in the state's pursuit of a broad-based and more resilient economic structure, it appears to be very amenable to expansion of cities as well as the development of new townships and industrial areas in traditionally greenbelt areas, as shown by the apparently 'accommodating' attitude when dealing with **land-use change applications**. The market consequently behaves as if approvals are fairly easy to obtain and therefore price farmland largely based on this expectation. A table showing predicted baseline parcel prices (Table 6.16) confirmed that despite the land agricultural status, value of farmland with perceptible development potential is far higher than a like-to-like parcel with purely agricultural potential. Because location is as important to agriculture as it is to most other economic activities, it is important that the government identify and preserve areas with highest 'use-capacity' in agricultural and relatively lower development pressures, where possible. Better regulations and enforcement space should be explored to ensure optimisation of land resource that would allow agricultural, forestry and other sectors to thrive well side-by-side. Approval of industrial, residential and commercial sites must fit into a larger and longer-term land-use plans. It should not be given haphazardly in order to protect prime agricultural areas from excessive speculation and development demand.

Conversion of farmland at the urban fringes continues to be a critical issue for large cities. However, the thesis's empirical results show that the further a developable parcel is away from the city centre, the higher its per unit price, holding other factors constant. As shown above, this apparently diffused pattern of development is not entirely unintentional. The government embarked on various policies that is deliberately aimed to spread development to areas which have been pre-dominantly agricultural and poor in the past. Consumers themselves are increasingly willing to pay premium prices for low-density development to avoid pollution and congestion in the cities. Obviously, to limit speculation on land in traditional agricultural sites, approvals for new township developments must not be allowed or if it is, they should come with the strictest rules tailored to ensure the area's environmental sustainability and overall farming viability (e.g. proper buffer zones are established, rules on land sub-division, zoning and infrastructure additions are set up to ensure there is no conflict with agriculture's dominant place in the local economy). At the same time, government policies on urban renewal must be revised to find ways to restrict development to existing cities and town borders as much as possible. Politicians must discard the 'bigger is better' mentality, and work to formulate policies that encourage more **efficient urban land use** including considering greater building density, re-development of city brownfields, improving the cities' mass transport network other urban amenities which can enhance quality and comfort of urban dwellers.

As a whole, we strongly believe that the method of **positive planning** whereby state or local authority purchase or alienate land, lay out and service the land with infrastructure prior to selling the ready sites for specific purposes (even that in the form of leaseholds) should prevail over the usual ad hoc use-change approval methods. The recent proposals to pursue separate economic corridors different economic sectors are in our opinion steps in the right direction. Instead of the focus on spreading development to balance regional growth, the government should encourage **clustering** of similar activities to maximise comparative advantage of the respective areas, promote economies of agglomeration and improve necessary logistics to suit the sector. Specific targets for the agricultural sector have included the setting up of permanent food production parks in each state, improving infrastructure to increase rice's yield/hectare rates in existing granary areas and shift to higher-value agricultural activities such as horticulture, agri-tourism and aquaculture.

One may ask whether these measures are sufficient or effective in preserving existing agriculture land given the generally low rate of agricultural return relative to other land-uses. Malaysia might want to consider other formal farmland preservation measures that directly compensate the landowners for not converting land to other uses. One such example may be modelled after **direct payments** or "decoupled" type of subsidies such as the Single Payment Scheme (SPS) in the EU gives farmers right to farm according to the demands of the market i.e. including the freedom to leave the land idle when market returns are persistently poor, as long as farmers comply with certain environmentally friendly farming practices. However, the system obviously requires a great amount of paperwork and detailed and strict land audits to be carried out to ensure only fair and justifiable payments are given out. It will presumably be more complicated where there are multiple owners involved and payments are to be made separately to each individual. Moreover, the method is which is presumably financed largely through public funds may find strong resistance from the public as taxpayers are neither able nor willing to bear additional fiscal burden from the current levels. Many developing countries, including Malaysia are already spending a large portion of tax funds on food and fuel subsidies as well as other social public infrastructure; whilst taxation rates must be kept low to support the economic growth momentum. Private funds or bond schemes to invest in agriculture are still unable to garner sufficient interests because of the generally low rate of return from its activities (although hopefully this will change in the near future as price of food and other agricultural commodities increase from the combined effect of climate change, stronger oil prices and higher population demand for food and value-added agricultural products).

Chapter 3 showed that applications to convert agriculture land to development status can in fact be motivated by the **regulatory conditions** themselves. Two examples come to mind. Land legally classified as agricultural cannot be partitioned into plots less than 0.4 hectares. This makes resolution of shared ownership on small inherited lands rather difficult. Agricultural land is also no longer saleable to non-nationals after the country's independence. Although these restrictions are meant to curb further land fragmentation and excessive speculation, respectively, people are able to get around these restrictions simply by applying to have the land status changed to development. In the absence of (or lack of adherence to) a set of comprehensive and longer term land plans, the ad hoc approvals would promote haphazard land-use composition in the particular area. As Coughlin and Keane (1981) argued, even if relatively small portions of land are sold to non-agricultural buyers, land values in the whole affected area will tend to rise, subject to the gap between agricultural and (the perceived) development rents from land.

At the same time, effective and inexpensive ways to resolve **co-ownership issues** without breaking up the land are either (i) still elusive or, (ii) not sufficiently promoted to the masses of (iii) ignored due to lack of political will and enforcement. To be fair, there are already various levels of arbitration avenues available to suit different needs: at the district land office, the courts as well private or semi-private bodies offering consulting services. It is particularly important that these authorities or agencies give priority to solutions that keep the land **intact (**although no doubt this would lead to a host of other issues). The process can be dreadfully cumbersome than it already is if family members are reluctant to cooperate and agree to find quick resolutions to the relevant matters.

With respect to land abandoned or underutilised because of co-ownership matters, merely establishing of a 'clearing house' for abandoned plots of lands is hardly sufficient because these entities do not have the power to address and impose resolutions to ownership issues. The state must demonstrate stronger political will to **confiscate** unused or unclaimed land as provided by the law (e.g. Section 117 and 127 of the National Land Code) and reallocate them to more efficient users. Perhaps a few high profile cases would be 'helpful' to enhance the level of public awareness. It is expected that the number of lands abandoned due to such institutional constraints will be greatly reduced in the future. We are of course in favour of a more market-based solution to the problem i.e. one that first compensates the family the fair market value of the land and at the same time maybe extend (relatively cheap) financing to any family member or outsider to re-purchase the land for continued agricultural use. Intuitively, the model can be easily taken up by the country's existing agricultural and rural credit agencies.

8.3.2 Reviving Interest in Farming

It is extremely important to address known structural weaknesses in the agricultural sector in order to generate sufficiently attractive conditions for investments in agriculture. Well-known factors critical to the sector's profitability are location and land quality, input cost, technical know-how and level of mechanisation, access to capital support, distribution and storage, and sufficient commercial or industrial linkages to absorb farm supply timely and competitively.

Indeed there should be an overall greater sense of urgency to create a new breed of farmers outside or inside the organised agricultural schemes who are well-equipped to manage modern farming projects. They need to acquire and demonstrate reasonable levels of legal literacy, technical knowledge, business negotiation and planning skills. Better methods of protection against farm risks are necessary to ensure stable income in agriculture, which is an important issue for new and remaining farmers. For instance, a major component in U.S. farm support programmes involved counter-cyclical payments that are payable to farmers in the event that effective price or yield for a commodity falls below a certain ‘target’ level. These crop insurance indemnity or revenue insurance programmes can take group and individual risk protection nature. Another fundamental issue with respect to smallholders concerns promotion of up and downstream linkages that could create a dependable and consistent source of input and output outlets. The solution involves selecting business models that are proven practical and robust in the long run (e.g., contract farming, cooperative farming, purchase agreements, joint ventures, agricultural marketing boards). Ultimately, the model should suit the crop type as well as the preferences of participating farmers. Corporate participation in agricultural linkages can be boosted by a judicious spread of tax incentives (e.g. customs duty exemptions and so forth) as well as incentives for vertical and horizontal integration for companies already involved in agri-based businesses.

