Microeconometric Analysis of Firm Level Adjustment to Globalisation

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To Lucilla

Abstract

The globalisation process of national economies, through trade and foreign direct investment flows, has been one of the most important forces of economic changes in the latest decades. This thesis contributes to the growing literature on firm level adjustment to globalisation. This literature initiated a new paradigm in international trade based on heterogeneous firms. The recent availability of large firm-level data sets and new theoretical models allow to examine how heterogeneous firms react to internationalisation processes, and how their responses determine changes at more aggregate levels.

In each chapter of this dissertation we deal with one different aspect of firm-level adjustment to globalisation processes using a data set of manufacturing firms based in the United Kingdom. The United Kingdom is a good example of a globalised economy given that it is second largest host of multinational enterprises and relatively open to international trade.

Overall, our results support the view that heterogeneous firm-level adjustments are important to our understanding of the impact of internationalisation processes on national economies. We argue and find evidence (in chapter two) that import competition does not necessarily lead to higher elasticity of the demand for labour at firm and industry-level, as it has been claimed before. Furthermore, we show (in chapter three) that foreign affiliates contribute disproportionately to the export performance of United Kingdom manufacturing sectors. The export decisions of multinational enterprises seem to depend on motives different from those of domestic firms. Finally, we

present evidence (in chapter four) of the relationship between firm-level productivity and participation to globalisation processes, through trade or foreign direct investment, comparing not means, but productivity distribution functions, which allows to account for the heterogeneity of productivity level across firms.

In general, these findings underline the importance of building from microeconomic evidence to gauge the likely impact of globalisation processes on national economies.

Acknowledgments

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Two chapters of this PhD dissertations were published with co-authors in referee journals. I want to thank them in particular for their collaboration. Working with has been a fruitful and worthwhile experience. The analysis in chapter three appeared as "Export Oriented FDI in the UK"' (with Richard Kneller) in *Oxford Review of Economic Policy*, Vol. 20. No. 3, 2004. Chapter four was published as "Export versus FDI: An Empirical Test" (with Richard Kneller and Sourafel Girma) in *Review of World Economics*, Vol. 141, No. 2, 2005.

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Chapter 1

Introduction

1.1 Motivation of the thesis

The general aim of this thesis is to contribute to the fast growing literature on firm-level adjustment to globalisation processes. Globalisation is here intended as both international trade and foreign direct investment (henceforth FDI) flows.

Research interest in this topic has risen dramatically in the last decade in parallel with the seemingly unstoppable process of internationalisation of national economies and with the availability of firm-level data sets. The latter have provided economists with an additional and extremely rich source of information, which has made it possible to analyse the impact of international trade and FDI flows at the highest possible level of disaggregation, namely firms or plants.

Overall, this new research line can be seen as a major step forward further development in the international trade and FDI literature, where attention has shifted from countries and industries to *heterogeneous* firms. Traditional trade theories, built upon the works of Heckscher, Ohlin (1933) and Vanek (1968) (HOV), deal with countries and industries, the former characterised by different factor endowments. The relative abundance/scarcity of factors is the only determinant of international trade. Countries will specialise in and export the product of the industry that uses intensively their relative abundant input. These models have subsequently evolved in the so called "new trade theory" (Helpman and Krugman 1985), which allows for increasing return to scale and imperfect competition. This development has made it possible to explain some important empirical phenomena completely unaccounted for by the HOV framework, notably intra-industry trade and FDI (i.e. multinationals). However, this strand of research still relies on the representative firm, thereby yielding knife edge-solutions in which all firms in an industry will behave in exactly the same way. Therefore, although new trade theory is able to explain important empirical regularities, which are unexplained in the HOV framework, little understanding has been gained of how heterogeneous firms respond to globalisation processes and how these determine aggregate responses at industry and country-level.

The last stage in this evolution, stimulated by the availability of firm-level data sets, puts heterogeneous firms at the center of the analysis. This has been mainly an empirical-led research endevour, so far. Indeed, empirical findings have pointed to the fact that firms, even in narrowly defined industries, are diverse in many respects, such as productivity-level and growth, participation in international commerce through export and FDI, spending on research and development, employment, skill of workers and so on. International economists have tried, subsequently, to explain these findings in new theoretic trade models (Melitz 2003; Helpman, Melitz, and Yeaple 2004; Bernard, Eaton, Jensen, and Kortum 2003) and incorporating heterogeneous firms in the "traditional" factor endowment trade model (Bernard, Redding, and Schott

2004).

This new literature on globalisation and heterogeneous firms has already had important consequences from both an academic and policy standpoint. From an academic point of view, it has improved our comprehension of how decreasing international trade barriers may affect firms and industries (for instance, productivity seems to be the main determinant of survival probabilities after trade liberalisation policies and of export-FDI decisions). This has important implications for policy makers as well, since taking firms as a unit of reference makes it possible to target more precisely economic policies towards those agents that are likely to benefit from them most. For instance, countries undertake export promotion policies in various fashions; knowing what firms are more likely to export may allow officials to offer incentives to those firms that most need them. Furthermore, if imports from low wage countries displace jobs at home at different rates in different firms (according to their productivity level, for example, or ability to diversify into new products), compensation programs aimed at workers who lose jobs may be better targeted and their cost more precisely estimated in advance.

This new international economics literature is still in its infancy. Although, it has already contributed answers to some important questions it has raised also new ones, such as: How is the level of employment at the firm and industry-level affected by rising imports? Are FDI and exports complements or substitutes at the firm level? What are the main determinants of acquisition of domestic firms by foreign companies? This thesis aims at providing a contribution to answering some of these questions.

1.2 Firm-level analysis of the impact of globalisation

The globalisation process is a pervasive phenomenon that is changing dramatically the economic landscape where firms operate. In the latest decades the world economy has experienced a surge in both international trade and FDI flows. As table 1.1 shows exports of goods and non-factor services increased nearly threefold from 1982 to 1999. The total assets of foreign affiliates (as a measure of FDI) rose even more, from nearly 2000$ billions to 17680$ billions. These increments correspond to an average annual growth rate of world exports of about 9 percent, during the 80s, and 7 percent, during the 90s; for FDI the corresponding figures are 24 percent, during the 80s, and 23 percent, during the 90s.

It is worth noting that these figures dwarf the average annual rates of growth of the world GDP for the same periods. Thus, it appears that the growth in trade and FDI flows cannot be explained by the growth of the world economy alone. This is better seen as a phenomenon that is changing the structure of national economies around the world.

Furthermore, from table 1.1 it is possible to note as the exports of foreign affiliates outpaced, in both decades, the worldwide exports of goods and non-factor services. In 1999, figures show that foreign affiliates accounted for nearly half of the worldwide exports.

The rise in international trade and FDI flows poses threats and opportunities for firms. On the hand, they may face increased import competition from low costs countries or from foreign multinationals establishing new foreign affiliates. On the

Table 1.1: Major trends of the globalisation process

	Value at current prices (billions of USD)			Annual growth rate (%)	
	1982	1990	1999	1982–1990	1990–1999
Exports of goods and non-factor services	2401	4173	6892	9.2	7.2
Total assets of foreign affiliates	1886	5706	17680	24.30	23.31
Sales of foreign affiliates	2462	5503	13564	15.44	16.27
Exports of foreign affiliates	637	1165	3167	10.36	19.09
GDP at factor costs	10611	21473	30061	12.80	4.44

Source: UNCTAD - Division of Transnational Corporations and Investment.

other hand, domestic companies may take advantage of these processes. They could benefit from knowledge spillovers originated from their geographical proximity to more productive and more technology intensive foreign firms or they may become exporters and/or multinationals themselves.

There is a burgeoning literature of firm-level adjustment to globalisation. It presents different, but obviously related, strands. This PhD dissertation presents three distinct contributions to this literature. The fist regards the impact of imports on the elasticity of the demand for labour. In the second, we look at the export strategies of foreign affiliates, whereas the third concerns how to rank unambiguously, in terms of productivity, non-exporters, exporters and multinationals. Before outlining in more details the work in this thesis and its findings, it is worth to step back and discuss what are the more actively researched topics in the literature of firms-level adjustment to globalisation.

One research area that has attracted particular attention concerns the relationship between productivity and participation in international commerce. This literature has been initiated by the seminal work of Bernard and Jensen(1995, 1999), which showed, for the US, that exporting firms are larger, more productive and pay higher wages than those selling to the domestic market only. In addition, their analyses support the idea that more productive firms self-select into the export market, rather than becoming so after having started exporting (learning by exporting). This type of study has been replicated using data for many other countries (Delgado *et al.*(2001) for Spain; Bernard and Wagner (1997) for Germany; Girma *et al.* (2004) for the UK to cite a few).

Overall, these studies provide further evidence that exporters are more productive than non-exporters irrespective of the sample period and country considered. These types of studies have also looked at how exporting may actually improve overall industry/country productivity. There are mainly two hypotheses: learning by exporting and reallocation. The latter seems to be the main effect of exports on aggregate producitivity for the US; indeed, Bernard and Jensen (2004a) have shown that after entry, exporters present higher output and employment growth rates than non-exporters, but not productivity growth rates. This suggests that there is a reallocation of activity from less productive plants (i.e. non-exporters) to more productive ones. The learning by exporting hypothesis, whilst rejected by Bernard and Jensen, has found some support in other empirical studies of Girma *et al.* (2004), Castellani (2002), for Italy, and Wagner (2002), for Germany. The main contribution of these studies has been to make theorists and policy makers pay attention to the importance of sunk costs of entry into the export market and how exports may actually contribute to the evolution of productivity at the country and industry-level.

Other work has dealt with job turnover and trade. Here, analysts have tried to identify the effect of trade on jobs at the industry-level, building from microeconomic evidence. The first contribution of this literature has been to distinguish between gross and net job turnover of industries and, more importantly, that net job turnover appears to be only a tiny fraction of the gross figure. Several studies have corroborated the finding of Davis *et al.* (1996) who shows, for the US, that there is "excess" job turnover. For what concerns the impact of trade on gross and net job turnover, Klein *et al.* (2003) have shown that, for the US, long-term changes in the exchange rate significantly affect gross job flows, but not net job flows, in manufacturing industries producing tradable goods. This represents a further advance in the understanding of how trade might affect jobs with respect to aggregate level studies where only net job flows where considered.

Another fruitful research area has looked at spillovers from foreign affiliates to domestic firms. Governments all over the world engage in inward-FDI promoting policies. These have been motivated on the existence of productivity/techonology spillovers, which should raise the productivity of domestic enterprises. However, empirical studies have not shown significant evidence of positive spillovers (see Gorg and Greenaway (2004) for review of the literature). This casts some doubt over the expected economic benefits of those financial incentives offered to multinationals to establish foreign affiliates.

Other researchers have looked at industry productivity dynamics and import competition. Overall, reallocation of economic activity from low productivity plants to highly productive ones seems to be one of the main sources of industry productivity growth (see for instance Foster *et al.* (1998) for the US, and Disney *et al.* (2003) for the UK). In addition, it has been observed that import competition is a significant determinant of within-firm productivity improvement (Tybout 2000; Disney, Haskel, and Heden 2003; Pavcnik 2000).

1.3 Outline of the thesis

This doctoral dissertation aims at contributing to the literature about firm-level adjustment to globalisation. It presents three contributions concerning the relationship between the elasticity of the demand for labour and trade, the different export strategies of domestic firms and foreign affiliates, and differences in the productivity distribution of non-exporting, exporting and multinational firms.

The firm-level data set that has been used for this dissertation is OneSource. It contains information on all private and public companies operating in the UK. This makes the studies contained in this thesis empirically consistent. The dissertation is organised as follows.

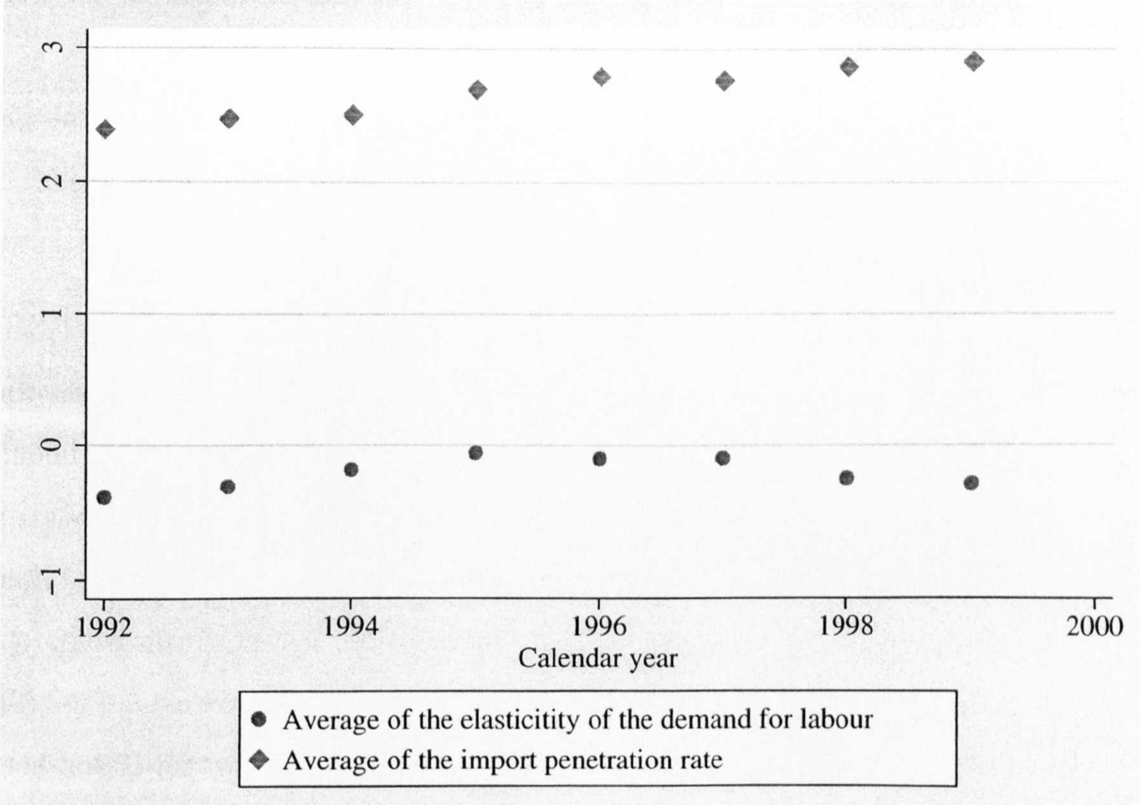
Chapter two deals with the issue of labour demand elasticity and trade. This has been an active research area since Rodrik (1997) argued that trade makes labour demand more elastic. This statement has been subject to further qualifications (Panagariya 2000b) and empirical tests. It has attracted the attention of policy makers too, given the debates about the effect of trade on workers that have appeared regularly in the popular press.

Figure 1.1 and table 1.2 give a crude idea of the relationship between the elasticity of the demand for labour and the import penetration rate in the UK during the nineties. As it is possible to see the average import penetration rate across UK manufacturing industries grew steadily over this period. This signals that the UK economy became more open to foreign products and competition. The average elasticity of the demand for for labour is reassuringly negative, as expected, throughout, but its behaviour over time seems to be more erratic. The demand for labour appears to have become less elastic until the mid-nineties; after this point, it grew more elastic.

The correlation between the import penetration rate the elasticity of the labour demand is shown in table 1.2. As it is possible to observe the correlation became negative and stronger over the course of the nineties. Although for the whole sample period there is a positive correlation, from 1994 onwards it becomes negative, i.e. the higher the import penetration rate of an industry the higher (in absolute value) the labour demand elasticity, and more pronounced in the latest years. This lends support to hypothesis advanced by Rodrik (1997).

Then, for the UK it seems that the elasticity of the demand for labour became more elastic, during the second half of the nineties, as the import penetration rose. However, empirical studies to date that have dealt with this issue have mainly failed to detect any significant effect of trade on the elasticity of demand for labour. In chapter two we advance some motives why it may be so. The whole empirical literature has referred to the Allen-Uzawa elasticity formulation. However, this is appropriate only at the industry level considering constant return to scale. We extend the Allen-Uzawa relationship to imperfectly competitive markets and allow for a non-homogeneous production function. This extension is consistent with a profit maximising firm. In this setting we show how the elasticity of demand for labour is still composed of two terms, namely the substitution and scale effect. However, unlike in the Allen-Uzawa framework, the scale effect is comprised of two elements, one of which is the result of the pro-competitive effect among firms. This reduces the absolute value of the scale effect. The extent of the reduction depends on industrial structure, but our estimates, using a firm-level data set of UK manufacturing sectors, show that it is noteworthy. Aggregating the firm-level relationship to a higher level, we can formally show how the industry-level elasticity of the demand for labour is increasing in the import penetration rate. Yet, because of the scale effect reducing element, the increase in

Figure 1.1: The relationship between import penetration and the elasticity of the demand for labour in the UK



Note: The elasticity of the demand for labour was computed as $\frac{\Delta \log l}{\Delta \log w}$ (where l and w are labour and wages, respectively) using only manufacturing firms in the OneSource data set. To avoid outliers the values below the 5^{th} and above the 95^{th} percentiles were not considered. The import penetration rate was calculated using yearly the Input-Output Supply and Use Tables. It is the ratio between imports in each industry and the total domestic production (plus imports) of each industry.

Table 1.2: Correlation between the discrete approximation of the elasticity of the demand for labour the import penetration rate.

	1992–1999	1993–1999	1994–1999	1995–1999	1996–1999	1997–1999	1998–1999
ρ	0.47	0.16	-0.35	-0.95	-0.98	-0.97	-0.94

Note: ρ is the correlation coefficients of the variables of interest. Their values were computed as described in the note of figure 1.1.

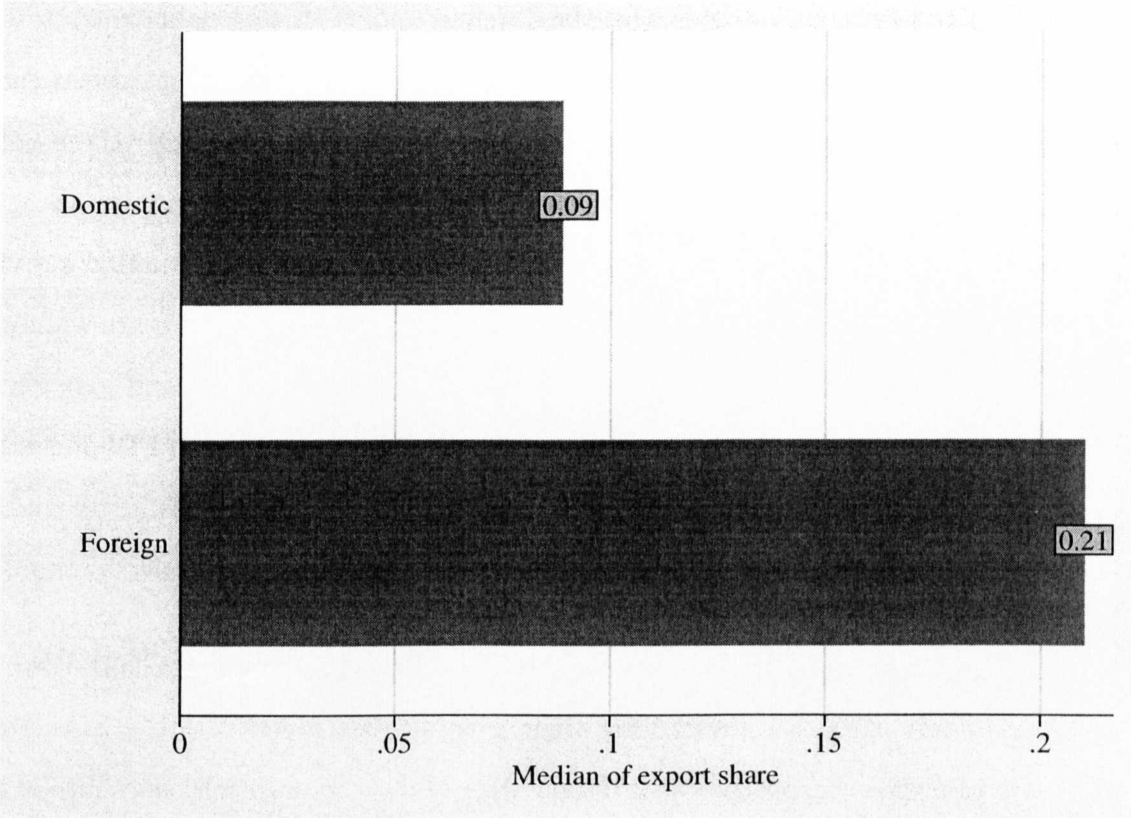
the elasticity due to a rise in the import penetration, is found to be limited.

The next chapter deals with the different export strategies of domestic and foreign firms. Policies aimed at attracting foreign firms and promoting exports have figured prominently in the agenda of policymakers the world over. Under these policies, various financial incentives have been offered to multinational enterprises to establish plants within national borders. By the same token, export promotion activities ranging from financing trade fairs to offering export credit insurance are widely used. All such initiatives are based on the belief that foreign affiliates and exports positively affects economic growth. A neglected aspect of the literature on FDI and export is the contribution of foreign affiliates to exports. This chapter investigates and compares the export strategies of foreign multinational and domestic firms.

To give an idea of the growing importance of the export activities of foreign affiliates, table 1.1 shows that their exports rose notably during the eighthes and and nineties (respectively by 10 and 19 percent). In addition, the share of worldwide exports accounted for by foreign companies rose from 31 percent in 1982 to 45 percent in 1999. The surging export activities of foreign firms suggest that they are not established to just sell products in host countries. Products produced therein are likely to be exported back to the home country and/or to third countries. These FDI strategies do not fall neatly within the dichotomy, vertical versus horizontal FDI, which the theoretical literature refers to (Markusen 2002). Then, the expansion policies pursued by multinational enterprises appear to be more complex than those envisaged in the literature.

To assess the relevance of the export activities of foreign firms in the UK, figure 1.2 depicts the median of the export share of foreign and domestic manufacturing firms

Figure 1.2: Median of the export share of foreign and domestic manufacturing companies in the UK (1988–1999)

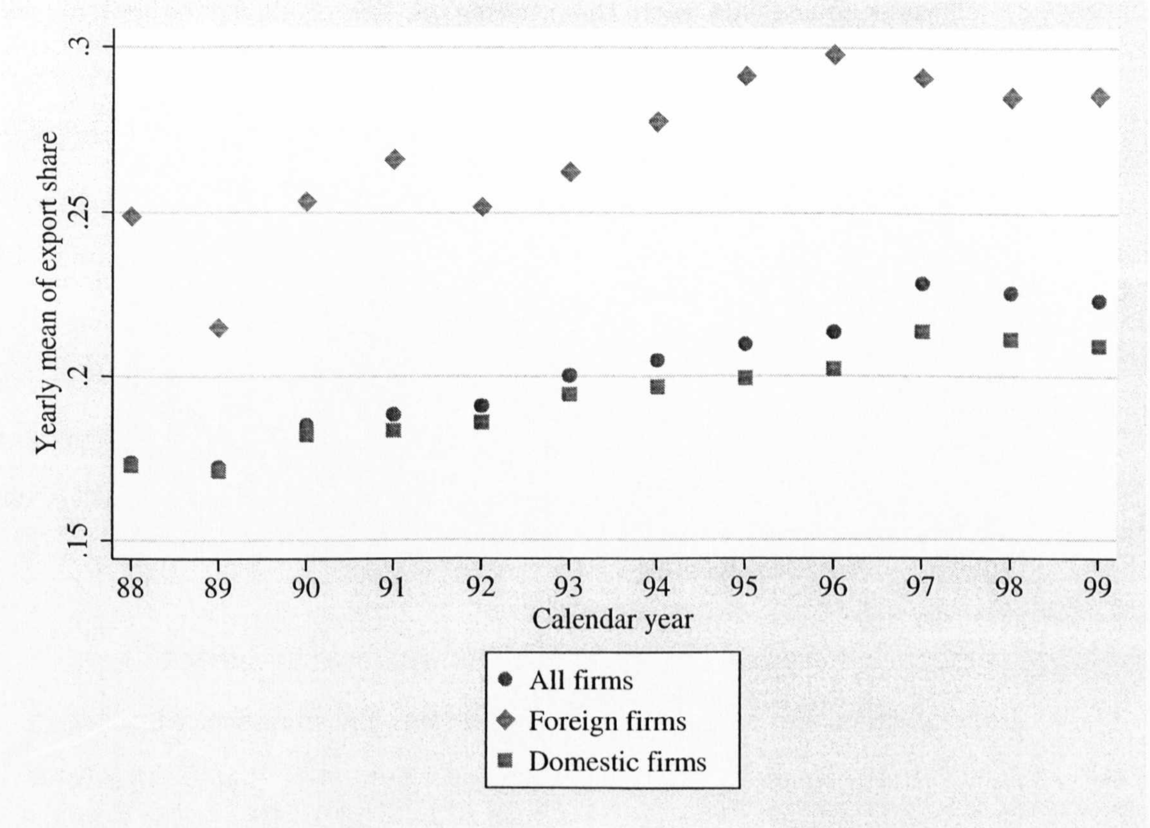


Source: Author's calculations from OneSource.

operating in the UK. Foreign firms seem to be more export intensive than domestic enterprises, their median export share being 12 percent higher than that of UK companies. Furthermore, as shown in figure 1.3 foreign affiliates had throughout nineties an average export share higher than domestic businesses. Whereas indigenous companies appear to be less export intensive than the average firm, enterprises owned by foreigners seem to be more export intensive.

In the empirical analysis of chapter three we find that foreign firms contribute disproportionately to UK exports of manufacturing industries. Not only are foreign firms more likely to export than UK owned firms, but also, when they export, their

Figure 1.3: Behaviour over time of the export share of foreign and domestic manufacturing companies in the UK (1988–1999)



Source: Author's calculations from OneSource.

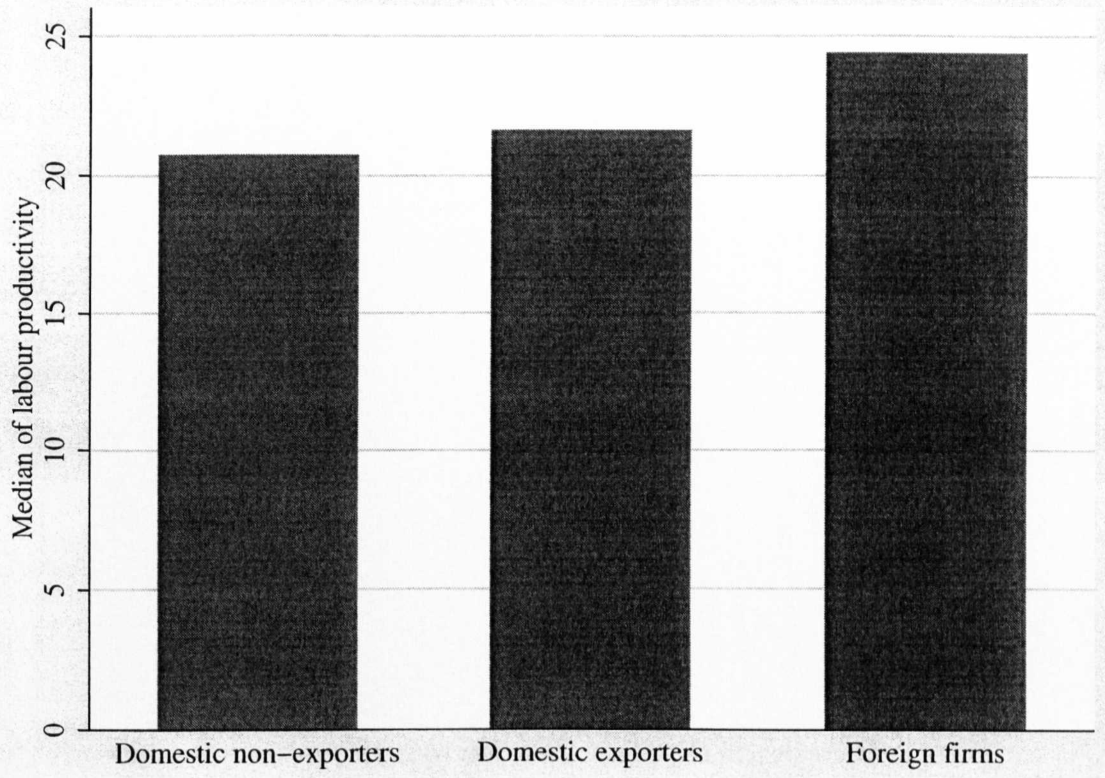
export share is higher. This finding sits somewhat awkwardly with economic theory. The export activity of foreign affiliates is not strictly consistent with traditional theories of the multinational enterprise (Markusen 1995) and with past empirical evidence, which have shown that most FDI flows are motivated by horizontal motives. According to theory firms invest in foreign production facilities to avoid the costs of international trade; empirically, it has been shown that the bulk of the FDI flows is between developed countries, which is consistent with horizontal FDI strategies. Then, we consider theories that can explain the export behaviour of multinationals. In addition, in this chapter we show how export affects the mode of entry of multinationals.

Chapter four deals with the ranking of the productivity distribution of non-exporting firms, exporting firms and multinationals. This is of relevance given that one of the main concerns of policy makers is to rise overall productivity. In addition, vast amount of public funds are spent in promoting exports and FDI on the ground that exporting and multinational firms are "better" companies, in terms of productivity, than others. Recent empirical and theoretical works (e.g.: Bernard and Jensen (1999) and Helpman, Melitz and Yeaple (2004)) has shown that productivity is the main determinant of involvement of firms in international trade, either as exporters or multinationals. This is because of the sunk costs of exports or establishing affiliates in foreign countries.

Figure 1.4 shows at glance how labour productivity levels of domestic exporters, non-exporters and foreign firms differ in the UK manufacturing sector. Domestic non-exporting firms appear to be the least productive, their median value added per worker being around 20700 pounds. Domestic exporters are more productive than non-exporting firms, but less productive than foreign firms; their median value added per worker is 21600 pounds. The latter appear to be the most productive kind of firms with a median of about 24300 pounds of value added per worker.

Most of the previous empirical research has conducted this type of comparisons, namely of means, among different types of firms. This approach, although appealing because of its simplicity, may be highly misleading given the large dispersion of firms productivity levels even in narrowly defined industries. If distributions overlap, means are insufficient statistics to judge random payoffs (productivity levels in this case) without specifying a precise objective function to be maximised (Wolfstetter 1999,

Figure 1.4: Labour productivity of manufacturing firms in the UK (1987–1996).

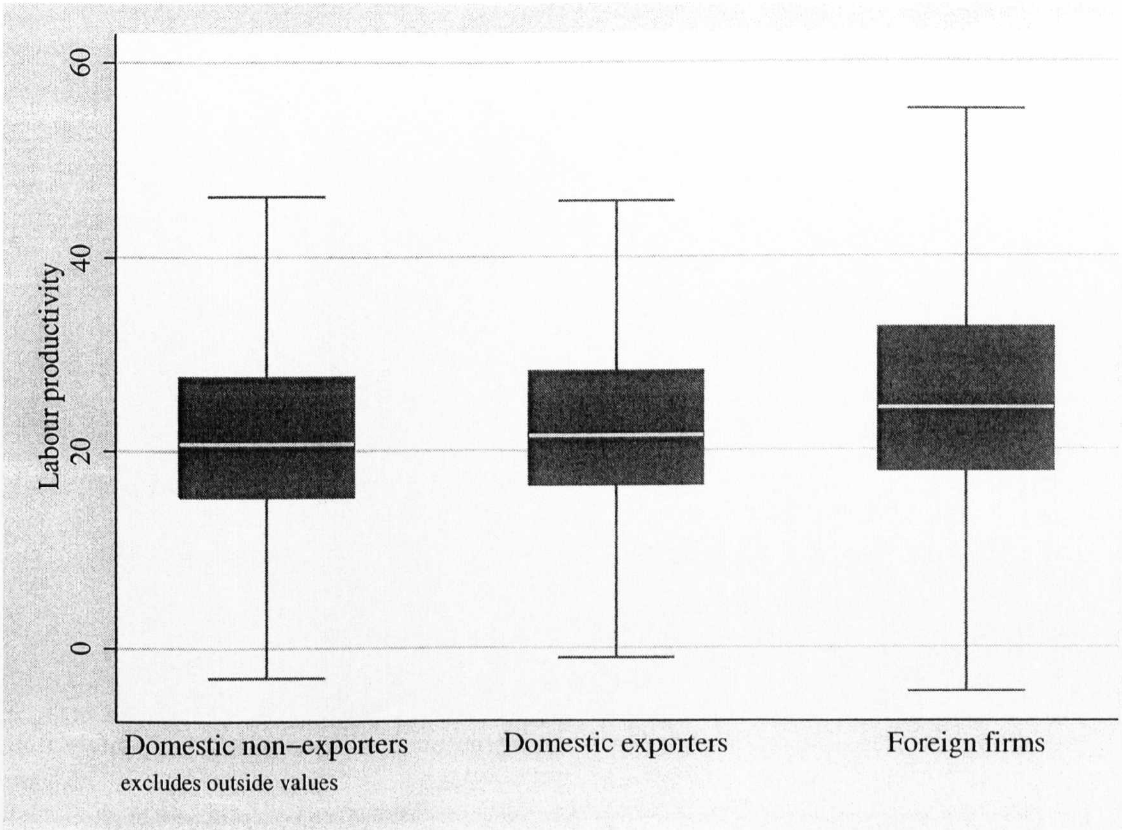


Note: Author's calculations from OneSource. The labour productivity has been computed as value added (in thousands of pounds) per worker.

pp. 135). To show that this is likely to be the case for the UK manufacturing sector, figure 1.5 exhibits the box plot of labour productivity for the three types of firms under consideration. It is worth noting that the distributions have different degree of dispersion, the one of exporters being the less disperse and the one of foreign affiliates being the most. Simple comparisons of means ignore these features, which may invalidate conclusions based on these tests if they are not properly allowed for.

To tackle this issue, we depart from the previous literature and employ a non-parametric approach that allows us to rank productivity distributions and therefore

Figure 1.5: Distribution of the labour productivity of manufacturing firms in the UK (1987–1996).



Note: Author's calculations from OneSource. The labour productivity has been computed as value added (in thousands of pounds) per worker. The grey box represents the interquantile range (25 and 75 percentiles of the distribution). The white line inside the bos is the median. The two extreme horizontal lines are the lowest and largest value; outliers have been excluded for the sake of clarity.

firms, unambiguously, i.e. irrespective of who is the judge. More specifically, we deploy the Kolmogrov-Smirnov tests of stochastic dominance, using firm-level data on UK manufacturing firms. Establishing stochastic dominance implies that one cumulative distribution lies to the right of another. In addition, we also report evidence on the issue of self-selection versus learning. This chapter provides the first evidence on this issue for the UK using tests of stochastic dominance.

The ranking of productivity distributions of firms involved differently in the international trade is of interest from a theoretical viewpoint as well. Recently, trade theories have been developed in which firms are heterogeneous (Bernard, Eaton, Jensen, and Kortum 2003; Helpman, Melitz, and Yeaple 2004; Melitz 2003). Firm heterogeneity results in self-selection in the structure of international commerce (Helpman, Melitz, and Yeaple 2004). Only the most productive firms find it profitable to establish production facilities abroad; the next set of firms serve foreign markets through exporting only; while the least productive firms find it profitable to sell goods in domestic market, only. This model assumes that the choice to establish foreign affiliates is based, exclusively, on considerations of market access. All FDI is indeed horizontally motivated. Nevertheless, when there are factor price and market size differentials across countries, firms that become multinationals may no longer be the most productive (Head and Ries 2003). Then, the empirical analysis conducted in this chapter can be viewed as a test of whether or not the export/FDI and export/no-export decisions are ordered according to the productivity of firms as predicted by Helpman, Melitz and Yeaple (2004).

Finally in chapter five we present the main conclusions and briefly discuss the policy implications. In addition, we suggest what may be future interesting areas of research, which may further enhance our understanding of the firm-level adjustment to globalisation.

1.4 Appendix: Data set

The firm level data used throughout this doctoral dissertation were extracted from the OneSource database. This is made available by InfoUSA under the payment of a fee. For this thesis we used the CD Vol. 1 2000 and CD Vol. 1 1996.

This database contains information about the Balance Sheet, Profit and Loss account, ownership details, industry activities, parents and subsidiaries of all UK companies that under the Companies Act and related legislation have the obligation to submit the Balance Sheet and the Profit and Loss account every year to Company House.[1] In this data set there are information about 110000 companies operating in the UK and we will focus on the manufacturing sector only.

Whereas all companies operating in the UK have the obligation to provide information concerning their existence and operations to Company House, the nature of these information varies according to the size of the company. More specifically, medium-sized, small, and very small companies can prepare and file "abbreviated accounts" (246 and 246A of the Companies Act 1985). The size of the company is determined considering its turnover, balance sheet total (i.e. the total of the fixed and current assets) and average number of employees.

Medium companies are those that meet at least two of the following three criteria:[2]

- the annual turnover is equal to 11.2 million or less;

[1]The stated main functions of Companies House are to: incorporate and dissolve limited companies; examine and store company information delivered under the Companies Act and related legislation and make this information available to the public.

[2]Note that the legislation concerning the size classification of companies has changed. We refer to the old taxonomy since our database contains data until 1999 and the new legislation need be applied to financial years ending after 30 March 2004

- the balance sheet total is equal to 5.6 million or less;
- the average number of employees is 250 or fewer.

Small companies are those that meet at least two of the following three criteria:

- the annual turnover is equal to 2.8 million or less;
- the balance sheet total is equal to 1.4 million or less;
- the average number of employees is 50 or fewer.

Very small companies are those that satisfy all the following conditions:

- classify as as a small company;
- have a turnover of not more than 1 million;
- have a balance sheet total of not more than 1.4 million.

Medium and small-sized company can file "abbreviated accounts". These include the abbreviated balance sheet, notes, and a special auditor's report (unless the company is also claiming audit exemption). Medium companies have to present "abbreviated accounts" which must contain: the abbreviated profit and loss account, the full balance sheet, a special auditor's report, the directors' report, and notes to the accounts.

Very small companies qualify for the total exemption from audit. In this case unaudited accounts can be submitted in the form of an abbreviated balance sheet and notes.

Given the aforementioned exemptions granted to small and medium companies the data set we used present many missing values and therefore the sample of firms we were able to work with is significantly less than 110000. Therefore, all the estimates we present in this doctoral dissertation pertain to the population of firms classified as large companies since only for them a complete set of variables concerting output, exports, and inputs is available.

To infer estimates about the whole population of firms in the UK one should take into account the selection problem of this database through some technique such as the Heckman (1976) selection model. This methodology involves computing the probability that each firm is exempted from presenting "full accounts". This probability or some function of it (such as the inverse Mills' ratio) then should be used in the second stage regressions/tests to allow for the fact that these are conducted on a sub-sample of firms (the sample of firms that present "full accounts").

However, this methodology relies on a well specified selection rule, whereby some firms are selected and some others are not. This specific case is complicated by the fact that there are not one, but three types of firms that are be exempted from presenting "full accounts". In addition, there are three criteria (i.e. selection rules), different for each type of exempted firms, that need to be considered. Also, not all firms will comply with these selection rules since firms that are exempted may present "abbreviated accounts", but they also can, if they want, file "fulls accounts".

Thus, the selection rule (which determines the exemption) cannot be accounted for in a satisfactory fashion. In addition, consistent and efficient self-selection estimators have not yet been developed for some of the tests used in this dissertation (like the Kolmogorov-Smirnov tests of Chapter 4 and the seemingly unrelated regressions of chapter 2). The development of these estimators is beyond the scope of this thesis.

Given the selection issue, caution is needed in interpreting the estimates reported in this dissertation. The problem, however, is not probably so severe in chapter 3 and 4. In these chapters, we consider the export behaviour of foreign and domestic firms and their productivity distributions. Since theoretical and empirical studies have shown that both exporters and foreign firms are larger and more productive than purely domestic firms (Bernard and Jensen 1999; Griffith, Redding, and Simpson 2004; Helpman, Melitz, and Yeaple 2004; Haskel, Pareira, and Slaughter 2002) in these chapters we will make like to like comparisons and our estimates will be conservative.

Table 1.3 contains the list of the variables extracted from Onesource and used in this dissertation. Their description is from Onesource. Nominal values of output, exports, value added, intermediates and capital were deflated using price indices. Output and exports were deflated using Producer Price Indices of output of detailed manufacturing industries provided by the Office of National Statistics (ONS). Intermediates were deflated using the Producer Price Indices of materials and fuels purchased by manufacturing industries provided again by the ONS.[3] The deflation of capital presents many problems due to the fact that it aggregates different types of fixed assets (i.e. properties, equipment, plant and machinery and so on). Each kind of fixed assets should be treated separately since they have different prices and different degree of depreciation. Given the unavailability of industry-level price indices of fixed assets, capital figures in OneSource were deflated using the deflator of fixed capital formation. This is an economy-wide (i.e. macro) price index that is, again, provided by ONS.

[3]The Producer Price Indices of output and materials and fuels purchased can be obtained in electronic form from the website of the ONS. These indices are also published in the ONS periodical MM22.

As it is possible to see from table 1.3 OneSource contains information about the country of origin of each company. This is defined as the country of the company that ultimately controls firms registered in the UK. Yet, this information is available for the latest year alone. To track the dynamics of foreign ownership we obtained from the ONS the list of firms operating in the UK that were acquired by foreigners from 1988 to 1996. This information, which is in hard copy format, was matched by names with the OneSource data. Table 1.4 exhibits the number of foreign acquisitions by year that were matched with OneSource.

