Essays on Firm Level Responses to Trade and Foreign Direct Investment Liberalization in India

Sandra Lancheros

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Abstract

During the past three decades policy makers from a number of developing countries have undertaken outward-oriented economic reforms with the objective of stimulating global capabilities and allowing domestic firms to catch up with the technological frontier. In the case of India, one of the most important features of such economic reforms has been the promotion of exports and outward foreign direct investments (FDI). Using a rich set of econometric methodologies, we examine the forces underlying Indian firms' global strategies in the form of exporting and investing abroad and the impact of such decisions upon their future performance. Our analysis covers the years from 1999 to 2007, a period of gradual internationalization of Indian firms in response to ongoing trade and FDI liberalization. We contrast the strategies followed by manufacturing and service firms and pay particular attention to the role of technological and financial factors in shaping firms' globalization processes.

The first chapter of this thesis starts with an analysis of the individual and complementary effects of exporting and investing abroad in stimulating the development of firms' in-house technological capabilities. We find that outward FDI substitutes the rate of technology investments at home, a result that is consistent with the notion of technology-seeking Indian multinationals investing abroad with the purpose of acquiring foreign technology. In contrast, we uncover evidence of technology-enhancing effects from exporting amongst Indian multinationals, indicating that exporting has been an important channel through which Indian multinational expansion has encouraged greater domestic economic activity. Finally, we fail to find evidence that exporting non multinational firms always invest more in technology than non-exporting ones.

Rather, the nature of this association varies according to the sector under consideration and the type of technology.

In the second chapter we analyze the process of productivity growth in Indian firms. We examine the individual and complementary roles of technology investments and international activities in stimulating innovation and technological convergence, two potential sources of firms' productivity growth. Our findings indicate that technological convergence has been an important source of productivity growth in India, with service firms converging faster to the technological frontier than manufacturing companies. We also find that exporting boosts the rate of innovation of Indian multinationals, whereas their overseas investments speed up their rate of technological convergence. In the case of non-multinational companies, exporting stimulates productivity growth by accelerating their rate of technological transfer. There are also positive complementary effects between international activities and technology investments in stimulating firms' productivity growth either through innovation and/or through technological transfer.

Finally, in the third chapter we evaluate the role of external finance for service exports. In contrast to some findings for the manufacturing sector, we find that external finance is not a significant determinant of Indian service firms' exporting activity.

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Chapter 1

Introduction

In this chapter a broad introduction to the topics investigated in this thesis is presented.

1.1. Context and background

Indian economic performance has been impressive since the initiation of its economic reforms in 1991. The economy has grown at an average annual growth rate of 6 per cent during 1991-2008. This growth has been particularly rapid since 2003, averaging over 8.5 per cent per annum. The services and manufacturing sectors have been the two engines driving the overall growth of the economy in recent years, growing at average annual rates of 9.8 and 9.1 per cent respectively during the period 2003-2006 (WTO, 2007). As a result of its rapid economic growth India has become one of the top four largest economies in the world, together with China, Japan and USA.

This impressive economic performance is largely attributed to Indian unilateral economic reforms, including the liberalization of trade and FDI and

other market-oriented reforms initiated in 1991. One of the most important features of Indian outward-reforms has been the promotion of exports and outward FDI, which have resulted in India becoming a major player in world trade and an increasing source of FDI from the developing world.

1.1.1. Export Policy

Since 1991, the Indian Foreign Trade Policy acknowledges that exports are not an end in themselves but a means to stimulate greater economic activity. With this view, the Indian Government has put in place a complex set of export promotion schemes and has reduced licensing, quantitative restrictions and other regulatory and discretionary controls on exports [1]. Alongside these unilateral measures, India has also signed a number of bilateral and regional free-trade agreements in order to increase market access for its exports. Moreover, India has assumed an active role in global trade negotiations and is now pushing for a more liberal international trade regime, especially in services, where the country has shown important comparative advantages.

As a result of these export promotion policies, Indian exports have increased sharply from the early 1990s and the country has emerged amongst the fastest-growing exporters in the world. By 2008-09 Indian exports reached a level of US$168 billion, up from US$ 63 billion in 2003-04. Service exports have

[1] See annex A.1.1 for a summary of the main features of the Indian Export Promotion Schemes

been principally responsible for this dynamism. In particular, the exports of business services and software and IT-related services have been impressive and India has become a major supplier of these services in the world[2].

While the Indian Export Policy has produced remarkable results in terms of export expansion, the revenues forgone by the Indian government from its export supporting schemes are significant. For instance, the Ministry of Finance estimates that forgone taxes from the export-oriented Special Economic Zones will reach Rs 1,750 billion (US$39.6 billion) by 2011[3]. The cost-effectiveness of the Export Policy in generating greater domestic economic activity is therefore open to question.