8.3.3 Agricultural Land Organisation and Role of Agricultural Schemes

Malaysia needs to correct the imbalance its agricultural land-use which currently is highly dominated by export crops (see Figures 3.3 through to 3.5 for a rough indication of the disproportionately high hectarage devoted to rubber and oil palm compared to rice). It is regrettable that export commodity-based firms have been allowed to continue to expand their landholdings to new virgin land (mostly in Sabah and Sawarak on the Borneo island). Their expansion comes at the cost of precious tropical jungle reserves and usually leads to greater dependence on foreign labour to work on these plantations.

Food production hectarage, particularly in the rice sector which suffered heavily from policy neglect in the past decades, are dwindling due to a multitude of factors: aging farmer, scarce and expensive labour, higher farm input costs, low farm-gate price, poor management and most importantly, small uneconomic sizes. The country has long been a net importer of rice, the country mostly produces only the lower and medium-grade varieties. Despite being the sector with the most number of support measures, these subsidies do not appear to have any effect in making rice farming attractive. Rice subsidies are generally linked to production costs support and incentive e.g. cash subsidies for plowing, fertiliser and machinery expenses, yield improvement incentive (RM650 for every metric tonne exceeding the previous year's level) and additional price subsidy of RM 248.10 per tonne if the farm output is sold to government-associated rice mills. The current Guaranteed Minimum Price stands at RM 650.00, a rate that is reviewed very rarely. Ultimately, there are simply very narrow profit margins to be made from rice-planting, particularly for small farmers who do not benefit from economies of scale and particularly because higher costs of production cannot be passed on to consumers. Indeed, results of the empirical analysis concerning price of rice land (Chapter 6) led us to conclude that the subsidies are not capitalised into land price (which is expected since they are connected to crop rather than land) or even if they are, the effect is largely offset by the relatively unappealing rates of return.

The government's effort have been fairly commendable in respect to provision of technical support, research and development, rural and farm infrastructure and so forth, but are presently inadequate to curb the declining interest in rice farming. One of the most enduring problems in the rice sector is uneconomic farm sizes which affected many of the landowners. Rationalisation of these farms may substantially improve yield per hectare, and Malaysia should strive to model itself after more successful rice producers. The Australian rice industry's average farm size is 400 hectares and the mean yield is 10 tonnes per hectare (as compared to Malaysia's average which is 3 to 4 tonnes per hectare). Approximately 56% of our sample rice parcels belong to some form of group land schemes (see Table 6.14). This high percentage showed that local rice production requires high capital outlay for infrastructure, and these are usually only found in government-backed schemes. The main advantage of these schemes is in its large production area, which can be exploited more efficiently to achieve higher yields rates.

A quick look at Figure 3.8 suggests that yield rates of these granary areas are close to double the country's average yield rate. Hence, these schemes provide the best hope to correct the food versus export agriculture imbalance mentioned earlier. However, the government have yet to effectively sort out fundamental problems of low land-to-farmer ratio and exiting farmers. Again, all efforts should be taken so that exiting farmers are able to transfer the land intact to a more efficient (if possible) farmer and not have it divided amongst the children later.

As a matter of fact, the problem of uneconomic farm size and continuous breaking up of the land unit is a major threat to overall agricultural hectarage. Remaining farmers (those who have not left agriculture for other sectors or due to old age) are trapped with small plots of land (because of low farm surplus income) and high land prices meant that they have limited opportunity to expand. At some point, the farmers may opt to withdraw their land from agriculture. If the trend continues, there will be small and scattered pockets of farms in the rural landscape, even in the absence of typical development pressures. To some extent, the state might be able to step in as caretaker owner and eventually lease the land to more efficient farmers. As mentioned earlier, this may warrant the state to exercise its full regulatory powers. Of course, sufficient opportunities should be given for more market-based measures as well as greater use of the media to locate absentee landlords and advertise for buyers. Where the problem is more widespread, block compulsory land takings could be initiated to ensure minimal problems with existing built constraints (too many structures or access roads in a unit of land) and ownership conflicts. This is also means that the land area can be reorganised into economic-sized lots of land and sold to interested farmers.

In organised smallholder schemes where equity shares or wages are given to the participants instead of individual land titles, there is very little to tie the farmers to the land. To many, it is unthinkable that their children should continue as scheme participants particularly under such arrangements. There is a great deal of provisions in the collective agreements between the original participants and the agency that may not appeal to the second generation; and should therefore be revised to keep up with modern realities. At the end of the day, it may be best to leave the land to fewer but more efficient farmers. More importantly, the present group land schemes need to take a long term view to work out some 'succession' mechanism that is mutually beneficial for both the family and the agency.

To conclude, it is strongly believed that if policy-makers continue to be lenient and complacent with respect to the various land issues discussed above, there may be little chance of achieving the desired levels success of existing programmes to modernise agriculture and secure higher levels of food security.

8.4 LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

Whilst the thesis has been able to provide a fairly comprehensive and realistic description of the key drivers in the Malaysian agricultural land market, as well as make some important empirical contributions in new areas such as spatial dependence and real options in agricultural land studies, it is not without its limitations.

The first set of limitations involves data for empirical estimation. Naturally, all empirical findings are limited by the availability of data. The thesis showed processes adopted to overcome challenges of obtaining a suitable micro-level dataset for the hedonic model. The annual Property Market Report has proven to be a valuable primary source of information regarding land values. Follow-up research could also benefit by securing access to unpublished data i.e., data captured on the PDS(15). For instance, information about land co-ownership can be used to test market distortion arguments. Similarly, information regarding sellers and buyers' entities (private individuals versus firms) would be useful to investigate the effects of bargaining power on price. Type of lease and the number of years remaining of the lease are important considerations when purchasing land, hence should feature in the model for land price. It is also hoped that certain information will be recorded more consistently in the PMR, for instance, information regarding MRL status, which in past is displayed differently from state to state. However, if access to the unpublished data is actually granted, the researcher must plan how to execute the mammoth task of screening the sales data for non-arms-length transactions and other irregularities. This is only one of the many challenges in dealing with large-scale sample sizes with many variables.

Test for size effect – ideally it is useful to highlight the significance of dualism in the agricultural sector. In small or co-owned plots where a substantial amount of the sale price goes to transaction costs and costs of land assembly – per unit cost of land greater than per unit expected return in normal circumstances. Whereas large scale plantations enjoy lower infrastructure cost per hectare for farming, hence it is common to find that they prefer to purchase land from each other rather than from the open market.

Plans to establish a GIS unit in the Valuation and Property Management Department are already set in motion by the time the thesis is completed. Therefore, future researchers can expect spatial information to be integrated with sales data, and this will greatly change the approach to studying land prices in the future. Equally useful would be remote sensing data on land use and the ability to integrate the data with socio-economic and administrative data. The thesis's own spatial data suffers from lack of precision because plot numbers of the land are not known, making it impossible to ascertain its exact location and hence, physical or locational features.

The general purpose of introducing variables indicating neighbouring land-use into the function is to gauge the degree of land-use diversification in the parcel's area i.e., how many types of land-uses there are and how pervasive they are. Examples of variables in this category are adjacent-parcel's specific land-use, percentage of land in non-agricultural use, index of non-agricultural infrastructure and index of land fragmentation per a unit of land. The spatial arrangement of an area's diverse set of economic activities has important implications for price (see Bockstael, 1996). For instance, if development activities are scattered within a traditionally agricultural region, the customary advantages of accessibility and complementarity when different agricultural activities exists in the same location (including those relating to labour supply, machine use, storage, processing and so on) will decline and be replaced by advantages from having different types of economic activities located together.[191] Positive and negative externalities and their spatial patterns are known to affect price (Geoghegan et al., 1997).

The second set of limitations concerns the spatial analysis component of the thesis. The inconclusive outcome could be due to assumptions made about the unobserved extent of spatial influences which formed the basis of spatial weight determination, although the thesis did attempt all estimations with three different spatial weights. The model also was not able to test for the temporal effects of earlier sales on prices of nearby parcels. This is mainly because of the small sample size, i.e., approximately 2200 observations and the decision to analyse spatial effects based on land groupings.[192] It is believed that spatial effects are not strong between lands used for different purposes (for instance, it is hard to imagine price spill-over effects between rubber and developable land parcels even if they are located near each other).

Future research could explore the use of government-published property price index to determine the impact of house price uncertainty on land values. There are various possible pairings and when the time series are sufficiently long, an extensive time series analysis can be performed.