Our firm-level database does not provide information on the multinational activity of UK-owned firms. To single out UK multinationals we merged OneSource with a database containing information about multinational activities. This database, named European Linkages and International Ownership Structure (ELIOS), was built at the University of Urbino by Davide Castellani and Antonello Zanfei.[4]. The information in ELIOS about foreign plants owned by firms registered in the UK was retrieved by Amadeus. This is a pan-European data set containing firm-level data in 38 European countries. More specifically, this database has ownership information, so that firms can be classified as multinationals if they own subsidiaries abroad. The multinational indicator was available for 1996 alone and we backcast the indicator to the start of the sample period. The information obtained from ELIOS was also complemented with a list of U.K firms that made foreign acquisitions compiled from various issues of Acquisitions Monthly. This is a monthly periodical published by Thomson Financial Services, which reports mergers and acquisitions conducted world-wide. This allowed us to match a total of 209 multinationals in 1996.

To give an idea of the range of values of the variables in OneSource, Table 1.5

[4]We wish to thank them for having made this data available to us

Table 1.3: Description of variable from OneSourse used in this dissertation.

Variable	Description
Turnover (Output)	Turnover is defined as the value of all services rendered and goods or equipment sold in the UK and overseas and includes: Work In Progress adjustments where shown for contracting companies, duties in some sectors such as Distillers and intra-group turnover (where non-consolidated).
Value added	Employees Remuneration, Directors Remuneration, and Depreciation to the Operating Profit. Value Added is that fraction of market value of production which has been added by a company's processes of production, administration, selling and distribution. Generally speaking, it is the difference between turnover and the cost of bought-in materials and sources.
Exports	Exports are defined as total direct exports from the UK.
Employment	Number of employees defined as the average number of employees during the accounting year.
Capital	Fixed Assets defined as tangible fixed assets at their net book value, ie: cost less accumulated depreciation.
Intermediates (materials)	Calculated as the difference between Turnover and Value added. (Author's calculation)
Employees remuneration	Defined as the amount paid to employees in wages and salaries, excluding any tax, insurance, social security and pension payments.
Wage per employee	Calculated as Employees Remuneration divided by Employment. (Author's calculation)
Country of Origin	The country of origin of a company's ultimate holding company, if the ultimate holding company is not a UK company.
Industry	Primary 1992 SIC Code is the 1992 UK Standard Industrial Classification for a company's principal line of business.

Table 1.4: Number of foreign acquisitions by year.

Year	Number of foreign acquisitions
1988	48
1989	108
1990	103
1991	124
1992	123
1993	84
1994	148
1995	151

Source: Office of National Statistics and OneSource.

exhibits the minimum, median and maximum values (in 1996) for some of the variables in table 1.3, distinguishing between domestic non-MNEs, foreign firms and domestic MNEs. As it is possible to see foreign companies appear to be larger (in terms of output, employment and capital), pay higher wages and also export more than their domestic counterparts. Foreign and UK MNEs appear to be similar. The same raw relationships between foreign and domestic companies have also been found using the UK census manufacturing database (Griffith 1999; Criscuolo and Martin 2004). This lends support to the matching processes we have undertaken to identify foreign firms and UK multinationals in OneSource.

Table 1.5: Summery statistics of main variables.

		Domestic	**Foreign**	**UK MNE**
	Min	151	0	573
Turnover (Output)	Median	5566	11682.5	10244
	Max	5707000	7111000	768389
	Min	-48727	-34645	-3554
Value added	Median	1744	2920	3301
	Max	1280664	1190506	254639
	Min	0	0	0
Exports	Median	327	2697.5	2076
	Max	5008000	3054400	247591
	Min	3	1	10
Employment	Median	83	111	132
	Max	45173	39335	7241
	Min	0	0	0
Capital	Median	860	1686	1651.5
	Max	1650000	2121800	229471
	Min	38	1	345
Intermediates (materials)	Median	3589	9190	6512
	Max	4432440	6204464	580269
	Min	56	0	183
Wage per employee	Median	1256	1813	2059
	Max	731000	853900	129761

Source: OneSource.
Notes: The year used for these summary statistics is 1996. All the values are in thousands of pounds expect employment, which is in unit.

Chapter 2

Labour demand and international trade: Theory and evidence

2.1 Introduction

In recent years the relationship between globalisation, in particular international trade, and the labour market has elicited much attention and discussion in and outside the academic environment. From a theoretical point of view the topic is rooted in the general equilibrium theory of international trade, but recently, as with all other aspects of globalisation and trade, it has also been examined in partial equilibrium models. These models have been mainly concerned with the shift in labour demand caused by globalisation, which should result in an increase in the demand for certain types of workers and in a reduction for other kinds of labourers.

Recently, however, it has been highlighted that international trade and generally globalisation could also affect labour demand elasticities, rendering them more elastic. Our concern is to test this proposition. As Rodrik (1997) has underlined, this is a topic worth investigating since increases in the elasticity of labour demand could have three main effects: 1) it shifts the cost of higher labour standards and benefits from the employer to employees; 2) it leads to greater variation in labour market outcomes, since for instance, shocks to labour productivity will result in larger changes in salaries and hours worked; 3) it moves bargaining power away from employees (or unions) to employers, thus reducing the rents of the former.[1]

The next two sections of this chapter provide a brief overview about how to derive the labour demand and its elasticity of a profit maximizing firm. The following two sections describe what effects international trade may have on the elasticity of the demand for labour and the main empirical studies conducted thus far on the subject. In the following section we extend the Allen-Uzawa elasticity, which is based on the assumption of perfect competition, to imperfectly competitive markets. Next, we assess how this affects the labour demand elasticity at industry level and proceed to test the labour demand elasticity formulation we derived with a firm level data set of UK manufacturing firms. The last section concludes.

2.2 Demand for labour

Labour is an input used in the production process along with other factors of production such as capital, energy and materials. Therefore its demand can be derived in the same way as that for other inputs and in the following treatment we will consider the demand for a general input that can be interpreted as labour.

The demand for any factor used in the production process is a derived demand in the sense that it originates from the profit maximizing behaviour of the firm. For

[1]This issue has been investigated by Borjas and Ramey (1995) who have confirmed that import penetration diminishes the rent shared by less skilled workers in concentrated industries.

this reason it can be obtained analytically considering a firm choosing the profit maximizing level of output and combination of inputs. Assuming a production function $y = F(\mathbf{x})$ with $\partial F(\mathbf{x})/\partial x_i > 0$ and $\partial^2 F(\mathbf{x})/\partial x_i^2 < 0$, where $\mathbf{x} \in R_+^n$ is the vector of the inputs employed, and the firm operates in perfectly competitive input and output markets with factor and output prices being respectively w_i for every input $i = 1, 2, ...n$ and P, the first order condition (FOC) to maximize profits $\pi = PF(\mathbf{x}) - \mathbf{wx}$ is,

$$\frac{\partial \pi}{\partial x_i} = Pf_i(\mathbf{x}^*) - w_i = 0 \quad \text{for every } \ i = 1, 2, ...n$$

where $f_i(\mathbf{x}) = \partial F(\mathbf{x})/\partial x_i$ is the *marginal physical product of input i.* This is the *additional output* that the firm obtains using an additional unit of input i. Thus, the first order condition can be rewritten as $Pf_i(\mathbf{x}^*) = w_i$ where the right hand side can be defined as the *marginal revenue product of input* i and the left hand side is its price. The marginal revenue product of input i is, in fact, the *additional revenue* that the firm can attain employing a marginal additional amount of the same input. Since we are assuming that $\partial F(\mathbf{x})/\partial x_i > 0$ and $\partial^2 F(\mathbf{x})/\partial x_i^2 < 0$, this condition implies that input i will be utilized up to the point where its (decreasing) marginal revenue product equals its price (which is fixed). Hence, the demand for factor i can be identified in its marginal revenue product $Pf_i(\mathbf{x}^*)$, which is indeed downward sloping since its derivative (that is the second derivative of the production function $\partial^2 F(\mathbf{x})/\partial x_i^2$) is negative. The FOC also implies that for a profit maximizing firm the real remuneration of each input (w_i/P) is equal to its *marginal physical product.* This is true both in the short-run, when only one input can be varied whereas all the others are fixed, and in the long-run, when all factors can be changed.

However, the response of the firm to a change in input prices will be different in the short-term from the long-term. On the one hand, in the short-run, only some factors of production, say input i, can be varied. In this situation the demand of input i can still be derived from the first order condition necessary to maximize the restricted or short-run profit function $\pi = PF(x_{i,}\bar{\mathbf{x}}_{-i}) - w_i x_i - \mathbf{w}\bar{\mathbf{x}}_{-i}$ where $\mathbf{w}\bar{\mathbf{x}}_{-i}$ is the sum of the product between each fixed input and its unit cost. Maximizing this short-run profit function involves respecting the first order condition (1), this time concerning input i only. If w_i decreases to w_i^1, the demand for factor i will increase. This is because the marginal revenue product of input i is, now, higher than the cost of an additional unit of it, namely w_i^1, and therefore the profit can be raised producing more output, which in turn involves expanding the employment of factor i until the marginal revenue product of it is equal to its price (w_i^1) again.

On the other hand, in the long-run not only will the demand for input i depend on its price w_i, but also on the level of employment of all the other inputs, which can be adjusted freely. This can be proved by the Young theorem, whereby $\partial^2 F(\mathbf{x})/\partial x_i \partial x_j = \partial^2 F(\mathbf{x})/\partial x_j \partial x_i$. Thus, for instance a decrease in w_i leads, in the short-run, to an increase in the demand and use of x_i as highlighted before. In addition, this modifies the marginal physical product of factor j (if $\partial^2 F(\mathbf{x})/\partial x_j \partial x_i \neq 0$), more precisely it rises if $\partial^2 F(\mathbf{x})/\partial x_j \partial x_i > 0$ or decreases if $\partial^2 F(\mathbf{x})/\partial x_j \partial x_i < 0$. In the former (latter) case the employment of x_j will be increased (reduced) to bring its marginal revenue product back to w_j, which is unchanged. However, the increase (decrease) of x_j will increase the marginal physical product of factor i so that the firm can further augment employment of factor i up to the point where its marginal revenue product equals w_i. Still, this will modify the marginal physical product of factor j again and this process will be repeated until the marginal revenue product of each factor equates with the corresponding price.

Thus, in the long-run the increase (decrease) in the use of an input following a reduction (rise) in its price is, in absolute value, equal or larger than the corresponding variation in the short-run since the firm can adjust all factors of production, not only those whose price has changed. Mathematically this means that the absolute value of the prime derivative of the demand function ($|\partial w_i/\partial x_i|$) in the short-run is the same as or larger than that of the long-run and that the own-price elasticity of the demand for labour ($|(\partial x_i/\partial w_i)|w_i/x_i$) in the short-run is equal or smaller than the corresponding one in the long-term.

This is the LeChatelier-Samuelson theorem (Samuelson 1966) and can be formally proved through Hotelling's lemma (1935). In fact, long-run profits are always at least as large as in the short-run, hence

$$\pi^L(p, \mathbf{w}) = pF(\mathbf{x}) - \mathbf{wx} \geq \pi^S(p, \mathbf{w}, \bar{x}_i) = pF(\bar{x}_i, \mathbf{x}_{-i}) - \mathbf{w}_{-i}\mathbf{x}_{-i} - w_i\bar{x}_i \qquad (2.1)$$

where $\pi^L(p, \mathbf{w})$ and $\pi^S(p, \mathbf{w}, \bar{x}_i)$ are the long and short-run profit functions, respectively, and input i is the only fixed factor (note that the long-run profits depend on the parameters p and $\mathbf{w}$; then condition (1) must be met for all inputs, whereas the short-run profits are a function of the parameters p, $\mathbf{w}$ and $\bar{x}_i$; thus condition (1) can be satisfied only for all inputs but factor i, since its employed quantity is fixed). Thus, it is possible to define a function

$$D(w_i) = \pi^L(p, \mathbf{w}) - \pi^S(p, \mathbf{w}, \bar{x}_i) \geq 0 \qquad (2.2)$$

This function will reach its minimum zero, if w_i is such that the quantity of the factor i employed in the long-run is equal to the fixed amount that is employed in the short-run $(\bar{x}_i)$. Since this is a minimum point $D(w_i)$ is a convex function. So it is possible to write

$$\frac{d^2D(w_i)}{dw_i^2} = \frac{\partial^2\pi^L(p,\mathbf{w})}{\partial w_i^2} - \frac{\partial^2\pi^S(p,\mathbf{w},\bar{x}_i)}{\partial w_i^2} \geq 0 \tag{2.3}$$

that is equivalent to

$$\frac{d^2D(w_i)}{dw_i^2} = \frac{\partial - x_i^L(p,\mathbf{w})}{\partial w_i} - \frac{\partial - x_i^S(p,\mathbf{w})}{\partial w_i} \geq 0 \tag{2.4}$$

The last formula shows that, in absolute value the slope of the long-run demand function is as large as or smaller than the slope of the short-run demand [2]

The demand for labour and all the other inputs can be more easily derived starting from the assumption that firms minimize costs of production after having decided the level of output to produce. Indeed, in this case we do not have to worry about whether the firm is operating in a competitive product market or not.

The cost minimization problem provides the conditional input demands. This can be written as (see for instance Jehele and Reny (1998))

$$c(\mathbf{w},y) = \min_{\mathbf{x}\in R_+^n} \mathbf{wx} \quad \text{subject to } F(\mathbf{x}) \geq y$$

[2]The last passage follows from the Hotelling's lemma(1935) whereby the profit-maximizing demand functions can be derived from the profit function. This lemma states that the demand of input i is equal to the prime derivative of the profit function with respect to the price of input i (w_i), $\frac{\partial\pi}{\partial w_i} = -x_i(p,\mathbf{w})$. Obviously this is the quantity that satisfies the first order condition in expression (1). The above derivative is negative since if the price of an input increases, provided that nothing else changes, then the profit must decrease. The Hotelling's lemma allows to derive some properties of the input demand straightforwardly. Indeed: (i) it is homogeneous of degree zero in $(p,\mathbf{w})$ since it is the first derivative of the profit function that is a linearly homogeneous function in $(p,\mathbf{w})$; (ii) it is downward sloping, i.e. its first derivative with respect w_i is negative $(\partial x_i(p,\mathbf{w})/\partial w_i < 0)$ since the profit function is indeed convex in $(p,\mathbf{w})$.

Setting the Lagrange equation, deriving the first order conditions and assuming that the solution $\mathbf{x}^* = \mathbf{x}(\mathbf{w}, y)$ exists, is positive and that the production function is differentiable at $\mathbf{x}^*$, it is possible to obtain

$$f_i(\mathbf{x}^*) / f_j(\mathbf{x}^*) = w_i / w_j \qquad \text{for every } i \neq j \text{ and } i, j = 1, 2, 3...n \tag{2.5}$$

where the right hand term represents the ratio of the first derivatives of the production function with respect to the factor i and j, that is the marginal rate of technical substitution (i.e. the decrease in one input per unit increase of another that is just sufficient to produce the same quantity of output) and the left hand side represents the ratio of the cost of the two inputs (i.e. the slope of the isocost line).

From the first order conditions of the cost minimization problem it is possible to derive the conditional input demands that can be written as $\mathbf{x}^* = \mathbf{x}(\mathbf{w}, y)$. Multiplying each conditional input demand for the respective factor price we get the cost function $c(\mathbf{w}, y) = \mathbf{w}\mathbf{x}^* = w_1 x_1^* + w_2 x_2^* + ... + w_n x_n^*$. Then, if the cost function is differentiable at $\mathbf{w}$ and y it is possible to obtain the conditional input demand of each factor applying Shephard's lemma (Shephard 1970), whereby

$$\frac{\partial c(\mathbf{w}, y)}{\partial w_i} = x_i^* = x_i(\mathbf{w}, y)$$

Provided that the production function is homogeneous of degree α, strictly increasing and strictly quasiconcave the cost function and the conditional input demand can be written as

$$\begin{aligned} c(\mathbf{w}, y) &= y^{1/\alpha} c(\mathbf{w}, 1) \\ \mathbf{x}(\mathbf{w}, y) &= y^{1/\alpha} \mathbf{x}(\mathbf{w}, 1) \end{aligned}$$

where $c(\mathbf{w},1)$ and $\mathbf{x}(\mathbf{w},1)$ are the cost function and the conditional demand function for one unit of output.

If instead the production function is homothetic, strictly increasing and strictly quasiconcave the cost function and the conditional input demand can be expressed as

$$
\begin{aligned}
c(\mathbf{w},y) &= h(y)c(\mathbf{w},1) \\
\mathbf{x}(\mathbf{w},y) &= h(y)\mathbf{x}(\mathbf{w},1)
\end{aligned}
$$

2.3 The price elasticity of labour demand

The price elasticity of any input demand can be decomposed into two effects , namely the substitution effect and the scale effect (see for example Sapsford and Tzannatos (1993)). The former is a function of the elasticity of substitution between the factor whose price is changed and all the other inputs. The higher in absolute value the elasticity of substitution, the larger the substitution of the factor whose price is varied with all the other factors. It captures the price elasticity of the factor demand at *constant output.* The scale effect derives from the elasticity of the output demand. This is because the more elastic the output demand, the larger the effect on output of a reduction in, say, wages, that induces an increase in output and therefore results in employment of more workers.

Thus, in the case of linearly homogeneous production function with 2 inputs the elasticity of factor i with respect to the price of input j can be written as (see Hamermesh (1993 pg. 27) and Allen (1938, pg. 373)

$$\frac{\partial \ln x_i(\mathbf{w},p)}{\partial \ln w_j} = \alpha_j\left(\sigma_{ij}-\eta\right) = \left(1-\alpha_i\right)\left(\sigma_{ij}-\eta\right)$$

In the above expression α_i is the cost share of factor i (i.e. $w_i x_i / \left(w_i x_i + w_j x_j\right)$), $\sigma_{ij} = d\ln(x_i/x_j)/d\ln(w_j/w_i)$ is the elasticity of substitution between input i and j (which is always > 0 in the 2 input case) and η is the absolute value of the elasticity of product demand.

The own-price demand elasticity of input i is

$$\frac{\partial \ln x_i(\mathbf{w},p)}{\partial \ln w_i} = -\left(1-\alpha_i\right)\left(\sigma_{ii}-\eta\right)$$

Thus it is possible to see these types of elasticities can be divided in two parts that represent respectively the substitution and the scale effect.

For the case of more than 2 inputs the above expressions become (Hamermesh (1993 pg. 35) and Allen (1938 pg. 508))

$$\frac{\partial \ln x_i(\mathbf{w},p)}{\partial \ln w_j} = \alpha_j\left(\sigma_{ij}-\eta\right) \tag{2.6}$$

$$\frac{\partial \ln x_i(\mathbf{w},p)}{\partial \ln w_i} = \alpha_i\left(\sigma_{ii}-\eta\right) \tag{2.7}$$

where σ_{ij} is the the partial elasticity of substitution between input i and j and σ_{ii} is the elasticity of substitution of input i with respect all other inputs, both proposed by Allen (1938, pg. 505).

As it is clear from the above expression the substitution effect depends on factor share and on the elasticity of substitution. The latter was further investigated by Hicks (1963) in a 2 factors production framework. His original intent was to assess quantitatively and qualitatively the proportional change in the relative factor share (α_k/α_l) caused by a proportional change in their price ratios (w_l/w_k). This can be expressed as

$$\begin{aligned}
\frac{\partial \ln \frac{\alpha_k}{\alpha_l}}{\partial \ln \frac{w_l}{w_k}} &= \frac{\partial \ln \frac{w_k w}{w_l l}}{\partial \ln \frac{w_l}{w_k}} \\
&= \frac{\partial \ln \frac{k}{l}}{\partial \ln \frac{w_l}{w_k}} + \frac{\partial \ln \frac{w_k}{w_l}}{\partial \ln \frac{w_l}{w_k}} \\
&= \sigma_{kl} - 1
\end{aligned}$$

The above expression links the proportional variation in the relative factor shares due to a proportional change in relative input prices to a scalar measure (viz. σ_{kl}), which represents the ease of substitution between inputs. If $\sigma_{kl} > 0$ the inputs are said to be substitutes and this is necessarily true in the two inputs case.

Different generalizations of σ_{kl} to the case of more than two inputs have been proposed since the seminal contribution of Hicks. The most ubiquitous, at least so far, has been the Allen (1938)-Uzawa (1962) elasticity of substitution (thereafter AES). Allen (1938, pg. 504) has shown that

$$\sigma_{ij} = \frac{y}{x_i x_j} \frac{F_{ij}}{|F|}$$

where $|F|$ is the determinant of a bordered Hessian matrix containing all the derivatives and partial derivatives of the production function while F_{ij} is the co-factor of the ij partial derivatives in the bordered Hessian.

The previous equation is quite involved since it requires all the derivatives of the production function. A much simpler formulation, which appeared in Uzawa (1962), is the following

$$\sigma_{ij} = \frac{C(\mathbf{w}, y)\, C_{ij}}{C_i C_j} \tag{2.8}$$

A well known property of the σ is symmetry whereby $\sigma_{ij} = \sigma_{ji}$. Before proceeding further in our discussion it is worth underlining the connection between the σ_{ij} and the elasticity of the cost-minimizing demand equation x_i with resect to w_j (for any i and$j$), i.e.

$$\varepsilon_{ij} = \frac{\partial \ln x_i(\mathbf{w}, y)}{\partial \ln w_j} = \frac{\partial x_i(\mathbf{w}, y)}{\partial w_i} \frac{w_j}{x_i(\mathbf{w}, y)} \tag{2.9}$$

Multiplying and dividing the right hand side by $x_j = C_j$ and $C(\mathbf{w}, y)$ and remembering that $\partial x_i(\mathbf{w}, y)/\partial w_j = C_{ij}$, it is possible to write

$$\varepsilon_{ij} = \alpha_j \frac{C(\mathbf{w}, y)\, C_{ij}}{C_i C_j} = \alpha_j \sigma_{ij} \tag{2.10}$$

where α_j is the cost share of input j. The above expression is indeed the substitution effect (i.e. the effect due to the substitution among inputs taking output as given). The sign of the ε_{ij} depends on σ_{ij}. Therefore, if $\sigma_{ij} > 0$ the two factors are said to be Allen substitutes whereas if $\sigma_{ij} < 0$ the two factors are said to be Allen complements. As it is possible to see from relationship 2.9, the importance of the Allen-Uzawa elasticity of substitution derives from the fact that multiplying it for the factor share one obtains the constant output cross price (or own price) input demand elasticity. In addition, it is worthwhile mentioning the following property of the AESs, which derives from the homogeneity of degree zero in $\mathbf{w}$ of the input demand $\sum_j \varepsilon_{ij} = 0$.[3]

[3]Indeed the homogeneity of degree zero in $\mathbf{w}$ implies the Euler's theorem, whereby $\sum_j [\partial x_i(\mathbf{w}, y)/\partial w_j]\, w_j = 0$ from which it follows that $\sum_j \varepsilon_{ij} = \sum_j [\partial x_i(\mathbf{w}, y)/\partial w_j]\, w_j / x_i(\mathbf{w}, y) = 0$.

The Allen-Uzawa formulation has figured prominently in empirical studies trying to assess the degree of substitutability between inputs. Yet, Blakorby and Russel (1981) have argued that this measure is not a generalization for the multi-factor setting of the corresponding concept in the 2 factors framework. More specifically, the authors have underlined that the AES: is not a scale of the ease of substitution between inputs; does not provide any information about proportional changes in factor shares; cannot be derived from the logarithmic derivative of the quantity ratio with respect to the price ratio. They conclude that the AES is quantitatively meaningless and qualitatively has not more information than the constant output price elasticity.

The ineffectiveness of the Allen-Uzawa elasticity as a measure of the ease of substitution derives ,mainly, from the fact that it depends on prices and therefore it can assume different values whenever prices change. Its inability to provide information about proportional changes in factor shares is due to the fact that it cannot be derived from the logarithmic derivative of the quantity ratio with respect to the price ratio, $\partial \ln \left(x_i/x_j\right) / \partial \ln \left(w_j/x_i\right)$; this is because this partial differentiation requires that only w_j varies and not w_j and w_i. Since both input demands x_i and x_j depend on *all* factor prices if w_i were to vary along with w_j, this would not be consistent with the rules of partial differentiations, whereby differentiation may be computed with respect to one variable at a time (see Blackorby and Russel (1989)).

For these reasons the Morishima (1967) elasticity of substitution (henceforth MES) seems to be more appropriate. As Blakorby and Russel (1989) have emphasized, contrary to the AES, the MES is a measure of the easiness of substitution; provides information about proportional changes in factor shares; can be derived from the the logarithmic derivative of the quantity ratio with respect to the price ratio (when only one price changes).

The MES for the ij input pair can be derived as the logarithmic derivative of the quantity ratio with respect to the price ratio when only one price changes, say w_j, which yields

$$\begin{aligned} MES_{ij} &= \frac{\partial \ln \frac{x_i}{x_j}}{\partial \ln \frac{w_j}{w_i}} = \frac{\partial \ln x_i}{\partial \ln w_j} - \frac{\partial \ln x_j}{\partial \ln w_j} \\ &= \varepsilon_{ij} - \varepsilon_{jj} = \alpha_j AES_{ij} - \alpha_j AES_{jj} \end{aligned} \tag{2.11}$$

Thus as can be noted from above, the proportional change in the quantity ratio generated by a proportional change in the price ratio (when only one price varies) is decomposable into two parts. The first represents the proportional change of one input with respect to the price that is changed. The second stands for the proportional change on the other input with respect to the same price.

The MESs are not symmetric in the n input case. This is at odds with AESs, which are indeed symmetric. The asymmetry of the MESs arises from the fact that MES$_{ij}$ and MES$_{ji}$ measure the proportional variation of the quantity ratio in two different directions. The former in the w_j direction while the latter in the w_i direction. Only, when there are two inputs MES$_{ij}$ = MES$_{ji}$.

The symmetry of the MESs in the 2 factors case can be proved together with the fact that in this setting the MES is equal to the AES (Blackorby and Russel 1981). Using the relationship between the MES, the AES in the previous formula and the fact that the AESs are symmetric we have that

$$\begin{aligned} MES_{lk} &= \alpha_k AES_{lk} - \alpha_k AES_{kk} = \alpha_l AES_{kl} - \alpha_l AES_{ll} = MES_{kl} \\ MES_{lk} &= (1-\alpha_l)\, AES_{lk} - \alpha_k AES_{kk} = (1-\alpha_k)\, AES_{kl} - \alpha_l AES_{ll} = MES_{kl} \end{aligned}$$

$$
\begin{aligned}
MES_{lk} &= AES_{lk} - \alpha_l AES_{lk} - \alpha_k AES_{kk} = AES_{kl} - \alpha_k AES_{kl} - \alpha_l AES_{ll} = MES_{kl} \\
MES_{lk} &= AES_{lk} = AES_{kl} = MES_{kl}
\end{aligned}
$$

If $\mathrm{MES}_{ij} > 0$ the inputs i and j are said to be Morishima substitutes whereas if $\mathrm{MES}_{ij} < 0$ they are said to be Morishima complements.[4] Yet, the Allen and Morishima substitutability/complementarity concepts are not equivalent. This is because the former simply refers to the effect of a change in the price of input j on the demand for factor i (and therefore depends on the sign of AES_{ij} only) while the latter concerns the effect of a variation in the same input price on the quantity ratio x_i/x_j (and for this reason hinges on the sign of both AES_{ij} and AES_{jj}).

In contrast to the MES, the AES, is consistent with the original purpose for which the concept of elasticity of substitution was envisaged by Hicks more than seventy years ago. In fact, the MESs provide information about the proportional change in relative factor shares as a result of the proportional change in the price ratio (caused by the variation of only one price not both). This can be seen below; when w_j varies we have that

$$
\begin{aligned}
\frac{\partial \ln \frac{\alpha_i}{\alpha_j}}{\partial \ln \frac{w_j}{w_i}} &= \frac{\partial \ln \frac{w_i x_i}{w_j x_j}}{\partial \ln \frac{w_j}{w_i}} \\
&= \frac{\partial \ln \frac{x_i}{x_j}}{\partial \ln \frac{w_j}{w_i}} + \frac{\partial \ln \frac{w_i}{w_j}}{\partial \ln \frac{w_j}{w_i}} \\
&= MES_{ij} - 1
\end{aligned}
$$

Thus increases in the price ratio (generated by the variation of the price in the numerator, say input j) will increase the factor share of factor i relative to factor j if

[4]It is worth noting as two inputs can be at least theoretically Morishima complement and substitute at the same time. This is because the MES is not symmetric thereby it is possible to have $\mathrm{MES}_{ij} < 0$ and $\mathrm{MES}_{ji} > 0$ or viceversa

$\text{MES}_{ij} > 1$ and will reduce it if $\text{MES}_{ij} < 1$.

2.4 The effect of international trade on the labour demand function

Openness to international trade can have effects of different kinds on labour demand, or more generally, on any input demand. These effects can be dichotomized in *shifts* in the labour demand schedule (predicted by general equilibrium trade theories) and in changes that flatten or steepen it, modifying directly its *price elasticity* (the latter having recently been stressed by Rodrik (1997) and predicted by partial equilibrium models).

According to general equilibrium international trade theories, greater openness will increase the export of goods for which domestic firms have a comparative advantage and increase imports of goods for which they have a comparative disadvantage. This will cause *outward or inward shift* of input demands. The exact repositioning depends on whether we are considering a developed country (DC), an economy with a relatively abundant endowment of capital/highly skilled labourers or a less developed one (LDC), viz., an economy with a relatively abundant provision of low skilled workers.

Considering a 2 factors, 2 goods production process, a DC trading with a LDC will cause an outward shift in the demand for the relatively abundant factor (capital/highly skilled workers) and inward shift in the demand for the relatively scarce factor (low skilled labourers). This is the celebrated Stolper-Samuelson (1941) theorem. This theorem in embedded in the Hecksher-Ohlin framework where perfectly competitive inputs and output markets are assumed and the remuneration of factors of production are adjusted to guarantee full utilization of all inputs. The Stolper-Samuelson theorem posits that openness to international trade will increase the real remuneration of the relatively abundant factor and reduce that of the relatively scarce one, thus increasing the real wage differential between the two. It is worth adding that real factor price changes are caused by alteration in product prices; without them, there can not be any modification in the real factor price. Changes in the relative endowment of any input and trade with other DCs (which have similar factor endowments) does not have any effect on the input demands and on the real input prices since products prices are unaffected.

With regard to the impact of international trade on *input demand elasticity*, general equilibrium trade models are mute. Indeed, in this framework input demands are infinitely elastic simply because product demand is infinitely elastic, as it possible to see from 2.6 and 2.7. However, in empirical studies estimates of the elasticity of the labour demand never approach infinity (Hamermesh 1993).

Long ago Marshall (1890) in his *Principles of Economics* stated the four rules governing the elasticity of input demands. The elasticity of the demand for labour will be larger: 1) the larger the elasticity of substitution among inputs (σ_{ii} in 2.7); 2) the greater the elasticity of demand for the final product (η in 2.7); 3) the greater the share of labour in total cost (α_i in 2.7); 4) the greater the elasticity of supply of the other factor of production.

Thus, how can trade actually modify labour demand elasticities? Firstly, trade could increase the elasticity of substitution among inputs. However, this is unlikely to be a direct effect of international trade since σ_{ii} is determined exclusively by the technology used. Nevertheless, trade may trigger, at least in principle, technology progress, which, in turn, might render factors more substitutable. Secondly, assuming imperfectly competitive output market, trade with both LDCs and DCs makes the output market more competitive and thus input demands more elastic.[5] Finally, international trade can alter factor shares, but it is not clear in which direction. Indeed, if trade liberalization changes the relative remuneration of inputs, firms will try to use more intensively the now more economical inputs and less intensively the now less economical inputs. The total effect on factor shares of these changes in the usage and remuneration of factors depend on the technology of production and is thereby ambiguous.

2.5 Empirical studies

Empirical studies have so far been mostly concerned with estimating the effect of trade on labour demand *shifts* trying to explain the rising wage gap between production and non-production workers recorded in the USA and UK during the 80s. They went in search of the Stolper-Samuelson effect (1996) that predicts that trade with LDCs will shift the demand schedules of the relatively abundant factor outward and that of the relatively scarce one inward.

However, these general equilibrium trade theories have performed so far very poorly empirically (Trefler 1995). Empirical results point to the fact that trade contributed to a tiny measure of the wider wages differentials. Cline (1997) provides a research literature on the rising skill wage gap in the USA and claims that the contribution of trade is likely to be around 20%. Krugman (1995) reaches a similar

[5]Some of the theoretical models of international trade with less than perfect outputs markets are discussed in Helpman and Krugman (1989 chapter 3)

conclusion underlining that imports of manufactured goods from LDCs amount to only 2% of GDP of OECD countries and this small figure cannot explain the much larger wage inequality experienced in the 1980s. Greenaway and Nelson (2001), in the conclusion of their synthesis of the literature on globalization and labour markets, argue that, in contrast with public opinion, there seems to be very limited empirical support corroborating the hypothesis of large impacts of globalization on labour markets.

A different approach which yielded much higher estimates of the effect of international trade on wages is the factor content of trade. This methodology is rooted in labour economics more than in general equilibrium trade theory. Indeed, labour economists consider the labour market in partial equilibrium, thereby assuming a downward sloping demand curve and a vertical supply curve. In this framework the labour content of imports and exports can be added to the domestic supply of labour causing it to shift.

More specifically, the factor content of trade approach consists in assessing how much skilled and unskilled labour is necessary to produce the products a country exports and and how much it would be necessary to produce the imported ones. Then, the difference between these figures can be interpreted as the net impact of trade on the demand for skilled and unskilled workers.

Wood (1995, 1994) is probably the most eminent advocate of this methodology. The estimates he obtained suggest that trade could actually have played an important and significant role in explaining increased wage inequality. Indeed, Wood(1995) argues that taking into account non-competing imports, defensive innovations and the impact on services trade reduced the demand for labour by about 20%. However, Leamer (2000) and Panagariya (2000a) argued that the assumptions on which the factor content of trade is based are too restrictive to obtain reliable estimates.

Pizer (2000) also looked at the impact of international trade on wages, but from a different perspective. He concentrates on the impact of imports on wage premia under different mode of competition. If firms engage in Cournot competition, then imports decrease wage premia, whereas under price competition, imports increase wage premia. The latter results is due to the fact that with lower barriers prices decrease. This raises sales, which in turn stimulates labour demand.

The relatively poor performance of the Hecksher-Ohlin trade theory in explaining the rising skill wage gap should not be surprising since they assume perfectly competitive product markets and that factor returns are adjusted to guarantee full employment of any input. The input-demands are therefore horizontal or completely elastic.[6] Yet, empirical estimations of the latter suggest that the own-price labour demand elasticity never approaches infinity. Indeed, Hamermesh (1993 pp. 103) in his authoritative survey of labour demand studies proposes a range with limits -0.15 and -0.75 as plausible estimates of the own-price labour demand elasticity.

Thus far, skill biased technological change (SBTC) has mostly been deemed to be an alternative explanation for increasing wage inequality. Mainly, this has been a tool in the arsenal of labor economists who consider a one sector economy and a downward sloping input demand curve. Slaughter (1999) highlighted this distinguishing between the labour and trade approach to study the determination and changes of real wages. The change in technology has been advocated by exponents of the former to explain the rising skill premium relying on its skill biased nature. In fact, SBTC raising the

[6]This is true only in the non-complete specialization case (Panagariya 2000b).

marginal productivity of more educated workers will cause the increase of the skill premium, accompanied by a rise in the share of skilled workers on total employment.

Yet, as suggested by Rodrik (1997) and more recently underlined by Greenaway and Nelson (2001) some of the technological change could be trade-induced. Indeed, firms that are or feel to be under threat from increased foreign competition could be induced to adopt labour saving technology to slash costs and be more productive to compete better with foreign products. One of the examples of empirical evidence of this phenomenon is provided by Morrison and Siegel (2001) using the NBER data set.[7] Indeed, not only do they find that both trade and technological change have a direct impact on labour composition (the latter having a larger effect than the former), but also that trade has an indirect role, since it stimulates computerization.

The empirical literature concerned with the consequences of trade or more generally of globalization on labour demand elasticities is fairly limited. Greenaway *et al.* (1999) have estimated a log-linear labour demand equation controlling for the technological efficiency improvements induced by international trade. Using a data set covering UK manufacturing industries from 1979 to 1991 they have estimated a negative relationship between the level of imports and exports and the labour, demand. However, the authors have not found an absolute increase in the own-price elasticity due to the trade variables as advanced by Rodrik (1997).

Slaughter (2001) has estimated whether or not the own-price elasticity of the demand for labour increases because of international trade. In this study, using industry level data from 1961 to 1991 of the NBER manufacturing database it has been found that the overall manufacturing labour demand for production workers had

[7]This data set contains information about inputs, outputs and productivity of US manufacturing sectors; for more information see Bartelsman and Gray (1996).

become more elastic in that period whereas that for non-production workers had not experienced significant increase in the own-price elasticity.

As regards the hypothesis that trade had contributed significantly to the augmentation of the wage-elasticity of labour demand Slaughter (2001) has not found definitive support for that. Indeed, for less skilled workers when the estimated elasticities are regressed on trade variables these have the expected effect when industry effects, only, are used. Yet, when time controls are employed they disappear. For skilled workers the trade variables have the plausible sign and are generally significant at least at the 90 % significance level when both industry and time controls are employed. In the end Slaughter (2001) concludes that the rise in labour demand elasticities is mostly explained by time(since it is presumably a proxy of some unobserved variable).

Krishna *et al.* (2001) have investigated the effect of trade liberalization in Turkey using yearly plant level data for the period 1983-1986. They set up a monopolistically competitive model with a Cobb-Douglas production function to derive a log linear labour demand function. The estimates obtained of the *change* in the own-price elasticity of the labour demand after the liberalization reforms are not significant in most of the industries examined, thus leading to the conclusion that more trade openness did not have any effect on it.

Fabbri, Haskel and Slaughter (2002) have compared the own-price labour demand elasticities of non-production and production workers considering UK non-multinational, UK multinational and foreign multinational plants, using the ARD data set for the period 1973-1992.[8] Over the sample period, the estimated wage elasticities of the demand for the former type of labourers in overall UK manufacturing grew significantly (in absolute value) from -0.25 to -0.35, whereas the analogous estimates for the latter kind of workers seems to have been stable. With regard to the demand for labour of the different types of firms analyzed, the results show how the wage elasticity of the demand for blue collar increased, in absolute value, for all the categories of companies. Besides, those of UK and foreign multinationals augmented more than that of UK non-multinational companies, thus corroborating the hypothesis that international companies have more flexibility organizing their production. On the contrary, the estimated elasticities of the demand for white collar workers do not show any precise trend upward or downward in the sample period. It is noteworthy that the results of this paper could be due to the fact the multinational enterprises enjoy more power over unions than non-multinational firms and therefore find easier to substitute non-production labour with other factors of production.

Jean (2000) has presented a model concerning the impact of trade on *aggregate* labour demand elasticity. He rightly motivated his work stressing the fact that 2.7 is a partial equilibrium relationships that does not necessarily hold at a more aggregate level. His model is characterised by perfect competition and homogeneous goods, but finite elasticities are generated through the Armington hypothesis, whereby domestic products are differentiated from foreign ones. He notes that the scale effect (i.e. the effect of the elasticity of the product demand on the elasticity of the labour demand), in general equilibrium, is of a different sort, since one has to consider the sectoral trade specialisation of an economy. The intuition behind this is that in an open

[8]This paper does not deal with international trade per se, but with the related phenomenon of FDI.

economy with perfect competition an exogenous increase in the price of, say, labour, has the effect of making domestic producers less competitive. This effect will be stronger in labour-intensive sectors, which will experience large decrease in market shares. The higher the degree of openness the larger the decrease in market shares since domestic firms are less protected from foreign competition. Therefore, the loss of competitiveness due to the increase in wages will modify the trade specialization of the country, that will become more specialized in the less labour intensive industries. His computation, for some French industries, show that this effect is relevant.

Overall, the results obtained in these studies (summarised in table 2.1) support the conclusion that the elasticity of production workers is larger than that of non-production ones and that the former has grown more elastic over the last two decades. Besides, there is not enough evidence to support the hypothesis that international trade affects it, although it seems that FDI can be regarded as a plausible cause since multinationals have a greater ability to re-organize their production.

2.6 The Allen-Hamermesh relationship

2.6.1 Perfect competition

As we have highlighted above, a growing body of the literature in international trade has tried to investigate whether openness has resulted in an increase in labour demand elasticities. From a labour theory perspective in partial equilibrium, the theoretical relation in 2.7 became one of the few general frameworks to refer to.[9] This theory states that labour demand elasticity should be positively affected by two principal

[9] One should also note that Leamer (1996), Wood (1995) and also Panagariya (2000b) discussed the effect of trade on labour demand elasticities, but applying HO or specific factor trade theories in General Equilibrium.

Table 2.1: Selected studies on trade and labour demand elasticities.

Author	**(year)**	**Data**	**Results**
Greenaway *et al.*	(1999)	UK industry data set 1979-1991	No relation between the level of imports and exports in the sectors and the elasticity of the labour demand
Slaughter	(2001)	NBER manufacturing data set 1961-91	The constant output own price elasticities of the demand for production workers increased in the sample period. That of non-production workers did not. Time explains most of the increase
Krishna *et al.*	(2001)	Turkish firm level data set 1983-86	The trade liberalization undergone by Turkey in the sample period did not increase the elasticity of the labour demand
Fabbri *et al.*	(2002)	UK ARD firm level data set 1973-92	The constant output labour demand elasticities for blue collars of UK-MNEs, non-UK-MNE and UK-non-MNEs increased in the sample period. The same elasticities for white collars did not have any precise trend

determinants: the elasticity of substitution between labour and other factors and the elasticity of demand for goods to prices. Under the assumption that openness is affecting these factors by increasing the possibility of substitution among factors and goods respectively, that relationship would then predict a consequent increase in the elasticity of demand for labour.