1.1.2. Outward FDI regime

While exports have been a key policy tool for economic growth and development, over more recent years the promotion of outward FDI has become a central strategy in the policy agenda of Indian policy makers. The liberalization of rules and simplification of procedures for outward investments started in October 1992, but major changes have occurred during the last decade with a progressive and significant relaxation of ceilings on overseas investments,

[2] Currently, India serves 65 per cent of the global outsourcing market for IT software and Information Technology Enabled Services (ITES) and 46 per cent of the global Business Process Outsourcing (BPO) market (WTO, 2007)

[3] The Economist, 25 January 2007, "A Peasant Surprise". Available at http://www.economist.com/node/8597150

the elimination of restrictions on Indian participation in overseas ventures and the expansion of sources allowed to fund overseas projects, amongst other reforms[4] .

The gradual liberalization of the outward FDI regime has spurred the expansion of Indian overseas investments since 2000. From less than US$100 million in 1986, the stock of outward FDI rose to US$800 million in 2000, and increased to more than US$8 billion in 2006. Indian outward FDI from the software and IT services sector along with pharmaceuticals have been particularly robust in recent years. The recent global expansion of Indian companies has been accompanied by a number of changes in the character of their overseas investments, including the increasing interest of Indian firms in investing in developed countries, their notable preference for majority control over their overseas production activities and the considerable diversification of firms engaged in overseas investments (Pradhan, 2011).

As with the case of exports, while Indian firms have responded impressively to outward FDI liberalization, the question of whether outward investments enrich home activities rather than diverting national resources from home to foreign countries also boils down to an empirical question.

[4] See appendix A.1.2 for a summary of the major changes in the regulatory regime governing outward FDI

1.2. Motivations and research questions

One of the reasons for the Indian government to promote indigenous firms to go global is the hope that it will stimulate greater domestic economic activity and allow indigenous firms to acquire foreign technologies, skills, and capabilities. Yet, there is no conclusive evidence regarding the adjustment process of Indian firms as they respond to these institutional changes and the positive effects of global expansion on firms' performance at home.

This research is aimed at filling these gaps. Using a rich set of econometric methodologies and the best publicly available microeconomic data, we examine the forces underlying Indian firms' global strategies in the form of exporting and investing abroad and the impact of such decisions upon their future performance. Our analysis covers the years from 1999 to 2007, a period during which Indian firms have gradually expanded their international operations in response to ongoing trade and FDI liberalization. We contrast the strategies followed by manufacturing and service firms and pay particular attention to the role of technological and financial factors in shaping their globalization processes.

In this thesis we address three empirical issues that remain underexplored in the international economics literature. First, whether firm's global activities influence their in-house technology investments. Second, the relative importance of global activities and technology investment in stimulating

firm's productivity growth. And third, the role of external finance in promoting service exports.

India's rapid economic growth and successful integration with the global economy makes it an excellent case study for these topics. As many developing countries are becoming active global players, there is growing interest from researchers and policy makers in understanding the unique business modes of firms from these countries as they adjust to liberalization. As such, the policy implications of this research are by no means limited to India.

Two main motivations guide this research. First, it seeks to contribute to future policy discussions on the design of effective economic policies for developing nations. Second, by providing systematic empirical evidence on the determinants and effects of firms' globalization strategies in a major emerging economy, this research also aims to inform future theoretical work in the field.

1.3. Contributions

The policy and academic contributions of this thesis are as follows. First, an emerging body of research in international economics is seeking to better understand the sources of firm heterogeneity and its relationship with international market participation. The first chapter of this research contributes to this literature by providing a systematic empirical analysis of the individual

and complementary effects of exporting and outward FDI on the rate of technology adoption, a key driver of firm heterogeneity. A clear understanding of the nexus between exporting, investing abroad and investing in technology is central to academic and policy efforts that seek to pin down the channels through which the choice of foreign market participation shapes firms' competitive advantages.

Second, a large body of work within the macroeconomic literature has shown that innovation and international technological convergence are two important sources of technological progress for countries lagging behind the technological frontier. However, the issue of how these two processes interact at the firm level has received little attention in the empirical literature. The second chapter of this research contributes to this scarce literature by providing a microeconometric analysis of the individual and complementary roles of in-house technology investment and international commerce activities in speeding up the rate of innovation and technological convergence amongst Indian firms. Examining productivity convergence at the firm level is of the utmost importance in order to understand the macroeconomic processes of international technology diffusion. Also, for policy makers, a clear understanding of the relative roles of in-house technological efforts and the acquisition of foreign technology through global linkages is central for the efficient allocation of scarce resources towards more effective channels of economic growth.