Another important extension to the thesis would be sector-specific analyses, according to crop type and the market for the crop (local versus international). This thesis has shown that a sector-specific approach is more informative primarily because markets for different land-uses have been shaped by different historical and economic factors, hence are organised differently. More importantly, the composition and behaviour of farmers are different from one sector to another, as well as between the smallholders and large-scale agriculturalists in the same sector. Accordingly, policy discussions and subsequent land-related strategies must fully embrace the distinct features of the market they are

[191] For a discussion regarding merits of accessibility and complementarity in 'economics of location', please see Lean and Goodall (p. 141).

[192] There are five land categories and seven years in the study period; the number of observations in each group would be too small to produce reliable estimates.

dealing with. To researchers, the topic should provide many interesting avenues for future research.

8.5 FINAL REMARKS

The evolution of agricultural land pattern in Malaysia reflects the extensive economic and social transformation the country underwent over the decades. The subject of agricultural land price has a unique but far-reaching consequence on the identity, income and sustainability of the economy and the people. It cannot be denied that institutional factors affect the market as much as economic forces of demand and supply, a point that is reflected in the extremely broad nature of the thesis's coverage. It is hoped that the thesis will pave the way for greater thinking among academicians and policy-makers to address fundamental issues relating to land-use.

REFERENCES

Alston, J.M. (1986). "An Analysis of Growth of U.S. Farmland Prices, 1963-82", *American Journal of Agricultural Economics*, Vol. 68, pp. 1-9.

Amriah Buang, (1991). "Mengenai pembangunan tanah terbiar di Semenanjung Malaysia: masalah dan cabaran", Paper presented at *Seminar Kebangsaan Menilai Pencapaian Penyelidikan IRPA dalam Rancangan Malaysia Kelima (Sains Sosial)*, 25-26 Nov 1991, Sintok, Kedah Darulaman.

Andersson, D.E. (2000). "Hypothesis testing in hedonic price estimation - On the selection of independent variables", *The Annals of Regional Science*, Vol. 34, pp. 293-304.

Anselin L. (2003). "Spatial Externalities, Spatial Multipliers and Spatial Econometrics", *International Regional Science Review*, Vol.26, No. 2, pp. 153-166.

Anselin L., and Bera A.K. (1998). "Spatial dependence in linear regression models with an introduction to spatial econometrics", in Ullah A. and Giles D. (eds.) *Handbook of Applied Economic Statistics*, Marcel Dekker, New York, NY, pp. 237-289.

Anselin L., and Rey S. (1991). "Properties of Tests for Spatial Dependence in Linear Regression Models", *Geographic Analysis,* Vol. 23, pp. 112-131.

Anselin L., Bera A.K., Florax R., and Yoon M.J. (1996). "Simple Diagnostic Tests for Spatial Dependence", *Regional Science and Urban Economics*, Vol. 26, pp. 77-104.

Anselin, L. (1988). *Spatial Econometrics: Method and Models*, Kluwer Academic Publishers, Dorddrecht.

Anselin, L., and Rey, S. (1997). "Introduction to the Special Issue on Spatial Econometrics", *International Regional Science Review,* Vol. 20, pp. 1–7.

Anselin, L. (1990). "Some Robust Approaches to Testing and Estimation in Spatial Econometrics", *Regional Science Urban Economics*, Vol. 20, pp. 141–163.

Anselin, L., and Rey, S. (1991). "Properties of tests for spatial dependence in linear regression models", *Geographical Analysis*, Vol. 23, pp.112–131.

Ansic, D., and Pugh, G. (1999). "An Experimental Test of Trade Hysteresis: Market Exit and Entry Decisions in the Presence of Sunk Costs and Exchange Rate Uncertainty", *Applied Economics*, Vol. 31, pp. 427–436.

Arnott, R.J., and Lewis, F.R. (1979). "The Transition of Land to Urban Use." *Journal of Political Economy*, Vol.87 No. 1 161-169

Awokuse, T.O., and Duke, J.M. (2006). "The Causal Structure of Land Price Determinants." *Canadian Journal of Agricultural Economics*, Vol. 54 227-245

Baland, J. M., and Platteau, J. P. (1997). "Wealth Inequality and Efficiency in the Commons: The Unregulated Case", *Oxford Economic Papers*, New Series 49 No. 4, pp. 451-482.

Baldwin, C. (1982). "Optimal Sequential Investment When Capital is Not Readily Reversible", *Journal of Finance*, Vol. 37, No. 3, pp. 763-782.

Barlowe, R. (1986). *Land Resource Economics: The Economics of Real Estate* (Fourth Edition). Englewood Cliffs, New Jersey, Prentice Hall.

Basir Ismail (2005). *Land and Agricultural Policy: A Mismatch,* Malaysian Palm Oil Board, Kuala Lumpur, pp. 529

Basu, Kaushik, (1990). *Agrarian Structure and Economic Development*, Harwood Academic Publishers.

Basu, S., and Thibodeau, T.G. (1998). "Analysis of Spatial Autocorrelation in Housing Prices", *The Journal of Real Estate Finance and Economics*, Vol. 17, pp. 61–85.

Baum, C. F. (2006). *An Introduction to Modern Econometrics Using Stata*. College Station, TX: Stata Press.

Bekkerman, A. (2007). "The Housing Boom and Its Effect on Farmland Acreage", No. 9697, paper presented at *American Agricultural Economics Association Annual Meeting*, July 29-August 1, 2007, Portland, Oregon TN.

Bell, K.P. and Irwin, E.G. (2002). "Spatially Explicit Micro-level Modelling of Land Use Change at the Rural-urban Interface", *Agricultural Economics*, Vol. 27, pp. 217–232.

Benirschka, M. and Binkley, J.M. (1994). "Land Price Volatility in a Geographically Dispersed Market", *American Journal of Agricultural Economics,* Vol. 76, No. 2, pp. 185-195.

Bentick, B.L. (1979). "The Impact of Taxation and Valuation Practices on Timing and Efficiency of Land Use". *Journal of Political Economy,* Vol. 87, pp. 858-868.

Berry, D. (1978). "Effects of Urbanization on Agricultural Activities." *Growth and Change*, Vol. 9, No. 3, pp. 1-8.

Black, F., and Scholes, M. (1973). "The Pricing of Options and Corporate Liabilities", *Journal of Political Economy*, Vol. 81, pp. 637-654.

Bockstael, N. E. (1996). "Modeling Economics and Ecology: The Importance of a Spatial Perspective", *American Journal of Agricultural Economics*, Vol. 785, pp. 1168–80.

Bowen, W.M. and Mikelbank, A., Prestegaard, D.M. (2001)."Theoretical and Empirical Considerations Regarding Space in Hedonic Price Model Applications", *Growth and Change*, Vol. 32, No. 4, pp. 466-490.

Bowman, E.H. and Moslowitz, G.T. (2001). "Real Options Analysis and Strategic Decision Making", *Organisation Science*, Vol. 12, No. 6, pp. 772–777

Box, G. and D. Cox. (1964). "An Analysis of Transformations", *Journal of the Royal Statistical Society Series B*, Vol. 26, pp. 211-252.

Brabec, E., Smith, C. (2002). "Agricultural Land Fragmentation: The Spatial Effects of Three Land Protection Strategies in the Eastern United States", *Landscape and Urban Planning*, Vol. 58, No. 2-4, pp. 255-268.

Brachinger, H. W. (2002). "Statistical theory of hedonic price indices". *DQE Working Paper 1*, Department of Quantitative Economics, University of Fribourg, Switzerland.

Brennan, M.J. and Schwartz, E.S. (1985). "Evaluating Natural Resource Investments," *Journal of Business*, Vol. 58, No. 2, pp. 135-157.

Brown, J. and Rosen, H. (1982). "On Estimation of Structural Hedonic Price Models", *Econometrica*, Vol. 50, pp. 765-788.

Brownstone, D. and De Vany, A. (1991). “Zoning, Returns to Scale, and the Value of Undeveloped Land”, *Review of Economics and Statistics*, Vol. 73, pp. 699-704.

Brueckner, J.K. and Colwell, P.F. (1983). “A Spatial Model of Housing Attributes: Theory and Evidence”, *Land Economics*, Vol. 59, pp. 58-69.

Brunstad, R. J., Gaasland, I. and Vårdal, E. (1995). “Agriculture as a Provider of Public Goods: a Case Study for Norway,” *Agricultural Economics*, Vol. 13, pp. 39-49.

Buang, Salleh (2005). Compulsory Land Acquisition, *New Strait Times Property*, 18 June 2005.