Although most of the empirical studies in the field have been inspired by this relationship (i.e. Slaughter (1999), Fabbri *et al.* (2002) among others), two issues remain. Firstly, Allen (1938) showed that this relationship holds in a perfect competition environment at the industry level. It is now widely recognized that an imperfect competition framework is necessary for explaining the rise in trade and multinational activities. The first question addressed then in this chapter is how this relationship can be extended to an imperfectly competitive setting[10]. Following Dixit's (1990) modelling framework, we show that AH can be generalized to allow for imperfect competition. In particular, under the assumption of oligopoly, the elasticity of labour demand depends on a third term, neglected so far by the AH relation. This term is reducing the burden on labour demand elasticity: the elasticity of prices to wages. Actually, an increase in wages has a pure cost effect, but is reducing at the same time the market share of the firm and thus its mark-up. As a result of this pro-competitive effect, there might be incomplete pass through between prices and wages and the adjustment of labour demand would be smaller than expected.

The second issue left out by the AH relation is that it does not show *formally* the relationship between trade openness measures and labour demand elasticities.[11] We try to fill that gap by showing that the average elasticity of labour demand depends, in a formal manner, on the import penetration rates. Also, our model provides an explanation for why the elasticity of demand has not been increasing that much with trade, a result that was pointed out by previous studies. In fact, it predicts that the effect of import penetration would be high, if there is complete pass-through from

[10]Note that Krishna *et al.* (2001) have studied the impact of trade on labour demand elasticities by emphasizing the role of imperfect competition as well. However, the authors design a framework based on monopolistic competition (i.e. they do not consider strategic interaction among firms) and assume a Cobb-Douglas production function.

[11]Jean (2000) could also link trade measures with the elasticity of labour demand but he uses a different framework than that of Allen-Hamermesh. His work is built on a perfect competition world in general equilibrium with an Armington type hypothesis on the demand side and a Leontief production function on the supply side

wages to prices. But in the case of incomplete pass-through, then a small effect of import penetration should prevail.

Previous empirical works have used as theoretical framework the ***industry-level*** relationship in 2.7, which was derived by Allen (1938), further investigated by Uzawa (1962) and discussed in details by Hamermesh (1993). We report it below for convenience

$$\eta_{lw} = \alpha_l \sigma_{ll} + \alpha_l \eta_{Yp} \tag{2.12}$$

where $\alpha_l = \frac{wl}{pY}$ is the share of labour cost to revenue in the industry; σ_{ll} represents the elasticity of substitution between l and all all the other factors of production in the industry[12]. Allen (1938) proves this relation by resolving a program of profit maximisation in perfect competition.

What is the intuition behind this relation? If wages increase, and given a fixed output, employers will want to substitute labour towards other factors of production whose price is now relatively lower (the employers change the technique of production along the same isoquant). The extent of this effect depends on α. The higher the share of labour cost, the smaller the pass-through from σ to η_L.

However, industry output is not fixed. In fact, for a given production technique an increase in wages positively affects commodity prices in the industry which in turn reduces industrial production overall. (The isoquant moves inward.) This affects

[12]The concept of the Allen elasticity of substitution has been called into question not long ago. Blackorby and Russel (1981) highlight that the AH elasticity of substitution is completely uninformative about the ease with which inputs can be substituted (when there are more than two inputs). They underline that the Morishima (1967) elasticity of substitution is the true elasticity of substitution. However, this argument is not strictly relevant to the purpose of this paper since what we are interested in is the own price labour demand elasticity. Although σ_{ll} is not the true elasticity of substitution, multiplied by the cost share of labour, yields the constant output wage elasticity of labour.

downward the demand for the two factors and *a fortiori* that for labour. The extent of this decrease in labour demand following the adjustment of production to the new prices, depends on the share of labour cost.

Notice moreover that the factor of pass-through from substitution to labour demand is now α_L. Hence, the effect of substituting from labour towards all other factors has a greater impact on labour demand, the greater the share of labour in total cost.

2.6.2 Generalization to imperfect competition

The elasticity of the labour demand (or of any other input) can be obtained from a more elegant and simpler formal setting by Dixit (1990) who minimizes total costs instead of maximizing profits. We thus follow the same type of formulation as Dixit in what follows, but extend the framework to the case of imperfect competition.

Assume a firm that produces with constant returns to scale. If the production function is linearly homogeneous, i.e. with constant return to scale, its total cost can be written as follows[13] (e.g.: Jehele and Reny (1998, pp. 239))

$$C = C(w, y^s) = y^s c(\mathbf{w}, 1) \tag{2.13}$$

Where $c(\mathbf{w}, 1)$ is the cost of 1 unit of output, $\mathbf{w} = (w_1, \ldots w_m)$ is the price vector of m factors of production and $y^s(\mathbf{w}, p)$ is the supply function . By Shephard's Lemma,

[13] We could have supposed an increasing returns to scale technology by assuming an alternative expression that includes fixed costs like $C = y^s c(W) + F$, but this does not affect the relation to be estimated hereafter.

the conditional demand for labor is the derivative of total costs with respect to the price of labor:[14]

$$L(\mathbf{w}; y^s) = \frac{\partial C}{\partial w_l} = y^s \frac{\partial c(\mathbf{w})}{\partial w_l} = y^s c_w \qquad (2.14)$$

Taking the log and deriving with respect to log of w_l we obtain the elasticity of the labour demand with respect to wages

$$\eta_{lw_l} = \sigma_{ll}\alpha_l + \eta_{y^s w_l} = \varepsilon_{lw_l} + \eta_{Yw_l}\frac{1}{s} \qquad (2.15)$$

Then, the labour demand elasticity can be expressed as the sum of two terms: 1) the constant output labour demand elasticity, i.e. $\sigma_{ll}\alpha_l$; 2) and the elasticity of the supply function to wages (also known as scale effect), viz. $\eta_{y^s w_l} = \eta_{Yw_l}\frac{1}{s}$.

We have that σ_{ll} is the Allen-Uzawa elasticity of substitution, $\sigma_{ll} = \frac{c(W)c_{w_l w_l}}{c_{w_l}c_{w_l}}$ (Uzawa 1962; Hamermesh 1993). The elasticity of the output function to wages $\eta_{y^s w_l}$ may be also expressed as the elasticity of the industry output (Y) to wages (η_{Yw_l})over the market share ($s = y^s/Y$).[15]

Knowing that the optimal supply depends on factor prices and the price of the final good, to wit $y^s = (\mathbf{w}, p)$, we can derive an analytical formulation of $\eta_{y^s w_l}$ in different competitive settings. In perfect competition the price is taken as given, therefore $\eta_{y^s w_l} = \eta_{y^s w_l|p}$, where $|p$ indicates that the derivative has been taken keeping the price, p, as constant. $\eta_{y^s w_l|p}$ is the effect on the labour demand of a variation in

[14]The labour demand with output considered as given $L(\mathbf{w}; y^s)$ is called conditional labour demand since it is *conditional* on the given level of output y^s.

[15]This is because $\partial \log y/\partial \log w_l = (\partial \log y^s/\partial \log Y)(\partial \log Y/\partial \log w_l) = \eta_{Yw_l}/s$. If we consider a monopolist, i.e. $y^s = Y$ or $s = 1$ we have that the two elasticities are the same since, in equilibrium the output supplied by the firm is the same as the total output demanded by consumers.

output, taking the product price as given, caused by a change in wages. In imperfect competition firms can affect prices, thus the elasticity of the supply function must include another term that takes into account the variation in the product price induced by a change in wages. By the rule of partial differentiation it is possible to show that in imperfect competition

$$\eta_{y^s w_l} = \eta_{y^s w_l|p} + \eta_{y^s p|w_l}\, \eta_{pw_l}$$

The first addend of the right hand side is the elasticity of the output supplied with respect to wages, taking the market price fixed. The second addend is the product between the elasticity of the firm supply function with respect to the market price, keeping wages constant, and the elasticity of the market price with respect to wages. Substituting this expression in 2.15 we can write

$$\eta_{lw_l} = \underbrace{\varepsilon_{lw_l} + \eta_{y^s w_l|p}}_{\eta_{lw_l|p}} + \eta_{y^s p|w_l}\, \eta_{pw_l} = \varepsilon_{lw_l} + \underbrace{\eta_{Yp}\frac{1}{s}\eta_{pw_l}}_{Scale\ effect} \tag{2.16}$$

where the rightmost term is the total scale effect and is derived from $\eta_{Yw_l} = \eta_{Yp}\eta_{pw_l}$ (where η_{Yp} is the elasticity of the market demand to the market price). Note that the scale effect is $\eta_{y^s w_l|p} + \eta_{y^s p|w_l}\, \eta_{pw_l} = \eta_{Yp}\, \eta_{pw_l}/s$.

The above expression decomposes the labour demand elasticity in all its components and allows to assess which one is likely to be affected by international trade. In the central term, ε_{lw_l} is the constant output labour demand elasticity; the sum of the first two addends ($\varepsilon_{lw_l} + \eta_{y^s w_l|p}$) is the constant price labour demand elasticity, denoted by $\eta_{lw_l|p}$. This is the elasticity of the unconditional labour demand $L(\mathbf{w}, p)$.[16]

[16]Note that $L(\mathbf{w},p)$ is the profit maximizing labour demand function $L(\mathbf{w},p) = L(\mathbf{w}, y^s(\mathbf{w},p))$ obtained assuming the firm chooses the profit maximizing output $Y^s(\mathbf{w},p)$, see Jehele and Reny (1998, pp. 239–241)

It is indeed the sum of the constant output labour demand elasticity and the elasticity of the profit maximizing output with respect to wages, taking the market price as given. The sum of the last two terms $(\eta_{y^s w_l|p} + \eta_{y^s p|w_l}\ \eta_{pw_l})$ is the scale effect. It encompasses the effect on the labour demand of a variation in both output and product price caused by a change in wages.

From the central term in 2.16, it is already possible to see that the scale effect in imperfect competition (i.e. $\eta_{y^s w_l|p} + \eta_{y^s p|w_l}\ \eta_{pw_l}$) is smaller than the scale effect in perfect competition (i.e. $\eta_{y^s w_l|p}$), in the likely case that $\eta_{pw_l} > 0$. However, the scale effect is still negative since, as it is possible to note from the rightmost term in 2.16, $\eta_{Yp}(1/s)\eta_{pw_l} < 0$ (since $\eta_{Yp} < 0$, i.e. the product demand is downward sloping, and $\eta_{pw_l} > 0$). This is because as wages increase output will decrease, as in perfect competition; however the decrease in output will be less than in a perfectly competitive setting since producers will be able to pass part of the increase in wages to prices.

Thus, from equation 2.16 it is possible to see that in a oligopolistic competition, as it is the case in a perfectly competitive market, the labour demand is more elastic the higher the cost share of of labour α_l, the larger the absolute value of the Allen-Uzawa elasticity of substitution between factors (i.e. σ_{ll}), and the more elastic is the the product demand (η_{Yp}). In addition, the labour demand of a firm is less elastic the higher its market share. This is because given η_{Yp}, the higher the market share, the lower the *perceived* product demand elasticity $\eta_{y^s p} = \eta_{Yp}/s$.

Relationship 2.16 is quite different from the familiar expression in 2.12. To write it in more comparable terms, we start noting that the the mark up μ is the ratio between the price and the marginal cost, $\mu = p/c(\mathbf{w})$, so $\mu c(\mathbf{w}) = p$. Then, the elasticity of the market price with respect to wages can be expressed as $\eta_{pw_l} = \eta_{\mu w_l} + \eta_{c(w)w}$. When the production function presents constant return to scale, the elasticity of the marginal cost with respect to wages $\eta_{c(w)w}$ is equal to the cost share of labour (α_l).[17] Therefore we have that

$$\eta_{pw_l} = \eta_{\mu w_l} + \alpha_l \tag{2.17}$$

Substituting 2.17 in 2.16 we obtain an expression of the elasticity of the labour demand like the one in 2.12

$$\eta_{lw_l} = \varepsilon_{lw_l} + \eta_{Yp}\frac{1}{s}\alpha_l + \eta_{Yp}\frac{1}{s}\eta_{\mu w_l} \tag{2.18}$$

In an oligopoly framework, however, $\eta_{\mu w_l} \neq 0$. In this case, the third term of the right hand side in expression 2.18 will be different from zero and its sign will depend upon $\eta_{\mu w_l}$. In the conventional case where $\eta_{\mu w_l} < 0$ this term is positive and therefore it is *reducing in absolute values* the elasticity of labour demand to wages. It is doing so because of the pro-competitive effect generated by the variation in wages on mark-ups. In order not to lose much of their competitiveness, the firms are constrained to pass a part of the increase in wages on to less mark-ups, making eventually a relatively small adjustment on prices and thus demand. Hence, in an oligopoly world, this incomplete pass through between wages and prices would make labour demand less elastic.

In both perfectly competitive markets and monopolistic markets the last term of the right hand side of expression 2.18 disappears, since $\eta_{\mu w_l} = 0$, and therefore reduces to 2.12. In perfect competition $\eta_{\mu w_l} = 0$ since the profit maximization condition

[17] This can be obtained writing the elasticity of the marginal cost to the wage as $\partial \log c(w)/\partial \log w_l = (\partial \log c(w)/\partial c(w))\,(\partial c(w)/\partial w_l)\,(\partial w_l/\partial \log w_l) = (1/c(w))lw_l = \alpha_l$.

ensures that the market price (p) equals the marginal cost ($\partial C(\mathbf{w}, y)/\partial y = c(w)$), i.e. the mark-up is one, and therefore its elasticity is zero and $\eta_{pw_l} = \eta_{c(w)w_l} = \alpha_l$. Thus, in perfect competition if the wage increases by 1 percent, the price must increase by α_l percent for the firm to continue to produce. In other words, the price (i.e. marginal revenue) has to increase by the same proportion as the marginal cost for the firm not to exit the market.[18]. In monopoly we have that $\eta_{\mu w_l} = 0$ since the profit maximization implies that the mark-up depends only on the elasticity of the product demand.[19] Hence $\eta_{pw_l} = \alpha_l$. This means that a monopolist who experiences an increase in the wage by 1 percent will increase the price of the final good by α_l percent.

However, in perfect competition the elasticity of the demand for labour is *infinitely* elastic whereas in monopoly is not. This is because in the former case $s = 0$. This implies that the perceived product demand elasticity ($\eta_y p = \eta_{Yp} 1/s$) is infinite. On the other extreme, in a monopolistic setting $s = 1$, which means that the perceived product demand elasticity is equal to the *finite* industry product demand elasticity ($\eta_{yp} = \eta_{Yp}$).

If we assume that firms compete in the quantity space (i.e. Cournot oligopoly) we have the mark-up is $\mu = 1/(1 + s/\eta_{Yp})$. So, the elasticity of μ with respect to wages is,

$$\eta_{\mu w_l} = -\mu(s/\eta_{Yp})\eta_{sw_l} \tag{2.19}$$

[18]Obviously, in perfect competition the firm cannot affect the market price. Therefore, whenever the wage or the price of any other input increases the firm will have to exit the market since it becomes uncompetitive (viz. its marginal cost is higher than the market price). What we are saying here is that in perfect competition if the wage increases by 1 percent there must be an *exogenous* increase by α_l percent in the market price for the firm to stay competitive.

[19]In a monopolistic setting the mark-up is $\mu = \frac{1}{1+\frac{1}{\eta_{yp}}}$

where η_{sw_l} is the elasticity of the market share to wages. Under the traditional assumption of downward sloping best response functions, it is well known that market share is decreasing with the marginal cost of the firm: thus, $\eta_{sw_l} < 0$ and for this reason $\eta_{\mu w_l} < 0$. Substituting expression 2.19 in 2.18 we obtain the elasticity of the labour demand in Cournot competition,

$$\eta_{lw_l} = \sigma_{ll}\alpha_l + \eta_{Yp}\frac{1}{s}\alpha_l - \mu\eta_{sw_l} \tag{2.20}$$

The last term in the right hand side of the above expression is negative and will lower the elasticity of the labour demand (in absolute value).

Thus far, we have considered a production function with constant return to scale, whose cost function can be expressed as in 2.13. The relationship shown above are slightly modified in case of a homothetic production function with no constant return to scale or a non-homethetic one.

Assuming that the production function is homothetic with no constant return to scale the cost function is multiplicative separable and can be written as (Jehle and Reny 1998, pp. 231)

$$C(\mathbf{w}, y^s) = c(\mathbf{w})h(y^s) \tag{2.21}$$

where $h(y^s)$ is strictly increasing. In this case, by Shepard's lemma the labour demand is $L(\mathbf{w}, y^s) = L(\mathbf{w})h(y^s)$. Therefore taking logs and deriving with respect to the log of wages we obtain the elasticity of the labour demand

$$\eta_{lw_l} = \epsilon_{lw_l} + \eta_{Cy}\,\eta_{y^s w_l} = \epsilon_{lw_l} + \eta_{Cy}\,\eta_{Yw_l}\,\frac{1}{s} \tag{2.22}$$

This relationship is the equivalent to that in 2.15. The only difference is in the scale effect, where the term η_{Cy} appears. η_{Cy} is the elasticity of the cost function with respect to y^s (i.e. the inverse of the return to scale).[20]

As we have seen above the elasticity of the market price with respect to wages can be expressed as the sum of the elasticity of the mark-up to wages and the elasticity of the marginal cost to wages, $\eta_{pw_l} = \eta_{\mu w_l} + \eta_{C_y w_l}$. The second term of the right hand side of the above expression is equal to α_l as in the constant return to scale case.[21] Therefore the equivalent of equation 2.18 is,

$$\eta_{lw_l} = \epsilon_{lw_l} + \eta_{Cy}\,\eta_{Yp}\frac{1}{s}\,\alpha_l + \eta_{Cy}\,\eta_{Yp}\frac{1}{s}\,\eta_{\mu w_l} \tag{2.23}$$

The only difference with 2.18 is that the scale effect is multiplied by the elasticity of the cost function with respect to y^s (η_{Cy}), that is the inverse of the return to scale. It is worth noting that if $\eta_{Cy} = 1$, we have constant return to scale and relation 2.23 is equal to 2.18. If $\eta_{Cy} > 1$, i.e. decreasing return to scale, ($\eta_{Cy} < 1$, i.e. increasing return to scale) the labour demand elasticity will be higher (lower), in absolute value, than in the constant return to scale case, ceteris paribus.

Assuming Cournot competition and, therefore, substituting, 2.19 in 2.23 we get an expression analogous to 2.20

$$\eta_{lw_l} = \epsilon_{lw_l} + \eta_{Cy}\,\eta_{Yp}\frac{1}{s}\,\alpha_l - \eta_{Cy}\,\mu\,\eta_{sw_l} \tag{2.24}$$

[20] $\eta_{Cy} = \partial \log[c(\mathbf{w})h(y)]/\partial \log y = \partial \log h(y)/\partial \log y = h'(y)(h(y)/y)$. This quantity is the inverse of the return to scale; indeed if the output supplied augments by 1 percent and the cost by 1.02 percent, i.e. $\eta_{Cy} = 1.02$, this means that input usages increase by 1.02 percent, since $C(\mathbf{w}, y^s) = \{\sum_i q_i w_i : y = y(\mathbf{q})$. The return to scale of the production function $y = y(\mathbf{q})$ can be shown to be $RTS = \sum_i \eta_{yq_i} = 1/\eta_{Cy}$.

[21] This is because $\eta_{C_y w_l} = [\partial \log(c(\mathbf{w})h'(y))]/\partial \log w_l = \partial \log c(\mathbf{w})/\partial \log w_l + \partial \log h'(y)/\partial \log w_l = \alpha_l$.

If the production function is non-homothetic then we have $C(\mathbf{w}, y) \neq C(\mathbf{w}, 1)h(y)$. The elasticity of the demand for labour is

$$\eta_{lw_l} = \epsilon_{lw_l} + \eta_{ly^s|w_l}\,\eta_{y^s w_l} = \epsilon_{lw_l} + \eta_{ly^s|w_l}\,\eta_{Yw_l}\,\frac{1}{s} \tag{2.25}$$

where $\eta_{ly^s|w_l}$ is the elasticity of the labour demand with respect to output ($\eta_{ly^s|w_l} > 0$). Note that when the production function is homothetic $\eta_{Cy} = \eta_{ly}$ and the expression 2.25 will be the same as 2.22.[22] The elasticity of the market price to wages is $\eta_{pw_l} = \eta_{\mu w_l} + \eta_{ly}/\eta_{Cy}\,\alpha_l$. Therefore the mathematical relationship 2.23 becomes

$$\eta_{lw_l} = \epsilon_{lw_l} + \frac{\eta^2_{ly^s|w_l}}{\eta_{Cy}}\,\eta_{Yp}\,\frac{1}{s}\,\alpha_l + \eta_{ly^s|w_l}\,\eta_{Yp}\frac{1}{s}\,\eta_{\mu w_l} \tag{2.26}$$

Perusing 2.26 it is possible to observe that if the production function is homothetic, since $\eta_{ly} = \eta_{Cy}$, 2.26 reduces to 2.23. In the non-homothetic case the labour demand will be more elastic than in the homothetic setting if the use of labour is augmented (diminished) more than that of the other inputs when output is increased (decreased), i.e. if $\eta_{ly} > \eta_{Cy}$.

Again, if we assume firms compete in the quantity space, we can substitute 2.19 in 2.26 we get a relationship comparable to that in 2.20

$$\eta_{lw_l} = \epsilon_{lw_l} + \frac{\eta^2_{ly^s|w_l}}{\eta_{Cy}}\,\eta_{Yp}\,\frac{1}{s}\,\alpha_l + \eta_{Cy}\,\mu\,\eta_{sw_l} \tag{2.27}$$

[22]The homotheticity of the production function implies that factor shares do not depend on the level of output since if the output increases by 1 percent, all demands for input will increase by 1 percent as well and therefore the cost will grow by the same percentage; then, homotheticity ensures that $\eta_{Cy} = \eta_{iy}$ for any factor i.

2.7 Elasticity of labour demand and trade at industry level

Trade could affect labour demand elasticity through both the elasticity of substitution and the elasticity of the supply function (viz., scale effect). The first elasticity, could indeed be affected as openness increases the possibility of combining domestic and foreign factors in the production process of a firm (e.g.: Slaughter(2001)).

In addition, international trade may augment or reduce the scale effect due to the perceived elasticity depending on whether it causes an increase or decrease in the market share and in the cost share of labour. These are not obvious questions. The answer hinges on how firms react to increased foreign competition.

The literature concerning international trade and labour demand has amply investigated the effect of trade on the cost share of skilled and unskilled workers. Generally, trade has not been found to affect directly the cost share of labour while technology has. The relationship between the market share and trade has not been investigated sufficiently thus far. Consider first that the number of domestic firms is given in the market. An increase in foreign firms' shares due to a larger openness would then reduce the domestic firms market shares and hence, increase the elasticity of product and labour demand. However, the number of firms might be endogenous to trade. Under this new assumption an increase in foreign competition might lead the least productive firms to exit the market, thereby resulting in a more concentrated market and hence higher market share for all surviving firms.

To sum-up, at the firm level the effect of import penetration on market shares is ambiguous. However, the effect becomes unambiguous at the industry level, irrespective of whether the number of firms is endogenous or not. In order to see this, we relate formally hereafter import penetration to the *mean* labour demand elasticity prevailing in the industry.

From equation 2.16, we multiply each term by the market share of the firm computed considering only domestic companies ($s_i^d = \frac{y_i}{Y^D}$)[23] and sum over all domestic firms in order to obtain an expression of the weighted mean elasticity of labour demand in the industry, $\overline{\eta}_{lw_l} = \sum_i s_i^d \eta_{ilw_l}$. After simplification we obtain:

$$\begin{aligned}
\sum_i \eta_{i;lw_l} s_i^d &= \sum_i \sigma_{i;ll}\alpha_{i;l}\ s_i^d + \sum_i \eta_{iYp}\frac{1}{s_i}\eta_{ipw}\ s_i^d \\
\overline{\eta}_{lw_l} &= \overline{\sigma_{ll}\alpha_l} + \sum_i \eta_{iYp}\eta_{ipw}\frac{1}{S} \qquad (2.28)
\end{aligned}$$

with $S = s/s_i^d = Y^d/Y$ being the total market share of domestic firms on their market. $1/S$ is increasing in the import penetration rate I/Y^d since $1/S = Y/Y^d = (Y^d + I)/Y^d = 1 + I/Y^d$. Hence, at the industry level, the higher the import penetration, the higher the industry mean elasticity of the labour demand, in absolute value. In this relation, we can thus estimate the pure effect of import penetration via its impact on perceived product demand on average in the industry.

2.8 Data set

UK firm level data were used in this chapter. These come from the OneSource database from 1989 to 1999. It includes information on all public limited companies, all companies with employees greater than 50, and the top companies based

[23] Y^D is total sales of domestic firms; i indexes firms

on turnover, net worth, total assets, or shareholders funds (whichever is largest) up to a maximum of 110,000 companies, in both manufacturing and service industries. Companies that are dissolved or in the process of liquidation are excluded from the OneSource sample. In this paper we concentrate on manufacturing firms from this data source, which do not export.[24] Full description of the data set is given in the data appendix at the end of the Chapter 1.

The data set was screened to keep only those firms for which there were a complete set of information about turnover (i.e. output), inputs and prices. In addition, outliers that were eliminated; the 1 percent tails of the distribution of employment, wages per employees, net book value of fixed assets, and deflated turnover were not considered in the analysis. This left an unbalanced panel data of around 26000 observations regarding 9897 firms.

Full details about the variables used can be found in Appendix.

2.9 Empirical results

2.9.1 Labour elasticity regression

Equation 2.18 can be estimated on firm level data using variables for employment, wages and market shares. Taking discrete approximations, accounting for firm i cross-section and time t variations, equation 2.18 could be estimated as:

$$\Delta \log l_{it} \quad = \quad -\sigma \left[\alpha_{it} \Delta \log w_{it}\right] -$$

[24]Selecting the sample of non-exporters was necessary because we need market shares. Reliable market shares are available only for the UK market.

$$- \quad \beta_1 \left[(\alpha_l/s_{it})\Delta \log w_{it}\right] + \beta_2 \left[(1/s_{it})\Delta \log w_{it}\right]$$
$$+d_t + d_i + \varepsilon_{it} \qquad (2.29)$$

where d_i and d_t represent individual and time effects and ε_{it} is standard error term. The Δ operator expresses here first differences. The parameter β_1 represents the product demand elasticity (i.e. η_Y) whereas β_2 estimates the interaction between the product demand elasticity and the elasticity of the mark-up to wages (viz. $\eta_Y \eta_\mu$). Independent variables, $\Delta \log w$, α_l and $(1/s)$ can be easily computed from our data (see appendix) which would allow us to estimate the above regression.

Equation in 2.18 is derived from theory and therefore refers to the long-term. It does not allow for any adjustment dynamics, which in reality may be important. Here, we are interested in the long-run behaviour of our variables since we want to test the proposition implied by theory.

It is widely believed that cross-sectional studies tend to yield results concerning the long-run while time series studies conduce to short-run estimates. This association was investigated by Kuh (1959). By the same token, the between estimator in a panel data set is supposed to generate long-term results since it exploits the cross-sectional (i.e. between) variation of the data whereas the within estimator is thought to yield short-term coefficients because this methodology uses the time series (viz. within) variation of the data (Baltagi 2001, pp. 197–198).

Various authors have tackled the issue of why between and within estimates often differ markedly while theoretically they should not. The culprits have been identified in unobserved individual heterogeneity, dynamic misspecification and measurement errors. The former leads to a source of bias which arises if the individual effect is correlated with the regressors. In this occurrence the within estimates would be consistent while the between would not, since the former wipes out the individual effect whereas the latter does not. Dynamic misspecification could also be the cause of the discrepancy between the within and between estimates as underlined by Baltagi and Griffin (1984). Indeed, long-lags and short panel data, as is the norm in firm level data, may result in dynamic misidentification. With regard this problem, Pirotte (1999) shows that the static between estimator converges towards the long-run coefficient even though the true data generating processes is dynamic.[25] Griliches and Hausman (1986) have investigated the bias induced by measurement error. They claim that any transformation that eliminates the individual fixed effect such as the within and first difference transformation is likely to exacerbate the measurement error bias. This point is further analysed by Mairesse (1990) who underlines that, provided the measurement error is not autocorrelated, the between estimators minimizes the bias induced by measurement errors, because of the averaging, whereas within estimates magnify it.

In the estimation of regression 2.29 biases due to the unobserved individual heterogeneity, measurement errors and dynamic misspecification are likely to be encountered. Between the first two, measurement error seems to be the gravest since the discrete approximation of continuous derivative admittedly cannot be expected to be very precise. Thus, this would favour the between estimator since, as discussed before, the within may aggravate the measurement error bias (Grilishes and Hausman 1986). Besides, the bias related to the unobserved individual effect is probably eliminated by first differencing the data in order to obtain a discrete approximation. In addition

[25]For the converge it is required that T tends to infinity, N is fixed and the parameters are homogeneous. In addition this result holds irrespectively of the number of autoregressive and distributed lag terms appearing in the true data generating process

the between estimator has the advantage of being robust to dynamic misspecification as Pirotte (1999) has shown.

Given the above discussion, regression 2.29 has been estimated by means of the following more general panel data model

$$y_{it} = \delta_0 + \overline{x}_i\delta_1 + (x_{it} - \overline{x}_i)\,\delta_2 + \mu_t + \varepsilon_{it} \tag{2.30}$$

where y_{it} is $\Delta \log l_{it}$ and x_{it} is the vector of explanatory variables as in expression 2.29. This model permits to distinguish the effect of a temporary variation in the independent variables from the impact of a permanent one. Indeed, it assumes that changes in the mean of variables ($\overline{x}_i$) to wit long-run changes, affect the dependent variable differently than temporary deviations from it ($x_{it} - \overline{x}_i$).

It therefore combines the within and the between estimator. Indeed, $\overline{x}_i$ is the between transformation ($\overline{x}_i = \sum_t x_{it}$) whereas $x_{it} - \overline{x}_i$ is the within transformation.

It is worth noting that averaging over time it is possible to obtain

$$\overline{y}_i = \delta_0 + \overline{x}_i\delta_1 + \varepsilon_i \tag{2.31}$$

where δ_1 is the Between estimator. Subtracting the last equation from 2.30 one obtains

$$y_{it} - \overline{y}_i = (x_{it} - \overline{x}_i)\,\delta_2 + \mu_t + \varepsilon_{it} - \overline{\varepsilon}_i \tag{2.32}$$

where now, the δ_2 is the Within estimator.

The parameters of 2.29 were estimated according to model 2.30. To control for the size of the firm the lagged log of employment was included as additional regressor.

The results are shown in table 2.2. The coefficients of variables with a bar refer to the effect of permanent variations whereas the others concern the effect of a temporary variation. In other words, the first set of results are the between estimates whereas the second set are the within estimates.

With reference to the long-run, it is possible to note that the size of the firm seems to increase the absolute value of the elasticity of labour demand. This means that other things equal large firms are more inclined than small companies to substitute labour with other inputs when its cost increases. Furthermore, the long-run constant output wage elasticity of labour, the AH elasticity of substitution, is negative as expected and significant. It implies that a permanent increase in the cost share of labour will result in a more elastic labour demand.

Finally, the terms concerning the scale effect provide somewhat mixed results . Indeed, the product demand elasticity is estimated to be negative and significant at the 5 percent confidence level whereas the pro-competitive term is positive, as theory predicts, but insignificant.

With regard to the coefficient of the variables concerning a temporary departure from their mean (within estimates) it is possible to note that the size of the firm appears to affect the labour demand elasticity in the same direction as in the long-run. In fact, the two lagged values of employment in log are both negative and significant.

In addition, the elasticity of substitution is expected to be negative and significant, but the last two terms, which refer to the short-run scale effect are insignificant and have the opposite sign of what the theory posits. Therefore, it seems that whereas

Table 2.2: Elasticity of labour demand equation: The following model was estimated by OLS:

$$\begin{aligned}\Delta \ln l_{it} &= \delta_0 + \delta_1 \overline{\ln l_i} + \sigma_{ll}^B \overline{\alpha_{li} \Delta \ln w_i} + \eta_Y^B \overline{(\alpha_{li}/s_i) \Delta \ln w_i} + \eta_Y^B \eta_\mu^B \overline{(1/s_i) \Delta \ln w_i} \\ &+ \delta_2 (\ln l_{it-1} - \overline{\ln l_i}) + \delta_3 (\ln l_{it-2} - \overline{\ln l_i}) + \sigma_{ll}^W \left[\alpha_{lit} \Delta \ln w_{it} - (\overline{\alpha_{li} \Delta \ln w_i})\right] \\ &+ \eta_Y^W \left[(\alpha_{lit}/s_{it}) \Delta \ln w_{it} - \overline{(\alpha_{li}/s_i) \Delta \ln w_i}\right] + \\ &+ \eta_Y^W \eta_\mu^W \left[(1/s_{it}) \Delta \ln w_{it} - \overline{(1/s_i) \Delta \ln w_i}\right] + \varepsilon_{it}\end{aligned}$$

$\overline{l_i}$	-.018611** (.001236)
$\overline{\alpha_{li} \Delta \ln w_i}$	-.842043** (.203486)
$\overline{(\alpha_{li}/s_i) \Delta \ln w_i}$	-.000122* (.000058)
$\overline{(1/s_i) \Delta \ln w_i}$	.000015 (.000021)
$\ln l_{it-1} - \overline{\ln l_i}$	-.135285** (.02664)
$\ln l_{it-2} - \overline{\ln l_i}$	-.27508** (.016242)
$\alpha_{lit} \Delta \ln w_i - (\overline{\alpha_{li} \Delta \ln w_i})$	-.817545** (.157535)
$(\alpha_{lit}/s_{it}) \Delta \ln w_{it} - \overline{(\alpha_{li}/s_i) \Delta \ln w_i}$	.000024 (.000064)
$(1/s_{it}) \Delta \ln w_{it} - \overline{(1/s_i) \Delta \ln w_i}$	-1.00e-07 (.000018)
cons	.14133** (.00729)
Observations	26150
Firms	9897
R^2	.143915

Notes

(i) Robust standard errors in parenthesis

(ii) * significance at 5% confidence level; ** significance at 1%

(iii) Time dummies included

the elasticity of substitution has a role both in the short-term and the long-term the scale effect does not have any effect in the short-run.

However, these results should be interpreted keeping in mind the econometric caveat discussed above. More specifically, all the short-term coefficients are probably biased because they are in fact within estimates. These are subject to the likely major sources of bias impairing our estimation, namely measurement error bias (Grilishes and Hausman 1986) and dynamic misspecification (Baltagi and Griffin 1984; Pirotte 1999). Contrariwise, the estimates derived from permanent variation of independent variables, i.e. the between estimators, are not affected by dynamic misspecification (Pirotte 1999) and less affected by measurement errors (Mairesse 1990).

For this reason it appears that from this first set of results the theory is only partially corroborated by the data exploiting the between variation. Indeed, only one term of the two scale effect terms is significant. More precisely, the elasticity of product demand is negative and significant whereas the elasticity of the product demand times the elasticity of mark-up with respect to wages is estimated to be positive, but insignificant.[26]

2.9.2 Cost function approach

In the previous section we have estimated relationship 2.18 a simple via linear regression. This method has yielded estimates of coefficients representing the Allen/Uzawa elasticity of substitution and the product of the elasticity of product demand to prices times the elasticity of the product price to wages.

[26]It is worth stressing that in table 2.2 not attempt was made to correct for endogeneity problems. However, given the above discussion about possible biases, endogeneity is not likely to be the major source of bias. Errors of measurement are probably so. The issue of endogeneity is discussed more thoroughly in the next section.

However, using this methodology has produced mixed results, which may be caused by the fact that the elasticities we are interested in are highly non-linear functions of firms' characteristics, such as market share, mark up and labour demand. These parameters are likely to assume different values for each firm. In addition if the underlining production function is characterized by non-constant returns to scale or is non-homothetic the elasticity of the labour demand is a function of additional elasticities, namely $\eta_{ly|w}$ and η_{Cy} as shown in 2.23 and 2.26. Hence, the interpretation of the estimates obtained in the previous section may be further complicated by the interactions among all these terms.

An alternative empirical strategy is to estimate a flexible cost function whose parameters can be used to derive the different components of the elasticity of labour demand. In addition, with this methodology we can explicitly take into account the possibility of a non-homothetic production function.

The first issue to consider concerns the choice of the cost function. We chose the translog variable cost specification taking capital as fixed factor and two variable inputs, namely labour and materials. The translog production function and its dual cost function were first introduced by Christensen *et al.* (1971) and since then they have become ubiquitous in the production function and input demands empirical literature (see for example Berndt (1991)). The translog is a flexible specification since it is a second linear approximations of any production or cost function. We considered a variable cost function with capital as the fixed factor since we assume that capital cannot be adjusted freely in each time period like other inputs.[27]

To begin with, two cost functions were estimated. One considers output as given

[27]This methodology has also the advantage that we do not have to consider the price of capital, which is not in our data set

i.e., $C(\mathbf{w}, y^s)$. From this, it is possible to derive the constant output labour demand elasticity $\varepsilon_{lw_l} = \sigma_{ll}\,\alpha_l$, i.e. the substitution effect. The other takes the product price as fixed $C[\mathbf{w}, y^s(\mathbf{w}, p)] = C(\mathbf{w}, p)$. From this, it is possible to compute the constant price labour demand elasticity $\eta_{lw|p}$. The latter elasticity must be larger (in absolute value) than the former elasticity. Their difference ($\eta_{y^s w|p} = \eta_{lw|p} - \varepsilon_{lw}$) is not the scale effect, but only its first (negative) component as shown in 2.16. If the production function is non-homothetic, then $\eta_{ly}\,\eta_{y^s w|p} = \eta_{lw|p} - \varepsilon_{lw}$.[28]

The fixed capital cost functions can be represented by $C = {}_yVC\,(w, m, y, k) + rk$ and $C = {}_pVC\,(w, m, p, k) + rk$. C and VC are the total and the variable cost, respectively; w, m and r stand for the price of labour (wage per employee), the price of intermediates and the user cost of capital, respectively.[29] y is the output of the firm, p is the price of the good (assumed to be the same across all firms) and k is the fixed capital.[30] Given that the capital is fixed, profit maximising firms will minimize ${}_yVC$ and ${}_pVC$. These functions were approximated and estimated using the translog specification[31]

$$\ln\,{}_yVC \;=\; \gamma_0 + \sum_i \gamma_i \ln w_i + \frac{1}{2}\sum_i\sum_j \gamma_{ij} \ln w_i \ln w_j +$$

[28]Remember that if the production function is homothetic, but with no-constant return to scale, then $\eta_{ly} = \eta_{Cy}$; besides if there are constant return to scale $\eta_{Cy} = 1$.

[29]Note that our firm level data set does not contain information on the price of intermediates. Therefore, 4 digit SIC92 deflators of material and fuels provided by the Office of National Statistics were used. Other authors have used deflators as a proxy of prices of inputs in cost functions (e.g. (Krishna, Mitra, and Chinoy 2001; Levinsohn 1993). Deflators may be deemed to be reliable proxies of the actual price paid by firms in input markets are competitive.

[30]Anew, since the data set does not have information on product prices we used disaggregated producer price indexes as proxies. This index varies over industries; therefore we have restricted the following analysis to homogeneous sectors as classified by Oliveira *et al.* (1996).

[31]The translog specification we use is a second order linear approximation of any cost function, whose dual production function may be *non-homothetic*.

$$
\begin{aligned}
&+ \quad \gamma_k \ln k + \frac{1}{2}\gamma_k (\ln k)^2 + \gamma_y \ln y + \frac{1}{2}\gamma_{yy}(\ln y)^2 + \\
&+ \quad \sum_i \gamma_{ki} \ln k \ln w_i + \sum_i \gamma_{yi} \ln y \ln w_i + \gamma_{ky} \ln k \ln y \qquad (2.33)
\end{aligned}
$$

$$
\begin{aligned}
\ln {}_pVC \quad &= \quad \beta_0 + \sum_i \beta_i \ln w_i + \frac{1}{2}\sum_i \sum_j \beta_{ij} \ln w_i \ln w_j + \\
&+ \quad \beta_k \ln k + \frac{1}{2}\beta_k (\ln k)^2 + \beta_p \ln p + \frac{1}{2}\beta_{pp}(\ln p)^2 + \\
&+ \quad \sum_i \beta_{ki} \ln k \ln w_i + \sum_i \beta_{pi} \ln p \ln w_i + \gamma_{kp} \ln k \ln p \qquad (2.34)
\end{aligned}
$$

where i and j index inputs. The first derivatives of the log of the cost function with respect to the log of the price of one input, say labour, yields its cost share of

$$
\begin{aligned}
\frac{\partial \ln {}_zVC}{\partial \ln w_l} &= \frac{\partial_z VC}{\partial w_l}\frac{w_l}{{}_zVC}; \qquad for\ z = y, p \\
&= L(\mathbf{w}, k, z)\frac{w_l}{{}_zVC} \\
&= \alpha_l
\end{aligned}
$$

Cost shares are estimable equations since they are linear function of a subset of parameters and variables appearing in the cost function. Therefore, a system of equations was estimated comprising the cost equation and the variable cost shares.[32] The estimation was conducted imposing the standard restrictions applying to any cost function, namely symmetry and linear homogeneity in factor prices, along with the relevant cross equation restrictions. We used Zellner's method for seemingly unrelated regression (SUR) equations. Due to the fact that the variable cost shares sum to one the disturbance covariance matrix of the system will be singular and one equation therefore needs to be dropped. We dropped the variable cost share of intermediates. The SUR estimates will normally not be invariant to the equation deleted. Fortunately, invariance can be obtained by iterating Zellners method (ISUR) so that the

[32]The estimation was conducted separately for the cases when output and price are considered as given.

parameter estimates and residual covariance matrix converge (Berndt 1991). The estimators obtained through ISUR are equivalent to the maximum likelihood estimators. We combined the SUR estimator with panel data estimation techniques deploying the within-transformation to control the firm fixed effect. A full set of time dummies was also added to the estimated equations to control for time fixed effects.[33]

It is worth underlining that we consider the price of inputs as exogenous to the firm and therefore not correlated with the error term of the cost function and cost share regressions. This is equivalent to say that firms face a infinitely elastic supply of inputs. This assumption may be problematic using aggregate data; at county level, for instance, the supply of labour is not infinitely elastic, but infinitely rigid since it corresponds to the number of worker in that country. At more disaggregate levels it is plausible to think that both the demand for and the supply of labour depends on wages. The latter, then, are determined endogenously by the movement of both the supply of and demand for labour curves. In this case to get consistent estimates of labour demand elasticities it is necessary to instrument wages to control for possible shifts of the supply of the labour curve, which determines wages.