Finally, while the importance of finance for exporting goods is well understood in the international trade literature, the question of whether finance also plays a role for the exports of services remains unanswered. The third chapter of this thesis contributes to this literature by examining the role of external finance for exporting services at the level of the firm. Answering this question has become relevant as an increasing proportion of global trade is in the form of service exports. From an academic and policy perspective, the relevance of answering this questions stems from the fact that some economists see financial development as being crucial for export promotion. Moreover, as a result of the recent collapse of global exports in the aftermath of the 2007/09-global financial crisis, the relationship between trade and finance has reaped attention from scholars and policy makers who have been trying to quantify the financial-channel mechanism behind such falls in exports. The chapter therefore has important policy implications as the provision of financial assistance is one of the tools employed by policy makers around the world to promote exports. Yet, there is no evidence whether these measures are effective in the case of service exports.

All three empirical chapters are based on the Prowess database compiled by the Centre for Monitoring the Indian Economy, the most up-to-date and comprehensive firm-level dataset in India. The database covers both publicly listed and unlisted firms from a wide cross-section of manufacturing, services, utilities, and financial industries. The companies covered by the database account for more than 70% of industrial output, 75% of corporate taxes and more than 95% of excise taxes collected by the Government of India.

A rich set of state-of-the-art econometric methodologies are employed to make full use of the data set and deal with common econometric concerns such as endogeneity of the model regressors, unobserved firm heterogeneity, sample selection, etc. Appropriate robustness checks are also employed to ensure that the results emerging from our preferred econometric methods are accurate.

1.4. Thesis structure and summary of chapter's content

The thesis consists of this introduction and three main empirical chapters, whose content are briefly described below.

1.4.1. Exporting, outward FDI and technology upgrading

The first empirical topic examines the effects of exporting and outward FDI on firms' technology investments in two highly globalized sectors in India, namely the software services and pharmaceutical industries. The analysis is based on a broad measure of technology investments that includes expenditures on in-house R&D, computers and software, royalty fees and imports of capital goods. To gain a deeper insight into the importance of the type of technology investment, the analysis is also performed distinguishing between investments in physical technology (i.e. imports of capital goods and computers purchased) and disembodied knowledge capital (i.e. own R&D, royalty fees and software).

A dynamic model of firms' technology investments is employed in the empirical strategy and the identification of causal effects is based on the dynamic panel data estimator due to Blundell and Bond (1998). This estimator ensures a rigorous econometric analysis as it accounts for unobserved firm heterogeneity and the endogeneity of the choice of foreign market participation. Moreover, it does not suffer from problems of weak instruments, especially in cases where the dependent variable is highly persistent. The appropriateness of this estimator is tested using the Hansen-Sargan test for the validity of the overidentifying restrictions and the Arellano and Bond (1991) test for the absence of serial correlation in the equation error.

A striking result from this chapter is the universal negative relationship between outward FDI and firms' domestic technology investments, a result that is consistent with the notion of technology-seeking Indian multinational firms devoting their resources to accessing existing technology abroad. While this result might raise concerns about the diversion of national resources that could otherwise be invested in creating technological capabilities at home, we caution that Indian multinationals may have higher returns to technology investment. As such, public policies should not just be concerned with the volume of technology investments, but also with the efficient utilization of such investments.

The unconditional effects from exporting depend on whether the firm is a multinational company; the sector in which it operates; and the type of technology. For example, we find a universal good deal of statistical evidence supporting the hypothesis of technology-enhancing effects from exporting amongst Indian multinationals. This finding is consistent with the notion of market-seeking exporting Indian multinational firms being induced to invest in technology at home in order to be more competitive in international markets. Exporting is, therefore, an important channel through which Indian multinational expansion has encouraged greater domestic economic activity.

In contrast, we do not find evidence that exporting non multinational firms always invest more in technology than non-exporting ones. Rather the nature of this association varies according to the sector and type of technology.

1.4.2. Innovation and technological convergence: the role of technology investments and international activities

The second empirical chapter is on the determinants of firms' productivity growth in the manufacturing and service sectors in India. The chapter extends the previous analysis by examining the individual and complementary effects of global activities and in house technology investment in stimulating firms' productivity growth through innovation and/or technological convergence.