Buang, Salleh (1989). *Malaysian Torrens System*, Dewan Bahasa dan Pustaka, Kuala Lumpur.

Buitelaar, E., (2007). *The Cost of Land Use Decisions: Applying Transaction Cost Economics to Planning & Development*, Blackwell Publishing, Oxford, pp. 196.

Burt, O.R. (1986). “Econometric Modeling of the Capitalization Formula for Farmland Prices”, *American Journal of Agricultural Economics*, Vol. 68, No. 1, pp. 10-26.

Can, A. (1990). “The Measurement of Neighborhood Dynamics in Urban House Prices”, *Economic Geography*, Vol. 66, pp. 254-272.

Can, A., (1992). “Specification and Estimation of Hedonic Housing Price Models”, *Regional Science and Urban Economics*, Vol. 22, No. 3, pp. 453-474, Special Issue Space and Applied Econometrics.

Can, A. (1993). “Specification and Estimation of Hedonic Housing Price Models”, *Regional Science and Urban Economics*, Vol. 22, pp. 453-474.

Can, A. and Megbolugbe, I. (1997). “Spatial Dependence and House Price Index Construction”, *Journal of Real Estate Finance and Economics*, Vol. 14, pp. 203–222.

Capozza, D. and Li, Y. (1994). “The Intensity and Timing of Investment: The Case of Land”, *American Economic Review*, vol. 84, pp. 889-904.

Capozza, D.R. and Helsley, R.W. (1990). “The stochastic city”, *Journal of Urban Economics*, Vol. 28, pp. 187-203.

Capozza, D.R. and Sick, G. (1991). “Valuing Long Term Leases: the Option to Redevelop”, *Journal of Real Estate Finance and Economics*, Vol. 4, pp. 209-23.

Carrión-Flores, C. and Irwin E.G., (2004). “Determinants of Residential Land-Use Conversion and Sprawl at the Rural-Urban Fringe”, *American Journal of Agricultural Economics*, Vol. 86, No.4, pp. 889-904.

Carter, M. and Zimmerman, F. (2000). “The Dynamic Costs and Persistence of Asset Inequality in An Agrarian Economy”, *Journal of Development Economics*, Vol. 63, No. 2, pp. 265-302.

Carter, M. and Mesbah, C. (1993). “Can Land Market Reform Mitigate the Exclusionary Aspects of Rapid Agro-Export Growth?” *World Development*, Vol. 21, No. 7, pp. 1085-1100.

Cassel, E. and Mendelsohn, R.O. (1985). "The Choice of Functional Forms for Hedonic Price Equations: Comment." *Journal of Urban Economics*, Vol. 18, No. 2, pp. 18135-142.

Castle, E.N. and Hoch, I. (1982). “Farm Real Estate Price Component, 1920-78”, *American Journal of Agricultural Economics*, Vol. 64, pp. 8-9.

Cavailhes, J. and Wavresky, P. (2003). “Urban Influences on Periurban Farmland Prices”, *European Review of Agricultural Economics*, Vol. 30, pp. 333–357.

Chai, H. C. (1967). *The Development of British Malaya*, *1896-1909,* 2nd. Edition, Oxford University Press.

Chance, D.M., (2004). *An Introduction to Derivatives*, 6th Edition, Thomson/South Western.

Chavas, J.P. and Thomas, A. (1999). “A Dynamic Analysis of Land Prices”, *American Journal of Agricultural Economics*, Vol. 81, No. 4, pp. 772-784.

Chavas, J.P. and Shumway, C.R. (1982). A Pooled Time-series and Cross-section Analysis of Land Prices”, *Western Journal of Agricultural Economics*, Vol. 7, pp. 31-41.

Chicoine, D.L. (1981). “Farmland Values at the Urban Fringe: An Analysis of Sales Prices”, *Land Economics*, Vol. 57, pp. 353-62.

Cheshire, P. and Magrini, S. (2006). “European Urban Growth: Now for Some Problem of Spaceless and Weightless Econometrics”, Paper prepared for the *46th Congress of the European Regional Science Association,* Volos, Greece, 30 August-3 September 2006.

Chow, G. (1960). “Tests of Equality between Sets of Coefficients in Two Linear Regressions”, *Econometrica*, Vol. 28, pp. 591–605.

Ciaian P. and Swinnen, J.F.M. (2009). “Credit Market Imperfections and the Distribution of Policy Rents”, *American Journal of Agricultural Economics*, Vol. 91, No. 4, pp. 1124-39.

Clark, J.S., Fulton, M. and Scott, J.T. (1993). “The Inconsistency of Land Values, Land Rents, and Capitalization Formulas”, *American Journal of Agricultural Economics*, Vol. 75, No. 1, pp. 147-155.

Colwell, P. and Sirmans, C.F. (1993). :A Comment on Zoning, Returns to Scale, and the Value of Undeveloped Land”, *Review of Economics and Statistics*, Vol. 75, No. 4, pp. 783–86.

Coughlin, R.E. and Keene, J.C. (1981). *The Protection of Farmland: Report to the National Agriculture Land Commission.* Washington D.C.: U.S. Government Printing Office.

Court, A. T. 1(939). “Hedonic Price Indexes with Automotive Examples.” *In The Dynamics of Automobile Demand*. General Motors Corporation, New York, pp. 99–117.

Cox, J. and Ross, S. (1976). “The Valuation of Options for Alternative Stochastic Processes”, *Journal of Financial Economics,* Vol. 3. pp. 145-166.

Cotteleer, G., Stobbe, T. and Van Kooten, G.C. (2008). “A Spatial Bayesian Hedonic Pricing Model of Farmland Values”, paper presented at the *12th European Association of Agricultural Economists*, Ghent, Belgique, August 2008.

Cropper, M. L., Deck, L.B. and McConnell, K. E. (1988). "On the Choice of Functional Form for Hedonic Price Functions." *The Review of Economics and Statistics*, Vol. 70, No. 4, pp. 668-675.

Cunningham, C.R. (2006). "House Price Uncertainty, Timing of Development, and Vacant Land Prices: Evidence for Real Options in Seattle," *Journal of Urban Economics*, Vol. 59, pp.1-31.

Currie, J.M. (1981). *The Economics of Agricultural Land Tenure*, Cambridge: Cambridge University Press.

de Fontnouvelle, P. and Lence, S.H. (2002). “Transaction Costs and the Present Value "Puzzle" of Farmland Prices” *Southern Economic Journal*, Vol. 68, No. 3, pp. 549-565.

Dixit, A. (1992). “Investment and Hysteresis”, *Journal of Economic Perspectives*, Vol. 6, No. 1, pp. 107-132.

Dixit, A., Pindyck, R. (1994). *Investment under Uncertainty*. Princeton University Press, Princeton, NJ.

Drozd, D.J. and Johnson, B.B. (2004). “Dynamics of a Rural Land Market Experiencing Farmland Conversion to Acreages: The Case of Saunders County, Nebraska”, *Land Economics*, Vol. 80, No. 2, pp. 294-311.

Dubin, R. (1988). “Estimation of Regression Ccoefficients in the Presence of Spatially Autocorrelated Error Terms”, *Review of Economics and Statistics*, Vol. 70, pp. 466–474.

Dubin, R. (1992). “Spatial Autocorrelation and Neighborhood Quality”, *Regional Science and Urban Economics*, Vol. 22, pp. 433–452.

Dubin, R.A., (1998). “Predicting House Prices using Multiple Listings Data”, *Journal Real Estate Finance and Economics*, Vol. 17, pp. 35–59.

Dunford, R.W., Marti, C.E. and Mittelkammer, R.C. (1985). “A Case Study of Rural Land Prices at the Urban Fringe Including Subjective Buyer Expectations”, *Land Economics*, Vol. 61, pp. 10-16.

Duvivier, R., Gaspart, F. and de Frahan, B.H. (2005). “A Panel Data Analysis of the Determinants ofFarmland Price: An Application to the Effects of the 1992 CAP Reform in Belgium”, paper prepared for the *XIth EAAE Congress (European Association of Agricultural Economists), The Future of Rural Europe in the Global Agri-Food System*, Copenhagen, Denmark, August 23-27, 2005.

Elad, R.L., Clifton, I .D. and Epperson, J.E. (1994). “Hedonic Estimation Applied to the Farmland Market in Georgia”, *Journal of American Agriculture and Applied Economics*, Vol. 26, pp. 361-5.