However, at very disaggregate levels, like in this study, it is reasonable to envisage a infinitely supply of labour since firms may try to hire workers from an infinitely large pool (with respect to their demands) of workers. In this case, no instruments are needed since changes in wages (determined by exogenous movements of the supply of the labour curve) trace out the demand for labour. In addition, also if we wanted to instrument wages we would need variables determining the labour supply

[33]The estimation was conducted in two steps: 1) within transformation of the cost function and cost share to be estimated; 2) system estimation by ISUR of the cost function and cost share. Industry dummies were not estimated since they cancel out as result of the within transformation. The ISUR estimation was implemented with Stata 8 using the command *sureg*.

to be used as good instruments in the labour demand regression. This information is extraneous to the data set used. Also previous empirical studies on labour demand using disaggregate data have treated wages as exogenous (Slaughter 2001; Krishna, Mitra, and Chinoy 2001).[34]

The results of the ISUR estimation are shown in table 2.3. Those considering price as given are in column 1, whereas those considering output as given are in column 2. These figures cannot be easily interpreted since they are the estimates of the parameters of the cost functions. However, from the estimated parameters in table 2.3 it is possible to see that the production function (dual of the estimated cost function) is non-homothetic since γ_{yy}, γ_{wy} and γ_{my} are statistically significant.

Since the translog specification is in log and involves cross-product term it is not possible to obtain the labour demand and its elasticity by simple differentiation. However, the first derivative of the cost share with respect to wages can be shown to be a function of the labour demand elasticity and the cost share itself

$$\begin{aligned}\frac{\partial \ln \alpha_l}{\partial \ln w_l} &= \frac{\partial \frac{\ln w\, L(\mathbf{w},z)}{\ln {}_zVC}}{\partial \ln w_l} \\ &= \frac{\partial \ln w_l}{\partial \ln w_l} + \frac{\partial \ln L(\mathbf{w},k,z)}{\partial \ln w_l} - \frac{\partial \ln {}_zVC}{\partial \ln w_l} \\ &= 1 + \frac{\partial \ln L(\mathbf{w},k,z)}{\partial \ln w_l} - \alpha_l; \qquad for\ z = y, p\end{aligned}$$

[34]In results not reported we have tried to instrument wages and all its cross terms with lagged values and their square terms applying the three-stage least square methodology. Very unreliable estimate were obtained since the elasticity of the demand for labour was always positive. This may be caused by the poor quality of instruments. Lagged values of wages probably are not a good predictor of the supply of labour so they do not help to identify correctly the demand for labour curve. It seems that instrumental variables in this case produce more bias than that which is supposed to correct. Slaughter (2001) reported similar problems.

Table 2.3: Regression results of cost functions: Fixed effects ISUR

	${}_pVC$		${}_yVC$
	(1)		(2)
β_w	.7104 (.0353)**	γ_w	.2015 (.0216)**
β_m	.2896 (.0353)**	γ_m	.7985 (.0216)**
β_k	.7986 (.0715)**	γ_k	.2733 (.0238)**
β_p	-8.9215 (1.6403)**	γ_y	.6559 (.0103)**
β_{ww}	.0411 (.0029)**	γ_{ww}	.0678 (.0028)**
β_{kk}	.0202 (.0028)**	γ_{kk}	.0161 (.0015)**
β_{mm}	.0411 (.0029)**	γ_{mm}	.0678 (.0028)**
β_{pp}	2.2908 (.3634)**	γ_{yy}	.0855 (.0027)**
β_{wk}	.0015 (.0009)	γ_{wk}	.0154 (.0009)**
β_{wm}	-.0148 (.0097)	γ_{wm}	-.0405 (.0053)**
β_{wp}	-.0482 (.0089)**	γ_{wy}	-.0556 (.0015)**
β_{mk}	.0204 (.0137)	γ_{mk}	-.0595 (.0051)**
β_{mp}	.0483 (.0089)**	γ_{my}	.0557 (.0015)**
β_p	-.1741 (.0186)**	γ_{ky}	-.0303 (.0016)**
cons	-.0024 (.0102)**	cons	-.0443 (.0039)**
observ.	11430	observ.	11430

Notes:

(i) Robust standard errors in parenthesis.

(ii) + significant at 10%; * significant at 5%; ** significant at 1%.

(iii) Subscripts refers to labour (w), materials (m), capital (k), output (y), product price (p).

(iv) Year dummies included.

Then,

$$\frac{\partial \ln L(\mathbf{w}, k, z)}{\partial \ln w_l} = \frac{\partial \ln \alpha_l}{\partial \ln w_l} - 1 + \alpha_l; \qquad for\ z = y, p$$

From this relationship given an estimate of $\frac{\partial \ln L(\mathbf{w},k,z)}{\partial \ln w_l}$ it is possible to get an estimator of the labour demand elasticity. From the cost function in 2.33 and 2.34 it is possible to see that

$$\begin{aligned}
\frac{\partial \ln \alpha_l}{\partial \ln w_l} &= \frac{\partial \alpha_l}{\partial \ln w_l} \frac{1}{\alpha_l} \\
&= \frac{\partial \frac{\partial \ln {}_z VC}{\partial \ln w_l}}{\partial \ln w_l} \frac{1}{\alpha_l} \\
&= \frac{\partial \ln^2 {}_z VC}{\partial (\ln w_l)^2} \frac{1}{\alpha_l} \\
&= \gamma_{ll} \frac{1}{\alpha_l}; \qquad \text{for } z = y \\
&= \beta_{ll} \frac{1}{\alpha_l}; \qquad \text{for } z = p
\end{aligned}$$

Thus, constant output and constant price labour demand elasticities can be expressed, respectively as

$$\epsilon_{lw_l} = \frac{\partial \alpha_l}{\partial \ln w_l} \frac{1}{\alpha_l} + \alpha_l - 1 = \gamma_{ll} \frac{1}{\alpha_l} + \alpha_l - 1 \tag{2.35}$$

$$\eta_{lw_l|p} = \frac{\partial \alpha_l}{\partial \ln w_l} \frac{1}{\alpha_l} + \alpha_l - 1 = \beta_{ll} \frac{1}{\alpha_l} + \alpha_l - 1 \tag{2.36}$$

The variance of these estimates can be computed respectively as $Var(\varepsilon_{lw_l}) = 1/\alpha_l^2 Var(\gamma_{ll})$ and $Var(\eta_{lw_l|p}) = 1/\alpha_l^2 Var(\beta_{ll})$.

We computed labour demand elasticities and their standard errors at the median of the cost share of labour and for each observation. At the median of the cost share, the elasticity estimates are $\eta_{lw|p} = -.5847$ and $\varepsilon_{lw} = -.4789$ and they are statistically significant at any confidence level.[35] In addition, their relative value is consistent with theory, since $\eta_{lw|p} - \varepsilon_{lw} = \eta_{ly|w}\eta_{yw|p} < 0$ (see expression 2.16). This means that the optimal adjustment of output, caused by a change in wages, makes the labour demand more elastic. This is because, as wages increase firms will substitute labour, given output (i.e. substitution effect); however firms will reduce output as well, since the marginal cost has increased, and this will cause a further reduction in the labour requirements. Table 2.4 exhibits the mean and percentiles of the constant price and constant output elasticity of the labour demand, as well as their difference, calculated for all observations. If the cost function is well behaved the own-price input demand elasticities, should be negative for all data points. It is noteworthy that only those estimates in the upper tail of the distribution are inconsistent with theory, being positive.[36] For all the other observations, the estimates have the expected (negative) sign. Excluding the upper and lower tail of the distribution, the elasticity estimates vary between -0.60 (95^{th} percentile) and -0.30 (5^{th} percentile), for the constant price elasticity, and between -0.49 (95^{th} percentile) and -0.04 (5^{th} percentile), for the constant output elasticity. The values of the latter are, in general within the 0.15-0.75 range that Hamermesh (1993) has identified as plausible for a typical firm.

As underlined above, these estimates are consistent with theory since $\eta_{lw|p} < \varepsilon_{lw}$). As it is possible to see in table 2.4, column 3 this difference is negative for all observations and ranges from 0.35 (5^{th} percentile) to 0.05 (95^{th} percentile). These estimates suggest that the optimal adjustment in output, caused a variation in wages by 1 percent, adds 0.05–0.35 percentage points to the substitution effect. These may

[35]The standard errors are respectively 0.0114 and 0.0111.

[36]These values are generated for very low and high value of the cost share of labour.

Table 2.4: Summary statistics of the estimates of the elasticities of the demand for labour.

	$\eta_{\mathbf{lw}\mid\mathbf{p}}$ (1)	$\varepsilon_{\mathbf{lw}}$ (2)	$\eta_{\mathbf{ly}\mid\mathbf{w}}\,\eta_{\mathbf{yw}\mid\mathbf{p}} = \eta_{\mathbf{lw}\mid\mathbf{p}} - \varepsilon_{\mathbf{lw}}$ (3)
1%	-.5945	-.4791	-.8574
5%	-.5941	-.4788	-.3470
10%	-.5926	-.4779	-.2393
25%	-.5835	-.4710	-.1447
50%	-.5476	-.4447	-.0965
Mean	-.4963	-.3536	-.1407
75%	-.4844	-.3837	-.0708
90%	-.3934	-.2456	-.0575
95%	-.2988	-.0362	-0507
99%	.3501	1.20	-.0401

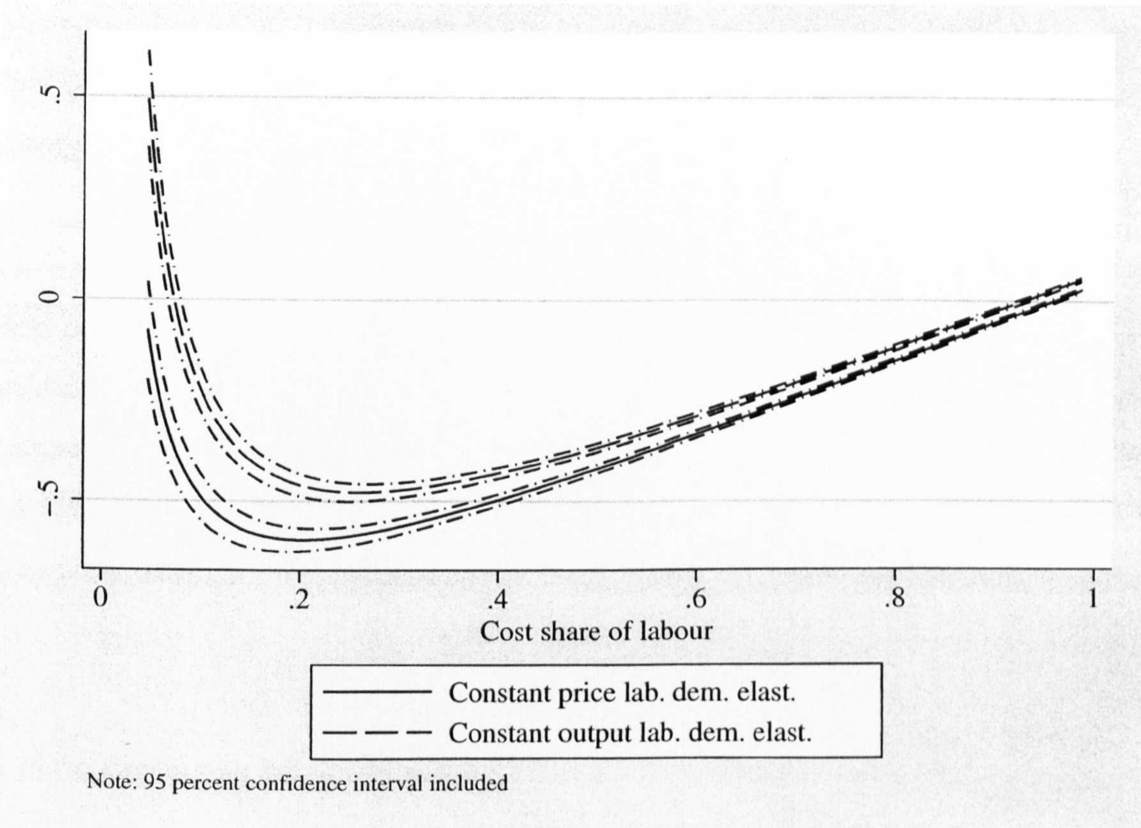
be deemed as substantial figures since they correspond to 40 percent of constant output elasticity ($\varepsilon_{lw|p}$) at its mean value (and 22 percent at its median).

To assess the statistical significance of the constant output and constant price labour demand elasticities computed for all firms, table 2.1 graphs them against the cost share of employment, including their 95 percent confidence interval.[37] As it is possible to see they are statistically different from zero and from each other, bar at extreme values of the cost share of labour. In addition the constant price elasticity is larger, in absolute value, than the substitution effect for all observations.

Thus far, we have not explored the total labour demand elasticity, which take into account the variation in the product price besides the change in output. In the preceding section we have seen that if the production function is non-homothetic, as the estimates in table 2.3 suggest, the total labour demand elasticity can be written as

[37] 5 percent tails of the distribution have been excluded to display a neater graph.

Figure 2.1: Elasticities and cost share of employment.



$$\begin{aligned}\eta_{lw} &= \varepsilon_{lw} + \eta_{ly|w}\, \eta_{yw} \\ &= \underbrace{\varepsilon_{lw} + \eta_{ly|w}\, \eta_{yw|p}}_{\eta_{lw|p}} + \eta_{ly|w}\eta_{pw}\end{aligned}$$

The total elasticity comprises a third term, which is the result of oligopolistic competition. It is expected to be positive, thereby reducing the absolute value of the responsiveness of the demand for labour to wages. To quantify the effect of this third term, we need to estimate another cost function in which the product price is not taken as exogenous, but determined by the behaviour of firms.

It is well known that in an oligopoly setting the total quantity produced in an industry (and therefore the market price) depends on the sum of the marginal cost of competing firms, not on its distribution (Bergtrom and Varian 1985). Furthermore, the optimal supply of output is increasing in the relative marginal cost; firms with relatively high marginal cost will produce less than those with a relatively low marginal cost. To allow for this type of competitive behaviour, determining the total industry output and the product price, we estimated a translog cost function analogous to those in 2.33 or 2.34 where the output or price was substituted with a measure of the marginal cost of firms relative to the industry average (rmc). The variable cost function we are interested in estimating is $VC(r, m, k, rmc)$. It is worth underlining that its first derivative with respect to the relative marginal cost is negative since,

$$\frac{\partial VC}{\partial rmc} = \underbrace{\frac{\partial VC}{\partial y}}_{>0} \underbrace{\frac{\partial y}{\partial rmc}}_{<0} < 0$$

The marginal cost was computed from the estimated parameters of the cost function ${}_yVC$. Indeed, it is easy to show that

$$\eta_{Cy} = \frac{\partial \ln C(\mathbf{w}, \mathbf{y})}{\partial \ln y} = \gamma_y + \gamma_{yy} \ln y + \gamma_{Ly} \ln L + \gamma_{My} \ln M + \gamma_{Ky} \ln K$$

From the estimated elasticity η_{Cy} it is possible to derive the marginal cost as $MC = \eta_{Cy}(y/C)$. Here a problem arises because we do not have y_{ijt} (real output of firm i, in industry j at time t); what we have is total turnover deflated, $y_{ijt}p_{ijt}/p_{ijt}/p_{j0} = y_t p_{j0}$ (i.e. turnover expressed in base year pounds). Therefore $MC_{ijt} = \eta_{C_{ijt}y_{ijt}}(y_{ijt}/C_{ijt})[C_{ijt}/(y_{ijt}p_{j0})] = (\partial \ln C_{ijt}/\partial \ln y_{ijt})/p_{j0}$. The marginal cost in scaled by the industry price as at the base year. However, what we are interested in is not the marginal cost per se, but the marginal cost *relative* to the industry-time average $rmc_{ijt} = \ln MC_{ijt} - \overline{\ln MC_{.jt}}$;[38] with this transformation the scale factor

[38] i, j and t, respectively, index firms, industries and year.

cancels out.[39]

We estimated a system of equation (the cost function $VC(r, m, k, rmc)$ and the relative labour cost share equation) via three-stage least square. This methodology was chosen to correct for the measurement errors introduced by the generated regressor (i.e. relative marginal cost). Indeed, measurement errors will result in biased and inconsistent estimates. In addition, any transformation of the data, such as first difference and fixed effect, will worsen the measurement errors bias (Grilishes and Hausman 1986). To correct for this, additional information (as instrumental variables) or additional assumptions to identify the parameters are needed. We followed Hsiao (2003, pp. 305) and employed instrumental variable estimation, which in a system of equations results in the three-stage least square methodology. We instrumented all the variables in the translog specification of $VC(r, m, k, rmc)$ where the relative marginal cost enters (i.e. its value, squared value and all its cross-product) with the corresponding one period lag. As before we iterated over the estimated disturbance covariance matrix and parameter estimates until convergence was achieved to make our estimates invariant to the choice of which cost share is estimated.

The result of the estimation are in table 2.5.[40] Given these estimates we can compute the total labour demand elasticity like in 2.36, substituting β_{ww} with δ_{ww}. Before doing this, it is worth checking whether the elasticity of the cost function with respect the relative marginal cost is estimated to be negative as expected. Table 2.6 shows the percentiles and mean of the distribution of such elasticity computed for all

[39]This is because $\underline{rmc_{ijt}} = \ln 1/p_{j0} + \underline{\ln MC_{ijt}} - [1/N \sum_i (\ln 1/p_{j0} + \ln MC_{ijt})] = \ln 1/p_{j0} + \ln MC_{ijt} - \ln 1/p_{j0} + \overline{\ln MC_{.jt}} = \ln MC_{ijt} - \overline{\ln MC_{.jt}}$.

[40]To assess the quality of our instruments we checked the p-value of the F-statistics of the first stage regressions. If the p-value is above ten then the null that all regressors in the first-stage regression is not rejected and the instruments are too weak. We found that the null is rejected at any significance level for all first-stage regressions, thus we concluded that the instrument used are not weak.

observations. As it is possible, to see for all observations the elasticity is negative. The mean and median are similar being respectively -11.6 percent and -10.81 percent. This means that if the marginal cost, relative to the industry average, decreases by 1 percent, the variable cost will decrease by 11 percent, on average.

Turning on total labour demand elasticity, η_{lw}, we computed its estimates at the median of the cost share of labour and for all observations. The latter is -0.5091 and is significant at any confidence interval.[41] The corresponding value of the constant output and constant price labour demand elasticity were $\eta_{lw|p} = -.5847$ and $\varepsilon_{lw} = -.4789$. Then, we have, as theory predicts, that the total elasticity is smaller than the constant price elasticity and larger than the constant output elasticity, in absolute value. The difference $\eta_{lw} - \eta_{lw|p} = \eta_{ly|w}\, \eta_{yp|w}\, \eta_{pw}$ is an estimation of the pro-competitive term and it should be positive. Previously, Slaughter (2001) has tried to estimate the total and constant output labour demand elasticities using US industry data. However, he failed to obtain negative scale effect. This is probably due to the aggregation bias.

To check whether the scale effect is negative for all observations, table 2.7 exhibits the percentiles and mean of the distribution of the total elasticity η_{lw}, scale effect $\eta_{lw} - \varepsilon_{lw}$ and the pro-competitive term $\eta_{lw} - \eta_{lw|p}$. It is noteworthy that the value of η_{lw} are in the most of the cases negative as expected. Only in the upper 1 percent of the distribution the estimates are negative; these correspond to extreme value of the cost share of labour. The estimates of the scale effect are all less than zero, anew as predicted. This means that the total elasticity of the demand for labour is larger in absolute value than the constant output labour demand elasticity (i.e. substitution effect). This is the scale effect introduced by Allen (1938). Furthermore,

[41] Its standard error is 0.0201

Table 2.5: Regression results of cost function $VC(\mathbf{w}, rmc)$: Fixed effects 3sls.

	VC
	(1)
β_w	.0106 (.0028)**
β_m	.9894 (.0028)**
β_k	.7803 (.0797)**
β_{rmc}	4.6259 (.8612)**
β_{ww}	.0602 (.0051)**
β_{kk}	.0062 (.0057)
β_{mm}	.0602 (.0051)**
β_{rmcrmc}	-3.8678 (1.0849)**
β_{wk}	-.0026 (.0016)+
β_{wm}	.0447 (.0095)**
β_{wrmc}	-.622 (.0174)**
β_{mk}	-.1241 (.0136)**
β_{mrmc}	.6221 (.0174)**
β_{rmc}	-.1936 (.1258)
Cons	.0106 (.0028)**
Observ.	7807

Notes:
(i) Robust standard errors in parenthesis.
(ii) + significant at 10%; * significant at 5%; ** significant at 1%.
(iii) Subscripts refers to labour (w), materials (m), capital (k), output (y), relative marginal cost (rmc).
(iv) Year dummies included.

Table 2.6: Elasticity of the variable cost function $VC(\mathbf{w}, rmc)$ with respect the relative marginal cost.

	$\eta_{\mathbf{Crmc}}$
	(1)
1%	-27.16
5%	-20.34
10%	-17.85
25%	-14.25
50%	-10.81
Mean	-11.60
75%	-8.29
90%	-6.09
95%	-5.05
99%	-3.17

table 2.7 shows that the difference between the total elasticity (η_{lw}) and the constant price elasticity ($\eta_{lw|p}$) is positive throughout. This is consistent with the extension of the elasticity of the labour demand in imperfect competition presented in the preceding sections. This term reduces the scale effect; if the pro-competitive effect were zero the scale effect would be higher. Indeed, the scale effect appears to be fairly small, thereby making the total labour demand elasticity only slightly higher than the substitution effect. According to the figures in table 2.7 the scale effect adds around 0.03 percentage points, on average, to the constant labour demand elasticity, whose mean value is 0.40. If the absence of the pro-competitive effect, the scale effect would increase (in absolute) by around 0.10 percentage points.

Overall, following relationship 2.25 and given our estimates the labour demand elasticity can be decomposed, at the median of the cost share of labour, as

$$\eta_{lw_l} \quad = \quad \epsilon_{lw_l} + \eta_{ly^s|w_l}\,\eta_{y^s w_l}$$

Table 2.7: Summary statistics of the estimates of the total labour demand elasticity, scale effect, and pro-competitive effect.

	Total elasticity	Scale effect	Pro-competitive effect
	η_{lw}	$\eta_{\mathrm{lw}} - \varepsilon_{\mathrm{lw}}$	$\eta_{\mathrm{lw}} - \eta_{\mathrm{lw\|p}} = \eta_{\mathrm{ly\|w}}\,\eta_{\mathrm{yp\|w}}\,\eta_{\mathrm{pw}}$
	(1)	(2)	(3)
1%	-.5092	-.2471	.0291
5%	-.5089	-.0937	.0364
10%	-.5081	-.0653	.0411
25%	-.5005	-.0406	.0504
50%	-.4725	-.0271	.0680
Mean	-.3977	-.0396	.0993
75%	-.4168	-.0201	.1019
90%	-.3070	-.0164	.1638
95%	-.1574	-.0145	.2352
99%	.9851	-.0116	.6201

$$\underbrace{\eta_{lw_l}}_{-0.5084} = \underbrace{\epsilon_{lw_l}}_{-0.4789} + \underbrace{\underbrace{\eta_{ly^s|w_l}\,\eta_{y^s w_l|p}}_{-0.1051} + \underbrace{\eta_{ly^s|w_l}\eta_{y^s p|w_l}\eta_{pw_l}}_{+0.0756}}_{-0.0295}$$

As it is possible to note the pro-competitive reduces (in absolute value) the scale effect substantially. This may be one of the reason why previous empirical studies did not find any effect of increased international competition on the elasticity of the labour demand (Slaughter 2001; Krishna, Mitra, and Chinoy 2001; Greenaway, Hine, and Wright 1999).

Previously we have shown in 2.28 that the total elasticity of the demand for labour in a given industry can be expressed as a weighted average of firm-level elasticities, with weights equal to market shares computed considering only the domestic production. This industry-level elasticity is increasing in the import penetration rate.

To aggregate our firm-level elasticities to the industry-level we need domestic production and imports for each sector. We took this information from the Input-Output Supply and Use Tables provided by the Office of National Statistics. They offer information at disaggregated industry level, correspondingly roughly to three and four-digit sectors of the SIC92 classification. Obviously, to compute reliable weighted average industry elasticities it is necessary to have information on all firms in the sector so that the weights will sum to one. Unfortunately, our data set is not a census so the sum of the markets shares differs from one in most industries and years; however we checked for which sectors and years the total domestic production in our firm level-data covers at least the ninety percent of the total domestic production extracted from the Input-Output tables. Only the industry under the heading "Production of mineral waters and soft drinks" in 1999 meets this criterion.[42]

Given our estimates of the elasticity of the demand for labour for those firms in this sector in 1999 the industry-level elasticity can be decomposed as

$$\underbrace{\overline{\eta}_{lw_l}}_{-0.434} = \underbrace{\overline{\sigma_{ll}\alpha_l}}_{-0.385} + \underbrace{\sum_i \eta_{iYp}\,\eta_{ipw}\frac{1}{S}}_{-.049}$$

Knowing that 1/S is equal to one plus the import penetration rate (I/Y^d) and that in this particular industry, in 1999, the import penetration rate was 0.102, as computed from the Input-Output tales, we can write

$$\overline{\eta}_{lw_l} = \underbrace{\overline{\sigma_{ll}\alpha_l}}_{-0.385} + \underbrace{\left(1+\frac{I}{Y^d}\right)}_{1.102}\underbrace{\sum_i \eta_{iYp}\,\eta_{ipw}}_{-.044}$$

Then, we can infer that if the import penetration rate increases by 10 percent (from 0.102 to 0.112), this will add around 0.004 percentage points to the labour demand elasticity, which is around one percent of its estimated value (-0.385). This small increment in the total elasticity may be deemed due to the pro-competitive term of the labour demand elasticity, which is reducing the responsiveness of the labour demand to wages.

[42]This is the sector 19 in the Input-Output classification corresponding to 1598 SIC92.

2.10 Conclusion

In recent years much effort has been devoted to analyze the effect of international trade on labour demand elasticities. Rodrick (1997) has suggested that one of the consequences of increasing international competition is a more elastic demand for labour. This statement has spurred new empirical studies (Slaughter 2001; Krishna, Mitra, and Chinoy 2001; Greenaway, Hine, and Wright 1999), which however failed to identify any significant effect of trade on the elasticity of the demand for labour.

The Allen (1938)-Uzawa(1962) theoretical framework usually employed in all studies dealing with input demand elasticities assumes perfectly competitive markets and refers to the representative firm. These assumptions make this framework relevant at the industry-level, only; in addition, according to this relationship, at the firm-level the labour demand results infinitely elastic because the product demand is infinitely elastic too.

This is at odds with recent theoretical and empirical findings for two reasons. Firstly, from a theoretical standpoint imperfect competition and increasing return to scale have been shown to be one of the major causes of international trade (Helpman and Krugman 1985). Secondly, empirical researches suggest that the elasticity of the labour demand never approaches infinity (Hamermesh 1993), therefore the assumption of perfect competition in the product market, although theoretically convenient, does not seem to be appropriate.

In this chapter, following the approach of Dixit (1990) we have provided an extension to the traditional Allen-Uzawa formulation, by allowing for imperfect competition and non-constant return to scale. The labour demand elasticity is found to depend not only on the cost share of labour, its elasticity of substitution and the elasticity of the product demand, as in the traditional expression, but also on the market share of the firm.

Furthermore, two terms feature in the scale effect. The first one is the analogous of the scale effect in the Allen-Uzawa expression, with the only difference that the product demand elasticity is divided by the market share yielding the "perceived" product demand elasticity. The second term is a novelty. It is the result of the pro-competitive effect whereby firms respond to say, an increase in the price of labour, not only shedding jobs, but also reducing their mark-up. This term diminishes the scale effect, thereby lessening the responsiveness of the demand for labour to wages.

In the empirical sections of this chapter, we test this theoretical relationship in two fashions, using a firm-level data set of UK manufacturing firms operating in homogeneous industry. Firstly, the elasticity of the labour demand, approximated by the discrete annual changes in employment and wages, was regressed against variables as function of the cost share of labour and the market share to estimate the three components of the elasticity. This regression posed particular difficulties because of measurement errors problems and non-linearities in the coefficients. However the results seems to corroborate, at least partially, the theoretical framework. In the long-run, the elasticity of substitution of labour, its cost share and the firm's market share have the expected effect on labour demand elasticities. However, of the two term characterizing the scale effect only one appears to have an explanatory power.

In the second empirical exercise, we find, consistently with theory, that the scale effect is composed by two terms of which one, the pro-competitive effect, diminishes its magnitude. From out estimates, it appears that the effect of this term is substantial. Indeed, the scale effect seems to add only 0.03 percentage points to the total elasticity of the demand for labour, estimated to be 0.50, at the median of the factor share of labour. These estimates were obtained estimating different cost functions, from whose parameters it is possible to derive the constant output, constant price and total elasticity of the demand for labour. Therefore, we were able to identify all the components of the elasticity of the demand for labour.

Aggregating these firm-level figures to the industry level, for the only sector and year our data set allows us, we infer that an increase of the import penetration rate by 10 percent will add only around 0.004 percentage points to the total labour demand elasticity.

The scale effect reducing pro-competitive term that we have identified gives a possible explanation of why previous empirical studies, ignoring the strategic interaction among firms, have failed to detect any impact of international trade on the elasticity of the demand for labour.

One likely important point we have not considered in this research is the different wage costs across countries. Whereas, imports from either low-wage or high-wage countries makes the product market more competitive, and therefore both make the labour demand more elastic, it is plausible that the former will exert a stronger competitive pressure towards domestic companies than the latter. Then, imports from low-wage countries should have a larger effect on the elasticity of the demand for labour than those from countries with high labour costs.

The issue of differentiating the impact on the elasticity of the demand for labour of imports from countries with different labour costs will be the subject of future research.

2.11 Appendix: Construction of variables

Labour demand (l): Total number of workers employed by the firm. Onesource does not contain information on the number of production and non-production workers so their aggregate measure was used in this exercise.

Wage (w_l): The wage of workers in each firm was calculated dividing the total wage bill by the number of workers (from OneSource).

Cost share of labour (α_l): This figure is the ratio between the cost of labor and the total cost of production. The cost of labour is the wage bill from OneSource whereas the total cost of production is the sum of the cost of labour and cost of intermediates (also from OneSource).

Capital (k): Net-value book of assets taken from OneSource. Since no industry or firm level price deflator for capital are available in the UK, the nominal value was deflated using the GDP deflator of capital formation.

Output (y): Total turnover deflated with disaggregated producers price indexes provided by the Office of National Statistics.

Market share (s): Turnover of firms over total production of in the corresponding industry, taken from the Input-Output Supply and Use Tables; industries are defined according to the classification of the Input-Output table. Input-Output Supply and Use Tables have been provided by the Office of National Statistics and are available in its web site.

Chapter 3

Export Oriented FDI in the UK

3.1 Introduction

Attracting foreign direct investment (FDI) and promoting exports have figured prominently in the minds of policymakers in the UK. A single agency, namely UK Trade & Investment, started recently to manage and coordinate policies concerning the promotion of exports and inward FDI.[1] Its stated role "...is to help companies realise their international business potential through knowledge transfer, and on-going partnership support." For "those [firms] exporting for the first time or businesses experienced in international trade expanding into new markets ..." the UK Trade & Investment "... can help develop export capabilities and provide expert advice, reliable data, and professional research." As regards inward FDI, this agency "... provides information and services to help you locate or expand your business in the UK."[2]

Under these policies, financial incentives such as tax breaks, duty drawbacks, investment allowances and so on have been offered to multinational enterprises (MNEs)

[1]Until not so long ago two agencies were responsible for export and inward FDI, namely Trade Partners UK and Invest UK.

[2]This information have been found in the web-site of UK Trade & Ivestment.

to establish foreign affiliates (see Haskel *et al.* (2002)). Likewise, export promotion activities range from financing trade fairs, through providing free information about foreign markets and financing market research, to export credit insurance.

The rationale of all such initiatives is founded on the belief that FDI inflows and exports contribute positively to economic development. While this policy intervention reflects, partly at least, an entrenched attitude whereby exports are good and imports are bad, econometric evidence has recently suggested why exports might actually promote long-term growth.[3] Foreign direct investments are also deemed to bring many benefits. Recently, Porter and Ketels (2003) have summarised what advantage FDI inflow may bring to the UK. FDI increases the level of competition in the domestic economy, and offers consumers greater choice. They are also seen as an important source of new technologies, innovation and business practice. It has become an established fact that foreign multinationals have higher productivity and superior technology than domestic firms and there is some evidence that these both help to raise aggregate productivity in the economy through the reallocation of resources, and also spills over to domestic firms resulting in some self-improvement. There are also important effects on employment and wages from FDI.

A neglected aspect of the effect of foreign multinationals on the UK economy is their contribution to UK exports. This chapter is the first attempt to investigate the export behaviour of foreign multinational firms in the UK, using a firm level data set for the manufacturing sector from 1988-1999.[4]

[3]At the macro level GDP growth is strongly positively correlated with the growth of exports (Edwards 1993; Edwards 1998), and there is now supporting evidence at the micro level. Exports raise aggregate productivity by encouraging productivity improvements within the firm (e.g.: Girma *et al.* (2004); Wagner (2002)) and by reallocating resources towards high productivity firms within the industry (low productivity firms either shut down or lose market share; e.g.: Bernard and Jensen (2004a)).

[4]The relationship between FDI and aggregate export has been investigated before by, inter alia,

Our sample shows that foreign firms contribute disproportionately to UK exports of manufacturing industries. In 1996 foreign multinationals accounted for one third of all exports from the UK manufacturing sector (they contributed 28 percent of total output).[5] Foreign firms are more likely to export than UK owned firms, and when they do, exports account for a greater proportion of total sales. In the data 85 percent of multinational firms export compared to 75 percent of domestically owned firms, while the share of exports in total output is 10.3 percent and 5.6 percent respectively. Moreover, the size of this gap has been increasing over time.

In this chapter we attempt to shed light on a number of issues. These include why foreign firms export at all. The export activity of foreign affiliates is not strictly consistent with traditional theories of FDI (for example Markusen (1995)). According to this set of models firms invest in foreign production facilities to avoid the costs of international trade (there is a cost advantage of proximity versus concentration, Brainard (1993, 1997)).

Exports and FDI are substitute methods of serving markets. Exporting foreign firms may be envisaged in three situations: 1) the good is exported to a third country being part of a free trade area as the host country (this leads to tariff jumping FDI; e.g.: Motta and Norman (1996) and Ekholm *et al.* (2003)); 2) multinational enterprises undertake, so called, complex integration strategies, which involve export

Blake and Pain (1994), for the UK. This exercise study is more in the spirit of Hanson *et al.* (2001) and Feinberg and Keane (2003) where they analyse the export behaviour of *foreign affiliates* of US multinationals.

[5]As explained later the data set used in this study does not contain all manufacturing firms within the UK. There is a bias in our sample towards large firms. This will have the effect of increasing the share of multinational firms in total manufacturing output. In the manufacturing census data set (ARD) multinational firms accounted for 21 percent of total manufacturing output in the 2001 (Griffith, Redding, and Simpson 2004). The effect on the share of exports of multinational firms will be less affected by this bias because large firms are more likely to export than smaller firms (Bernard and Jensen 1999; Girma, Greenaway, and Kneller 2004).

to a third country and intra-firm trade (this happens when there are more than two stages of production and more than two countries); e.g.: Grossman *et al.* (2003), Yeaple (2003) and Ekholm *et al.* (2003); 3) the firm produces multiple products that are delivered to foreign markets through different means and there is a positive correlation in demand across these products (cross-product complementarity); Head and Ries (2004). We try to assess which one is the more likely to explain the UK experience.

We also focus on the policy implications of our results: Is there a one-size fits all export promotion policy? Do foreign firms face the same incentives and costs as domestic firms in their export decisions, or are other characteristics important? Can the financial incentives granted to foreign affiliates to locate in the UK be justified on grounds (i.e. export promotion) other than those traditionally advocated (i.e. direct productivity and employment gains)? Finally, we also consider the strategic motives for using the UK as a platform for exports.

The chapter is organized as follows. The economic theory underpinning export and FDI decisions is outlined in section 2. Section 3 then documents the empirical evidence for the UK. This is considered at various levels of aggregation and brownfield FDI. Finally, Section 4 provides a summary of the evidence found and an assessment of the predictions from the theoretical models.

3.2 What does theory tell us?

In traditional theories of the multinational firm, exporting and FDI are alternative methods of supplying foreign markets (e.g.: Markusen (1995)). Firms invest in foreign production facilities to avoid the costs of international trade, there is a cost advantage of proximity to markets versus the concentration of production facilities (Brainard 1997).

The process of modelling the export and FDI decisions of MNEs has developed along two lines: First, export platform FDI; second, complementarity between export and FDI. These can broadly be distinguished by the number of product lines that the firm is assumed to produce. Export platform FDI is typically defined as the establishment of production facilities in a foreign country and the use of part or all of the output from those facilities to serve a third country. It therefore refers to the export of a single product line, where these exports are not back to the parent country. Complementarity between exports and FDI refers instead to the case of a multi-product firm and to the export and FDI flows from the home country to foreign countries: exports and FDI become positively correlated if there are horizontal or vertical complementarities across product lines.[6] We concentrate on the first of these two strands of literature.

In a model with two countries and two stages of production (e.g. manufacturing and headquarter services) the integration strategies of MNEs have been broadly classified as vertical and horizontal (Markusen 2002). Vertical FDI occurs when stages of production occurs in more than one country; and horizontal FDI when the stages of production occur entirely in one country (home and foreign). Vertical FDI is factor seeking, whereas horizontal FDI is termed as market seeking. When there are more than two countries and more than two stages of production, multinationals are likely to undertake more complex FDI choices, which involves intra-firm trade and export platform FDI.

[6] For a review and assessment of this literature see Head and Ries (2001)

The process of modelling more intricate integration decisions by MNEs and export platform FDI has generally consisted in adding more countries, and stages of production into more traditional theories of MNEs. For example in a very simple case, adding a third country closely located to one of the others a firm may choose to locate an affiliate in only one of the two foreign lands, thus serving the other through export. In addition, considering intermediates a more complex picture arises since firms may produce them in different countries. This will cause exports of intermediates where the final good will be assembled.

When there are more than two countries and more than two stages of production, multinationals are likely to undertake FDI choices involving intra-firm trade and export platform FDI. The effect of adding more countries to the model is to allow for the possibility of a horizontal motive for export platform FDI, whereas adding more stages of production allows for a vertical motive.

Motta and Norman (1996), motivated by the observation that much FDI is between countries involved in regional trading blocks such as NAFTA or the EU, consider the case of three identical countries and a single stage of production. Costs of production do not differ between countries but costs of trading do (because two either enter a free trade agreement or raise external barriers against the third). If we assume that we start from an equilibrium where each firm exports to the other two from its home country, then the action of raising external barriers or creating a free trade area will encourage the outside firm to set up production facilities inside the free trade area and export to the other country in the regional bloc. Which of the countries the outside country chooses to locate production in and export from is left undetermined, as both are identical. Again, because of identical costs neither of the inside countries choose export platform FDI as a strategy.

However, the actual integration strategies pursued by MNEs appear to be more complex than those envisaged by most economic models, thus far. As emphasized in the World Investment Report (1998) trans-national corporations have been adopting complex integration strategies, which involve FDI as export platform. Indeed, multinationals are progressively undertaking internationalisation strategies that are neither purely horizontal nor purely vertical, but are both at the same time. Such strategies lead to export platform FDI, which involves exports of intermediates or final goods by foreign affiliates.

Theoretical models have been produced trying to explain these hybrid integration strategies, which complicate the classical distinction between horizontal and vertical FDI (e.g.: Yeaple (2003); Ekholm *et al.* (2003); Grossman *et al.* (2003)). These models share a common set-up, namely, there are two identical countries in the North and one other country in the South; in addition firms produce intermediate and final goods. Firms must provide headquarter service from their home northern country, but can choose where to produce intermediates as well as assembly of the final product. The predictions these three models generate are robust to different competitive settings. Yeaple (2003) employs the new trade theory framework consisting of a representative firm operating in monopolistic competition. Ekholm *et al.* (2003) uses a strategic choice model, a duopoly, whereas Grossman *et al.* (2003) relies on the heterogeneous firms model introduced by Melitz (2003).