The econometric analysis is also based on the dynamic panel data estimator due to Blundell and Bond (1998), which allows us deal with some econometric concerns such as unobserved firm heterogeneity, the endogeneity of some model regressors and potential spurious regressions due to measurement errors in firm's productivity. We also control for sample selection, as firms' exit decisions are likely to be correlated with their productivity levels. To this end, we adapt the parametric estimation procedure developed by Semykina and Wooldridge (2010) to estimate panel data models with sample selection in the presence of endogenous regressors and unobserved heterogeneity. As a robustness check, and to make our work comparable with previous studies, we also use the Heckman two-steps and maximum likelihood (ML) estimators.

Our analysis yields the following core results. First, we confirm that technology diffusion is an important engine of productivity growth in India, with service firms converging faster to the technological frontier than manufacturing companies. Second, outward FDI has a positive indirect impact on firms' productivity growth by speeding up the rate of technology transfer. Third, in line with our findings in the first chapter, we find that the unconditional effects from exporting depend on firms' multinational status. For instance a major conclusion resulting from our analysis is that the export intensity of Indian multinationals exerts a strong positive impact on their productivity growth by directly stimulating their innovation rates, whereas in the case of non-multinational firms exporting stimulates productivity growth indirectly via technological catch up. Finally, we find important synergetic effects

between international activities and technology investments in stimulating firms' productivity growth either through innovation and/or technological transfer. Thus, in the case of the manufacturing sector, there are important innovation-enhancing effects from investing in technology and participating in global markets via exports or overseas investments, whereas service firms that invest in technology and invest abroad converge faster to the technological frontier.

1.4.3. Does finance play a role in exporting for service firms?

Motivated by the importance of exporting in improving service firms' efficiency, the final empirical chapter examines the determinants of service exports. While most of the implications of new theoretical models on international trade have been tested on manufacturing firms, this chapter contributes to this literature by specifically looking at the role of finance for exporting services, a question that remains unanswered in the literature despite the growing magnitude and importance of services exports. The remarkable dynamism of India's service sector and the positive linkages between services exports and economic growth makes it an excellent case study for these issues. Examining whether finance plays a role in facilitating service exports has important policy implications, especially for developing countries with the potential to promote growth through service exports.

Specifically, the chapter examines whether long and short term bank borrowing matter for the decision to export and the amount exported amongst

service firms. To this end, the analysis explicitly accounts for firms' path-dependent exporting behavior and for other unobserved and observed firm characteristics that affect exports. Given these features, the analysis is performed using non linear dynamic panel data techniques with unobserved heterogeneity. To deal with the potential correlation between past export status and unobserved heterogeneity, the chapter follows Wooldridge' (2005) approach of modeling the distribution of the unobservables conditional upon the initial condition and the observed history of the exogenous explanatory variables. As robustness tests we use the instrumental variables Probit and Tobit estimatior due to Smith and Blundell (1986) and the system-GMM estimator due to Blundell and Bond (1998). To probe our findings further, we also examine the relationship between finance and exporting using bivariate probit models, which allow us account for the possibility that these decisions might be jointly determined, as suggested by recent theoretical models in international economics.

The key result emerging from our analysis is that access to any particular source of finance does not influence the decision to export or the amount exported amongst Indian service firms, *ceteris paribus*. These results contrast with similar findings for the manufacturing sector and suggest that the different nature of costs associated with the exports of services dampens the impact of finance on service firms' export behavior. On the other hand, similar to the case of goods exports, we find that firm size, productivity level and technology investments are key positive factors affecting Indian service firms' exporting behavior. This indicates that policy measures designed to stimulate these

activities are likely to be more effective than policies aimed at facilitating access to external finance with the view to directly promoting service exports. The econometric analysis points to the conclusion that access to external finance might have an indirect impact on exporting if service firms use these funds to develop their productive and technological capabilities

However, an alternative explanation for our findings is that financial factors do matter for service exports, but that Indian export promotion policies have been successful in reducing the financial constraints on firms' global expansion. As such, further empirical evidence on the role of finance to promote service exports in different institutional settings is essential to guide future theoretical work on the subject.