Epple, D. (1987). “Hedonic Prices and Implicit Markets: Estimating Demand and Supply Functions for Differentiated Products”, *Journal of Political Economy*, Vol. 95, pp. 59-80.

Evans, A. (2004). *Economics and Land-Use Planning* (Real Estate Issues), Blackwell Publishing Oxford, p.209

Falk, B., (1991). “Formally Testing the Present Value Model of Farmland Prices”, *American Journal of Agricultural Economics*, Vol. 73, pp. 1-10.

Featherstone, A.M. and Baker, T.O. (1987). “An Examination of Farm Sector Real Estate Dynamics: 1910-85.” *American Journal of Agricultural Economics*, Vol. 69, No. 3, pp. 532-46.

Feldstein, M., (1980). “Inflation, Portfolio Choice, and the Prices of Land and Corporate Stock.” *American Journal of Agricultural Economics*, Vol. 62, No. 5, pp. 910-16.

Fotheringham, A.S., Brunsdon, C. and Charlton, M. (2002). *Geographically Weighted Regression: The Analysis of Spatially Varying Relationships*, Wiley, John & Sons, Incorporated.

Freeman, A. M., III (1979). "Hedonic Prices, Property Values and Measuring Environmental Benefits: A Survey of the Issues", *Scandinavian Journal of Economics*, Vol. 81, No. 2, pp. 154-73.

Freeman, A.M. III (1975). “Spatial Equilibrium, the Theory of Rents, and the Measurement of Benefits From Public Programs: A Comment”, *The Quarterly Journal of Economics*, Vol. 89, No. 3, pp. 470-473.

Freeman, A.M. III (1974). "On Estimating Air Pollution Control Benefits from Land Value Studies," *Journal of Environmental Economics and Management*, Vol. 1, pp. 74-83.

Fujimoto, A. (1983) *Income Sharing among Malay peasants : a Study of Land Tenure and Rice Production*, Singapore National University Press, National University of Singapore,

Fulcher, C.M. (2003). *Spatial Aggregation and Prediction in the Hedonic Model*., PhD. diss., North Carolina State University

Gao Xuliaou, Yasushi A. and Chang-Jo F. Chung, (2006). “An Empirical Evaluation of Spatial Regression Models”, *Computers & Geosciences*, Vol. 32, pp.1040–1051

Gardner, B.D. (1977). “The Economics of Agricultural Land Preservation”, *American Journal of Agricultural Economics*, Vol. 59, No. 5, pp. 1027-36.

Gardner, B.L. (1994). “Commercial Agriculture in Metropolitan Areas: Economics and Regulatory Issues.” *Agricultural and Resource Economics Review*, Vol. 23, No. 1, pp. 100-109.

Geoghegan, J., Lynch, L. and Bucholtz, S. (2003). “Capitalization of Open Spaces: Can Agricultural Easements Pay for Themselves?”, *Agricultural and Resource Economic Review*, Vol. 32, No. 1, pp. 33-45.

Geoghegan, J., Wainger, L. and Bockstael, N. (1997). “Spatial Landscape Indices in a Hedonic Framework: An Ecological Economics Analysis Using GIS”, *Ecological Economics*, Vol. 22, No. 3, pp. 251-64.

Gibson, R. and Schwartz, R.S. (1990). “Stochastic Convenience Yield and the Pricing of Oil Contingent Claims”, *The Journal of Finance*, Vol. 45, No. 3, pp. 959-976.

Kim, Jungik, Goldsmith, P.D. and Thomas, M. (2004). "Using Spatial Econometrics To Assess The Impact Of Swine Production On Residential Property Values," 2004 Annual Meeting, August 1-4, Denver, CO 20186, *American Agricultural Economics Association* (New Name 2008: Agricultural and Applied Economics Association).

Goodman, A.C. (1989). “Topics in Empirical Urban Housing Research”, in *The Economics of Housing Markets*, R.F. Muth and A.C. Goodmann, (eds.). Harwood Academic, Chur,Switzerland, pp. 49-143.

Goodman, T.G. and Thibodeau, T.G. (1998). “Housing Market Segmentation”, *Journal of Housing Economics*, Vol. 7, pp. 121-143.

Goodwin, B., Mishra, A.K. and Ortalo-Magne, F. (2003). “What’s Wrong with our Models of Agricultural Land Values?”, *American Journal of Agricultural Economics*, Vol. 85, No. 3, pp. 744-752.

Greene, W. H. (2003). *Econometric Analysis* (5th Edition). Prentice Hall, Upper Saddle River, New Jersey.

Grenadier, S. R. and Weiss, A. M. (1997). “Investments in Technological Innovations: An option Pricing Approach”, *Journal of Financial Economics*, Vol. 44, pp. 397–416.

Griliches, Z. (1961). “Hedonic Price Indexes for Automobiles: An Econometric Analysis of Quality

Change", in *Price Statistics of the Federal Government,* Columbia University Press, New York, reprinted in Griliches, Z.: 1971, *Price Indexes and Quality Change*. Studies in New Methods of Measurement, Harvard University Press, Cambridge.

Gujarati, D. N. (2003). *Basic Econometrics,* McGraw-Hill Irving, New York

Halvorsen, R. and Pollakowski, H. (1981). "Choice of Functional Form for Hedonic Price Equations", *Journal of Urban Economics,* Vol. 10, pp. 37-49.

Hardie, I.W., Narayan, T.A. and Gardner, B.L. (2001). "The Joint Influence of Agricultural and Nonfarm Factors on Real Estate Values: An Application to the Mid-Atlantic Region", American *Journal Agricultural Economics*, Vol. 83, No. 1, pp. 120–132.

Harun, Azmi (1996). *Land Acquisistion: A Comparative Study of English and Malaysian Law.*, PhD. dissertation, University of Reading.

Hidano, N. (2002). *The Economic Valuation of the Environment and Public Policy: A Hedonic Approach*, Edward Elgar, Cheltenham, UK and Northampton, MA.

Hollander, S. (1979). *The Economics of David Ricardo*. University of Toronto Press.

Holloway, G., Lacombe, D., LeSage, J.P. (2007). "Spatial Econometric Issues for Bio- Economic and Land-Use Modelling." *Journal of Agricultural Economics*, Vol. 58, No. 3, pp. 549–588.

Hoover, C.B. (1962). *Economic Systems of the Commonwealth*, Cambridge University Press.

Horii Kenzō (1991) "Disintegration of the Colonial Economic Legacies and Social Restructuring in Malaysia", *Developing Economies, Vol.* **29**, No. 4, pp. 281–311.

Huang, H., Miller, G., Sherrick, B., and Gomez, M. (2006). "Factors Influencing Illinois Farmland Values", *American Journal of Agricultural Economics*, Vol. 88, No. 2, pp. 458-470.

Hull, J. (2003). *Options, Futures and Other Derivatives*, 5th Ed., Prentice, Hall, Englewood Cliffs, NJ.

Hushak, L.J. and Sadr, K. (1979). "A Spatial Model of Land Market Behaviour", *American Journal of Agricultural Economics*, Vol. 61, pp. 697-701.

Hutchison, N. and Nanthakumaran, N., (2000). "The Calculation of Investment Worth: Issues of Market Efficiency, Variable Estimation and Risk Analysis." *Journal of Property Investment and Finance*, Vol. 18, No.1, pp. 33-51.

Isgin, T. and Forster, D. L. (2006). "A Hedonic Price Analysis of Farmland Option Premiums Under Urban Influences", *Canadian Journal of Agricultural Economics*, Vol. 54, pp: 327-340.

Jeanty, P.W. (2010). *spmlreg: Stata module to estimate the spatial lag, the spatial error, the spatial durbin, and the general spatial models by maximum likelihood", Statistical Software Components,* [online], Available at:http://fmwww.bc.edu/repec/bocode/s/spmlreg.ado., [Accessed 23 June 2009].

Jeanty, P.W. (2010). *spwmatrix: Stata module to create, import, and export spatial weights*. [online], Available at:http://fmwww.bc.edu/repec/bocode/s/spwmatrix.ado., [Accessed 23 June 2009].

Just, R.E. and Miranowski, J.A., (1993). "Understanding Farmland Price Changes." *American Journal of Agricultural Economics*, Vol. 75, pp.156-168.