More specifically, Yeaple (2003) considers two industries, one producing a homogeneous good sold in a perfectly competitive market and the other producing a differentiated good sold in a monopolistically competitive market. The latter is consumed in the North only and requires two intermediate inputs labour and skill, of which skill is cheaper in the North whereas labour is cheaper in the South. Both final goods are internationally traded, but only that produced in the monopolistic competitive industry is subject to transport costs and its production process can be divided into different stages (production of two intermediates and costless assembly of the final good).

The author compares four integration strategies concerning the production of the differentiated good: 1) no FDI: companies concentrate all the production process in the country of origin and therefore serve the other northern market through exports; 2) vertical FDI: one intermediate is produced in the South and the other [illegible] he (northern) home country; 3) horizontal FDI: firms conduct the entire production process in both northern countries where the final good will be consumed; 4) comp[illegible] FDI: one component is produced in the South and the other in both Northern [illegible] ies where they will be assembled and sold.

The presence of transport costs and factor price differentials give [illegible] respectively, to horizontal and vertical motives for investing abroad. Low tr[illegible]t costs make vertical FDI more convenient since firms will exploit the low lab[illegible] in the South and ship intermediates produced using labour. By contrast, hi[illegible]nsport stimulate horizontal FDI since firms will try to save transport costs p[illegible]g both intermediates and assembling the final good where it will be consumed.

Yeaple shows the complex FDI strategy dominates the others in an [illegible] ediate range of transport costs. In this case firms will invest both in the So[illegible] rtical FDI) and in the other northern country (horizontal FDI). MNEs und[illegible] such an FDI strategy are neither purely horizontal nor vertical, but may be [illegible] to be hybrid. This model generates export platform FDI since internationa[illegible] tments in the south may be considered as vertical with respect to the home co[illegible] and as export-platform with respect to the other country in the North.

The conditions under which export platform FDI is likely to take place have been explicitly analysed by Ekholm *et al.* (2003). In their model there are two identical high cost countries in the North (E and W) and one low cost in the South (S). Each firm produces one intermediate and a final good. Firms must provide headquarter services from their home northern country but can choose where to produce intermediates as well as assembly of the final product.

In this model, starting from high transport costs and a small assembly cost advantage for S, lowering such costs produces the following sequence of equilibria: 1) no FDI; each country in the North serves the other through export; 2) horizontal FDI: both countries in the North have a production facility in the other northern country to serve such a foreign market; 3) export platform FDI: each of the northern country has a production facility in S to serve the respective foreign market in the North, only; 4) hybrid FDI strategy: all production is concentrated in the South; this kind of FDI is vertical with respect the home country and export platform with respect to the other northern country.

Furthermore, the authors deal with the case of a Free Trade Area (henceforth FTA) between one northern country, say E, and the South. The FTA means that it is always optimal for country E to locate production in the Southern country and export products back home (owing to the cost advantage from doing so). Therefore, unlike in Motta and Norman (1996), when there are no vertical motives for FDI, the country inside the free trade area always has an incentive to undertake export platform FDI.

For the other northern country (W) the model predicts three outcomes: 1) no

FDI: firm B produces in its home country and exports to the free trade area; 2) export-platform FDI: firm W produces in its home country the good to be sold there; whereas the final good sold in the other northern country is produced in the South and then exported; 3) hybrid FDI: firm W locates all production in the South and exports the good to both markets in the North. Again, this last alternative is a hybrid strategy because, towards the home country (W), the firm undertakes vertical FDI whereas, toward the other Northern country (E), it undertakes a pure form of export platform FDI. Which of these sets of alternative strategies occurs depends on the size of the (marginal) cost advantage to Southern firms, and the various trade costs between the different countries. As the cost advantage of Southern relative to Northern firms increases we move from the first equilibrium, to the second and then when the cost advantage of locating production in the South becomes large enough all production moves there.

The predictions of these models are driven primarily on cross-country differences in costs firms face (owing to the fact that some are inside and some outside the free trade area). Grossman, Helpman and Szeidl (2003), adopting a heterogeneous firms framework and developing the complex FDI model of Yeaple (2003), show that firm level characteristics may also be important. If firms within the same industry are heterogeneous in their productivity levels they may make different choices, even though the costs of exporting and FDI they face are the same. Like Yeaple (2003) and Ekholm *et al.* (2003), they assume three countries (two in the North and one in the South); firms must provide headquarter services, produce intermediates and assemble the final product. Their analysis allows for the coexistence in the same sector of a rich array of profitable FDI strategies. In brief, the general lesson that can be drawn from this paper is that least productive firms will not undertake FDI.

More productive firms will choose complex strategies that involve a mix of FDI and exports. In most situations these can be classified as neither purely horizontal nor purely vertical, but as complex and involve the export of intermediates and/or the final product.

A couple of empirical studies have dealt with the issue of the export propensity of foreign affiliates. Feinberg and Keane (2003) look at the intra-firm trade of US MNEs with establishments in Canada between 1984 and 1995. Hanson *et al.* (2001) consider the expansion strategies of US multinationals in foreign countries between 1982 and 1998. They use the same data on US multinationals.

Feinberg and Keane (2003) argue that the classical distinction between vertical and horizontal FDI does not describe well the behaviour of US MNEs. This is because the data shows two-way trade flows between the parent company in the US and its foreign affiliates in Canada. On the one hand, this is not consistent with purely horizontal FDI, since in such a case foreign affiliates are expected to replicate what the parent company does at home and not to export goods back to the parent company. On the other hand, this is not in accordance with purely vertical FDI either, since in this situation the trade flow is expected to be one way only (from the place of production of intermediates to the place of assembling of the final good). Overall, these intra-firm trade patterns suggest more complex FDI strategies.

Hanson *et al.* (2001) claim, as Feinberg and Keane (2003), that the vertical/horizontal taxonomy does not fit neatly the actual expansion strategies of US MNEs. They highlight that export platform FDI is a common phenomenon. More importantly, they show as the export share depends on host country and industry characteristics. Although the authors do not consider export destinations, the fact that export to sales ratio of foreign affiliates is higher for sectors usually associated with ourcing suggests that goods may be exported back to US.

3.3 The extent of export oriented FDI in the UK

3.3.1 Descriptive statistics

We study the export behaviour of foreign firms located in the UK usi nel of firms taken from OneSource for the period 1988 to 1999. A full descri of the data set is provided in the data appendix at the end of Chapter 1. Fo etails on the OneSource dataset can also be found in Oulton (1998). Onesou tains information on the country of origin of parent companies. In this way able to identify around 740 foreign firms for a total of about 4500 observa t of the industry wide variation we observe in the data may reflect the fact eign multinationals tend to be concentrated in industries with high produ while exports from the UK might be expected to reflect comparative advantage vide a comparison to foreign firms we therefore also report on the export r of domestic firms. Onesource report company account values for all firms wi han 50 employees operating in the UK. This data set contains information on 0000 of firms. Firms were screened to a complete series of turnover, export, nent, wages and cost of intermediates.

Nominal values of output and export were deflated using disaggrega stry level producer price indexes provided by the Office of National Statistic ion, value added per worker was computed as real turnover minus the real ods sold (which proxies real intermediates). Real intermediates were obtai ing the cost of goods sold using the price indexes of materials and fuels at disaggregated industry level provided again by the Office of National Statistics. Employment was measured as the total number of workers employed by the company and wages and the total wage bill (present in OneSource) divided by employment. To offset the effect of outliers in our econometric analysis the 1 percent tails of the distribution of employment, exports, turnovers and wages were not considered. This procedure and the presence of missing values left a sample of around 27000 observations concerning around 4000 firms.

To assess the extent to which foreign multinationals export we start by analysing the export share for the totality of firms in our sample. Figure 3.1 depicts the distribution of export share for all firms, whereas figure 3.2 for domestic and foreign companies, separately.[7]

From figure 3.1 it is possible to observe that about 25 percent of the observations in our sample have zero exports. More than 25 percent of them have positive, but low export share (i.e. between 0 and 10 percent). After this point the number of observations with higher export shares declines progressively. The pattern of export activities just described is broadly consistent with those of US and French firms depicted by Eaton *et al.* (2004). They report that the mode of the distribution of export intensity of firms that actually export is less than 10 percent as in our data set. In addition, the histogram they report exhibits the same behaviour as the one figure 3.1, with a progressive decay the higher the export share. The main difference between export activities of UK companies and US firms concerns the proportion of firms or observations that have positive exports. Indeed, as reported by Bernard, Eaton, *et al.* (2003) for the US this figure is around 25 percent (1992 figure) whereas

[7]The data in both figures represent averages across the full sample period. The distributions of export shares do not change significantly if they are computed on a cross section basis.

Figure 3.1: Distribution of the export share for all firms

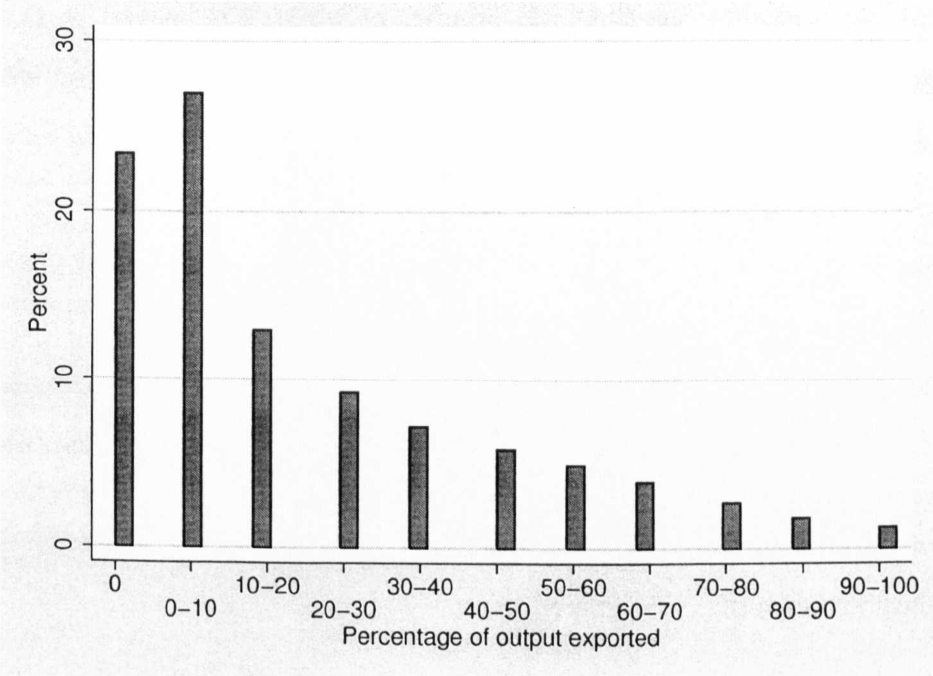
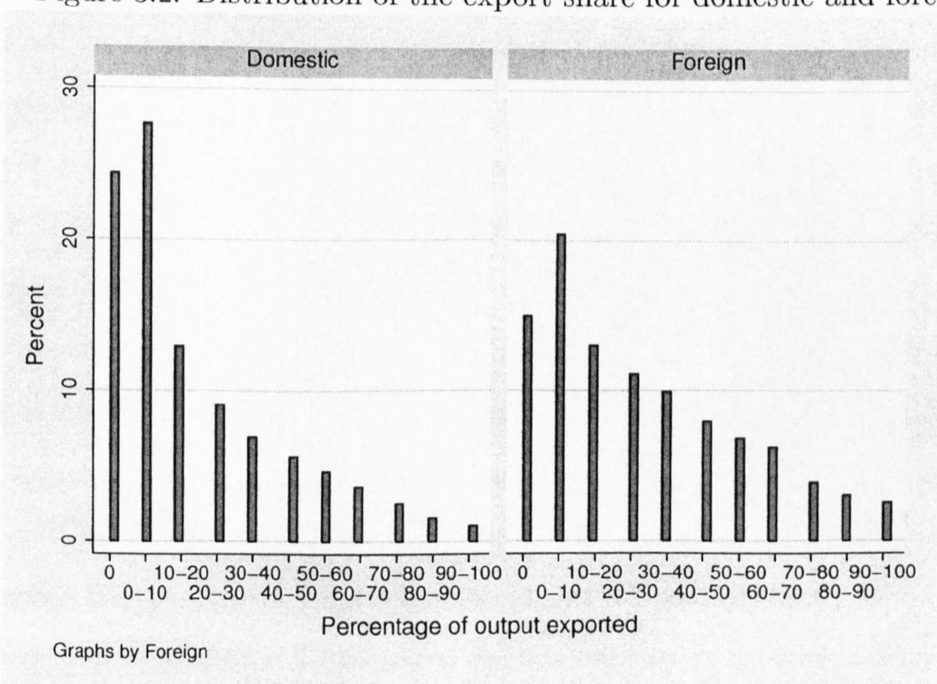


Figure 3.2: Distribution of the export share for domestic and foreign companies



in the data set used in this investigation the proportion is slightly more than 75 percent.[8]

Turning to domestic and foreign firms, figure 3.2 show that although their distributions exhibit the same overall characteristics there are also some notable differences between them. Foreign firms are more likely to export than indigenous enterprises, and on average when they sell abroad they export a higher share of total output. About 25 percent of domestic firms report no sales abroad, whereas the comparable figure for foreign enterprises is around 15 percent. The export intensity of domestic firms is also lower, the median export share of foreign owned firms being 21 percent compared with 8.8 percent for domestically owned firms. This difference between the two is manifest across the distribution of export shares. For example, 27 percent of domestic firms export less than 10 percent of total sales whereas just 21 percent of companies under foreign control report such a low level of export sales. Similarly foreign firms are more likely to have larger export shares than domestic firms: around 22 percent of foreign owned firms have an export share greater than 50 percent of total output, whereas the comparable figure for domestic firms is 13 percent.

A comparison of export sales by domestic and foreign firms of the type conducted above does not account for the fact that foreign firms might be concentrated in export intensive industries and may export more in certain years. To control for the effect of industries and the business cycle (i.e. industry and time effects) we measure the export share of each firm relative to median export share in the industry and year. The export intensity of firm i was computed as the percentage difference between the export share of the firm and the median export share at time t in industry j

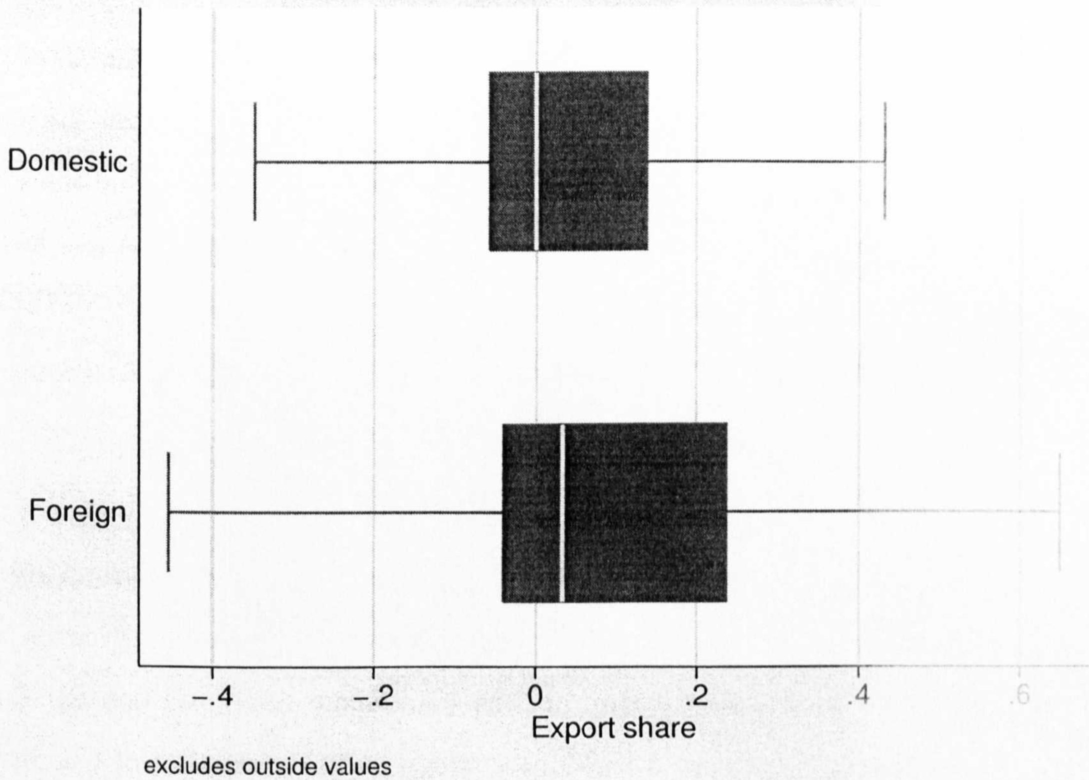
[8]For other European countries comparable quantities are: Germany 45 percent (Bernard and Wagner 1997); Italy 73 percent (Castellani 2002); Spain 62 percent (Delgado, Farinas, and Ruano 2001); and Sweden 80 percent (Greenaway, Kneller, and Gullstrand 2003).

(industries are at SIC92 3 digit level). All values lie within the range -1 and +1 (a value of 0.5 indicates that firm i has an export share 50 per centage points higher than the median firm in that industry and year). Figure 3.3 presents a box plot of the export share for UK and non-UK firms computed using this methodology. In addition to the median export share (represented as the vertical line inside the box) the boxplot presents information on other aspects of the distribution. The distance between the two extreme vertical segments is a measure of the dispersion of the data (observations beyond these segments were considered outliers and therefore excluded by the graph). The length of the box represents the interquartile range.

The results from this exercise would appear to confirm the evidence presented in figure 3.2: the export intensity of foreign owned firms is greater even conditioning on industry and time. At the median foreign firms export 3.4 percentage points more than domestic firms in the same industry and time period. Other works have reported that foreign businesses in the UK are bigger and more productive than domestic ones (e.g.: Girma *et al.* (2001)). From this figure we note that in addition they also have larger export shares.

Figure 3.3 also suggests however, that there are large differences in the export behaviour of foreign firms, and more so than UK owned firms. The inter-quartile range for the export share of foreign owned firms is 0.28. The equivalent figure for domestic firms is 0.19. In addition, the export share of foreign firms appear to be more dispersed than that of domestic firms. This might suggest greater heterogeneity in the type of FDI inflows the UK receives. Among foreign companies, there are some that are relatively export oriented (with respect to the median firm) and others that are relatively host market oriented.

Figure 3.3: Boxplot of the export share of domestic and foreign firms



Notes: The export share is measured as difference between the export share of firm i in industry j at time t and the median of the export share of all firms in industry j at time t.

We investigate these differences in the export share of foreign firms by disaggregating according to the country of origin of the parent company. The models of export platform FDI reviewed in Section 2 make predictions according to the country/indusry characteristics the firm. In the first two columns of table 3.1 we report the percentage of observations from each country that export or do not export. In the third column we report the mean export share of exporters (again calculated relative to the industry and year median), while the final column reports the number of observations we have on companies from each country. Figure 3.4 presents graphically the mean export share of firms by country.

As reported already, there is a higher percentage of foreign exp... is than domestic firms in our sample: 75 percent of domestic firms export ... to 85 percent of foreign firms. Of these foreign firms only European (80 ...) and Australian (50 percent) are noticeably less likely to export than the ... oreign firm. At the other end of the scale all Asian firms observed in our ... xport. With respect to UK firms, only Australian firms appear to be less lik... xport; EU companies seem to be slightly less export oriented, whereas all ... oreign affiliates are considerably more export oriented.

The percentage of exporters versus non-exporters in the sampl... ess by country than the export intensity. In terms of the share of output ... there would appear to be two broad groups of countries. In the first group ... itries and Australia where the export share is slightly below that for UK firm... econd group, which includes firms from the US, Japan, Asia, and non-EU ... xport intensities are between 5 and 9 percentage points above that of UK fir... dian firms are the most export oriented in the sample and appear somewh... lier. The mean export share of Canadian owned firms is 36 percentage ... the median in the respective industry and year.[9]

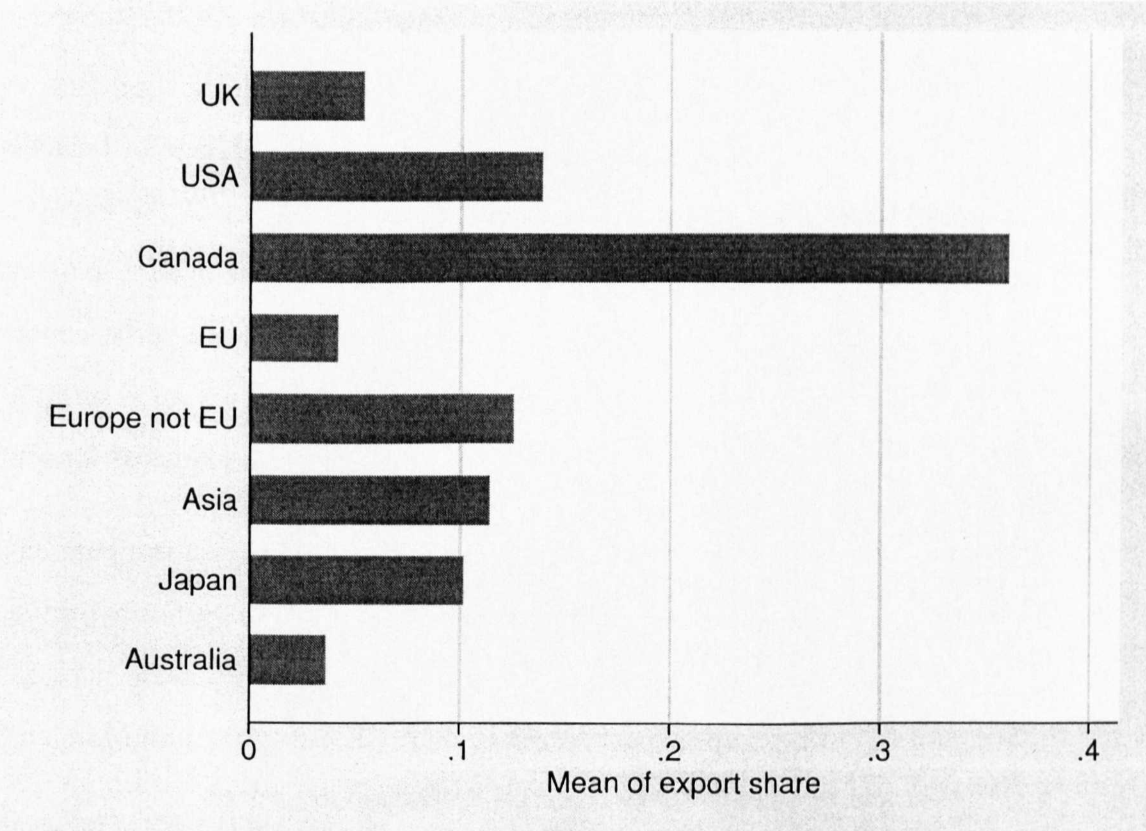
All in all, it is interesting to note that companies headquart... tries that are part of the EU have similar export characterisrics to domesti... ereas firms whose parent company headquarters are in non-EU European cou... nore export oriented. The former result might be used to suggest that vert... ited export platform FDI (complex FDI strategies) may be important for ... the UK as a location for production even by firms from other EU countri... ged by Yeaple (2003) and Ekholm *et al.* (2003). The latter result is consisten... lea

[9]Australian firms seem to be outliers as well given the small number of observ...

Table 3.1: Export share and the number of exporters and non-exporters by country.

	Non-export.	Export	Export share	Observ.
All firms	23.7%	76.3%	6.0%	30715
UK	24.7%	75.3%	5.3%	27617
All foreign	15.1%	84.9%	10.4%	3098
US	10.9%	89.1%	13.9%	1045
Canada	9.6%	90.4%	36.1%	135
EU	19.3%	80.7%	4.2%	1329
Europe non-EU	12.9%	87.1%	12.5%	241
Asia	0.0%	100.0%	11.4%	34
Japan	16.0%	84.0%	10.2%	156
Australia	50.0%	50.0%	3.6%	28
Others	10.8%	89.2%	12.8%	130

Figure 3.4: Mean of the export share of firms by country of origin.



Notes: The export share is measured as difference between the export share of firm i in industry j at time t and the median of the export share of all firms in industry j at time t.

that firms from non-EU European countries establish production facilities in the UK to gain access to the European market. This is a horizontal (tariff jumping) motive for FDI, as outlined in the theoretical models by Motta and Norman (1996) and Ekholm *et al.* (2003). This is apparent looking at the export behaviour of European firms, inside and outside the EU.[10] Although these firms may share the same technology, transport costs and other industrial characteristics, which are common or similar across Europe, those with headquarters outside the EU have higher export propensity than those inside the EU.

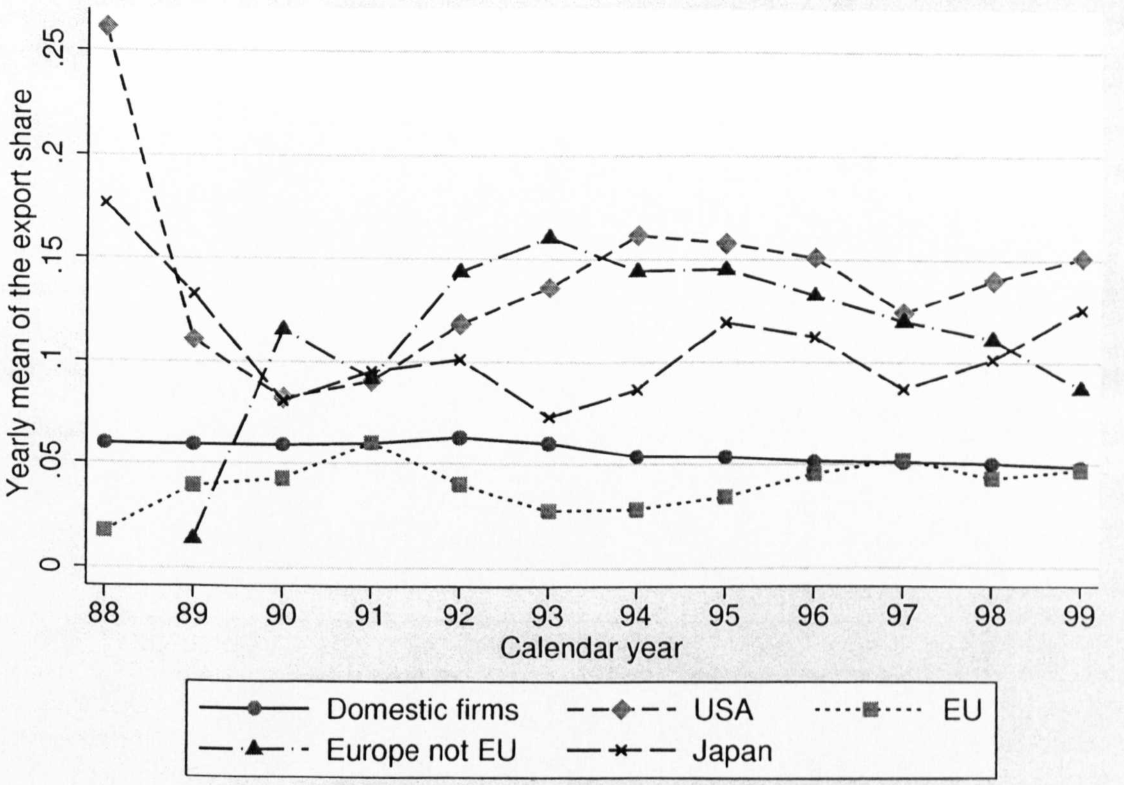
Thus far in the analysis we have ignored the question of whether these patterns have changed noticeably across time. There are some reasons to expect that this might be the case. The available sample period coincides with the creation of the European Single Market Programme in 1992. Given we have found that strategic motives are important for export platform FDI we might expect a change in behaviour around this point. Figure 3.5 shows the behaviour of the mean of the export share over time broken down by most important country/geographic area.[11] It is evident that in general foreign affiliates from outside the EU have been more export intensive than domestic enterprises in all years in our sample (there is some variation for some countries possibly due to the relatively small number of observations for some groups).

The same behavioral pattern of the export share is shown in figure 3.6 where the mean of the export share of domestic and foreign firms has been substituted with their median. Foreign affiliates, whose parent company is from outside the EU, appear as in figure 3.5 to be more export oriented than UK enterprises and foreign firms from

[10] In our sample, non-EU Europe comprises Switzerland and Norway.

[11] We do not display all of the countries included in the previous analysis in the chart for reasons of clarity, we focus instead on the main countries and the main trends.

Figure 3.5: Behaviour of the mean export share of foreign and domestic firms by year.

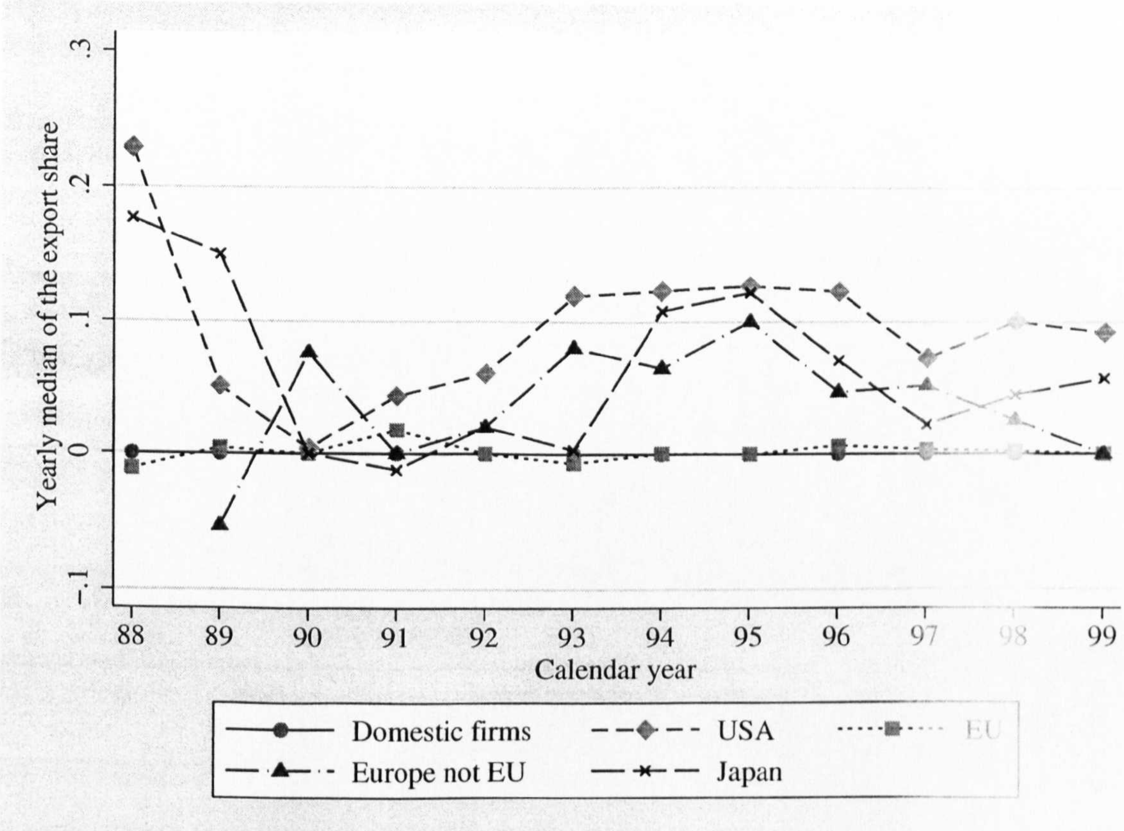


Notes: The export share is measured as difference between the export share of firm i in industry j at time t and the median of the export share of all firms in industry j at time t.

the EU (although the median export share of the latter group converges towards that of UK companies in the last years of the sample).

Overall it would appear that foreign companies have been contributing more over the years than domestic firms to the export performance of the manufacturing sector in the UK. However, there is no evidence of a clear break in behaviour around 1992. This also occurs irrespective of the country of origin. Firms whose owners are from the EU countries have lower export intensity than domestic firms at the start of the period and near identical levels by the end, whereas firms from non-EU have an export intensity that is above that of domestic firms at both the start and end of the period.

Figure 3.6: Behaviour of the median export share of foreign and domestic firms by year.



Notes: The export share is measured as difference between the export share of firm i in industry j at time t and the median of the export share of all firms in industry j at time t.

3.3.2 Export decision regressions

It remains possible that firm characteristics rather than strategic decisions could determine the differences among countries described above. Firm level microeconometric evidence both for the UK and other countries has for example, found that the export decision of domestic firms is driven by their advantageous underlying performance characteristics. Firms that are sufficiently large and productive self-select into becoming exporters (Bernard and Jensen 1999; Bernard and Jensen 2004a; Girma, Greenaway, and Kneller 2004; Greenaway and Kneller 2004a). Therefore it might be for example that Canadian firms are more productive than EU multin [illegible] nd it is this that explains their higher export intensity. Or similarly, mult [illegible] firms are known to be more productive than domestic firms and as such one [illegible] pect therefore that foreign multinational firms contribute disproportionat [illegible] ports from the UK because of these favourable characteristics.

We investigated the differences amongst countries more formally by [illegible] g for other covariates thought to be important determinants of the probabili [illegible] ting and the export share. For domestic firms the probability of exporting [illegible] und to be increasing in the size and productivity of the firm (Greenaw [illegible] ller 2004a). Similarly, Bleaney and Wakelin (1999) for the UK and W [illegible] for Germany report evidence of a significant inverted U shape relationship [illegible] ort intensity and size. Finally, the level of skill embodied in the workfor [illegible] an important role in the export behaviour of the firm since better wo [illegible] ad to better quality products and higher levels of efficiency (see Bern [illegible] en (2004b) for a similar argument).

We therefore include in the export dummy and export share regr [illegible] be estimated a set of firm level variables and a 0/1 variable indicating w [illegible] is foreign. If firm level variables fully explain the export behaviour of for [illegible] en we would expect this indicator to add no additional information to [illegible] on and to be insignificant. The firm level characteristics included in the [illegible] e: the number of employees (to control for size), its square (since it ha [illegible] d that export and size have an inverted U shape relationship), the wag [illegible] e (to control for the skill level of workers) and labour productivity (me [illegible] e added per worker). Also, a full set of time and industry dummies wa [illegible]

One complication of performing regression analysis with the export share as the dependent variable is that it is bounded by construction between 0 and 1. Two salient characteristics of the underlying data generation process of bounded dependent variable are that: the conditional expectation function is non-linear; the error term is heteroskedastic since its variance approaches to zero as the mean tends to either boundary point. Linear OLS is likely to produce highly biased estimates because of its inability of coping with the non-linearity of the conditional expectation. Besides, because of the same reason linear least square may lead to predictions of the dependent variable outside the extreme points.

The most common alternatives to linear OLS in this situation have consisted in employing the Tobit model (e.g.: Bleaney and Wakelin (1999)) and the log-odds ratio transformation of the limited dependent variable modelled as a linear function of the regressors (e.g.: Gourlay and Seaton (2003)). However, both methodologies have drawbacks. Indeed, the Tobit model is unsuited since the dependent variable is bounded by construction and not because of censoring. The tobit model assumes that the latent dependent variable is normally distributed and that the dependent variable is censored. That is, we observe the dependent variable only when the latent variable is inside a certain interval ([0,1] in this case). However, in case of proportions we do not observe the dependent variable when it is outside the interval not because because of censoring, but because it is not defined outside the boundaries. Thus, there is not censoring and the tobit model is inappropriate. The the log-odds ratio model suffers of grave drawbacks as well since it cannot handle observations at the extremes of the interval and it assumes homoskedastic conditional variance.

In this investigation we employ the quasi-likelihood method of estimation for fractional response variable introduced in the econometric literature by (Papke and

Wooldridge 1996). This methodology is a synthesis between the Generalised Linear Model (GLM) from the statistical literature (McCullagh and Nelder 1989) and the quasi-likelihood method from the econometric literature (Gourieroux, Monfort, and Trognon 1984).[12]

Denoting the propensity to export by $0 \leq y_{it} \leq 1$ and the vector of covariates by $\mathbf{x}$, we are interested in estimating

$$E(y_{it}) = G(\mathbf{x}_{\mathbf{it}}^{'}\beta) \tag{3.1}$$

where $0 \leq G(z) \leq 1$. Typically, $G(z)$ is chosen to be a cumulative distribution function and traditionally in the GLM approach it has been assumed to be the logistic function $G(z) = [exp(z)]/[1 + exp(z)]$. The estimation of the parameter vector β, say,$\hat{\beta}$, is conducted by quasi-likelihood method (QMLE) by maximising the following Bernoulli log-likelihood function:

$$l_{it} = y_{it} \log G(\mathbf{x}_{\mathbf{it}}^{'}\beta) + (1 - y_{it}) \log G(\mathbf{x}_{\mathbf{it}}^{'}\beta) \tag{3.2}$$

This is the same log-likelihood function used when the dependent variable is a binary outcome. However, as shown by (Gourieroux, Monfort, and Trognon 1984) the estimators obtained by QMLE are consistent and asymptotically normal regardless of the distribution of y conditional on $\mathbf{x}$, provided 3.1 holds. The standard errors of the estimators have been computed as in Papke and Wooldridge (1996) and are robust to heteroskedasticity.

[12]This methodology has been advocated by Kieschnick and McCullough (2003). Comparing different methodologies to fit proportions data, among which the OLS log-odds transformation, the beta distribution and the quasi-likelihood method, they argue in favour of the latter two.

Table 3.2, in the first two columns, reports the results from the export dummy and export share regression for all firms (both domestic and foreign).[13] The decision whether to export or not (i.e. export dummy regression) was estimated by means of pooled probit technique. We made attempts to estimate a panel probit to control for unobserved individual heterogeneity, but the maximum likelihood did not converge. As Wooldridge (2002, pp. 22–25; 470–471) underlines, unobserved heterogeneity in non-linear panel data models, as those estimated in table 3.2, will cause biased and inconsistent point estimates. However, one can still obtained consistent average marginal effects. (Wooldridge (2002) calls them average partial effects.)

Indeed, consider the non-linear panel data model

$$E(y_{it}|\mathbf{x}, c) = \Phi(\mathbf{x_{it}}\beta + \gamma c_i) \tag{3.3}$$

$E(y_{it})$ may represent the probability of success in a probit model or the average export share in a GLM model. c_i represents the idiosyncratic fixed effect, unobserved by the econometrician; we assume that $\mathbf{x}$ and c are independent and $c \sim N(0, \tau^2)$. (Obviously independence between $\mathbf{x}$ and c implies $Cov(\mathbf{x}, c) = 0$.)

It is possible to write 3.3 in the latent variable form as $y^*_{it} = \mathbf{x_{it}}\beta + \gamma c_i + \varepsilon_{it}$, so that if $y^*_{it} \leq 0$, $y_{it} = 0$ (both in the export dummy case and in the export share regression) and if $y^*_{it} > 0$, $y_{it} = 1$ (in the export dummy case) or $y_{it} > 0$ (in the export share regression). We assume that $\varepsilon|(\mathbf{x}, c) \sim N(0, 1)$, therefore the combined error term $\gamma c + \varepsilon$ is independent from $\mathbf{x}$ and is normally distributed with mean zero and

[13] Note that there are 27 fewer observations in the export dummy regression than in the export share regression. This is because all firms in the SIC92 industry "Tobacco" (industry number 16) export. These firms are dropped in the export dummy regression since there is not variation in the dependent variable (i.e. in the export dummy), but they are retained in the export share regression since they have different export intensity.

variance $\sigma^2 = \gamma^2\tau^2 + 1$, i.e. $(\gamma c + \varepsilon)|\mathbf{x} \sim N(0, \gamma^2\tau^2 + 1)$. Given this [illegible] we have that

$$E(y_{it}|\mathbf{x}) = Probability(\gamma c_i + \varepsilon_{it} > -\mathbf{x_{it}}\beta) = \Phi(\frac{\mathbf{x_{it}}\beta}{\sigma})$$

Then, the estimates we obtain neglecting the unobserved heteroge[illegible] downward biased since the probability limit of $\hat{\beta}$ is β/σ (where $\sigma > 1$). If w[illegible]erested in the marginal effects of, say, variable x^j on $E(y_{it})$, we want to obt[illegible]stimate of $\partial E(y_{it}|\mathbf{x}, c)/\partial x^j = \beta^j\phi(\mathbf{x_{it}}\beta + \gamma c)$, for various values of $\mathbf{x}$ and [illegible] $\phi(\cdot)$ is the first derivative of $\Phi(\cdot)$. However, from the probit estimates it is [illegible]o get $\beta_j/\sigma\ \phi(\mathbf{x_{it}}\beta/\sigma)$. Nonetheless, the latter quantity is useful since, as Wo[illegible] 2002, pp. 471) shows, this is the marginal effect of variable x^j averaged [illegible] listribution of c,

$$E_c\left[\partial E(y_{it}|\mathbf{x}, c)/\partial x^j\right] = E_c\left[\beta^j\phi(\mathbf{x_{it}}\beta + \gamma c)\right] = \beta_j/\sigma\ \phi(\mathbf{x_{it}}[illegible] \qquad (3.4)$$

Thus, although pooled estimation will only provide lower bounds [illegible]mates of interest from them it is possible to derive consistent and meani[illegible]ginal effects. In addition, although the estimates are biased, they are al[illegible]v the same figure (i.e. σ); thus it is still possible to gauge the relative [illegible]f the true parameters.[14]

[14]It is worth stressing that throughout we assume zero correlation between the [illegible]heterogeneity and the observed variables. Some authors have tried (Bernard and Jense[illegible]rnard and Wagner 1997) to correct for possible endogeneity problems. This has invol[illegible]ng a linear probability model, to apply the first difference or within transformation, i[illegible]nate the unobserved fixed effect, and instrumental variables in order to correct for th[illegible]bias. However, we think that this method, although simple, may exacerbate the bia[illegible]nates simply because the data generation process used (i.e. the linear model) is patent[illegible] the same reason the standard errors thus obtained are unreliable, so no valid inference [illegible]cted. This methodology to correct bias in the estimates (i.e. endogeneity), which is only li[illegible]duces a fault in the estimation (i.e. wrong data generation process), which is certain.