Appendix A.1.1: Main features of Indian Export Promotion Schemes*

Scheme	Incentive
Focus Market Scheme (FMS)	Exporters to notified countries are entitled for Duty Credit scrip equivalent to 3% (up from 2.5% in 2006) of the FOB value of exports for each licensing year. The Duty Credit may be used for import of inputs or goods including capital goods. The number of countries within the ambit of the FMS has increased over the years. Certain exceptions are outlined in the Handbook of Procedures.
Focus Product Scheme (FPS)	Exports of notified products are entitled for Duty Credit scrip equivalent to 2% (up from 1.25% in 2006) of the FOB value of exports for each licensing year. The Duty Credit may also be used for import of inputs or goods including capital goods. The Handbook of Procedures has also outlined some exceptions.
Market Linked Focus Product Scrip (MLFPS)	Exports of products/sectors of high export intensity or employment potential (which are not covered under the FPS list) are incentivized at 2% of FOB value of exports under FPS when exported to the Linked Markets (which are not covered in the FMS list).
Export Promotion Capital Goods Scheme (EPCG)	The scheme allows import of capital goods for pre production, production and post production at 3% customs duty subject to some export obligations. Capital goods would be allowed at 0% duty for exports of certain products, including agricultural, engineering, electronic, chemical and pharmaceutical, amongst other products.
Status Holder Incentive Scrip	Status Holders operating in some specific sectors are entitled to incentive scrip at 1% of FOB value of exports in the form of duty credit. This incentive is over and above any claimed duty credit scrip.
Serve from India Scheme	Under this scheme Indian service providers of notified services who have a total foreign exchange earning of at least Rs.10 Lakhs in preceding or current financial year are entitled for Duty Credit Scrip equivalent to 10% of free foreign exchange earned during preceding/current financial year (up to 5% for hotels of one-star and above and other service providers in tourism sector). The Duty Credit Scrip may be used for import of any capital goods and, in the case of hotels and stand-alone restaurants, the duty credit entitlement may also be used for the import of consumables, including food items and alcoholic beverages.
Duty Exceptions: Advance Authorization Scheme (AAS) and a Duty Free Import Authorization (DFIA) scheme.	This scheme allows duty free imports of inputs required for export production. The scheme consists of an Advance Authorization Scheme (AAS) and a Duty Free Import Authorization (DFIA) scheme. Under the AAS an advance authorization is issued to allow duty free imports of inputs that are either physically incorporated in export product. The scheme requires exports with a minimum value addition of 15%. DFIA is issued to allow duty free import of inputs, fuel, oil, energy sources, catalysts that are required for production of export product. A minimum of 20% value addition is required under this scheme.
Remission Schemes: Duty Entitlement Passbook (DEPB) and a Duty Drawback (DBK) scheme	A duty remission scheme enables post export replenishment or remission of duty on inputs used in export product. The scheme consists of a Duty Entitlement Passbook (DEPB) and a Duty Drawback (DBK) scheme. Under DEPB, which is issued after exports, an exporter may apply for duty credit at specified percentage of FOB value of exports. The credit available against such exports shall be used for the payment of customs duty on any freely importable item and/or restricted items. It can also be used for payment of duty against imports under EPCG scheme. Under DBK, exporters are entitled to refund custom duties paid in relation to inputs used for the production of the export product.
Export Oriented Units (EOU), Electronic Hardware Technology Parks (EHTP), Software Technology Parks (STP) and Bio-Technology Parks (BTP)	Units undertaking to export their entire production of goods or services may be set up under one of these schemes. An EOU/EHTP/STP/BTP unit may import and/or procure domestically all types of permitted goods used for export production without payment of duty. Other entitlements of EOU/EHTP/STP/BTP units include exemptions of income tax, exemptions on industrial licensing reserved for Small Scale Industrial (SSI) sector, amongst other benefits.
Special Economic Zones (SEZ) and Free Trade and Warehousing Zones	Units based in these zones enjoy duty-free imports of all types of goods. These units also benefit from tax holidays under the Income Tax Act

Deemed Exports	"Deemed Exports" are those transactions in which goods supplied do not leave the country. Provided that goods are manufactured in India, some categories of supplied goods considered "deemed exports" include: the supply of goods to EOU/EHTP/STP/BTP, the supply of capital goods to EPCG authorization holders, and the supply of goods to projects financed by multilateral or bilateral agencies, amongst others.
Assistance to States for Developing Export Infrastructure and Allied Activities (ASIDE)	The objective of the scheme is to provide assistance to the State Governments for creating infrastructure for the promotion of exports. Funds under the scheme can be utilized for creating new Export Promotion Industrial Parks/Zones, setting up electronic and other related infrastructure in export conclave, developing complementary infrastructure, etc.
Market Access Initiative (MAI)	Under this scheme financial assistance is provided for export promotion activities implemented by Export Promotion Councils, Industry and Trade Associations, Agencies of State Government, Indian Commercial Missions, and other national level institutions.
Market Development Assistance (MDA)	This scheme provides financial assistance for a range of export promotion activities undertaken by Export Promotion Councils and Trade Promotion Organizations.
Meeting expenses for statutory compliances in buyer country for trade related matters	The Department of Commerce provides financial assistant for reimbursement of charges/expenses for fulfilling statutory requirements in the foreign country (i.e. registration charges for pharmaceutical, bio-technology and agro-chemical products) and for contesting litigation(s) concerning restrictions/anti dumpy duties, etc.
Towns of Export Excellence (TEE)	Export promotion project from dynamic industrial towns received priority financial assistance under different export promotion schemes.
Brand Promotion and Quality	The Department of Commerce provides funds to national level institutions and Export Promotion Councils for capacity building for up-gradation of product quality. The India Brand Equity Foundation is in charge of promoting and creating international awareness of the "Made in India" label in international markets
Quality complaints/disputes	Regional Offices of the Directorate General of Foreign Trade investigate quality complains received from foreign buyers