Kam, C.D. and Franzese, R.J. Jr. (2007). *Modeling and Interpreting Interactive Hypotheses in*

Regression Analysis. Ann Arbor, The University of Michigan Press.

Kamal Salih, (1990). "Resource allocation for agricultural development in the sixth Malaysia plans, on Sixth Malaysia Plan", presented at the *Seminar on Agricultural Policies and Strategies,* 16-17 July 1990, Kuala Lumpur.

Kaufman, L. and Rousseeuw, P. J. (1990). *Finding Groups in Data: An Introduction to Cluster Analysis.* New York:Wiley.

Kennedy, G.A., Henning, S.A., Vandeveer, L .R. and Dai, M. (1997). "Multivariate Procedures for Estimating Rural Land Submarkets", *Journal of American Agriculture and Applied Economics*, Vol. 29, pp. 373-83.

Keogh, G. and D'Arcy, E. (1999). "Property Market Efficiency: An Institutional Economics Perspective", *Urban Studies*, Vol. 36, pp. 2401-2414.

Kim, C.W., Phipps, T.T. and Anselin, L. (2003). "Measuring the Benefits of Air Quality Improvement:A Spatial Hedonic Approach", *Journal Environmental Economics and Management*, Vol. 45, No. 1, pp. 24–39.

King, D. A. and Sinden, J.A. (1994) "Price Formation in Farm Land Markets." *Land Economics*, Vol. 70, No. 1, pp. 38-52.

Kuminoff, N.V., Parmeter, C.F. and Pope, J.C. (2009) "Specification of Hedonic Price Functions: Guidance for Cross-Sectional and Panel Data Applications", *Working Paper No. 2009-02, January 2009, Department of Agricultural and Applied Economics*, Virginia Polytechnic Institute and State University

Lancaster, K. (1966). "A New Approach to Consumer Theory", *Journal of Political Economics*, Vol. 74, pp. 132-157.

Lander, D.M. and Pinches, G.E. (1998). "Challenges to the Practical Implementation of Modeling and Valuing Real Options", Quarterly Review of Economics and Finance, Vol. 38, pp. 537-567.

Lavin, A.M. and Zorn, T. (2001). "Empirical Tests of Fundamental-Value Hypothesis in Land Markets", *Journal of Real Estate Finance and Economics*, Vol. 21, No. 1, pp. 99–116.

Lean, W. and Goodall, B. (1966). *Aspects of Land Economics*. Estates Gazette, London . p.414

Lence, S.H. and Miller, D.J. (1999). "Transaction Costs and the Present Value Model of Farmland : Iowa, 1900 – 1994", *American Journal of Agricultural Economics*, Vol. 81, pp. 257-272.

LeSage J. and Pace, K.R. (2009). *Introduction to Spatial Econometrics*, Boca Raton, Florida: Chapman & Hall/CRC, p. 374

LeSage, J.P. (1999). Spatial Econometrics, Morgantown: Regional Research Institute, University of West Virginia.

LeSage, J.P. (2000). "Bayesian Estimation of Limited Dependent-Variable Spatial Autoregressive Models", *Geographical Analysis*, Vol. 32, No. 1, pp. 19–35.

Li, Dun Jen. (1982). *British Malaya: An Economic Analysis,* 2nd rev. ed., Institute for Social Analysis, Kuala Lumpur.

Lin, Tzu-Chin and Evans, A. (2000). "The Relationship between the Price of Land and Size of Plot When Plots are Small", *Land Economics*, Vol. 76, No. 3, pp. 386–94.

Linneman, P. (1980). “Some Empirical Study Results on the Nature of the Hedonic Price Function for the Urban Housing Market”, *Journal of Urban Economics*, Vol. 8, pp. 47-68.

Livanis, G., Moss, C. B., Breneman, V. E. and Nehring, R.F. (2006). “Urban Sprawl and Farmland Prices.” *American Journal of Agricultural Economics*, Vol. 88, No. 4, pp. 915-929.

Lloyd, T.A. (1994). "Testing a Present Value Model of Agricultural Land Values", *Oxford Bulletin of Economics and Statistics*, Vol. 56, No. 2, pp. 209-223.

Lloyd, T.A., Rayner, A.J. and Orme, C.D. (1991). “Present Value Models of Land Prices in England and Wales”, *European Review of Agricultural Economics*, Vol. 18, No. 2, pp. 141-66.

Lopez, R., Shah, F. and Altobello, M. (1994). “Amenity Benefits and the Optimal Allocation of Land”, *Land Economics*, Vol. 70, No. 1, pp. 53-62

Maddison, D. (2004). “Spatial Effects Within the Agricultural Land Market in Northern Ireland: A Comment”, *Journal of Agricultural Economics*, Vol. 55, No. 1, pp. 123-25.

Maddison, D. (2000). “A Hedonic Analysis of Agricultural Land Prices in England and Wales”, *European Review of Agricultural Economics*, Vol. 27, No. 4, pp. 519-532.

Malaysia, Government of. (1971). *Second Malaysia Plan*, 1971–1975. Kuala Lumpur : Government Press.

Malaysia, Government of. (1973). *Mid-Term Review of the Second Malaysia Plan*, 1971–1975. Kuala Lumpur : Government Press.

Malaysia, Government of. (1981). *Fourth Malaysia Plan*, 1981–1985. Kuala Lumpur : National Printing Department.

Malaysia, Government of, (1984a) *National Agricultural Policy Malaysia*. Jawatankuasa Kabinet Mengenai Dasar Pertanian, Kuala Lumpur.

Malaysia, Government of. (1984b). *Mid-Term Review of the Fourth Malaysia Plan, 1981–1985*. Kuala Lumpur : National Printing Department.

Malaysia, Government of. (1986). *Fifth Malaysia Plan, 1986–1990*. Kuala Lumpur : National Printing Department.

Malaysia, Government of. (1991a). *Sixth Malaysia Plan, 1991–1995*. Kuala Lumpur : National Printing Department.

Malaysia, Government of. (1991b). *The Second Outline Perspective Plan, 1991–2000*. Kuala Lumpur : National Printing Department.

Malaysia, Government of, (1993). *National Agricultural Policy (1992-2010),* Malaysia. Kementerian Pertanian. Kuala Lumpur : Ministry of Agriculture Malaysia.

Malaysia, Government of. (1996). *Seventh Malaysia Plan, 1996–2000*. Kuala Lumpur : National Printing Department.

Malaysia, Government of. (1999). *Third National Agricultural Policy (1998-2010),* Kementerian Pertanian. Kuala Lumpur : Ministry of Agriculture, 1999,

Malaysia, Government of. (2001). *Eighth Malaysia Plan, 2001-2005*. Kuala Lumpur : National

Printing Department.

Malaysia, Government of. (2006). *Ninth Malaysia Plan, 2006–2010.* Kuala Lumpur : National Printing Department.

Malpezzi, S. (2003). "Hedonic Pricing Models: A Selective and Applied Review". In. O'Sullivan, T. and Gibb, K. (eds.), *Housing Economics & Public Policy*, Oxford: Blackwell Publishing, .

McDonald, R.L. and Siegel, D.R. (1986). "The Value of Waiting to Invest," *Quarterly Journal of Economics*, Vol. 101, No. 4, pp. 707-727.

Melichar, E. (1979). "Capital Gains Versus Current Income in the Farming Sector", *American Journal of Agricultural Economics*, Vol. 61, pp. 1085-74.

Merton, R.C. (1973). "Theory of Rational Asset Pricing", *Bell Journal of Economics and Management Science*. Vol. 4, pp. 141-183.

Merton, R.C. (1977). "An Analytic Derivation of the Cost Of Deposit Insurance and Loan Guarantees", *Journal of Banking and Finance*, Vol. 1, pp. 3–11.

Miranowski, A.J. and Hammes, B.D. (1984). "Implicit Prices of Soil Characteristics for Farmland in Iowa", *American Journal of Agricultural Economics*, Vol. 66, pp. 746-749.

Mokhzani, Abd. Rahim, (2006). *Credit in a Malay Peasant Economy*. Kuala Lumpur, Malaysia: Arus Intelek : Faculty of Economics & Administration, University of Malaya.

Mollard, A., Rambonilaza T. and Vollet, D. (2007). "Environmental Amenities and Territorial Anchorage in the Recreational-Housing Rental Market: A Hedonic Approach with French Data." *Land Use Policy*, Vol. 24, pp. 484–493.