From table 3.2 it is possible to observe that the estimates for the firm level variables are in line with those found in previous studies (Bleaney and Wakelin 1999; Wagner 2001; Girma, Greenaway, and Kneller 2004). According to the results from the first regression in the table export firms are more productive, larger and more skilled intensive than non-export firms. These same variables also matter for the export share. Firms that are more productive, larger and more skill intensive export a higher proportion of their total production. The significance of the firm level variables are usually interpreted as reflecting sunk costs of export market entry; product compliance, market studies, marketing necessary to penetrate foreign markets and to maintain international sales networks and product quality.

Conditional on these firm level variables we still find however, that the foreign indicator is positive and strongly significant in both regressions. This suggests that foreign firms are both more likely to export than domestic firms and to export more than domestic companies, even after controlling for the sort of firm level variables used in previous studies to model the export behaviour of firms. Foreign firms are different in their export behaviour from domestic firms.

In table 3.2, from columns three to five, we explore these results further in two ways. Firstly, we ask whether the firm level characteristics found to be important in the previous regressions predict export behaviour in the same way as for indigenous firms. This is done by splitting the sample according to the country of origin of the parent company. The results in table 3.2 suggest that there are differences between domestic and foreign firms. With respect to the export decision, firm level variables appear important for domestic firms (all coefficients have the expected sign and are strongly significant), whereas these variables all less important for foreign firms (only size is significant). The differences are less marked for the export share regressions.

Table 3.2: Results of export dummy (probit) and export share (quasi-likelihood method for fractional response) regressions for domestic and foreign firms separately.

	All Firms		Export Dummy		Export Share	
	Exp. Dummy	Exp. Share	Domestic	Foreign	Domestic	Foreign
	(1)	(2)	(3)	(4)	(5)	(6)
Size	0.196	0.115	0.205	0.156	0.122	0.078
	(22.16)**	(12.03)**	(21.96)**	(5.09)**	(11.87)**	(2.96)**
Size-squared	-0.030	-0.002	-0.033	-0.004	-0.006	0.022
	(6.54)**	(0.39)	(6.64)**	(0.28)	(1.03)	(2.05)*
Skill	0.142	0.190	0.132	0.165	0.231	-0.017
	(3.37)**	(2.19)*	(2.89)**	(1.38)	(2.25)*	(0.16)
Productivity	0.186	0.272	0.202	0.048	0.262	0.292
	(7.64)**	(8.31)**	(7.64)**	(0.76)	(7.07)**	(4.34)**
Foreign	0.180	0.238				
	(5.26)**	(8.40)**				
Constant	0.126	-2.627	-0.075	0.279	-2.716	-1.930
	(2.01)*	(38.38)**	(1.42)	(0.79)	(37.30)**	(8.39)**
Observations	26893	26920	24001	2809	24020	2900

Notes:
(i) Absolute value of robust z-statistics in parentheses;
(ii) + significant at 10%; * significant at 5%; ** significant at 1%;
(iii) Firm level variables are lagged one year: size is the number of employees, skill the wage per worker, productivity the value added per worker. Year and industry dummies (2 digit level) included.

Firm level variables play a similar role in the two sets of firms. Overall these results might be seen as consistent with the models of Grossman *et al.* (2003), where both firm level characteristics and strategic motives are important.

From a policy perspective, these results suggest that in the planning and evaluation of those incentives and policies aimed at turning non-exporters into exporters or at increasing exports, the ownership of firms should be take into consideration. Indeed, foreign affiliates may respond differently from indigenous companies to such initiatives given the apparent importance of strategic motives in their export decisions.

As underlined before and summarised in table 3.1, strategic motives may be important for the type of FDI firms undertake. These strategic motives differ across countries, therefore we would expect that foreign affiliates from different countries will make different export decisions. To distinguish whether or not this is the case we performed the export dummy and export share regressions substituting the foreign indicator with dummies indicating the country/area of origin of the corresponding firm. (The UK dummy was excluded so that the estimates of the country/area dummies take UK firms as a reference.) In addition, to account for differences in the relationship of firm level variables with respect to exporting across foreign and domestic firms found above, we allow the coefficients on these variables to vary across the two different types of firm.

As it was discussed before, the estimates in table 3.2, although useful to infer the direction (positive or negative) of the impact of the relevant variables and to and to gauge their relative magnitude, may be biased downward because of unobserved individual heterogeneity. However, meaningful and consistent marginal effects can be retrieved from these estimates, which are averaged across the distribution of the firm unobserved effects.

Table 3.3 exhibits the marginal effects of the relevant variables for the export dummy and export share regressions derived from the results in the first 2 columns in table 3.2. Standard errors were computed with the delta method. As it is possible to see, being foreign adds to the probability of exporting and to the export share 3.8 and 4.3 percentage points respectively. Among the other firm level variables employment (i.e. size) and productivity appear to have the strongest impact on the likelihood of selling overseas. A 1 percent increase in these variables adds to the probability of exporting 4.9 and 4.6 percentage points respectively. Productivity and wages (i.e. skill) seem to have the highest marginal effects on the export share. If they rise by 1 percent, this adds 4.2 and 2.9 percentage points to the export share. Thus, although the marginal effect of the foreign dummy is not strictly speaking comparable with the marginal effects of the other (continuous) firm level variables, these figures suggest that the foreign status raises substantially the degree of participation of firms in the international markets through exports.

In table 3.4 we disaggregate the foreign dummy from table 3.2 into the various countries of origin of the parent company. In this regression we also control for differences in the effect of firm level characteristics on the decision to export and the export share. Again a number of these country effects are significant, confirming that the export decisions (entry and share) of foreign multinationals does not just reflect the superior underlying performance characteristics of these firms.

There are few consistent patterns in the export behaviour of countries, where this might be considered to match the complex integration strategies of MNEs as highlighted in theoretical models by Yeaple (Yeaple 2003), Grossman *et al.* (2003)

Table 3.3: Marginal effects of export dummy (column 1 in table 3.2) and export share (column 2 in table 3.2) regressions.

	Exp. Dummy	Exp. Share
	(1)	(2)
Size	.049	.018
	(.002)**	(.001)**
Size-squared	-.006	-.0002
	(.001)**	(.0007)
Skill	.035	.029
	(.011)**	(.013)*
Productivity	.046	.042
	(.006)**	(.005)**
Foreign	.043	.038
	(.008)**	(.005)**

Notes:
(i) Absolute value of robust z-statistics in parentheses;
(ii) + significant at 10%; * significant at 5%; ** significant at 1%;
(iii) Marginal effects were computed at the mean of the relevant variables; standard errors were derived by means of the delta method.

and Ekholm *et al.* (2003). Foreign multinationals from the US, Canada and other countries are both more likely to export and have significantly higher export shares than domestic firms. Asian firms, who all export (and are therefore not included in the probit regressions) do not have significantly higher export shares. Firms from non-EU European countries and Japan are no more likely to export than domestic firms, conditional on the underlying characteristics, but are more export intensive than domestic firms when they do. Firms from the EU countries are not more likely to export than domestic firms (the coefficient is positive, but insignificant), but have significantly lower export shares, and finally Australian firms are less likely to export but do not have significantly lower export shares.

That said, the strong significance of the non-EU indicators (bar Australia and Asia) in the export share regressions suggests that tariff jumping and, possibly, strategic motives, along with country characteristics, are important for the export behaviour

Table 3.4: Regression results of the export dummy (probit) and export share (quasi-likelihood method for fractional response).

	Export Dummy	Export Share
	(1)	(2)
Size	.2033	.1218
	(.0093)**	(.0102)**
Size-squared	-.0331	-.0057
	(.0049)**	(.0051)
Skill	.1335	.2265
	(.0453)**	(.1015)*
Productivity	.1991	.2709
	(.0264)**	(.0269)**
Foreign*Size	-.0921	-.0796
	(.0324)**	(.0289)**
Foreign*Size-squared	.0412	.0254
	(.0149)**	(.0129)*
Foreign*Skill	-.0127	-.319
	(.1302)	[illegible]
Foreign*Productiv.	-.139	.0339
	(.0717)+	(.074)
US	0.243	0.472
	(3.73)**	(10.88)**
Canada	0.705	1.327
	(3.83)**	[illegible]
EU	0.038	-0.135
	(0.77)	(2.00)**
Europe not EU	0.100	0.441
	(0.87)	(5.13)**
Asia		-0.116
		(0.43)
Japan	-0.150	0.391
	(1.12)	(2.74)**
Australia	-0.613	-0.212
	(3.09)**	(0.84)
Others	0.575	0.436
	(3.25)**	(3.50)**
Constant	-0.052	-2.613
	(1.03)	(35.51)**
Observations	26860	26920

Notes:
(i) Absolute value of robust z-statistics in parentheses;
(ii) + significant at 10%; significant at 5%; ** significant at 1%;
(iii) Europe not EU includes Switzerland and Norway; Asia includes Hong Kong, Malaysia and Singapore;
(iv) Firm level variables are lagged one year: size is measured as number of employees, skill as wage per worker; productivity as value added per worker;
(v) Year and industry dummies (2 digit level) included.

of foreign firms in the UK. Foreign affiliates of multinationals with headquarters in the EU are less export oriented than affiliates of firms with headquarters outside the EU. However, if tariff jumping is the only motive of FDI in the UK we would expect that firms whose headquarters are outside the EU will have similar export propensity among them. If more complex integration strategies were undertaken, we would expect that firms from different countries would have different export intensities. In this situation the export intensity would depend on different strategic motives firms face, such as productivity and market size differentials between the UK and the country of origin and transport costs. Our analysis support this view.

Table 3.5 shows some figures that allow us to assess the importance of firm level variables relative to country/area of origin dummies, given the estimates in table 3.4 column 2. For each country/area of origin whose dummy is significant in the export share regression of table 3.4 we computed the predicted export share of foreign firms setting the relative geographic dummy to one and the firm level variables to their mean values (computed considering only those foreign affiliates whose parent company is headquartered in the respective country). This value was subtracted from the predicted export share, setting, one at a time, the variables in the columns of table 3.5 (i.e. geographic dummies, size and productivity) to the mean level of UK firms and the dummy to zero. The differences so computed let us gauge the change in the predicted export share of foreign firms caused by setting firm level variables or the geographic dummy to the average value for UK firms. Where foreign companies are larger, more productive or more export intensive than domestic firms, we would expect the figure in table 3.5 to be negative.[15]

[15]Marginal effects are of no help in this instance since we want to compare the effect of a discrete variable with the effect of continuous variables

Table 3.5: Effect of geographic dummies and firm level variables on the predicted export share

Origin	Geographic Dummy	Size	Productivity
USA	-.091	-.007	-.008
Canada	-.300	-.008	-.025
EU	.022	-.000	-.003
Europe not EU	-.085	-.010	-.009
Japan	-.055	-.012	.001

As one can see, the country/area dummies have a bigger effect than firm level variables; indeed, setting the respective geographic dummies to zero (and given the estimates in table 3.4) would decrease the export share of US foreign affiliates by 9.1 percentage points, of Canadian firms by 30, of European firms not in the EU by 8.5 and Japanese firms by 5.5 percentage points. By contrast, the export share of foreign affiliates whose parent company is headquartered within the EU would increase by 2 percentage points. The effects of the main firm level variables, namely size and productivity, on the export share appear to be smaller for all foreign countries. The highest refers to productivity for Canadian firms and it is just 2.5 percent. This finding would suggest that strategic motives related to countries differences in costs, productivity and market size may be more important than firm level variables in determining the export intensity of foreign firms.

The results in table 3.4 column 2 have been obtained assuming that the decision whether to export or not and how much to export are the same and, consequently, can be modelled in the same way. This is unlikely to be true. For this reason we estimate an export share regression allowing for the fact that the two decisions may be different. This involves estimating an endogenous sample selection model, also known as Tobit type II model (see Hsiao (2003, pp.229–230) and Duncan (1980)).

This methodology is similar to the Tobit or truncation model, insofar as it deals with a censored or truncated variable (a censored one, i.e. export shares, in this case), but in addition it allows to treat the censoring or truncation value as endogenous.

Two equations are estimated: a latent response function, $y^*_{it} = \mathbf{x}'_{it}\beta + u_{it}$ (export share regression); a selection equation, $d^*_{it} = \mathbf{z}'_{it}\gamma + v_t$ (export decision) where $d_t = 1$ if $d^*_t > 0$ and $d_t = 0$ if $d^*_t \leq 0$; besides $y^*_t = y_t$ if $d_t = 1$ and $y_t = 0$ if $d_t = 0$. Thus, the observed export share (y_t) is zero when the firm decides not to export (d_{it}=0) and assumes a positive value when the firm decides to export ($d_{it} = 1$). The distribution of the error terms (u_{it}, v_{it}) is assumed to be bivariate normal with correlation ρ. The two equations (i.e. decisions) are related if $\rho \neq 0$. In this case estimating only the export share regression would induce sample selection bias in the estimate of β since the error term u_{it}, and the regressor x would be correlated. To avoid this problem both equations must be estimated. The estimation can be conducted via maximum likelihood or two-step method proposed. We employed the former since it is more efficient than the latter.[16]

The vectors of covariates x_{it} and z_{it} may be the same. If this is the case and $\gamma = \beta$ and $u = v$ the model reduces to the Tobit: the two choices will be the same. The explanatory variables will affect exporters and non-exporters in exactly the same way. In this instance, the model is, in principle, identified, but identification relies exclusively on the model and the normality assumption concerning the two error terms being correct. These assumptions are in most of the cases too weak (Johnston and DiNardo 1997, pp. 450).

[16]The two-step methodology involves estimating first the probit of the export decision (i.e. selection equation), computing the inverse of the Mills ratio and inserting it as regressor in the export share regression. Although, this method is easy and intuitive is less efficient with respect to the maximum likelihood method.

For this reason, we estimated the two equations adding in the selection equation the lagged export dummy. This allows to identify the model more easily and take into account the state dependence of the export behaviour related to sunk costs (Bernard and Jensen 2004b).[17]

From the results exhibited in table 3.6 it is evident that sunk cost of exporting are important. Indeed, the lag of the export dummy in the export decision equation is positive and strongly significant. This is consistent with previous empirical evidence (Bernard and Jensen 2004b; Bernard and Jensen 1999) and recent theoretical models (Melitz 2003). The other firm characteristics determining the export decision have in general the same sign and statistical significance of the estimates in table 3.4, with the notably exception of the USA dummy that is now insignificant. Thus, USA firms do not seem to be more likely to export than UK companies when we control for the state dependence in the export behaviour. The results from the export share equation, in column 2 of table 3.6, have a similar pattern of those in table 3.4, although they appear to be smaller (in absolute value). US, Canadian, European not in the EU, and Japanese firms have higher export propensity than domestic businesses, whereas EU companies are less export intensive.

In addition from the results in table 3.6 it is worth noting that rho (the correlation coefficient between the error terms of the two structural equations) is estimated to be significantly different from zero. This means that linear regression would yield biased results because of sample selection; in addition since rho is also estimated to be different from one the model does not reduce to the Tobit.

[17]It is worth stressing that we pooled the cross sections. Simple and tested estimation methods of selection processes that account for firms or individuals heterogeneity have not yet been properly developed. Some of them are quite involved since require non-parametric estimations (Hsiao 2003, chapter 8). However, as discussed before to gain an understanding of the relative magnitude of variables and their marginal effects it suffices to pool the cross sections together.

Table 3.6: Heckman selection model

	Export Dummy	Export Share
	(1)	(2)
Lagged Export Dummy	3.0935	
	(.0329)**	
Size	.0654	[illegible]
	(.0153)**	[illegible]
Size-squared	-.0181	[illegible]
	(.0078)*	[illegible]
Skill	-.0606	[illegible]
	(.0589)	[illegible]
Productivity	.1142	[illegible]
	(.0424)**	[illegible]
Foreign*Size	-.0247	[illegible]
	(.0436)	[illegible]
Foreign*Size-squared	.0056	[illegible]
	(.02)	
Foreign*Skill	-.0284	[illegible]
	(.2014)	[illegible]
Foreign*Productiv.	-.1156	[illegible]
	(.1053)	[illegible]
US	.0653	[illegible]
	(.0837)	[illegible]
Canada	.7366	[illegible]
	(.2428)**	[illegible]
EU	-.0269	[illegible]
	(.0765)	
Europe not EU	.1327	[illegible]
	(.1912)	[illegible]
Asia		[illegible]
		[illegible]
Japan	-.0974	[illegible]
	(.2083)	[illegible]
Australia	-.4347	[illegible]
	(.1259)**	[illegible]
Others	-.0721	[illegible]
	(.226)	[illegible]
Constant	-.9205	[illegible]
	(.2249)**	[illegible]
Rho	-0.3107	
	(.0172)**	
Observations	25854	
Censored Obs.	5299	

Notes:
(i) Robust standard errors in parentheses.
(ii) + significant at 10%; * significant at 5%; ** significant at 1%
(iii) Europe not EU includes Switzerland and Norway; Asia includes Hong Kong, Malaysia and Singapore.
(iv) Firm level variables are lagged one year: size is measured as number of employees, skill as wage per worker; producitivity as value added per worker. Year and industry dummies (2 digit) included.

To compare the effect of firm level variables and country/area of origin dummy table 3.7 shows results computed in an analogous way to those presented in 3.5. As it is possible to see, the country/area of origin still matters relatively to other firm level characteristics, such as size and productivity, albeit less than what appears from table 3.5.

Table 3.7: Effect of geographic dummies and firm level variables on the predicted export share (Heckman model).

Origin	**Geographic Dummy**	**Size**	**Productivity**
USA	-.033	-.053	-.003
Canada	-.081	-.071	-.007
EU	.012	-.035	-.001
Europe not EU	-.031	-.053	-.003
Japan	-.029	-.052	.000

Indeed, setting the respective geographic dummy to zero (and given the estimates in table 3.7) would cause a decrease in the export share of US foreign affiliates by 3.3 percentage points, of Canadian firms by 8, of European firms not in the EU by 3.1 and Japanese firms by 2.9 percentage points. The export share of foreign affiliates whose parent company is headquartered within the EU would increase by 1.2 percentage points. Size appears to have a bigger impact than geographic origin dummies by around 2 percentage points, whilst the impact of productivity is less than 1 percent.

This finding along with those in table 3.7 indicate that strategic motives related to countries differences in costs, productivity and market size are important in determining the export behaviour of foreign firms.

Table 3.8 exhibits the results of the Heckman selection model estimated considering total factor productivity (TFP) instead of value added per worker as in table 3.6.

[18] This productivity measure allows to capture the role of capital and intermediates in the production process, not only of labour as in labour productivity indexes. The two productivity measures (i.e. TFP and value added per worker) are highly correlated, their correlation coefficient being 0.52. The results obtained considering TFP corroborate those obtained using labour productivity in table 3.6. The only differences concern the significance of the productivity variable, of the US and Australia dummies in the export decision regression. Indeed, whereas labour productivity is significant in table 3.6 TFP is not in table 3.8. This may be caused by the fact that TFP, unlike labour productivity, takes properly into account the contribution of capital and intermediates.[19]

Again, to compare the role of strategic motives, embedded in the country/region dummies, with that of firm level variables, table 3.9 reports results computed in a similar way to those in tables 3.7 and 3.5. It is worth noting that the effect of the geographic dummies and size are quantitatively and qualitatively similar to those in table 3.7. On the contrary, the effect of productivity appears to be much smaller, being virtually zero. This confirms the importance of strategic motives related to differences among countries concerning costs, market sizes, producicitivity...for the export behaviour of foreign firms.

3.4 Acquisition

In the previous section we have seen that foreign affiliates are more export oriented than domestic companies. One interesting question related to the literature on foreign

[18]More details on how TFP was calculated can be found in the appendix

[19]Firms with high labour productivity may well be highly capital intensive. In this case, since TFP controls for the use of capital, if labour productivity is significant, TFP will be insignificant.

Table 3.8: Heckman selection model with total factor productivity

	Export Dummy		Export Share
	(1)		(2)
Lagged Export Dummy	3.1497 (.0361)**		
Size	.0615 (.0168)**		.0045 (.002)*
Size-squared	-.0146 (.0087)+		.0029 (.0011)**
Skill	.0641 (.0436)		.0419 (.0145)**
TFP	.0824 (.0778)		.0364 (.011)**
Foreign*Size	-.1119 (.05)*		.0028 (.0062)
Foreign*Size-squared	.0205 (.0245)		-.0011 (.0027)
Foreign*Skill	-.1875 (.1983)		-.0097 (.0236)
Foreign*TFP	.0117 (.1112)		-.0431 (.0207)*
US	.2145 (.0907)*		.0896 (.0099)**
Canada	1.0236 (.3205)**		.259 (.0402)**
EU	-.0223 (.0816)		-.0256 (.0091)**
Europe not EU	.1999 (.2196)		.074 (.0191)**
Asia			-.0768 (.0676)
Japan	.0331 (.2831)		.1078 (.0242)**
Australia	-.0919 (.1678)		.0025 (.0371)
Others	-.1036 (.2426)		.0423 (.0248)+
Constant	3.4456 (.3569)**		.3532 (.1509)*
Rho		-0.3017 (.0179)*	
Observations		22746	
Censored Obs.		4570	

Notes:
(i) Robust standard errors in parentheses.
(ii) + significant at 10%; * significant at 5%; ** significant at 1%
(iii) Europe not EU includes Switzerland and Norway; Asia includes Hong Kong, Malaysia and Singapore.
(iv) Firm level variables are lagged one year: size is measured as number of employees, skill as wage per worker; TFP is total factor productivity. Year and industry dummies (2 digit) included.

Table 3.9: Effect of geographic dummies and firm level variables on the predicted export share (Heckman model with total factor productivity).

Origin	**Geographic Dummy**	**Size**	**Productivity**
USA	-.034	-.054	.00002
Canada	-.094	-.074	-.00001
EU	.010	-.037	-.00004
Europe not EU	-.028	-.053	-.00009
Japan	-.041	-.057	.00002

acquisition is whether foreign MNEs that set up an affiliate in the UK are more likely to acquire domestic firms that have already some export experience or not.

This question is of relevance since foreign acquisition is the main mode of entry in a foreign market as opposed to greenfield investment. As reported in the World Investment Report (UNCTAD 2000) the share of total cross border merger and acquisitions in world total FDI flows has risen from 52 percent in 1997 to 83 percent in 1999. The most important mode of entry by foreign firms into the UK is through cross border mergers and acquisitions. Griffith *et al.* (2004) report that foreign acquisitions accounted for 80.9 percent of total FDI in all UK manufacturing sectors in the 1999-2001 period.

The literature on foreign acquisition has mainly focused on productivity. Previous work has indeed looked at whether foreign multinationals "cherry pick" domestic firms (i.e. acquire the best domestic firms) or improve their productivity after acquisition. The findings have not been unequivocal. Conyon *et al.* (2002), using UK firm level data, report that foreign acquisitions lead to an increase in labour productivity; Harris and Robinson (2002), using UK plant level data, find evidence that high productivity plants are acquired by foreigners and that total factor productivity declines after takeovers. Criscuolo and Martin (2004), using the same data as Harris and Robinson (2002), argue that the productivity advantage of foreign affiliates is explained by both "cherry picking" and post-acquisition productivity enhancement. In addition, they find that there are differences according to the country of origin of acquiring companies since US firms seem to be able to acquire the best domestic plants.[20]

Here, we are concerned with the export status of acquired domestic firms. Given the high export propensity of foreign affiliates an interesting question is whether foreign acquisitions target target domestic firms with export experience or turn firms that previously served just the domestic market into exporters, and if it is the former what happens to the export share in these acquired firms?

We compare the characteristics of acquired versus non-acquired domestic firms using a probit regression.[21] The dependent variable is one when the firm has been foreign acquired and zero otherwise. The probability of foreign acquisition depends on a set of firm level variables. Economic theory is not clear concerning which variables may be important. Along with the export share we included other firm characteristics used in previous empirical works, namely wage per employee (to control for the education of the workforce), employment (as a proxy of size), material and capital per employee, age, and labour productivity (computed as value added per worker). After some experimentation with the data we decided to include the squared and cubic terms for the export share and the square of productivity to control for non-linearities in these variables.

[20]For the US, McGuckin and Nguyen (1995) find that acquisitions are aimed at highly productive plants; furthermore productivity improves after the acquisition. Lichtenberg and Siegel (1987) argue that ownership changes are driven by low productivity levels and that total factor productivity increases under the new management.

[21]The sample period used for the probit regression reaches the year 1996 only since the foreign acquisition dummies is available only up to this year (see the data appendix at the end of Chapter 1).

Table 3.10 presents a comparison between the estimates obtained with random effects probit and the pooled probit estimates. As it is possible to see they are all remarkably similar. Foreign firms tend to target domestic firms with export experience, compared to their distribution in the population of domestic firms, even after controlling for other firm level characteristics. In addition there appear to be some non-linearities in the effect of export share on the probability of being acquired.

With regard to the other firm level variables, it is possible to see that firms that pay higher wage, that are larger and that use more more capital and intermediates are more likely to be acquired. Furthermore, firms that have high labour productivity are less probable to be the target of foreign takeovers. These results are consistent with those reported recently by Griffith *et al.* (2004) for the UK. They note that the value-added per employee of firms taken over by foreign enterprises is 6 percent below the corresponding industry average; however, such firms are three times as large as the average firm in the industry and are more capital and intermediate intensive.

Overall, it seems that the random effects model has little to offer more than the pooled model. The parameter estimates and standard errors are nearly the same whereas the log likelihood is only slightly higher for the random effects model. Given the considerable time necessary to estimate the random effects probit model, we will concentrate on the pooled results knowing that they are qualitatively and quantitatively similar to the random effects model.[22] In addition, as underlined in the previous section from the pooled estimates it is still possible to obtain consistent marginal effects.

[22]The estimation of the random effects model required more than one day. Note that the long time necessary for the maximumlikelihood to converge is not due to the number of observations (around 20000), but to the industry fixed effects, which increase notably the number of regressors.

Table 3.10: Comparisons between random effects probit and pooled probit estimates

	RE probit	Pooled probit
	(1)	(2)
Export Share	.8473	0.8572
	(.4082)*	(.3802)*
Export Share^2	-1.3856	-1.3996
	(.8211)+	(.7194)+
Export Share^3	.5291	0.5334
	(.4249)	(.2853)+
Wage	.5398	0.562
	(.1325)**	(.1169)**
Employm.	.0758	0.0743
	(.0212)**	(.019)**
Material/Employment	.2631	0.2653
	(.0414)**	(.0367)**
Capital/Employment	.0715	0.0695
	(.0288)*	(.0257)**
Age	-.0635	-0.0648
	(.0241)**	(.022)**
Labour Productivity	-.1498	-0.1563
	(.0691)*	(.0629)**
Labour Productivity^2	-.0615	-0.0647
	(.0474)	(.0354)+
Constant	-2.3625	-2.3499
	(.1491)**	(.1397)**
Observations	18560	18560
Log-likelihood	-1454.812	-1457.627

Notes:
(i) Standard errors in parenthesis (they are only robust for the pooled probit);
(ii) + significant at 10%; * significant at 5%; ** significant at 1%;
(iii) Firm level variables are in log (bar export shares) and lagged one year. Export Share^2 and Export Share^3 are export share to the power of two and three;
(iv) Year and industry dummies (2 digit level) included.

In table 3.11 we split the sample of foreign acquisitions to consider the effect of the region/country of origin of the parent company. Owing to a relatively small number of acquisitions for some countries and our interest in the differences in behaviour of countries inside and outside the EU we consider only EU and non-EU acquisitions.

It is noteworthy that the export share seems to be an important determinant of acquisition only for those MNEs that will establish high export intensive foreign affiliates, namely those with headquarters outside the EU. Indeed, non-EU MNEs appear to target firms with previous export experience, whereas this is not the case for EU MNEs. The export share coefficients are strongly significant in the non-EU acquisition regression, whereas they are much smaller (in absolute value) and insignificant in the EU acquisition regression. Thus, whereas non-EU multinationals seem to acquire UK companies with export experience the same is not true for their EU counterparts.

EU and non-EU firms also target different UK companies according other firm level variables. EU acquisitions seem to prefer enterprises with a skilled workforce (i.e. high wages), high intermediates and capital usage per employees, but low productivity. This may reflect under-performing firms (signalled by low labour productivity levels), with good growth potential (given their skilled workforce and their high levels of materials and capital usages). Non-EU acquisitions appear to involve UK companies with skilled workforce and high intermediates and capital use per employees, like EU acquisitions. In addition, large (in terms of employment) and younger firms seem to be preferred.

Overall these differences may be caused by different post-acquisition costs, non-EU and EU firms face to integrate the newly acquired firms in their operations. These

Table 3.11: Pooled probit regression of foreign acquisitions

	EU acquis.	Non-EU acquis.
	1	2
Export Share	-.4621	1.8861
	(.595)	(.4759)**
Export Share^2	.2023	-2.7468
	(1.1315)	(.8733)**
Export Share^3	.0704	.9767
	(.4203)	(.3353)**
Wage	.4519	.6467
	(.1757)*	(.1425)**
Employm.	.0249	.1047
	(.031)	(.0235)**
Material/Employment	.2916	.2495
	(.0568)**	(.045)**
Capital/Employment	.1156	.0548
	(.0414)**	(.0325)+
Age	-.0083	-.0985
	(.0372)	(.0262)**
Labour Productivity	-.3078	-.079
	(.1016)**	(.0769)
Labour Productivity^2	-.1025	-.0608
	(.0539)+	(.0518)
Constant	-2.4752	-2.6577
	(.2262)**	(.1709)**
Observations	15262	17905
Log-likelihood	-659.2131	-938.7099

Notes:
(i) Robust standard errors in parenthesis;
(ii) + significant at 10%; * significant at 5%; ** significant at 1%;
(iii) Firm level variables are in log (bar export shares) and lagged one year. Export Share^2 and Export Share^3 are export share to the power of two and three;
(iv) Year and industry dummies (2 digit level) included.

costs may be higher for non-EU firms, for cultural and legislative reasons ... fore they might prefer to acquire UK firms with characteristics more simi... of theirs (i.e. large firms, with a more skilled workforce, high capital and ... iate usage) since they can be integrated in their international operations mo...

These results, along with those in table 3.4 and 3.6, show that the ex... our of foreign affiliates in the UK not only differ according to the area of ori... t is also an important determinant of their entry in the UK market through ... on. Foreign affiliates that are highly export intensive (i.e. those from outsi... are more likely to enter the UK market through the acquisition of firms ... ous export experience, whereas for those that have low export share (i.e. the ... he EU), their entry does not appear to be affected by the export share of th... m.

The coefficients of the models estimated thus far are not marginal ... ey can only indicate whether the marginal effect is positive or negative. ... he marginal effect of, say, variable x_j for firm i at time t in the probit mo... ly non-linear since they are the product of the parameter (β_j) of interest a... l density evaluated at a certain data point.

Marginal effects vary across observations, therefore average margin... Es) of the variables of interest were computed calculating the marginal effects ... a points and averaging them. This way of computing marginal effects was ... o calculating them at a particular value of a variable since the latter method ... volves the choice of such value (usually the mean) which might pertain to ... or absurd observations.[23] Standard errors were obtained through delta ...

[23]Knowing that $P(y = 1|x) = F(x\beta')$ where $F(z)$ is the cumulative normal dis... average marginal effect of, say, variable x_i were computed as $AME_i = (1/T)\sum_k^T f_k(x' ...$ ... is the normal density evaluated at observation k.

Green (2000, pp. 357)).

Table 3.12 exhibits the marginal effects for the EU and non-EU acquisitions. The pattern of statistical significance is similar to that in table 3.11. More specifically, the marginal effects of export share are significant for non-EU acquisitions, but insignificant for EU acquisitions. Given the parameter estimates, an increase in the export share by 1 percent in wages will determine a rise in the probability of non-EU takeovers by 1.2 percent, on average, (this effect is significant at the 1 percent confidence level).[24] The same variation in export share will decrease the probability of EU acquisition by 0.3 percent, on average (this effect is not statistically significant).[25]

With regards the other firm level variable, an increase by 1 percent in wages raises the probability of takeovers by EU firms by about 0.9 percent points. The other significant marginal effects for EU acquisitions concern material, capital usage and labour productivity. An increase by 1 percent in the first two variables determine an increase in the probability of EU acquisitions by around 0.6 and 0.25 percent, respectively. For labour productivity, an increase by 1 percent will determine, ceteris paribus, a decline in the probability of foreign acquisitions by EU firms by about 0.8 percent. All firm level characteristics, except labour productivity, have a positive impact on the likelihood of foreign acquisitions, the larger being wage (1.7 percent).

To check whether these marginal effects are robust to changes in the methodology of estimation we estimated the same regressions as those in table 3.11 using panel probit. For the sake of brevity we report only the marginal effects, which are shown in

[24]An increment in the probability of acquisition by 1 percent means that the on "average" the probability of acquisition increases from, say, 5 percent to 6 percent.

[25]The total average marginal effect of export share was obtained as average of the sum of the marginal effect of export share, export share squared and export share to the power of three. Their standard error for hypothesis tests was estimated considering the covariance between the estimators.

Table 3.12: Marginal effects of pooled probit regressions

	EU acquis.	Non-EU acquis.
	1	2
Export Share	-.0010	.0480
	(.0124)	(.0124)**
Export Share^2	.0046	-.0651
	(.0235)	(.0226)**
Export Share^3	.0014	.0292
	(.0087)	(.0087)**
Wage	.0088	.0175
	(.0036)*	(.0038)**
Employm.	.0006	.0026
	(.0006)	(.0006)**
Material/Employment	.0061	.0065
	(.0012)**	(.0012)**
Capital/Employment	.0025	.0014
	(.0009)**	(.0009)+
Age	-.0001	-.0025
	(.0008)	(.0007)**
Labour Productivity	-.0059	-.0019
	(.0022)**	(.0020)
Labour Productivity^2	-.0020	-.0015
	(.0011)+	(.0013)

Notes:
(i) + significant at 10%; * significant at 5%; ** significant at 1%.

table 3.13. As it is possible to see the point estimate and the statistical significance of these marginal effects are very close to those obtained with the simpler pooled probit shown in table 3.12. Thus, firm random effects do not seem to play a significant role in the decision concerning which firms are acquired. This is consistent with the previous comparison between the pooled and panel probit results reported in table 3.10, where no relevant differences between the two sets of estimates were found.

In the final set of results we explore this strategic behaviour further by considering what happens to the export intensity of acquired firms in the post acquisition period.

Table 3.13: Marginal effects of panel probit regressions; these were estimated using the same variables as in table 3.11

	EU acquis.	Non-EU acquis.
	1	2
Export Share	-.0091	.0481
	(.0116)	(.0130)**
Export Share^2	.0046	-.0700
	(.0234)	(.0246)**
Export Share^3	.0011	.0249
	(.0113)	(.0119)*
Wage	.0088	.0166
	(.0037)*	(.0043)**
Employm.	.0006	.0027
	(.0006)	(.0007)**
Material/Employment	.0055	.0064
	(.0012)**	(.0014)**
Capital/Employment	.0023	.0014
	(.0008)**	(.0009)
Age	-.0001	-.0025
	(.0007)	(.0008)**
Labour Productivity	-.0057	-.0020
	(.0020)**	(.0022)
Labour Productivity^2	-.0019	-.0015
	(.0014)	(.0016)
Log-likelihood	-656.3683	-938.3737

Notes:
(i) Robust standard errors in parenthesis;
(ii) + significant at 10%; * significant at 5%; ** significant at 1%;
(iii) Firm level variables are in log (bar export shares) and lagged one year. Export Share^2 and Export Share^3 are export share to the power of two and three;
(iv) Year and industry dummies (2 digit level) were included in the regressions;
(v) The log-likelihood refers to the panel probit estimation whose estimates are not reported for the sake of brevity.

Table 3.14: Post acquisition export share.

	After acquisition
EU	-.1645 (.1088)
non-EU	.5378 (.0931)**

If multinationals from non-EU countries target exporters for strategic reasons we might expect the export intensity to rise over time. We measure this effect relative to the export intensity of non-acquired domestic firms. The evidence is presented in table 3.14.[26] Again we separate acquisitions according to the broad grouping of EU and non-EU.

In combination with the results from the previous table the evidence would appear to suggest that firms from EU countries do not target export firms, and when they do acquire exporters these firms do not tend to change their export propensity relative to domestic firms. In contrast firms from non-EU countries appear to both target exporters and then increase the export intensity of these acquisitions over time.

3.5 Conclusions

A well-known fact in the empirical literature concerned with FDI is the superior performance of foreign firms compared to domestic companies with respect to employment, wages and productivity. In this paper we investigate the export behaviour of foreign affiliates in the UK. Our findings show that foreign firms are more likely to export than indigenous ones, when they do so they are more export intensive and contribute disproportionately to total manufacturing exports from the UK.

[26]These results are derived from the pooled probit estimates.

In some regards this is surprising. Traditional theories of FDI (Markusen 2002) suggest that FDI and exports are alternative means of serving foreign markets not complementary and they do not predict exporting activities by foreign affiliates. Only recently, theoretical models have tried model the export behaviour of the affiliates of MNEs established in foreign countries (Ekholm, Forslid, and Markusen [illegible]; Grossman, Helpman, and Szeidl 2003; Yeaple 2003).

We find that the export behaviour of foreign firms is determined overwhelmingly by strategic considerations involving the differential in costs, productivity and market size between the UK and foreign countries. If there is complementarity between exports and FDI we would not expect the significant differences in behaviour across countries we find in the data. In this sense the evidence might be [illegible] to be more consistent with export platform FDI. In this literature there [illegible] main motives for export platform FDI: vertical and horizontal. There is strong evidence of horizontal motives in the data: firms from non-EU countries are much [illegible] likely to export than firms from EU countries located in the UK. However [illegible] not provide a full explanation: vertical motives are also important. There [illegible] of this not only from the fact that non-EU firms use the UK as an export platform, but that EU firms also use the UK to export back to mainland Europe.

While strategic motives appear to dominate the explanation, we also find that firm level variables are important. Our results show that the larger and the more productive are foreign firms the more export oriented they are. However [illegible] said, it is also clear from our analysis that what drives foreign firms to export is different from domestic firms. Even conditioning on firm level characteristics, which [illegible] appear to have a smaller role in the export behaviour of foreign firms than for domestic companies, foreign firms are more export intensive than domestic firms. Therefore, foreign firms may respond differently from domestic firms to policies devised to spur firms to start exporting or to increase their exports.

Policy markers within the UK clearly view exporting as a good thing. Foreign firms contribute disproportionately to exports from the UK, and could, given their favourable underlying performance characteristics, potentially offer a larger share. If policymakers aim to improve the export performance of the UK manufacturing sector this fact may provide an additional motive to invest public funds to attract affiliates of foreign multinationals to locate in the UK.

In addition, anything that threatens the permanence of foreign companies - for example it has been suggested by some that the UK's membership of the EU might be such a variable - could have significant consequences for the export performance of the UK manufacturing sector.

3.6 Appendix

To compute productivity levels the index number approach was chosen as suggested by Diewert (1992). The chosen method allows to eschew the difficulties involved in estimating flexible production functions and to obtain transitive comparisons among the productivity of firms in a multilateral setting.

The particular index used is a Tornqvist-type index. This index was first introduced by Tornqvist (1936) to make binary comparisons (i.e. comparison between two entities) and was subsequently used as output, input and productivity index. Two main advantages of the binary Torniqvist index are that it is superlative and transitive. Transitivity is one of the desiderable properties, set by Fisher (1922), index numbers should respect. Diewert (1976) introduced the concept of superlative index numbers, which are those that can be directly derived from flexible functional forms. The binary Torniqvist index is superlative since it can be derived from a translog function.

In economics we are mostly interested in multilateral comparisons (i.e. comparison between more than two agents). The binary Torniqvist index could be used in this case as well to generate the set of all possible binary comparisons, but transitivity would not be necessarily respected. In time series studies to bypass this difficulty the Tornqvist index has been employed chain-linking observations so that to attain, in addition to transitive bilateral comparisons between adjacent observations, bilateral transitive comparisons between non-contiguous ones, the latter by means of intervening observations. In cross section studies this method cannot be easily applied since there is not a inherent way of arranging observations.

For this reason Caves *et al.* (1982) introduced a modification of the binary Tornqvist index, which preserves its transitivity in a multilateral context even when there is not a precise ordering of the observations, as in cross section data sets. This multilateral Tornqvist index allows to construct a total factor productivity (TFP) index, which, in the one output case, is computed as the log of output of, say, plant f (expressed as difference of the log output of this plant from a reference point) minus the cost share weighted sum of the log of inputs (expressed as cost share weighted difference of the log of input from a reference point). The log of output and inputs are expressed as differences from a reference point to indeed ensure transitivity among all comparisons.