* For a detailed description of the specific objectives, performance requirements and exceptions of Indian export promotion schemes see Ministry of Commerce and Industry (2008), *Foreign Trade Policy 2004-09* available at http://www.embassyindia.es/IndianEmbassy/IndianEmbassy/Resources/documents/Indianforeigntradepolicy.pdf and *Handbook of Procedures Vol. 1*, Department of Commerce available at http://dgftcom.nic.in/exim/2000/procedures/hbcontents2007.pdf.

Appendix A.1.2: Main features of the policies governing outward FDI in India

Period	1969- 1992	1992-onwards
Regulatory regime	General Guidelines on Indian *Joint Venture* overseas	Guidelines for Indian *Joint Ventures* and *Wholly Owned Subsidiaries* Abroad
OFDI Policy objectives	• Promote economic co-operation between India and other developing countries • Increase the exports of Indian made machinery and equipment	• Promote economic co-operation between India and other countries • Increase the exports of Indian made goods and machinery and equipment • Promote global business by Indian entrepreneurs • Transfer technology and skills, share results of R&D and promote band image
Indian ownership participation	• OFDI is permitted only in the form of *joint ventures* (JV) and Indian parties are only allowed to have a *minority participation* in JV	• Removal of ownership restrictions in overseas ventures
OFDI approval procedures	• OFDI is permitted only through *normal route* under the approval of an Inter-Ministerial Committee	• *Automatic route* for overseas investments that do not require prior approval from the regulatory authority or the government. *Normal route* otherwise. • The automatic route facility is not available for investments in Pakistan • Evolution of the outward FDI limits under automatic route: o 1992: US$ 2 million o 1995: US$ 15 million o 2002: US$ 100 million o 2003: Minimum between US$ 100 million or 100% of the net worth of the Indian party. Exceptions: US$ 150 million in the case of investments in Myanmar and SAARC (excluding Pakistan) o 2004: 100% of net worth of the Indian party o 2005-2006: 200% of net worth of the Indian party o 2007: 300% of net worth of the Indian party o 2008-2010: 400% of net worth of the Indian party. Investments through the medium of a Special Purpose Vehicle (SVP) are also permitted under the automatic route.
Method of funding overseas foreign investments	• Overseas investments in JV should be founded thought exports of Indian made *new* capital equipment and technology. • Equity participation through capitalization of exports of second hand or reconditioned machinery is prohibited • Overseas investments in cash are not permitted, excepting in special circumstances.	• Investments in overseas JV/WOS can be founded out of one of more of the following sources: o Cash transfer o Capitalization of exports (including exports of second hand or reconditioned machinery) o Capitalization of royalties and other duties from the foreign entity for supply of technical know-how, consultancy, managerial and other services o Balances held in EEFC account of the Indian party o Drawal of foreign exchange from an authorized dealer Bank in India o Swap of shares o Utilization of funds raised through ADR/GDR issues o Utilization of proceeds of ECBs/FCCBs

Chapter 2

Exporting, FDI and technology upgrading

An emerging body of research in economics is seeking to better understand the sources of firm heterogeneity and its relationship with the choice of foreign market participation. Using firm-level data from the software services and pharmaceutical industries in India, this chapter contributes to this literature by providing a systematic empirical analysis of the impact of exporting and investing abroad on the rate of technology adoption, a key driver of firm heterogeneity. To check whether our conclusions can be generalized, we extend our analysis to other manufacturing and service industries in India.

2.1. Introduction

A key feature of recent theoretical models in international economics is the insight that firms' heterogeneity influences their participation in foreign markets (see Helpman, 2006 for a review). However, in spite of the remarkable empirical success of the pioneering models in this literature (e.g. Clerides et al. 1998 and Melitz, 2003), their fundamental assumption that firm heterogeneity is captured through exogenously determined and fixed productivity differentials remains unsatisfactory. This has led to the emergence of a body of work that seeks to understand the mechanisms by which firm heterogeneity is generated.