Mueller, J.M., Loomis, B. (2008). "Spatial Dependence in Hedonic Property Models: Do Different Corrections For Spatial Dependence Result in Economically Significant Differences in Estimated Implicit Prices?", *Journal of Agricultural and Resource Economics*, Vol. 33, No. 2, pp. 212-231.

Myers, S.C. and Majd, S. (1990). "Abandonment Value and Project Life," *Advances in Futures and Options Research*, Vol. 4, pp. 1-21.

Myers, S.C. (1987) "Finance Theory and Financial Strategy," *Midland Corporate Finance Journal*, Vol. 5, No. 1, pp. 6-13.

National Institute of Valuation, Valuation and Property Services Division. *Property Market Report*. Kuala Lumpur: Ministry of Finance Malaysia. (various issues)

National Land Code, *Malayan Law Journal*: 1965: 1: xxiv-xxvi.

Needham, B. and de Kam, G. (2004). "Understanding How Land is Exchanged: Co-Ordination Mechanisms and Transaction Costs", *Urban Studies*, Vol. 41, No. 10, pp. 2061-2076.

Nickerson, C. J. and Lynch, L. (2001). "The Effect of Farmland Preservation Programs on Farmland Prices", *American Journal of Agricultural Economics,* Vol. 83, pp. 341–351.

Oltmans, A.W., Chicoine, D.L. and Scott, J.T. Jr. (1988). "Farmland Price Indexes: An Evaluation of Alternatives for Illinois, 1975-1984", *Ag-Econ AERR Staff Paper*, University of Illinois at Urbana-Champaign.

Ooi, J.F.,T.,Sirmans C.F. and Turnbull, G.K., (2007). “Government Supply of Land in a Dual Market”, *Working Paper No. 702,* February 2007, School of Policy Studies, Georgia State University

Ord, J.K. (1975). “Estimation Methods for Models of Spatial Interaction”. *Journal of the American Statistical Association,* Vol.70, pp. 120–126.

Pace, R.K., Barry, R., Clapp, J.M. and Rodriquez, M. (1988). “Spatiotemporal Autoregressive Models of Neighbourhood Effects”, *Journal of Real Estate Finance and Economics*, Vol. 17, pp. 5–13.

Pace, R. K. (1997). “Performing Large Spatial Regressions and Autoregressions”, *Economics Letters,* Vol. 54, pp. 283–291.

Pace, R. K. and Barry, R. (1997). “Quick Computation of Regressions with a Spatially Autoregressive Dependent Variable,” *Geographical Analysis,* Vol. 29, No. 1, pp. 232-237.

Pace, R. K. and Barry, R. (1997). “Sparse Spatial Autoregressions”, *Statistics and Probability Letters,* Vol. 33, pp. 291–297.

Pace, R., Barry, R. and Sirmans, C.F. (1998). “Spatial Statistics and Real Estate”, *Journal of Real Estate Finance and Economics*, Vol. 17, pp. 5–13.

Paddock, J.L., Siegel, D.R. and Smith, J.R. (1988). “Option Valuation of Claims on Real Assets: The Case of Offshore Petroleum Leases”, *The Quarterly Journal of Economics*, Vol. 103, No. 3, pp. 479-508.

Palmquist, R .B. (1989). “Land as a Differentiated Factor of Production: A Hedonic Model and Its Implications for Welfare Measurement”, *Land Economics*, Vol. 6, No. 5, pp. 23-8.

Palmquist, R.B. (1992). “Valuing Localized Externalities”, *Journal of Urban Economics*, Vol. 31, pp. 59-68.

Palmquist, R.B., Roka, F.M. and Vukina, T. (1997). “Hog Operations, Environmental Effects, and Residential Property Values.” *Land Economics*, Vol. 73, No. 1, pp. 114–24.

Paterson, R. W. and Boyle, K. J. (2002) “Out of Sight, Out of Mind? Using GIS to Incorporate Visibility in Hedonic Property Value Models”, *Land Economics,* Vol. 78, pp. 417– 425.

Patton, M. and McErlean, S. (2003) “Spatial Effects within the Agricultural Land Market in Northern Ireland”, *Journal of Agricultural Economics*, Vol. 54, pp. 35–54.

Pazim Othman (1992). “Land-Abandonment in the Rice Sector in West Malaysia”, *Malaysian Journal of Economic Studies*, Vol. 29, No. 1, pp. 51-68.

Pazim Othman. (1997). “The Position of Idle land in Malaysia”, paper presented at *CAP National Conference on Land, Emerging Issues &* Challenges, 12-15 December 1997, Pulau Pinang.

Phipps, T. (1984). “Land Prices and Farm-Based Returns”, *American Journal of Agricultural Economics,* Vol. 66, No. 4, pp. 422-429.

Pindyck, R. (1988). "Irreversible Investment, Capacity Choice, and the Value of the Firm", *American Economic Review,* Vol. 78, No. 5, pp. 969-985.

Pindyck, R. (1991). "Irreversible Investment, Uncertainty, and Investment," *Journal of Economic Literature*, Vol. 29, pp.1110-1152.

Plantinga, A. J. and Miller, D. J. (2001). "Agricultural Land Values and the Value of Rights to Future

Land Development", *Land Economics*, Vol. 77, No. 1, pp. 56-67.

Plantinga, A.J., Lubowski, R.N. and Stavins, R.N., (2002) "The Effects of Potential Land Development on Agricultural Land Prices." *Journal of Urban Economics*, Vol. 52, pp. 561-581.

Quigg, L. (1993). "Empirical Testing of Real Option-Pricing Models", *Journal of Finance*, Vol. 48, pp. 621-640.

Ready, R.C. and Abdalla, C.W. (2005). "The Amenity and Disamenity Impacts of Agriculture: Estimates from a Hedonic Pricing Model", *American Journal of Agricultural Economics*, Vol. 87, pp. 314–326.

Ricardo, David (1815). "Essay on the Influence of a Low Price of Corn on the Profits of Stock", in *The Works and Correspondence of David Ricardo*, ed. Piero Sraffa (2005) with the Collaboration of M.H. Dobb Indianapolis: Liberty Fund

Riddiough, T. (1997), "The Economic Consequences of Regulatory Taking Risk on Land Value and Development Activity", *Journal of Urban Economics*, Vol. 41, pp. 56-77.

Robison, L.J, Lins, D.A., and VenKataraman, R., (1985). "Cash Rents and Land Values in U.S. Agriculture", *American Journal of Agricultural Economics*, Vol. 67, No. 4, pp. 794-805.

Roka, F., Palmquist, R. (1997). "Examining the Use of National Databases in a Hedonic Analysis of Regional Farmland Values", *American Journal Agricultural Economics*. Vol. 79, No. 5, pp. 1651–1656.

Rosen, S. (1974). "Hedonic Prices And Implicit Markets: Product Differentiation in Pure Competition", *Journal of Political Economy*, Vol. 82, pp. 32–55.

Ross-Larson, Bruce, ed. (1978). *Malaysia 2001: A Preliminary Inquiry*. Kuala Lumpur, Malaysia: Syed Kechik Foundation.

Sahak Mamat, (1986). "Memperdagangkan Tanah Sawah Terbiar Dalam Konteks Beberapa Polisi Kerajaan", Paper presented at *National Rice Conference* , 20-22 January, 1986, Serdang.

Salleh Buang (2001). *Malaysian Torrens System,* Dewan Bahasa dan Pustaka, Kuala Lumpur.

Schmitz. A. (1995). "Boom-Bust Cycles and Ricardian Rent", *American Journal of Agricultural Economics*, Vol. 77, No. 5, pp. 1110—25.

Schwartz E.S. and Trigeorgis, L. (2001). "Real Options and Investment Under Uncertainty: An Overview", in: Schwartz E.S. and L. Trigeorgis (eds.), *Real Options and Investment Under Uncertainty*. Cambridge Massachusetts: MIT Press: p. 1-16.

Schwartz, E. S. and Zozaya-Gorostiza, C. (2003). "Investment under Uncertainty in Information Technology: Acquisition and Development", *Management Sciences*, Vol. 49, No. 1, pp. 57–70.

Schwartz, E. S. and Smith, J. (2000). "Short-Term Variations and Long-Term Dynamics in Commodity Prices", Management Sciences, Vol. 46, No. 7, pp. 893–911.