The reference point is constructed as a hypothetical firm whose output and inputs levels are calculated, respectively, as the log of the geometric mean, across all firms, of the output and inputs levels. By the same token, the cost share of a certain input is computed as the arithmetic mean, across all firms, of the cost share of that input. Thus, the index can be represented by means of the following expression,

$$\ln TFP_f = (\ln y_f - \overline{\ln y}) - \frac{1}{2}\sum_{i=1}^{N}(s_{if} - \overline{s_i})(\ln x_{if} - \overline{\ln x_i})$$

$$\overline{\ln y} = \frac{1}{M}\sum_{f=1}^{M} \ln y_f; \quad \overline{\ln x_i} = \frac{1}{M}\sum_{f=1}^{M} \ln x_{if}; \quad \overline{\ln s_i} = \frac{1}{M}\sum_{f=1}^{M} \ln s_{if}$$

where y indexes the output of the M firms; x and s index respectively the N inputs and their cost share. The terms with an upper bar represent the log of the output, inputs and their cost share of the reference firm. It is worth stressing that this reference point is not chosen arbitrarily. Indeed, it descends from the fact that the multilateral Tornqvist index proposed by Caves *et al.* (1982) compares the productivity of firm f with respect not to another single firm, but with respect all the other firms. This comparison is conducted subtracting the mean across all firms of their productivity, in log, from the productivity, in log, of firm *f*. Assuming a translog functional form it is possible to show that the mean of the logarithmic productivity across all firms is equal to the productivity of the reference firm (Caves, Christensen, and Diewert 1982).

The above index is suited for cross section studies (all firms are compared to the refernce firm). Good *et al.* (1995) have modified it to deal with panel data sets. These feature both time series and cross section characteristics. In this situation both the chaining over time and the reference firm approaches, the former used in time series settings, whereas the latter in cross sections, have appealing facets.

The authors proposed an index that uses both methodologies since the hypothetical firm for each cross section is chain-linked over time as in time series studies. The index above then becomes

$$\begin{aligned}\ln TFP_{ft} \;=\;& (\ln y_{ft} - \overline{\ln y_{\cdot t}}) - \frac{1}{2}\sum_{i=1}^{N}(s_{ift} - \overline{s_{i \cdot t}})(\ln x_{ift} - \overline{\ln x_{i \cdot t}}) + \\ & + \sum_{t=2}^{T}(\overline{\ln y_{\cdot t}} - \overline{\ln y_{\cdot t-1}}) - \frac{1}{2}\sum_{t=2}^{T}\sum_{i=1}^{N}(\overline{s_{i \cdot t}} - \overline{s_{i \cdot t-1}})(\overline{\ln x_{i \cdot t}} - \overline{\ln x_{i \cdot t-1}})\end{aligned}$$

The first part of this index is equal to the Caves *et al.* (1982) index. The second part, instead, allows to chain the reference firm through time.

In this study the above index has been used to calculate the productivity level of each firm for each year and its yearly productivity growth rates. The inputs used are labour, material and capital. The labour factor is measured as the total number of workers employed by the firm and its cost as the total wage bill. The cost of material is the cost of production of goods sold. The capital is the fixed capital stock. Due to the lack of reliable measure of the user-cost of capital its expenditure share was calculated assuming constant return to scale so that it can be computed as one minus the cost-share of the other inputs.

To allow for fixed industry effects, the productivity index was computed separately for each 2 digit SIC92 sector. In this way the reference was constructed for every 2 digit industry and the productivity of all firms in the same industry was computed relative to it. Thus, the systematic productivity differences among industries is captured by the reference firms, and by the productivity of individual firms since this is measured as distance from the reference firm. This characteristic allows us to control for the fact that exporters and multinationals could be concentrated in highly productive sectors.

In addition, it permits to undertake sensible productivity comparisons across firms operating in different industries whose outputs are not obviously comparable given their different nature. Productivity of firms in the ship building sector is not commensurable with that of companies in the chocolate bars sector. However, if the productivity of firms operating in different industries is computed taking as a reference the average firms of the respective industry, meaningful comparisons can be conducted. For instance, firm A operating in the ship building sector has a productivity level that is 2 percent higher than the average ship building companies; firm B in the chocolate bars industry has a productivity level that is only 1 percent higher than the respective average firm. Then, it is possible to say that firm A is more productive than B (with respect to respective the average firm).

Chapter 4

Exports versus FDI: A Non-Parametric Empirical Test

4.1 Introduction

One feature of the rising integration of the world economy evident both in the present and previous rounds of globalisation is the simultaneous increase in arms-length trade (exporting) and foreign direct investment (see Obstfeld and Taylor (2003) and Maddison (2001) for further details). In traditional theories of international trade and multinationals these are substitute methods of serving overseas markets: domestic firms either export or establish foreign production facilities. Brainard (1993) provides an appealing characterisation of the FDI/export decision facing firms. Firms export when there are cost advantages to concentration (economies of scale), and establish foreign production facilities when proximity to local markets is more important. Empirical support can also be found for this model: the share of exports is increasing in scale economies and decreasing in trade costs and foreign market size (Brainard 1997).

The recent development of theories in which firms are heterogeneous in their underlying characteristics has added fine detail to this model of trade and FDI (Bernard, Eaton, Jensen, and Kortum 2003; Helpman, Melitz, and Yeaple 2004; Melitz 2003). There, firms within each industry face the same industry costs but make different choices about market entry. Firm heterogeneity leads to self-selection in the structure of international commerce (Helpman, Melitz, and Yeaple 2004, henceforth HMY). Only the most productive firms within an economy find it profitable to meet the higher costs associated with FDI; the next set of firms find it profitable to serve foreign markets through exporting; while the least productive firms find it profitable to serve only the domestic market.

In this chapter we test whether the export/FDI and export/no-export decisions are ordered according to the productivity of firms as in Helpman, Melitz and Yeaple (2004). The empirical question under test can be expressed as comparisons between the productivity distributions of different kinds of firms (namely, multinationals, exporters and purely domestic market oriented firms).

The theoretical framework of HMY predicts a strict relationship between the productivity of a firm and its choice about market entry that we might not expect to find in the data however. Firms with productivity above a given cut-off value enter exports markets or become multinational with certainty. The productivity level of all multinational firms must therefore be greater than that of all exporting firms, which in turn must be greater than that of all non-exporting firms. In practice we might expect that shocks to the level of productivity of the firm, uncertainty surrounding the fixed costs of entering export markets, undertaking FDI or the productivity level of the firm may lead some firms with identical characteristics to make different choices. The relationship between FDI and productivity becomes blurred.

The Helpman, Melitz and Yeaple (2004) model assumes that the choice to establish foreign production facilities is based purely on considerations of market access. All FDI is horizontally motivated. Head and Ries (2003) demonstrate that when there are factor price and market size differentials across countries, firms invest abroad for vertical motives also. They take advantage of low factor costs, such as wages, in some countries. As a result firms that become multinationals may no longer be the most productive within the industry. The most productive firms undertake market-seeking FDI, whereas the least productive conduct factor-seeking FDI. By implication we test their extension to the HMY model.

For these reasons to test whether firm productivity is associated with the structure of international commerce we apply Kolmogrov-Smirnov tests of stochastic dominance. Establishing stochastic dominance implies that one cumulative distribution lies to the right of another. These tests therefore go beyond tests for differences in mean productivity that are typically found in the literature. Delgado *et al.* (2001) have previously applied these Kolmogrov-Smirnov tests to data on Spanish exporters and non-exporters, while building on the ideas developed in this chapter Girma, Gorg and Strobl (2004) report on results for Irish data.

As in Delgado *et al.* (2001) we also report evidence on the issue of self-selection versus learning. Heterogeneous firm models predict a causal relationship between foreign market entry and productivity that is one directional, from productivity to exporting and FDI. Empirical evidence also exists for causation in the opposite direction however. The evidence on learning effects from export market entry, knowledge spillovers to domestic firms from the co-location of multinationals, and the effect on firm performance after the acquisition by foreign multinationals, appears dependent on the chosen sample frame and methodology. This chapter provides the first evidence on this issue for the UK using tests of stochastic dominance.

Finally, our empirical analysis relates to the literature on whether exports and FDI are complements or substitutes. The current evidence would appear to depend on the level of aggregation used. In the single product setting of the type discussed above exports and FDI are substitute methods of serving foreign markets. Complementarity between them is generated as we use higher levels of aggregation. For example, within the firm complementarity is possible once we allow for multiple products and cross-product dependence of demand (Lipsey and Weiss 1984), or strategic motives in the location decisions of firms (Choi and Davidson 2004).

A similar pattern of substitution at low levels of aggregation (albeit with net-complementarity) and complementarity at higher levels would also summarise the empirical evidence on this point. Using industry trade data Lipsey and Weiss (1984), Clausing (2001) and Graham (2000) all find strong evidence of complementarity. Exports tend to rise with sales by foreign affiliates. In contrast using product level data for trade in Japanese automobile parts between the US and Japan Blonigen (2001) finds clear substitution effects in nine of the ten product lines examined and vertical complementarity effects from Japanese automobiles in nine product lines. Finally, Head and Ries (2001) using firm level data find evidence of net complementarity in the most vertically integrated firms and substitution for the least integrated. If evidence of stochastic dominance is found then the results may be thought of as consistent with the idea of substitution between exports and FDI within the industry.

We find in this chapter strong support for the ranking of the productivity distributions predicted by the HMY model. The cumulative productivity distribution of multinational firms lies to the right of that of exporting firms, which in turn is to the right of that of non-exporting enterprises. The same ordering of firms is also found to exist when we replace domestic multinational firms with foreign multinational firms.

Establishing the direction of causality between productivity and the structure of commerce using this methodology produces less clear results. Firstly, evidence is found to suggest these differences in productivity amongst groups of firms are permanent, there are no significant differences in the growth rate of productivity across firms. This is consistent with the idea that firms involved in exporting or FDI do not experience faster rates of economic growth, in line with Bernard and Jensen (1999) for the US. There is no evidence of learning.

Secondly, we explore the idea of self-selection by using information on firms that transit between states, they become exporters or multinationals (through brownfield FDI), in the pre-entry period. From this we find weak evidence of self-selection. The cumulative productivity of new-exporters lies to the right of that of non-exporters but does not stochastically dominate it. Similarly, there is only weak evidence that the cumulative productivity distribution of firms acquired by foreigners dominates that of other domestically owned export firms. Overall new exporters and new multinationals do not clearly display productivity characteristics that are different from firms that do not then go on to become exporters or multinationals. This is supportive of the idea that firms are uncertain as to the costs and benefits of becoming an exporter or a multinational, such that firms with similar productivity characteristics make different choices. This argument is also consistent with the evidence of knowledge spillovers following from the co-location of existing exporters and multinationals on the probability of first time export market entry found in Greenaway *et al.* (2004), Aitken *et al.* (1997) and Greenaway and Kneller (2004b).

The rest of the chapter is organised as follows. In section 2 the theoretical underpinnings of the subsequent statistical tests are elucidated. Section 3 contains a description of the empirical approach used, the database and the methodology employed to compute TFP. The results are discussed in Section 4 and finally section 5 concludes.

4.2 The productivity of multinationals and exporting firms

In this section of the chapter we provide a brief description of the HMY model; in so doing we draw on that paper. The properties of the model of interest are generated through the assumptions of different costs (largely fixed costs) associated with serving the domestic market, and serving foreign markets (through FDI or exports), along with heterogeneity in the level of productivity across firms and imperfect competition. Before a firm can enter the industry it pays a fixed cost f_D. Upon entry it receives a level of labour productivity a drawn from a known distribution G(a). Using its knowledge about the level of labour productivity the firm then chooses whether to serve the domestic market only, in which case it bears the fixed cost f_D, or to bear additional costs and serve foreign markets also. A productivity draw below the level necessary to make positive profits (zero for the marginal firm) leads the firm to exit the industry.

If the firm chooses to serve foreign markets it has the choice over whether to do so through exporting or FDI. This is known as the proximity-concentration trade off. Exporting incurs both additional fixed and variable costs, while FDI incurs only additional fixed costs. The fixed costs of exporting are labelled f_X, while f_I represents the additional fixed costs associated with setting up a foreign subsidiary. The fixed costs of FDI are assumed to be greater than those of exporting, i.e. $f_I > f_X$. The sunk-costs of exporting are typically thought to include fixed costs of research into product compliance, distribution networks, advertising and so on. The fixed costs of FDI are the duplication of costs in f_D (the domestic set-up cost) as well as the building of new production facilities or acquisition of an existing firm. Goods that are exported are also subject to transportation costs, modelled as melting iceberg transport costs τ_{ij}, where i indexes the domestic country and j the foreign country. FDI therefore eliminates the variable transport costs of exporting, but involves higher fixed costs.

After entry firms engage in monopolistic competition. The demand side of the model is assumed to be of a form such that there is a demand function $A^i p^{-\epsilon}$ for every brand of the product and the brand of a producer with labour productivity a is offered for sale at a price $p = a/\alpha$, where $1/\alpha$ represents the mark-up factor. The level of profits (π), associated with serving the domestic market, exporting or setting a foreign subsidiary are then given by the following expressions

$$\text{(domestic market only)} \quad \pi_D^i = a^{1-\epsilon}\frac{(1-\alpha)\,A^i}{a^{1-\epsilon}} - f_D$$

$$\text{(exporting)} \quad \pi_X^{ij} = (\tau a)^{1-\epsilon}\,\frac{(1-\alpha)\,A^j}{a^{1-\epsilon}} - f_X$$

$$\text{(FDI)} \quad \pi_I^j = a^{1-\epsilon}\frac{(1-\alpha)\,A^j}{a^{1-\epsilon}} - f_I$$

These expressions confirm that the profitability of each of these activities is increasing in the productivity of the firm. The slopes of these lines are such that the level of profit a firm receives from each of these forms of commerce also differs according to the productivity level of that firm. Firms with productivity below $(a_D^i)^{1-\epsilon}$ choose not to enter the domestic market, while firms with productivity between $(a_D^i)^{1-\epsilon}$ and $(a_X^{ij})^{1-\epsilon}$ make positive profits from serving the domestic market, but would make negative profits if they chose to serve foreign markets. Firms with productivity between $(a_X^{ij})^{1-\epsilon}$ and $(a_I^{ij})^{1-\epsilon}$ make positive profit from serving the domestic market and from exporting, but not from FDI, and therefore serve foreign markets by the former. Finally, firms with productivity levels above $(a_I^{ij})^{1-\epsilon}$ can make positive profits from either exporting or FDI, but profits are greater if they choose to undertake FDI. Firms above this level therefore serve foreign markets through their foreign subsidiaries.

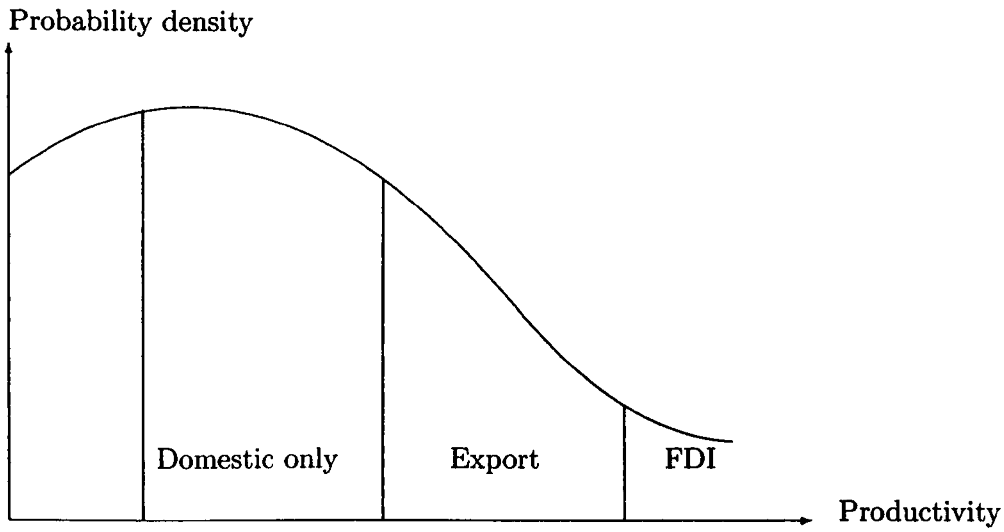
While the above is presented such that exporting and FDI are substitute choices it is worth noting that the ordering of productivity and commerce holds when export platform FDI is allowed.[1] That is, as we find in the data, multinationals also export. In this case the good is produced by the domestic firm in the foreign country to be sold therein and to be exported to other foreign countries.

For the case of symmetry in the level of fixed costs and the productivity distribution G(.), HMY produce a useful diagram that summarises the predictions regarding productivity and international commerce. For the probability density of $1/a$, figure 4.1 suggests that firms with a productivity level to the right of a given cut-off point(a_D, a_X, or a_I) must strictly be more productive than all firms to the left of the same cut-off. The multinational enterprise with the lowest productivity level must be more productive than the exporter with the highest productivity level. Similarly, the least productive business must have a higher productivity level than the most

[1]See the appendix of Helpman, Melitz and Yeaple (2004) for this proof.

productive firm choosing to exit the market. A test of this model could therefore be applied through a productivity comparison of these marginal firms.

Figure 4.1: Export FDI decision with no uncertainty



The relationship between productivity and international commerce can be made more complex, such that firms with similar productivity make different choices, within the current model if the fixed costs of exporting and FDI or the distribution from which productivity is drawn are not symmetric across countries. Firms may therefore choose to export to some countries but not others, or to serve some countries through foreign affiliates and some through exports.

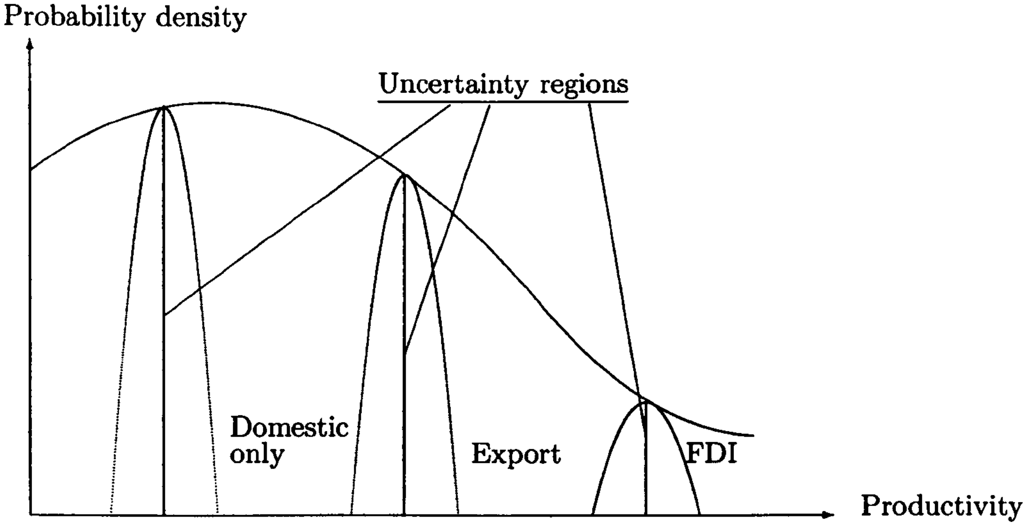
There are a number of changes in the assumptions of the model that would generate similar predictions. For example, firms might make different choices despite similar productivity levels if the assumption that productivity is fixed across time is removed. If instead the productivity of the firm is subject to random shocks, then the existence of fixed costs associated with entry may result in the firm choosing not to enter or exit in a given period in order to avoid paying these fixed costs in the future.

Alternatively there may be uncertainty surrounding the parameters of the model. For example, firms may be uncertain about the fixed costs of entering export markets or undertaking FDI and the degree of uncertainty differs across firms. Similarly, the firm may observe its productivity level with error. Finally, firms may differ in their degree of risk aversion, discounting expected future profits from entry into new markets at different rates. One possible representation of such a model that has parallels with figure 4.1 is given by figure 4.2.

In figure 4.2 there exist regions around each of the definite cut-off points in figure 4.1 in which firms of similar productivity levels make different choices regarding the market entry decision. For example, in the region around $1/a_X$ firms that would choose to become an exporter in figure 4.1 might not make the same choice in figure 4.2. By the same token in the region around the fixed cost $1/aI$ firms that became multinational with certainty in figure 4.1 may instead choose to serve foreign markets through exporting in figure 4.2. The relationship between productivity and international trade is not therefore as deterministic as in figure 4.1. Despite the existence of some uncertainty as to the choice of market entry made by firms in figure 4.2 there remains a precise ordering of the productivity distributions among the different type of enterprises. Hence a possible method of testing this model would be to compare the cumulative productivity distribution function of firms that serve domestic markets only, export or are multinational.

In addition, Head and Ries (2003) demonstrate that the ordering of the productivity distribution between multinationals and non-multinationals can even be reversed if one allows for differences in wages (i.e. factor costs) and market sizes across countries. If the foreign country is small and offers some cost advantage, for a certain range of the parameter of the model, least productive firms locate production abroad

Figure 4.2: Export FDI decision with uncertainty



whereas more productive ones concentrate production in the home country. In this case, low productivity enterprises have the greater incentive to pay the FDI related sunk cost because they use more intensively the production factor whose price in the foreign country is low.

Finally, the above models consider the case of single product firms. Multi-product firms face a more complex array of choices as the FDI/export decision may be product specific. If market demands, factor costs and firm productivity differ for each of the goods produced, firms will find it profitable to produce some products in the home country and export others. In this case, firms with a sufficiently high productivity level will serve foreign market through exports and/or FDI. If in addition we allow for differences amongst foreign countries, such as market size and factor costs it is apparent that even single-product firms could make different export/FDI choices to serve different countries (or groups of countries). These two cases would allow for firms that are both multinationals and exporters.

Given the theoretical discussion above it is clear that the question concerning the ordering of productivity distributions among purely domestic, exporting and multinational firms is mainly an empirical one. It is possible to blur or even reverse the order predicted by HMY. It is also clear that the test necessary to evaluate the general prediction of the model goes beyond simple comparisons in mean productivity and would require tests of the entire distribution for each type of firm.

Ranking the productivity distribution of different kinds of firms is also important from a policy perspective. Indeed, improving the efficiency and productivity of firms have figured prominently in the mind of policymakers, especially in the UK. High productivity levels and growth rates are considered highly beneficial since they lead to a better use of scarce resources and, in the long-run, to high standard of livings. For this reason, UK government agencies have been offering financial incentives to attract foreign multinationals and to facilitate export.[2]

Given these goals and the financial resources spent to achieve them, it would be of great interest to unambiguously rank different types of firms according to their productivity. Are multinationals unequivocally "better" than exporters, and the latter "better" than non-exporting firms, in terms of productivity? Our intent is to answer these questions without relying on unrealistic assumptions concerning productivity distributions and the objective function, supposedly maximised by policymakers.

Comparisons of means does not allow to accomplish this task, whereas the concept

[2]Tax breaks, duty drawbacks, investment allowances and so on have been offered to foreign multinationals to establish affiliates in the UK. Two cases in point refer to Samsung and Siemens, which were offered, respectively, the equivalent of $30000 and $50000 per employee to invest in North East England and Newcastle (UNCTAD 1996). By the same token, public money is spent in a number of export promotion activities such as free supply of information about foreign markets, financial helps for foreign market researches and participation in trade fairs, as well as export credit insurance.

of first order stochastic dominance does. First order stochastic dominance implies that the productivity distribution of one type of firms lies to the right of another.[3] If found to hold, the means of the two distributions also differ. It therefore provides a stricter test than simply comparing mean levels of productivity and one that does not rely on strict assumptions.

4.3 Empirical methodology, description of the data base and construction of TFP

4.3.1 Empirical methodology

In this chapter we test the rank ordering of the productivity distribution of firms which differ in their involvement in international markets. Specifically, we employ the nonparametric one-sided and two-sided Kolmogorov-Smirnov tests (e.g. Conover (1999); Sprent (1989)). These test for first order stochastic dominance between random variables. This methodology was first employed by Delgado *et al.* (2001) in a firm level data context; however, they limit their analysis to exporters and non-exporters.

As we have seen in the previous section, productivity comparisons across different kinds firms have usually involved means. However, comparing just the mean of two general random payoffs does not allow to conclude that one is unambiguously "better" than the other. To reach such a conclusion one has to make very restrictive assumptions about utility functions or the distribution of random variables. For instance, means are sufficient statistics to rank unambiguously random prospects if the objective function (i.e. the utility function or, alternatively, the social welfare

[3]The inverse is not true. Difference in means does not imply necessarily that the distribution, whose mean is larger, stochastically dominates the other.

function) used to grade them is quadratic or if probability distributions are normal (e.g. Wolfstetter (1999)). Both assumptions may be deemed too restrictive, since slightly altering them may lead to different orderings.

Contrariwise, stochastic dominance allows to reach unequivocal rankings of random variables without requiring precise knowledge of the objective function and their probability distributions. It only requires that the objective function belongs to a more general class with some common properties.[4] That is, stochastic dominance permits to judge two random prospects, irrespective of who is the judge. If one payoff (or choice) first stochastically dominates the other, then that payoff is preferred by all agents with increasing, monotonic utility function (Wolfstetter 1999, pp. 135). This is the only assumption needed to rank random payoffs using first order stochastic dominance and for this reason we may say that such a choice is unambiguously "better" than the other.

Given the discussion in the preceding section, rankings based on stochastic dominance are more suited in this context than those based on means for two reasons. Firstly, from a policy standpoint we want to assess whether or not firms participating in international markets, through FDI or export, are "unambiguously" better than firms that do not, with respect to productivity. This is of interest given the considerable amount of public money spent in promoting export and/or attracting FDI, and the emphasis on improving productivity. First order stochastic dominance allows to rank the different types of firms considered without specifying a precise objective function, bar that is monotically increasing. Secondly, from a theoretical viewpoint

[4]The theory of stochastic dominance has indeed been developed to analyse the economic behaviour of agents facing uncertain prospects, without making too restrictive assumptions (Hadar and Russell 1969; Hanoch and Levy 1969). Analogously, this approach has been subsequently used to rank income distributions to undertake welfare analysis independently of specific social welfare functions (e.g.: Anderson (1996)).

we want to encompass the possibility that firms of the same productivity level may choose different forms of commerce around a given cut-off point, but restrict the test such that there must be statistically robust differences between the distributions. That is, the degree of different behaviour among firms and the size of random shocks cannot be too large that the structure of commerce and firm heterogeneity are no longer meaningfully related.

To perform this test we define two cumulative distribution functions F and G. The latter corresponds to the group of interest, for example domestically owned exporters, and the former to the comparison group, for example UK multinationals. First-order stochastic dominance of F with respect to G is defined as: $F(z)-G(z) \leq 0, \ \ \forall\, z \in \Re$, with strict inequality for some z.[5] To establish first order stochastic dominance we need to conduct the one-tailed and two-tailed Kolmogorov-Smirnov tests.

The two-sided Kolmogorov-Smirnov statistic tests the hypothesis that the two distributions are different. The null and alternative hypotheses can be expressed as:

$$\begin{aligned} H_0: \quad F(z) - G(z) \ &= 0 \ \forall\, z \in \Re \\ H_1: \quad F(z) - G(z) \ &\neq 0 \ \textit{for some } z \in \Re \end{aligned} \tag{4.1}$$

The two-sided Kolmogorov-Smirnov alone is not sufficient to establish stochastic dominance. On the one hand, if the null is not rejected, the two distributions are not statistically different; therefore none dominates the other. On the other hand, if the null is rejected, the two distributions are statistically different. However, this could be caused by the fact that $F(z)$ dominates $G(z)$ (i.e. $G(z) \geq F(z)$ for all

[5]The same can be expressed in terms of probabilities: first order stochastic dominance of F with respect to G entails that for any chosen value $z=\overline{z}$, $P(z_F > \overline{z}) \geq P(z_G > \overline{z})$, where z_F and z_G are realizations drawn from F and G, respectively.

z) or alternatively that $G(z)$ dominates $F(z)$ (i.e. $G(z) \leq F(z)$ for all z). Another possibility is that, for certain values of z, $F(z) > G(z)$, whereas for others $F(z) < G(z)$ (i.e. the cumulative distribution functions cross each other).

To establish first order stochastic dominance of $F(z)$ with respect to $G(z)$, the one-sided Kolmogorov-Smirnov test must be conducted. It can be expressed as:

$$\begin{aligned} H_0: \quad F(z) - G(z) & \leq 0 \ \forall \, z \in \Re \\ H_1: \quad F(z) - G(z) & > 0 \ \textit{for some} \ z \in \Re \end{aligned} \tag{4.2}$$

To establish first order stochastic dominance of *F(z)* with respect to *G(z)* requires the rejection of the null hypothesis in the two-tailed test in 4.1, and not rejection of the null in 4.2.

Figures 4.3 and 4.4 depicts two imaginary productivity distribution functions for illustrative purposes. In figure 4.3, *F(z)* dominates *G(z)*, since the former lies beneath the latter. In this situation we would expect to reject the null of the two-sided test (i.e. equality of the distributions), and not to reject the null of the one sided test with difference favourable to *F(z)*.[6] In figure 4.4, the two distributions still differ, but they cross in addition. Thus, for "low" productivity levels, to wit, for productivity levels to the left of the intersection point, $G(z)$ dominates $F(z)$, whereas for "high" productivity levels the opposite is true. In this instance, we would expect to reject the null of the two-tailed test, and if the differences favourable to $F(z)$ and $G(z)$ are *both* large enough, we would reject *both* one-tailed tests, and first stochastic dominance would not be not established. It should be noted that in this situation, means are

[6]Obviously in this case, the null of the one-sided test with difference favourable to *G(z)* would be rejected.

not necessarily the same. Depending on the exact shape of the distributions and the point where they cross, one of the means may be statistically larger than the other; hence, comparisons of means may induce erroneously to conclude that one type of firms is unequivocally "better" than the other.

For the one-sided and two-sided test, the Kolmogorov-Smirnov statistics are, respectively:

$$\begin{aligned} KS_1 &= \sqrt{\frac{n\,m}{N}} \max_{1 \leq i \leq N} \{F_n(z_i) - G_m(z_i)\} \\ KS_2 &= \sqrt{\frac{n\,m}{N}} \max_{1 \leq i \leq N} |F_n(z_i) - G_m(z_i)| \end{aligned}$$

where n and m are the sample sizes from the empirical distributions of F and G respectively, and $N = n + m$. As it is possible to see the two statistics are very similar. The only difference is that the two-tail test considers the absolute value of the maximum value of the difference (i.e. vertical distance) between the two cumulative distribution functions, whereas the one-tail test does not. This is because the two-sided statistics tests for any statistically significant difference between the two distributions; this may be due either to the fact that $G(z)$ dominates (i.e. is down) $F(z)$ or the other way round. The one-sided statistics testing the hypothesis that $G(z)$ dominates $F(z)$ considers the maximum value of the difference $F(z) - G(z)$; if this difference is large enough the hypothesis will be rejected.

The Kolmogorov-Smirnov test requires independent observations. Given the panel structure of our data set, observations related to the same firm in different years cannot be deemed to be independent. Therefore the tests have bee conducted separately for each year.

Figure 4.3: Example of first stochastic dominance.

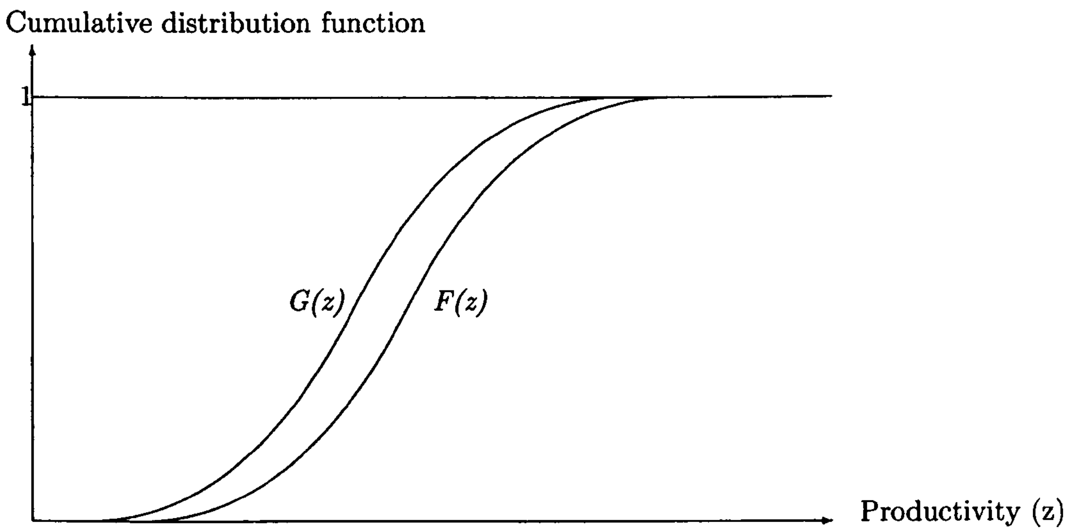
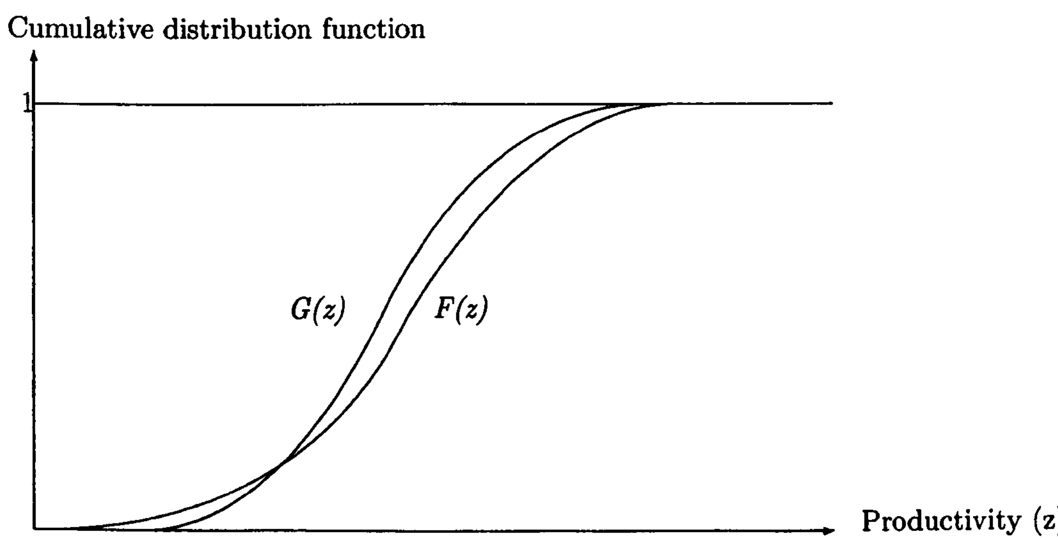


Figure 4.4: Example of different productivity distributions with no first order stochastic dominance.



4.3.2 Data sources and construction of variables

The United Kingdom is a relatively large industrialised economy, the fifth largest exporter of manufactures globally and the second largest host to FDI. Unfortunately the UK production census (the Annual Respondents Database) does not collect information on exporting activity of firms. In order to make progress on this issue, instead we employ the firm level survey OneSource which does. Further details on the OneSource dataset can be found in Oulton (1998); a full description of the data set is provided in the data appendix at the end of Chapter 1. [7] OneSource provides information on employment, physical capital, output and cost of goods sold in a consistent way both across firms and across time.[8] The data were screened to select those firms for which there are a complete set of information about the value of output, factors of production and export. Companies that are dissolved or in the process of liquidation were also excluded. This left a total sample of 11,824 observations containing information on some 3,799 domestic manufacturing firms, of which more than 50% were observed for 5 or more years.[9] We did not deem outliers to be a major obstacle in this exercise

[7]OneSource uses a non-stratified sample with an oversampling of large firms. Given that exporters and multinational firms have consistently been found to be larger than non-export firms this might be expected to bias the tests against finding a significant difference in the cumulative distribution with respect to non-exporters. Given the results found below this bias does not seem of concern. Tests between exporters and multinationals are less likely to be affected by this bias.

[8]For this study we used the OneSource CD-ROM entitled "UK companies, Vol. 1", for October 2000.

[9]The number of observations in the original data set that can be used for econometric analysis is greatly reduced because of missing values. This is a problem common to all firm level data sets. On the one hand, this problem can in principle create a sample selection bias if missing values follow some deterministic process whereby some firms report missing values and some others do not. To correct for this one would need to devise a selection rule, which determines what firms report missing values. This is notoriously difficult since there are missing values in all the variables in the data set and not only in the dependent variable of interest. On the other hand, if the missing values are due to a complete random process, no sample selection bias will arise. We did not correct for sample selection bias, because it is not clear how this can be done applying the Kolmogorov-Smirnov test. Besides, to author's knowledge, none of the papers that have used firm level data sets have ever undertaken such a correction.

since productivity is treated as a random outcome by the Kolmogorov-Smirnov test; outliers are therefore dealt with as extreme random outcomes.

OneSource does not provide information on the multinational activity of U.K-owned firms, but it proved possible to merge OneSource with a newly created database of foreign multinational activity to generate this indicator: the European Linkages and International Ownership Structure (ELIOS) database built at the University of Urbino.[10] This was available for 1996 which we backcast to the start of the sample period. The information obtained from ELIOS was also complemented with a list of U.K firms that made foreign acquisitions, compiled from various issues of Acquisitions Monthly. Backcasting the UK multinationals indicator works against out hypothesis that UK MNEs are more productive than non-multinational domestic companies; this is because we are likely to classify some non-multinational enterprises as multinationals.

In accordance with the theoretical model and its extensions we separate domestic firms into one of three types; domestically owned firms that export in all years of the sample (labelled domestic permanent exporters - DPE); domestically owned firms that do not export during the sample period (labelled domestic never exporters - DNE); and UK multinational firms (UKMNE), where these latter firms may or may not export. We exclude firms that switch into or out of export markets or overseas production during the sample period, preferring to view these as separate groups of firms that might provide insight into the question of learning versus self-selection.

From OneSource, output was measured using total turnover deflated by 4-digit producer price indices. Labour inputs were measured using the total number of

[10] I wish to express my gratitude to Davide Castellani and Antonello Zanfei for allowing me to use some information from this database.

workers employed by the firm and their cost is the total wage bill. The cost of intermediates was measured as the cost of production of goods sold and capital as the net book value of fixed assets. The cost of intermediates were deflated using highly detailed producer price indices of materials and fuels purchased, while because of the lack of deflators for fixed capital and investment goods, capital was deflated using the GDP deflator of fixed capital formation.[11] The expenditure share of capital is calculated as one minus the cost-share of the other inputs.

Levels and growth rates of total factor producitivity (TFP) were constructed using the index number (i.e. non-parametric) approach (e.g.: Caves *et al.* (1982); Good *et al.* (1995)) and previously employed among others by Aw *et al.* (2000) and Delgado *et al.* (2001). The principle advantage of this methodology over alternatives, such as the econometric estimation of the production function, is that it allows transitive multilateral comparisons of productivity growth rates and levels between firms. Further information on the construction of the index employed can be found in the Appendix of chapter three. In order to take into account fixed industry effects, the index was calculated for each 2 digit SIC92 industry separately.

In table 4.1 we report the basic productivity characteristics of the various groups of firms used in the subsequent analysis. It is noteworthy that exporters are the most numerous in our sample. This is consistent with evidence for the UK found in Girma, Greenaway and Kneller (2004) and for other OECD countries of a similar size such as Italy and Germany (Castellani 2002; Bernard and Wagner 1997).

The mean productivity differences reported in the table are in line with previous

[11] All the producer price indexes used to deflate the nominal output and the price indexes of materials and fuels purchased are at disaggregate industry levels. They were provided by the Official of National Statistics.

evidence for the UK and other countries. Mean productivity of multinational firms is higher than that of exporters which in turn is higher than that of non-exporting firms. The mean productivity level of new export firms is close to that of non-export firms, while mean productivity of domestic firms acquired by foreign multinationals is close to that of firms which export throughout our sample period. The last column of table 4.1 reports the mean export share by type of firms. It is worth observing that the export share of UKMNEs is nearly as high as that of export-only firms. This observation suggests a departure from HMY, but is consistent with its extensions highlighted in the previous paragraph (i.e. the existence of multi-product firms and foreign markets with different characteristics).

It is worth noting that this methodology of computing productivity (but also the regression based approach) may yield negative values. This is because the productivity is computed in log. As it is clear from the appendix of chapter 3, the methodology we employ, but also any regression based method, computes *TFP* as $\ln(y/\mathbf{X})$ where y is the output (assuming one product) and $\mathbf{X}$ is a index aggregating the n inputs. Obviously the ratio inside the parenthesis is always positive, but since we are taking the log, a negative TFP arises if the ratio is less than 1.

4.4 Empirical results

4.4.1 Differences in productivity among multinationals, exporters and purely domestic firms

In table 4.2 we report the results using Kolmogrov-Smirnov test on the cumulative productivity distributions of TFP levels for various types of firm.[12] The results are

[12] The Kolmogorov-Smirnov test was conducted using Stata 8.

Table 4.1: Summary statistics by group.

	Level of TFP			**Growth of TFP**			**Export share**
Group	Observ.	Mean	Stand Dev.	Observ.	Mean	Stand Dev.	Mean
Multin. (UKME)	964	-0.020	0.22	876	-0.005	0.15	0.25
Exporters (DPE)	7929	-0.061	0.22	7168	-0.005	0.14	0.27
Non-Exporters (DNE)	1658	-0.099	0.22	1372	0.003	0.13	0.00
New-Exporters (NDE)	521	-0.105	0.21	355	-0.011	0.11	0.00
New-Multin. (NFOR)	752	-0.064	0.21	620	-0.008	0.15	0.23

Notes: TFP is total factor productivity computed as described in the Appendix of chapter 3 reported on a cross-section by cross-section basis. We adopt this approach firstly because the limiting distribution of the Kolmogorov-Smirnov statistics is only known under independence of observations. Secondly, we might reasonably expect the sunk-costs associated with exporting and FDI to change across time as a result of policy changes, such as the tax treatment of multinationals, as well as cross-time changes in the exchange rate and reductions in transport costs. Finally, it overcomes problems associated with the observed transition of firms between groups, for example starting to export. We consider the productivity distribution of these transition firms below.