Yeaple (2005) offers a model in which heterogeneity results from firms' endogenous decision to employ alternative technologies and differentially-skilled workers. In a model of exports with heterogeneous firms, Bustos (2007) isolates technology investment as a key source of heterogeneity, while Lileeva and Trefler (2010) argue that the decision to export and invest in technology to raise productivity are both endogenously determined. Building a model of industry dynamics with innovation and export decisions, Constantini and Melitz (2008) show how anticipation of trade liberalisation leads firms to innovate in preparation for future participation in the export market. The model of Ederington and Mccalman (2008) predicts that heterogeneity arises in equilibrium as firms choose different dates to adopt a new technology. Atkeson and Burstein (2010) show conditions under which product and process innovation by monopolistically competitive firms shape their heterogeneity.

A much older literature stresses that firms that engage in foreign direct investment must possess some proprietary assets, such as a superior technology and knowledge that enable them to compete with local firms (e.g. Hymer, 1976). More recent papers have refined the theory of multinational firms by modelling jointly the relationship between knowledge capital, and the decision to engage in FDI and outsourcing (e.g. Chen et al., 2008). But there is also a different perspective that sees FDI as a strategy to access technology and organisational knowhow from more advanced host economies, leading to the notion of technology-seeking or technology-sourcing FDI (Neven and Siotis, 1996 and Driffield and Love, 2007).

We confront some of the predictions from the theoretical literature of technology investment and foreign market participation with recent firm level data from two highly globalised sectors in India, namely the software services and pharmaceutical industries. However this chapter is also designed to inform future theoretical efforts geared toward the better understanding of the complex effects of exporting and outward FDI on firms' technology upgradation. Furthermore, the policy relevance of this work stems from the fact that Indian policy makers have been actively promoting international agreements and liberalising trade and FDI regimes in order to encourage technology acquisition by indigenous companies, especially from 2000 onwards.

Our work is related to recent empirical papers on the impact of exporting on firms' innovation activity. Bustos (2007) provides empirical evidence from Argentina showing that firms in industries facing higher reductions in trade costs increase their investment in technology faster and exporters upgrade technology faster than other firms in the same industry. Baldwin and Gu (2004) and Aw et al. (2008, 2010) analyse the joint decision of exporting and innovation amongst firms in Canada and Taiwanese respectively. Also using data from Canada, Lileeva and Trefler (2010) show that tariff cuts would induce low productive firms to simultaneously export and adopt higher rates of technology, while Girma et al. (2011) conduct a comparative analysis of British and Irish firms' exporting and innovation behaviour. We build on these existing works and contribute to the literature by considering the decision to invest abroad and by examining the individual and combined effects of

exporting and outward FDI on firms' technology behaviour. We also consider a broader measure of technology investment that includes expenditures on in-house R&D, computers and software, royalty fees and imports of capital goods within the context of a major emerging economy.

Controlling for unobserved firm heterogeneity and the endogeneity of the model regressor, our analysis yields the following three core conclusions. First, the theoretical prediction of a positive relationship between the rate of technology adoption and productivity found robust empirical support. Second, outward FDI appears to substitute technology investments at home, a result that is consistent with the notion of technology-seeking FDI. Third, exporting is not always associated with greater technological effort. Rather the nature of this association varies according to the sector, ownership structure and type of technology. For example, a major finding is that the export-intensity of Indian multinationals is associated with higher rates of technology investments, whereas we fail to find evidence that exporting non multinational firms always invest more in technology than non-exporting ones. These results highlight the importance of taking the interaction between exporting and firm's outward FDI status into account.

The next section illustrates how the interrelationship between firm heterogeneity, technology investment and exporting has been modeled in the theoretical literature. Section 2.3 presents our empirical model. Section 2.4 describes the dataset and discusses the sample characteristics. Section 2.5 reports the main findings from the econometric estimations. Section 2.6 provides some

further analysis designed to put our findings into sharper perspectives. Section 2.7 concludes.

2.2. Theoretical underpinnings

The theoretical underpinnings of this paper lie in models of exporting and productivity investments developed, amongst others, by Bustos (2007), Lileeva and Trefler (2010) and Aw et al. (2010). As in Melitz (2003), consider a single monopolistically competitive industry in which a continuum of heterogeneous firms produces a different brand. Assume that the demand function for a particular firm's brand has a Dixit-Stiglitz form given by $x = Ap^{-\varepsilon}$, where p is the price, A is an exogenous demand shock and $\varepsilon = \frac{1}{1-\alpha}$ is a constant elasticity of demand, with $0 < \alpha < 1$.