Shi, Y.J., Phipps, T.T. and Coyler, D. (1997). "Agricultural Land Values under Urbanising Influences", *Land Economics*, Vol. 73, No. 1, pp. 90-100.

Shonkwiler, J.S. and Reynolds, J.E. (1986). "A Note on the Use of Hedonic Price Models in the Analysis of Land Prices at the Urban Fringe", *Land Economics,* Vol. 62, pp. 58–63.

Silcock, T. H. (1961). “Economics of Population Policy in the Federation of Malaya”, In *Readings in Malayan Economics*, edited by T.H. Silcock (1961), p. 85-93 Singapore: Eastern Universities Press.

Slade, M.E. (2001). “Valuing Managerial Flexibility: An Application of Real-Option Theory to Mining Investments”, *Journal of Environmental Economics and Management*. Vol. 41, pp. 193-233.

Smith, Adam (1977) [1776]. *An Inquiry into the Nature and Causes of the Wealth of Nations.* University Of Chicago Press.

Smith, V.K. and Huang, J.C. (1995). “Can Markets Value Air Quality? A Meta-Analysis of Hedonic Property Value Models”, *Journal of Political Economy*, Vol. 103, No. 1, pp. 209-227.

Spahr, R., and Sunderman, M. (1995). “Additional Evidence on the Homogeneity of the Value of Government Grazing Leases and Changing Attributes for Ranch Values”, *Journal of Real Estate Research*, Vol. 10, pp. 601–616.

StataCorp. 2009. *Stata Statistical Software: Release 11*. College Station, TX: StataCorp LP.

Sukor Kasim (1984). *“Land Reforms: Options and Realities in the Malaysia Economy at the Cross roads: Policy Adjustment or Structural Transformation”.* Lim Lin Lean and Chee Peng Lim (eds), Kuala Lumpur, Malaysia, jointly published by Malaysian Economic Association and Organizational Resources Sdn. Bhd.

Taff, S.J., Tiffany, D.G. and Weisberg, S. (1996). “Measured Effects of Feedlots on Residential PropertyValues in Minnesota:AReport to the Legislature.” *Staff Paper P96-12, Department of Applied Economics,* University of Minnesota, St. Paul, MN.

Taylor, L.O. (2003). “*The Hedonic Method”,* In *A Primer on Non Market Valuation*. P. A. Champ, K. J. Boyle, and T. C. Brown, (eds.), Vol. 3, Dordrecht, the Netherlands: Kluwer Academic Publishers, pp. 331-394.

Thong, G.T.S. (1987). “Effect of Diversification Strategy on Selected Malaysian Manufacturing Companies between 1972 and 1982”, paper presented at *Conference on Issues and Challenges for National Development*, 15-16 December, 1987, Kuala Lumpur.

Tiao, G. and Goldberger, A. (1962). “Testing Equality of Individual Regression Coefficients”, *WEBH, Paper 6201*, Social Systems Research Institute, University of Wisconsin.

Titman, S. (1985). "Urban Land Prices under Uncertainty," *American Economic Review*, Vol. 75, pp. 505-514.

Tobler W. (1970). "A Computer Movie Simulating Urban Growth in the Detroit Region", *Economic Geography*, Vol. 46, No. 2, pp. 234-240.

Towe, C., Nickerson, C. and Bockstael, N. E. (2005). “An empirical examination of real options and the timing of land conversions”, paper presented at the *2005 Annual Meeting of the American Agricultural Economics Associatio*n, Providence, Rhode Island.

Trigeorgis, L. (1996). *Real Options: Managerial Flexibility and Strategy in Resource Allocation*. MIT Press, Cambridge, MA.

Trigeorgis, L. and Mason, S.P. (1987). "Valuing Managerial Flexibility," *Midland Corporate Finance Journal*, Vol. 5, No. 1, pp. 14-21.

Trigeorgis, L. (1993). "The Nature of Option Interactions and the Valuation of Investments with Multiple Real Options," *Journal of Financial and Quantitative Analysis*, Vol. 28, No. 1, pp. 1-20.

Tsoodle, L.J., Golden, B.B and Featherstone, A.M. (2006). "Factors Influencing Kansas Agricultural Farm Land Values", *Land Economics,* Vol. 82, No. 1, pp. 124-139.

Turvey, C. (2002) "Can Hysteresis and Real Options Explain the Farmland Valuation Puzzle?" *Working Paper 02/11, Department of Agricultural Economics and Business University of Guelph*, Guelph, Ontario.

Tweeten, L. G. and Martin, J. E. (1966). "A Methodology for Predicting U.S. Farm Real Estate Price Variation", *Journal of Farm Economics*, Vol. 48, No. 2, pp. 378-393.

van Kooten, G. Cornelis (1993). *Land Resource Economics and Sustainable Development,* UBC Press, Vancouver.

Vandeveer, L.R., Kennedy, L.R., Henning, S.A, Chunxiao Li, Ming Dai, (1998). "Geographic Information Systems Procedures for Conducting Rural Land Market Research", *Review of Agricultural Economics,* Vol. 20, No. 2, pp. 448- 461.

Vanslembrouck, I., Van Huylenbroeck, G. and Van Meensel, J. (2005). "Impact of Agriculture on Rural Tourism: A Hedonic Pricing Approach", *Journal ofAgricultural Economics*, Vol. 56, No. 1, pp. 17-30.

Vranken, L., MacOurs, K., Noev, N., and Swinnen, J.F.M. (2007). "Property Rights Imperfections, Asset Allocation, and Welfare: Co-Ownership in Bulgaria," paper presented at the *104th Seminar European Association of Agricultural Economists*, September 5-8, 2007, Budapest, Hungary.

Wan Hashim, (1988). *Peasants : Under Peripheral Capitalism* . Penerbit Universiti Kebangsaan Malaysia. p. 205.

Wang, Li, and Ready, R.C. (2005). "Spatial Econometric Approaches to Estimating Hedonic Property Value Models", paper presented at *American Agricultural Economics Association Annual Meetings*. Providence, RI, July, 2005.

Waugh, F.V. (1928). "Quality Factors Influencing Vegetable Prices", *Journal of Farm Economics,* Vol. 10, No. 2, pp. 185-196

Weersink, A., Clark, S., Turvey, C.G. and Sarker, R. (1999). "The Effect of Agricultural Policy on Farmland Values", *Land Economics,* Vol. 75, No. 3, pp. 425-439.

White, H. (1980). "A Heteroskedasticity-Consistent Covariance Matrix and a Direct Test for Heteroskedasticity", *Econometrica*, Vol. 48, pp. 817–38.

Wilcox, D.L. (1978). "Malaysia's System of Conditional Land Titles as a Potential Policy Instrument". *The American Journal of Comparative Law,* Vol. 26, No. 2, pp. 321-332.

Wilhelmsson M. (2002). "Spatial Models In Real Estate Economics". *Housing, Theory and Society,* Vol. 19, pp. 92-101.

Wilhelmsson, M. (2004). "A Method to Derive Housing Sub-Markets and Reduce Spatial Dependency", *Property Management,* Vol. 22, No.4, pp. 276-288.

Williams, J.T. (1991). "Real Estate Development as an Option", *Journal of Real Estate Finance and Economics,* Vol. 4, pp. 191-208.

Xu, E., Mittelhammer, R.C. and Barkley, E.C. (1993). "Measuring the Contributions of Site Characteristics to the Value of Rural Land", *Land Economics,* Vol. 69, No. 1, pp. 356-69.

Yamazaki, R. (2001). "Empirical testing of real option pricing models using Land Price Index in Japan", *Journal of Property Investment & Finance*, Vol. 19, No. 1, pp. 53-72.

Yang, Pei Keng (1993). *The National Land Code (Amendment) Act 1992*, Insaf: : 22.1 : 29-39.

Yang, Pei Keng (1996). *The National Land Code (Amendment) Act 1996,* Insaf: : 25.1 : 3-46.

Yusuf, Nik Mohd. Zain (1989). *Land Tenure and Land Law Reforms in Peninsular Malaysia,* PhD. diss., University of Kent.

Zhang, P. (1998). *Exotic Options*, 2nd Edition. World Scientificc Publishing, River Edge, NJ.

Zimmerman, F. and Carter, M. (1999) "A Dynamic Option Value for Institutional Change: Marketable Property Rights in the Sahel", *American Journal of Agricultural Economics,* Vol. 81, No. 2, pp. 467-478.