The findings for export firms and domestic multinationals relative to firms that do not export match those from the previous literature, albeit where the literature has centred on differences in the mean productivity level (for example Girma *et al.* (2004)). In all seven years of the sample we reject the null of the one tailed test that that distribution of non-exporters dominates that of exporters, but we are able to accept the null from the one-tailed test that the distribution of exporters dominates that of non-exporters.[13] From the two-tailed test we find we can reject the null that the distributions are identical in six of the seven comparison years. Overall we can conclude that the productivity distribution of exporters stochastically dominates that of non-exporters.

We can draw a similar conclusion about the cumulative productivity distributions of non-exporting firms and domestic multinationals. We can reject the one-tailed test that the distribution of non-exporters lies to the right of multinationals in all years bar 1990, but accept the null of the one-tailed test that the distribution of multinationals dominates in all years. From the two-tailed test we conclude that the distributions

[13] It should remembered that the Kolmogrov-Smirnov test, tests for differences in the distribution at each level of productivity. For this reason the value of the test statistic is positive when the cumulative productivity distribution is to the left of the alternative distribution.

Table 4.2: Kolmogorov-Smirnov tests on the distribution of the productivity levels of UK multinational enterprises (UKMNE), domestic permanent exporting (DPE) and domestic never exporting (DNE) firms.

Year	Number of observ.			DNE v DPE			DNE v UKMNE			DPE v UKMNE		
				Equality	Difference fav. to		Equality	Difference fav. to		Equality	Difference fav. to	
	DNE	DPE	UKMNE		DNE	DPE		DNE	UKMNE		DPE	UKMNE
1990	233	1304	116	.1023	.1023*	-.0082	.1149	.1149	-.0030	.0894	.0637	-.0894
				(.076)	(.046)	(.981)	(.275)	(.163)	(.999)	(.325)	(.425)	(.186)
1991	288	1407	130	.1122*	.1122**	-.0088	.2009**	.2009**	-.0137	.1176	.1176*	-.0274
				(.012)	(.008)	(.971)	(.002)	(.001)	(.970)	(.060)	(.038)	(.836)
1992	350	1486	149	.1412**	.1412**	-.0111	.2223**	.2223**	-.0128	.1297*	.1297*	-.0145
				(.000)	(.000)	(.946)	(.000)	(.000)	(.969)	(.016)	(.011)	(.945)
1993	340	1550	164	.1246**	.1246**	-.0055	.2423**	.2423**	.000	.1444**	-.1444**	-0.021
				(.000)	(.000)	(.974)	(.000)	(.000)	(1.000)	(.003)	(.002)	(.999)
1994	361	1591	177	.1041**	.1041**	-.0060	.2230**	.2230**	-.0070	.1268**	.1268**	-.0076
				(.006)	(.004)	(.981)	(.000)	(.000)	(.989)	(.010)	(.006)	(.982)
1995	374	1681	175	.1233**	.1233**	-.0236	.1976**	.1976**	-.0119	.1351**	.1351**	-.0139
				(.000)	(.000)	(.736)	(.000)	(.000)	(.968)	(.005)	(.003)	(.941)
1996	610	1623	185	.0883*	.0883*	-.0116	.1816**	.1816**	-.0126	.1095*	.1095*	-.0149
				(.047)	(.028)	(.940)	(.001)	(.001)	(.965)	(.033)	(.020)	(.930)

Notes

(i) Asymptotic P-values are in parenthesis

(ii) * significance at 5% confidence level; ** significance at 1%

(iii) DPE and DNE are domestic firms that have never been acquired by foreign companies in our sample.

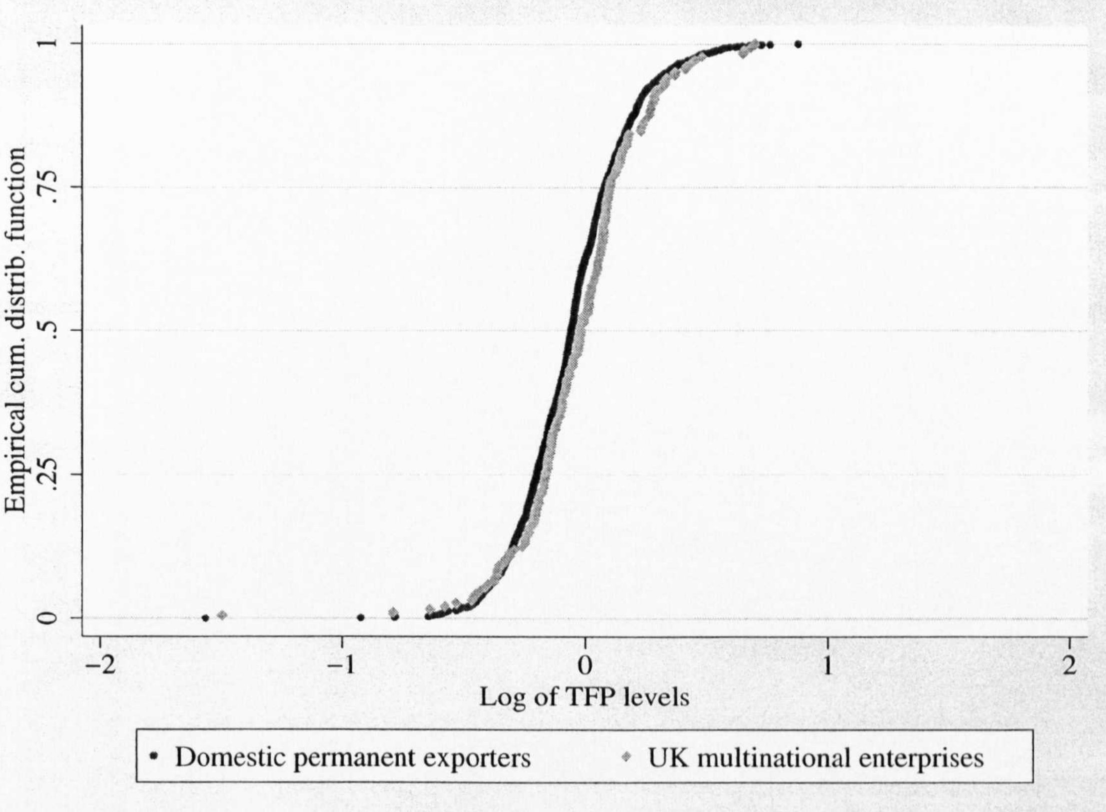
are different in every year except 1990. Stochastic dominance is therefore established in six of the seven years of the sample.

The cumulative productivity distribution of domestic multinational firms is also found to lie to the right of firms that export in every year of the sample period. The productivity distribution of UKMNE's dominates that of exporters. This relationship has not previously been investigated in the literature for UK firms. The cumulative productivity distribution of domestic multinational firms is found to lie to the right of firms that export in every year of the sample period from the one-tailed tests, but the null that the productivity distribution of exporters dominates that of multinationals is rejected for only six of the seven years. From the two-tailed test we reject the null that the distributions are identical in five of the seven sample periods. This evidence for the UK is consistent with that for Irish firms in Girma *et al.* (2004).

In figure 4.5 we provide a graphical example of the productivity distributions of domestic export firms and UKMNE for 1992. Even with relatively small sample sizes available a clear difference in the position of the cumulative productivity distribution is evident from this graph. Overall there is no evidence that low productivity firms become multinationals.

While in table 4.2 there is clear support for the modified HMY model we investigate more closely the failure to accept stochastic dominance in 1990 for a number of the tests. Figure 4.6 displays the graphs of the productivity levels for this year. There is evidence from these graphs that in two of the three cases the ordering of productivity distributions is as expected, specifically the cumulative distribution of UKMNE lies to the right of that of DPE and DNE. This is confirmed by a simple

Figure 4.5: Productivity levels differences between DPE and UKMNE in 1992.

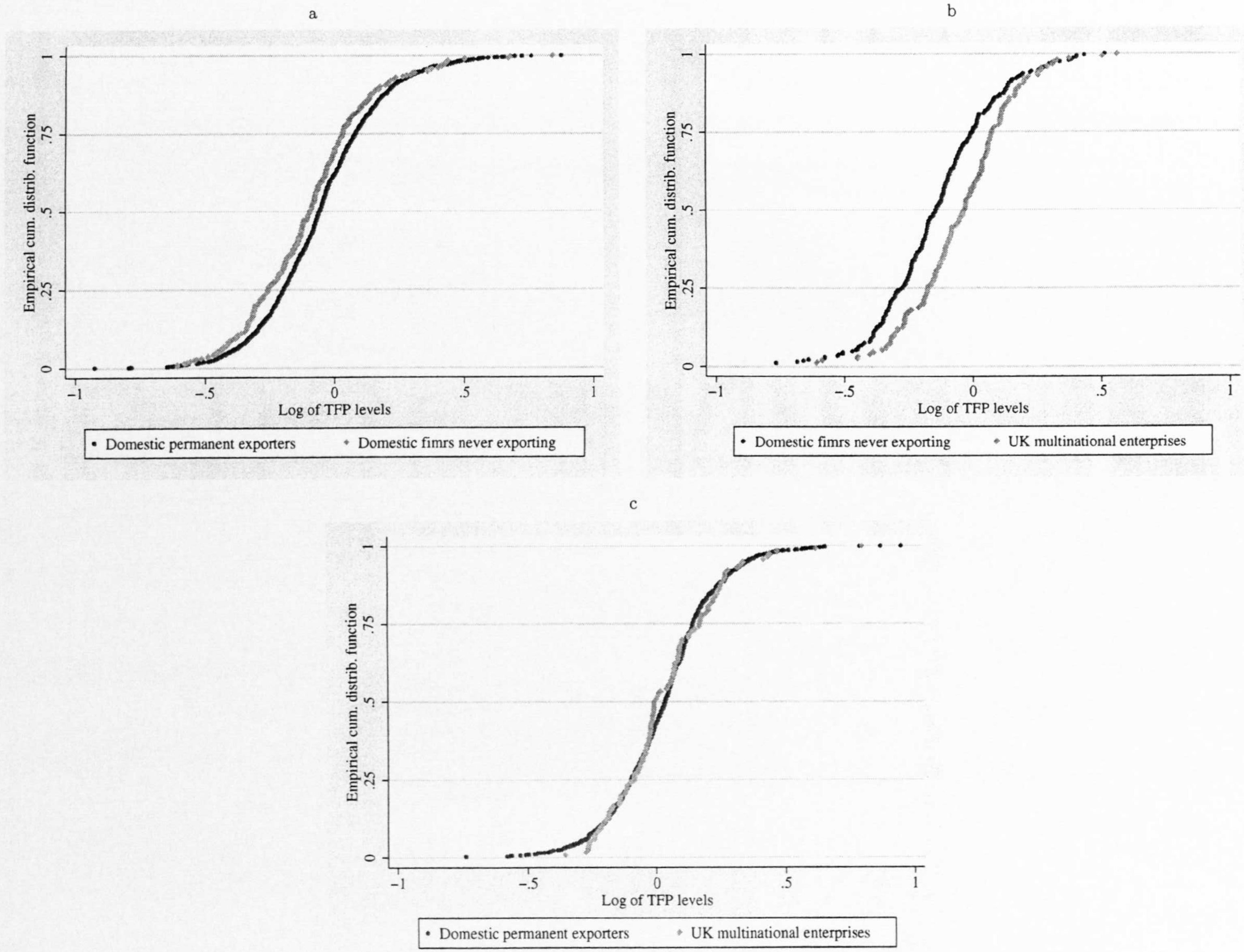


t-test for difference in means. The null of no difference in the mean of the two distributions is rejected for UK multinationals versus exporters (p-value 0.015) and UK multinationals versus non-exporters (p-value 0.008) but not between exporters and non-exporters (p-value 0.276). While this may suggest some caution in the complete acceptance of the heterogeneous firm assumption the relatively low number of observations available could provide one possible explanation for the lack of statistical significance in table 4.2.[14]

As an extension of the results just discussed and in order to increase the size of

[14]Conover (1999) underlines as the p-values of limiting distribution are too conservative in small sample.

Figure 4.6: Productivity levels differences between DPE and DNE in 1990 (part a), UKME and DNE in 1990 (part b), UKMNE and DPE in 1990 (part c).



the sample we employ information on foreign affiliates operating within the UK from the OneSource database. Symmetry within the model implies that foreign multinational firms operate within each industry and that these firms have productivity levels akin to those of domestic multinationals. OneSource contains information of foreign-ownership for the latest year only, so to track the dynamics of ownership we matched the population of manufacturing firms to a list of U.K. firms acquired by foreign multinationals.[15] Foreign multinational firms are labelled FOR in the tables.[16]

The results are in table 4.3. It is evident that the ordering of the producitvity distributions is not different from that in table 4.2. The evidence is strongest for the comparison of foreign multinationals and non-exporters. We do not reject the null of the one-tailed test that the distribution of foreign multinationals dominates that of non-exporters in every year, while we reject the same one-tailed test that the productivity distribution of non-exporters dominates in every year. We also reject the null from the two-tailed test for all years. Comparing foreign multinationals and domestically owned exporters we accept the null that the distributions are identical only for 1991, while we accept the null that the productivity distribution of foreign multinationals dominates in all seven years.

While consistent with the self-selection hypothesis of HMY the above results might also be interpreted as evidence of learning. Fiercer competition and imitation of

[15]This information which is in hard copy format is obtained from the Office of National Statistics upon special request. The matching process required considerable effort, and I wish to thank Mehtap Hisarciklilar for helping me in this regard.

[16]As Helpman *eta al.* (2004) underlines in footnote 6, the problem of the productivity of foreign affiliates compared to domestic companies is only indirectly related to the research question examined here. However, knowing that the bulk of FDI inflows to the UK is from other countries close to the technology frontiers (most of the FDI flows is indeed between OECD countries) and if we are ready to assume there is technology transfer from the parent to foreign affiliates, we would expect the latter to have similar productivity characteristics to UKMNEs.

Table 4.3: Kolmogorov-Smirnov tests on the distribution of the productivity level of foreign firms (FOR), domestically owned permanent exporters (DPE) and domestically owned never exporting (DNE) firms.

Year	Number of observ.			DNE v FOR			DPE v FOR		
				Equality	Difference fav. to		Equality	Difference fav. to	
	DNE	DPE	FOR		DNE	FOR		DPE	FOR
1990	233	1304	834	.1482**	.1482**	-.0141	.0769*	.0769*	-.0237
				(.005)	(.004)	(.950)	(.022)	(.013)	(.659)
1991	288	1407	978	.1465**	.1465**	-.0178	.0467	.0467	-.0285
				(.001)	(.001)	(.896)	(.201)	(.109)	(.438)
1992	350	1486	1093	.2040**	.2040**	-.0151	.0864**	.0864**	-.0061
				(.000)	(.000)	(.911)	(.000)	(.000)	(.959)
1993	340	1550	1109	.1606**	.1606**	-.0009	.0811**	.0811**	-.0061
				(0.000)	(.000)	(.100)	(.000)	(.000)	(.955)
1994	361	1591	1158	.1620**	.1620**	-.0054	.0786**	.0786**	-.0103
				(.000)	(.000)	(.986)	(.001)	(.000)	(.872)
1995	374	1681	1181	.2024**	.2024**	-.0106	.0926**	.0926**	-.0178
				(.000)	(.000)	(.942)	(.000)	(.000)	(.659)
1996	610	1623	687	.1565**	.1565**	-.0138	.0756**	.0756**	-.0076
				(.000)	(.000)	(.926)	(.008)	(.005)	(.948)

Notes

(i) Asymptotic P-values are in parenthesis

(ii) * significance at 5% confidence level; ** significance at 1%

(iii) DPE and DNE are domestic firms that have never been acquired by foreign companies in our sample.

superior technologies raises the productivity of exporters and multinationals relative to non-export firms. We attempt to discriminate between these two hypotheses in the remainder of the chapter.

In table 4.4 we test for stochastic dominance for the annual growth rate of TFP. The HMY (2004) model assumes that once the productivity of the firm is drawn from the productivity distribution there is no time variation in its value. The differences in the productivity distribution across firms in table 4.2 should be a long-run phenomenon. Learning might take two forms: firstly those involved within foreign markets might somehow benefit from their exposure to foreign firms. Secondly, domestic firms may learn from other domestic firms. The convergence literature suggests that technology transfer across firm over time should lead to convergence of productivity levels between domestic firms. The greater the size of the technological gap then the faster the rate of growth will be in a given period. Given the ordering of productivity levels in Table 4.1 we would expect if absolute convergence holds that the annual growth rate of TFP in non-exporters should lie to the right of firms that export, which should in turn dominate that of domestic multinationals. We might expect the reverse ordering if domestic firm productivity growth is increasing in their degree of exposure to foreign firms.

We find from 4.4 however that the differences in the level of productivity evident from table 4.2 are persistent across time. From the one-tailed test, differences in the growth rates of productivity amongst the three types of firm considered are never significant. We cannot therefore establish from these results which distribution dominates. This is confirmed from the two-tailed tests where we find evidence that the growth distributions are similar for the different groups of firms. Firms do not learn from either domestic or foreign firms with higher productivity levels in our data. This result confirms evidence against convergence in the manufacturing sector (Bernard and Jones 1996; Carree, Klomp, and Thurik 2000; Togo 2002) and are consistent with the evidence of no difference in mean growth between established exporters and non-exporters as in Bernard and Jensen (1999).

4.4.2 New exporters and recent foreign acquisitions

Within the data set there are a number of firms that transit between states of commerce. The possibility of transition by firms is allowed in the HMY model only if there is a change in the level of fixed costs associated with market entry and cannot explain the simultaneous movement of firms in both directions. An interesting question that arises out of the results in table 4.2 is whether these firms display significantly different productivity characteristics in the period before the change in export or multinational status takes place. That is, are these firms the marginal non-exporting or exporting firms with the highest/lowest productivity levels respectively?

We provide some evidence on this point. In table 4.5 we compare the distribution of productivity levels of first-time exporters with domestically owned firms that never export in the period before the former start exporting. Unfortunately we do not have data on UK multinational firms in the period before they become multinational and so we use instead information on firms before they are acquired by foreign multinationals (brownfield FDI). The information on foreign acquisition was retrieved from data supplied by the Office of National Statistics. We matched the population of manufacturing firms in Onesource to the list of U.K. firms acquired by foreign multinationals provided by the ONS.[17]

[17]Information on foreign acquisitions obtained from the Office of National Statistics is in hard copy format. The matching process required considerable effort, and we wish to thank Mehtap

Table 4.4: Kolmogorov-Smirnov tests on the distribution of the productivity growth rate of UK multinational enterprises (UKMNE), domestically owned permanent exporters (DPE) and domestically owned never exporting (DNE) firms.

Year	Number of observ.			DNE v DPE			DNE v UKMNE			DPE v UKMNE		
				Equality	Difference fav. to		Equality	Difference fav. to		Equality	Difference fav. to	
	DNE	DPE	UKMNE		DNE	DPE		DNE	UKMNE		DPE	UKMNE
1990	169	1135	116	.0721	.0494	-.0721	.0885	.0885	-.0824	.1008	.1008	-.0491
				(.622)	(.610)	(.348)	(.807)	(.473)	(.523)	(.388)	(.224)	(.702)
1991	225	1341	130	.0819	.0733	-.0819	.1101	.1101	-.0278	.0880	.0880	-.0327
				(.296)	(.240)	(.168)	(.357)	(.208)	(.905)	(.360)	(.205)	(.804)
1992	267	1420	149	.0427	.0385	-.0427	.0825	.0825	-.0478	.0622	.0622	-.0537
				(.892)	(.596)	(.530)	(.610)	(.344)	(.699)	(.721)	(.406)	(.511)
1993	322	1465	164	.0452	.0247	-.0452	.0627	.0389	-.0627	.0608	.0367	-.0608
				(.761)	(.731)	(.426)	(.720)	(.756)	(.407)	(.669)	(.699)	(.373)
1994	318	1445	177	.0274	.0263	-.0274	.0549	.0443	-.0549	.0532	.0532	-.0496
				(.991)	(.715)	(.694)	(.891)	(.664)	(.534)	(.781)	(.443)	(.492)
1995	340	1435	175	.0700	.0232	-.0700	.0927	.0085	-.0927	.0429	.0242	-.0429
				(.467)	(.772)	(.094)	(.277)	(.985)	(.159)	(.934)	(.840)	(.577)
1996	277	1341	185	.0485	.0333	-.0485	.0768	.0768	-.0758	.0539	.0539	-.0507
				(.681)	(.630)	(.376)	(.551)	(.308)	(.318)	(.759)	(.428)	(.472)

Notes

(i) Asymptotic P-values are in parenthesis

(ii) * significance at 5% confidence level; ** significance at 1%

(iii) DPE and DNE are domestic firms that have never been acquired by foreign companies in our sample.

From table 4.5 there is no evidence that the productivity distribution of first time exporters stochastically dominates that of firms that never export. While positive, the test of differences in the distribution is not significant in any years of the sample for the two-tailed test. While again from the one-tailed test it is not possible to establish which of the distributions dominates. New exporters are more productive but there are other equally productive non-exporters that do not enter export markets. Delgado *et al.* (2001) find similar results for large firms, but not small firms. This is consistent with what we find since the the data set used in this study over-represents large firms.

The fact that large firms do not self select in the export market may be interpreted as evidence of uncertainty about sunk costs and returns from starting exporting. This is consistent with the hypothesis of informational spillovers about export markets from multinationals to domestic firms, whereby non-export firms benefit from the experiences in foreign markets of other firms encouraging them to enter. Greenaway *et al.* (2004), Aitken *et al.* (1997) and Greenaway and Kneller (2004b) all have found significant results corroborating this hypothesis in regressions of the determinants of export market entry.

The evidence that the cumulative productivity distribution of newly acquired foreign firms stochastically dominates that of domestic export firms is while also, suggestive, not overwhelming. Using tests of stochastic dominance we find that the cumulative productivity distribution of acquired domestic firms lies to the right of their non-acquisition exporting counterparts, but statistical significance is established in only 3 of the 6 years. The two-tailed test that the distributions are identical is rejected in the same years. Therefore while there is some weak evidence for self-selection for new (foreign) multinational firms the evidence in the case of export

Hisarciklilar for helping us in this regard.

firms is weaker. Empirical studies of brownfield FDI by Conyon *et al.* (2002) and Harris and Robinson (2002) report that foreign MNEs tend to acquire UK firms with above average performance characteristics. This is perhaps one area that requires further empirical research before strong conclusions are drawn.

4.5 Conclusion

Recently developed theoretical models link the heterogeneous productivity level of firms with their involvement in international trade. These models predict that most productive firms will become multinationals, those in the middle range will self select into the export market, whereas least productive companies will focus on the domestic market only. Central to these theoretical results is the assumption about sunk costs of entry in the export market and establishing foreign affiliates in other countries.

However, as highlighted by Head and Ries (2003), when factor prices and size among countries differ such ordering can be reversed. Indeed, if the foreign country is small and has some cost advantage (e.g. low wages), the least productive firms will open foreign affiliates therein, whereas most productive companies will concentrate production at home. This happens because less productive enterprises will gain most from FDI since they use intensively the factor whose price is low in the foreign land.

Furthermore, the above models consider the case of single product firms only. Multi-product firms face a more complex array of choices as the export-FDI decision may be product specific. If market demand, factor costs and firm productivity differ for each of the goods produced, companies will find it profitable to produce some products in the home country and sell them therein; others will be produced at home

Table 4.5: Kolmogorov-Smirnov tests on the distribution of productivity levels at year t of domestic firms acquired by foreigners at $t+a$ ($a > 0$) (labelled new foreign firms, NFOR), domestically owned permanent exporters (DPE) and domestically owned never exporting firms (DNE).

Year	Number of observ.			DNE v NDE			DPE v NFOR		
				Equality	Difference fav. to		Equality	Difference fav. to	
	DNE	NFOR	NDE		DNE	NDE		DPE	NFOR
1990	233	293	73	.0871	.0871	-.0447	.1861*	.1861*	-.0753
				(.790)	(.461)	(.816)	(.038)	(.026)	(.552)
1991	288	267	137	.0643	.0523	-.0643	.1921**	.1921**	-.0453
				(.844)	(.628)	(.495)	(.003)	(.002)	(.712)
1992	350	221	134	.0650	.0610	-.0650	.1791**	.1791**	-.0099
				(.814)	(.515)	(.471)	(.008)	(.006)	(.984)
1993	340	180	115	.0739	.0578	-.0739	.1250	.1250	-.0058
				(.700)	(.568)	(.396)	(.185)	(.113)	(.995)
1994	361	115	79	.0901	.0522	-.0901	.1364	.1364	-.0275
				(.628)	(.708)	(.358)	(.288)	(.174)	(.931)
1995	374	51	53	.1548	.1548	-.0938	.2181	.2181	-.0741
				(.174)	(.111)	(.446)	(.126)	(.087)	(.754)

Notes

(i) Asymptotic P-values are in parenthesis

(ii) * significance at 5% confidence level; ** significance at 1%

and exported or produced in foreign countries. In this case, firms with sufficiently high productivity levels will serve foreign markets through exports and/or FDI. If in addition to this we allow for differences amongst foreign countries, such as market size and factor costs, it is apparent that even single product firms could make different export/FDI choices for different countries (or group of countries). These two cases would allow for firms that are both multinationals and exporters.

Therefore, the question concerning the ranking of the productivity distribution of multinationals, exporters and purely domestic firms, is an empirical one. From a policy perspective this question is important given the fact that increasing productivity figures prominently in the agenda of policymakers. To this end, government agencies have attracted foreign multinationals in the UK and facilitated the entry of UK firms in export markets, by means of various financial incentives.

In this chapter using a data set of manufacturing firms, based in the UK, covering the period 1990-1996, we deploy the Kolmogorov-Smirnov tests of stochastic dominance to rank the cumulative distribution for non-exporters, exporters and multinationals. First order stochastic dominance is a stricter test than that based on comparing means since it takes into account all moments of the distribution. If one distribution is found to dominates another, then its mean is larger, whereas the inverse is not always true.

From a policy standpoint, the main advantage of this statistical methodology is that it allows to "judge" different types of firms, according to their productivity, without making unattainable assumptions about the objective function policymakers, supposedly, maximise, bar that is monotonic and increasing. If the distribution of one kind of firms dominates that of another, the latter may be deemed to be "better" by all agents for whom "more is better" (no other assumptions about the shape of the utility function are necessary).

In addition from a theoretical perspective, the non-parametric approach employed allows for the likely possibility that productivity distribution of different types of firms overlap. This is because of uncertainty surrounding parameters of the models (such as sunk costs), different degree of risk aversion across firms, multiproducts firms, and foreign markets with different characteristics.

From the results, we conclude that the cumulative productivity distribution of multinational enterprises dominates (lies to the right of) that of non-multinationals, while that of exporters dominates the one of non-exporters. The findings of this investigation support the theoretical insights of Helpman *et al.* (2004). Only the most productive companies find it profitable to pay the higher costs associated with exporting and building/acquiring production facilities abroad. In so doing we provide a clear acceptance of the heterogeneous firm framework over alternatives such as those using the idea of a representative firm.

These same patterns were found to hold when domestic multinational firms were replaced with information on foreign multinationals. In addition, the comparison of the distribution of productivity growth rates suggest there are differences are permanent, there is no significant difference among the three type of firms in their growth rates.

These patterns of stochastic dominance lend support to the conclusion that multinational enterprises are "better" firms than exporters and the latter "better" than "non-exporters", in terms of productivity. This may be deemed to be consistent with favourable policies towards multinationals and exporters undertaken by policymakers whose aim is to increase overall productivity.

Chapter 5

Conclusions

5.1 Summary of results

This thesis contributes to the burgeoning literature on microeconometric analyses of firm-level adjustment to globalisation. This literature has been spurred by the recent availability of large firm-level data sets, which have provided new insights on how *heterogeneous* firms react to globalisation processes. This has been instrumental in shifting the attention of trade economists from the representative firm, referring to countries and industries, to heterogenous firms. This change of focus has already improved our understanding on how globalisation (intended as FDI and trade flows) affects firms in dissimilar fashions, according to their characteristics, and how firm level responses determine aggregate changes at the industry and country-level. Each chapter of this doctoral dissertation has dealt with one particular aspect of the firm-level adjustment to the increasing internationalisation of national economies.

Chapter two has tackled the issue of the elasticity of the demand for labour and trade. Recently it has been argued that trade should make the demand for labour more elastic; empirical tests to date, at the industry and firm-level, have failed to identify any significant effect of trade liberalisation policies on labour demand elasticities. Our theoretical and empirical analysis provide a reason why empirical research, thus far, has not found any relationship between trade and the elasticity of the demand for labour.

The first contribution of this chapter is to extend the Allen-Uawa formulation to an imperfectly competitive setting and allow for a non-homothetic production function. We argue that the Allen-Uzawa relationship, which all studies have invariably referred to, is inappropriate at the firm-level and when production function is characterised by non-constant return to scale. Indeed, this relationship was devised considering a representative firm operating in a perfectly competitive industry with constant-return to scale. In this setting, the elasticity of labour demand depends positively on the elasticity of labour with respect to all the other inputs (substitution effect) and the elasticity of product demand (scale effect). We show that, in homogeneous sectors, because of the strategic interaction among firms, the scale effect can be divided in two elements, of which one is reducing it, in absolute value. This term is a novelty. It is the result a the strategic behaviour, whereby firms react to an increase in wages not only firing workers, but also reducing their mark-up. This term softens the scale effect, thereby decreasing the responsiveness of the demand for labour to wages.

The empirical analysis of this chapter, using a firm-level data set of UK manufacturing firms operating in homogeneous industries, proceeds in two fashions. Firstly, we approximated the elasticity of labour demand by the discrete annual changes in employment and wages. This was regressed against variables, function of the cost share of labour and the market share in order to estimate the three different component of the elasticity identified in the theoretical section. This regression posed particular problems because of measurement errors and non-linearities in the coefficients. However the results seem to corroborate, at least partially, the theoretical framework. In the long-run, the elasticity of substitution of labour, its cost share and the firm's market share have the expected effect on labour demand elasticities. However, of the two term characterizing the scale effect, only one appears to have an explanatory power.

The second empirical exercise is based on a cost function approach. Different cost functions were estimated; from their parameters it was possible to derive all the components of the total labour demand elasticity. We find, consistently with theory, that the scale effect is composed by two terms of which one, the pro-competitive effect, reduces it. From our estimates, it appears that this term is substantial. Indeed, scale effect seems to add only 0.03 percentage points to the total elasticity of the demand for labour, estimated to be around 0.50, at the median of the factor share of labour. Thus, this empirical exercise seems to confirm the presence of a pro-competitive effect, which is reducing the absolute value of the elasticity of the demand for labour.

In addition, we were able to infer the magnitude of the elasticity of the demand for labour at the industry-level, and the impact of imports on it, aggregating the firm-level results. For the only sector and year our data set allows us to compute, our estimates suggest that an increase in the import penetration rate by 10 percent will add only about 0.004 percentage points to the total labour demand elasticity. This appears to be a rather small impact of imports on the elasticity of the demand for labour. This result may be attributed to the scale effect reducing pro-competitive term we have identified.

Chapter three has examined the export behaviour of foreign affiliates in the UK.

A well-known fact in the empirical literature about FDI concerns the superior performance of foreign firms with respect to domestic companies along several dimensions, such as employment, wages and productivity. However, an overlooked aspect of this literature concerns the export decisions of foreign affiliates compared with those of domestic companies. Our microeconometric analysis, conducted considering firm-level data of the UK manufacturing sector, shows that foreign firms are not only more likely to export than indigenous ones, but also, when they do, they export a higher share of their total output. In addition, they appear to contribute disproportionately to the total export of manufacturing industries in the UK.

There are different theoretical arguments behind the export strategies of foreign affiliates. Exports and FDI are, in general, seen as substitute methods of selling in foreign markets. Exporting foreign firms may be contemplated in three situations: the final good is exported to a third country being part of a free trade area as the host country (this results in tariff jumping FDI); multinational enterprises undertake, so called, complex integration strategies, which involve export to a third country and intra-firm trade; this happens when there are more than two stages of production and more than two countries; firms produce multiple products that are sold in foreign markets through different means and there is a positive correlation in demand across these products (cross-product complementarity). In this chapter we have tried to assess which one of these explanations is explains better the UK experience.

Overall, our data shows that strategic motives, possibly involving differential in costs, productivity and market size between the UK and foreign countries/regions, are strong determinant of the export strategies of foreign affiliates. The export strategies of foreign firms depend, indeed, on the country/region of origin. Complementarity between exports and FDI does involve significant differences in behaviour across countries that we find in the data. In this sense, the evidence we report, might be considered more consistent with export platform FDI. In this literature export platform FDI may be undertaken because of two motives: vertical and horizontal. Horizontal motives seem to be most important: affiliates from non-EU countries are much more likely to export than firms from EU countries. However, this is not the end of the story: vertical motives appear to be also relevant. There is evidence of this from the fact that EU firms also use the UK as export platform, since they have roughly the same export propensity as domestic firms.

We also find that firm level variables are important, in addition to strategic motives. The larger and the more productive are foreign firms the larger their export share. However, our results indicate that what drives foreign firms to export is different from domestic firms. Even controlling for firm level characteristics, which appear to have a smaller role in the export decisions of foreign firms than for domestic companies, foreign affiliates appear to be more export oriented than domestic firms. The country/area of origin seems to be one of the most important determinant of their export strategies.

Exports seem also to be important for the mode of entry of foreign firms in the UK. The evidence we present would appear to suggest that firms from EU countries do not target export firms, and when they do acquire exporters these firms do not tend to change their export propensity relative to domestic firms. In contrast firms from non-EU countries appear to both target exporters and then increase their export intensity over time.

In chapter four, we have conducted a series of non-parametric tests to rank the productivity distributions of non-exporters, exporters and multinationals. In the literature it has been argued that exporters and multinationals have higher productivity levels than purely domestic firms. This conclusion is based on comparisons in means of productivity distributions, which belie the tremendous heterogeneity in productivity among firms. The approach followed in this chapter is different in that comparisons among firms have been conducted considering their entire productivity distribution. Comparing the productivity distribution of different kinds of firms allows to rank them correctly, taking into account the dispersion in productivity across firms. Our results using firm-level data for the UK manufacturing sector, show that the cumulative productivity distribution of multinational enterprises dominates (lies to the right of) that of non-multinationals, while that of exporting companies dominates that of non-exporting firms. The findings of this investigation corroborate the theoretical model of Helpman *et al.* (2004): only the most productive companies find it profitable to pay the higher costs associated with exporting and building/acquiring production facilities abroad. These same patterns were found to hold when domestic multinational firms were replaced with information on foreign multinationals. In addition, the results of this chapter highlight that differences in productivity levels, among the three type of firms considered, appear to be permanent since there are no significant difference in the distribution of productivity growth rates.

5.2 Policy implications

The results of the microeconometric analysis of the firm-level adjustment to globalisation conducted for this doctoral thesis have important policy implications as well.

In chapter two we examined the relationship between trade and labour demand elasticities. From a policy perspective, the results obtained underline the fact that to gauge the impact of international trade on the elasticity of the demand for labour of a particular sector is important to consider its industrial microstructure. At the firm-level the impact of import competition on the labour demand may be ambiguous; however, assuming that the market share of domestic firms will decrease because of import competition, opening to trade will increase the absolute value of the elasticity of the demand for labour of firms, because of the scale effect. The extent of the increase will depend on the market power of firms; firms with high market power will be able to pass an exogenous increase in wages to consumers, through higher product price. This ability is reducing the scale effect, because firms will decrease their output less than what they would do if product prices were considered as given. Aggregating firm-level labour demands to the industry-level, import competition increases unambiguously the industry-level elasticity of the demand for labour, since it reduces the total market share of domestic firms. However, the degree of the increase may be limited if the firm-level scale effects are small because of the pro-competitive term.

Therefore, different markets are likely to experience different increases in the elasticity of the demand for labour, according to their industry microstructure. Highly competitive and homogeneous sectors are those that are going to face high rises in the elasticity of the demand for labour as import penetration rises, whereas the elasticity of the labour demand of those sectors, where domestic firms have more market powers, are going to undergo more limited increases. These results may inform better policymakers about the likely effects of further trade liberalisation policies on the demand for labour of different industries.

The empirical analysis conducted in chapter three has shown that foreign firms contribute disproportionately to exports from the UK. Therefore, if one of the aim of policymakers is to enhance the export performance of the UK manufacturing sector, this fact may provide another motive to grant financial incentives to foreign multinationals in order to locate affiliates in the UK. Furthermore, since foreign affiliates appear to be in general highly export oriented, it is possible to argue that a business and macroeconomic environment conducive to high exports may reinforce the UK position as one of the preferred destination of FDI inflows. This may be one of the reason why the UK has consistently received, during the latest years, higher FDI inflows than other European countries, albeit being smaller than other potential destinations such as France and Germany. Macroeconomic policies and a business environment favorable to export are likely to become even more important in attracting FDI, in the near future, as more multinational enterprises undertake complex integration strategies (UNCTAD 1998) involving shipping of intermediates and final goods. Finally, we have shown the different importance that firm-level variables have in determining the export behaviour of foreign and domestic firms. This may be important in devising effective export promotion policies, which should take into account the fact that foreign firms are likely to respond differently from domestic firms to such initiatives.

In chapter four we have ranked the productivity-level and growth rate distributions of exporters, non-exporters and multinationals. Unlike tests based on comparisons of means, this type of analysis allows to judge which of these firms is "better" without specifying a particular objective function to be maximised. From a policy point of view, this is noteworthy given the public money spent in attracting FDI. With regard to productivity levels our results suggest that foreign firms are are "better" than exporters, which are in turn "better" than non exporters; the same is not true for productivity growth rates: none of the type of firms considered seem to be "better" than the others. Therefore, financial resources used to attract FDI seem to be justified if we look at productivity levels, but not if consider productivity growth rates. The problem is what the objective function of policymakers is. If they aim at increasing productivity levels, then FDI consistent with their objectives, since foreign firms are to be preferred to non-exporters, in this respect. If they aim at increasing productivity growth rates, then such policies seem to be unjustified, since foreign companies do not seem to be "better" than non-exporters, in this respect.

More caution is needed in interpreting these results to justify those policies implemented to promote exports and outward FDI from the UK. According to our results such policies do not seem to encourage higher productivity growth rates. Indeed, although we found that both UK exporters and MNEs are more productive than UK firms with no involvement in the international trade we found no difference in their productivity growth rates. Therefore, difference in their productivity levels must have arisen before firms started exporting or established affiliates in foreign lands. The best companies seem to self select to become exporters and multinationals. After they do so they do not appear to experience higher productivity growth ares than other enterprises.

In general, globalisation processes, which involve high volume of exports, overseas investment and inward FDI inflows, and policies sustaining them are likely to contribute positively to the overall UK productivity-level (through reallocation effect), but not to the productivity growth rate. This would be better achieved with more targeted policies towards those firms and sectors that probably will experience higher productivity growth rates, such as research and development intensive firms and industries.

5.3 Further research

The research in this dissertation can be extended in many directions. The relationship between trade and the elasticity of the demand for labour deserves to be further investigated considering unskilled and skilled workers separately. This is an important difference, which may improve our understanding on how trade makes different types of jobs more responsive to wages. In addition, in our analysis we considered only the effect of imports on the elasticity of the labour demand; another related topic worth investigating concerns the impact of export. How is the labour demand elasticity likely to be affected by export? And are skilled and unskilled workers affected differently? This research agenda will clarify better how the demand for labour adjusts, overall, to liberalisation policies.

The export behaviour of foreign affiliates also warrants additional research. The classical distinction between horizontal and vertical FDI is becoming increasingly blurred as multinationals undertake more complex FDI strategies, which involve export of intermediates and export platform FDI. This is a relatively new area of investigation where both empirical and theoretical works are needed. Theoretical works, building on those already existing (Grossman, Helpman, and Szeidl 2003; Ekholm, Forslid, and Markusen 2003; Yeaple 2003), should aim at providing clear and testable hypotheses in an heterogeneous firms setting. The model of Grossman *et al.* (2003) adopts this framework, but not clear testable hypotheses are derived, since it seems that everything can happen. For the UK, future empirical works might try to explain the different export strategies of foreign affiliates of different countries with variables controlling for country-size, productivity and cost differentials, transport costs and other industry and country characteristics. Besides, data on export destination would make possible to identify the proportion of output exported back to the home country and to third countries.[1] This would allow to compare the export strategies of domestic and foreign firms and investigate the determinant of the export behaviour of foreign companies in more details.

The analysis in chapter four concerning the ranking of productivity distributions of non-exporters, exporters and multinationals can be further extended considering bivariate empirical distributions and ranking them using appropriate tests as explored by Crawford (1999). This would involve taking two characteristics of firms policy-makers are interested in, such as productivity-level and growth rate or employment, compute their empirical bivariate distribution functions and conduct tests of stochastic dominance. From a policy point of view, this is important since firms are judged considering their contribution to national economies along several dimensions, such as productivity, employment, export, to cite a few. Bivariate tests would allow us to judge what type of firms is "better" considering two dimensions, not only one. Additional research in this area may employ microsimulation techniques to assess how the *entire* productivity distribution of firms, involved differently in international trade, shifts according to policy changes, like tariff reductions, exchange rate movements and so on. This would permit analysts to assess the likely impact of policy changes without relying on the unrealistic representative firm, but taking into account the heterogeneity of firms responses.

[1]The HM Customs and Excise possesses these data; they are not publicly available for confidentiality reasons. However, we plan to ask permission to access them in due course.

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