Before entering the market, firms face uncertainty regarding their productivity level, θ. Upon entry they draw their productivity from a known cumulative distribution function, $G(\theta)$, and decide whether to exit the market or to start producing. If a firm chooses to produce, its profit-maximizing strategy is to charge $p = \frac{c}{\alpha\theta}$ when the variable cost per unit of output is $\frac{c}{\theta}$ and the fixed cost of production is cf_D, with c measuring the cost of production factors, which for simplicity is normalized to 1. The firm's operating profits can then be expressed as:

$$\pi = \varphi A - f_D \tag{2.1}$$

Where $\varphi = (\varepsilon - 1)^{\varepsilon-1} \varepsilon^{-\varepsilon} \theta^{\varepsilon-1}$ is a transformed measure of firm's productivity (as in Lileeva and Trefler, 2010).

Surviving firms (that is, firms which productivity level is above the cut-off point $\varphi_D = \frac{f_D}{A}$) self-select into different international activities according to their productivity level and the fixed and variable costs associated with each activity. For instance, as illustrated by Helpman (2006), exporting entails a fixed cost f_X, and a per-unit melting iceberg trading costs, $\tau > 1$, so that τ units of output have to be shipped for 1 unit to arrive in the foreign country. Assuming that the foreign demand function for a particular brand is given by $x^* = A^* p^{-\varepsilon}$, only those firms with a productivity level above $\varphi_X = \frac{f_X}{\tau^{1-\varepsilon} A^*}$ find it profitable to enter the export market. Thus, the firm's maximum profits as a function of its exporting decision are given by:

$$\pi(e) = \phi\left[A + e\tau^{-\varepsilon} A^*\right] - e f_E \tag{2.2}$$

With $f_E = f_D - f_X$ and e=1 if the firm exports and e=0 otherwise.

In addition to the exporting decision, firms can increase their productivity from φ to $\lambda\varphi$ ($\lambda > 1$) by upgrading their technology, which

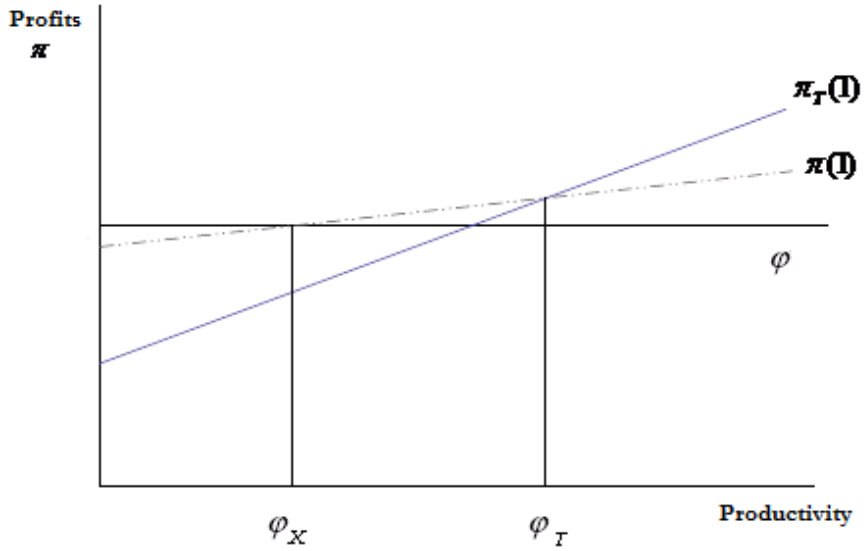
requires the payment of an additional fixed cost, f_I. The maximum level of profits for a firm that invest in technology (T) is given by:

$$\pi_T(e) = \lambda\phi\left[A + e\tau^{-\varepsilon}A^*\right] - ef_E - f_I \tag{2.3}$$

It follows that only firms with a productivity level above $\phi_T > \frac{f_I}{\left[A + e\tau^{-\varepsilon}A^*\right](\lambda - 1)}$ find it profitable to invest.

Bustos (2007) focuses on the case where the productivity level above which a firm finds it profitable to export and adopt a new technology is greater than the productivity level above which a firm is only induced to export: $\phi_T > \phi_X$ (see Figure 2.1). Under these restrictions, firms that only serve the domestic markets do not adopt a new technology and some firms find it profitable to export without technology upgrading.

Figure 2.1. Exporters' technology choice



Adapted from Bustos (2007)

Interestingly, Lileeva and Trefler (2010) consider the case in which f_I is large enough so that a firm will never invest in productivity enhancement without exporting. This situation is depicted in Figure 2.2 where firms are sorted according to their initial productivity, φ (expressed on the horizontal axis) and their productivity gains from investing, $(\lambda-1)\varphi$ (represented on the vertical axis).

Lileeva and Trefler (2010) consider the following profits differences resulting from exporting and investing, $\pi_T(1)$, and neither exporting nor investing, $\pi(0)$:

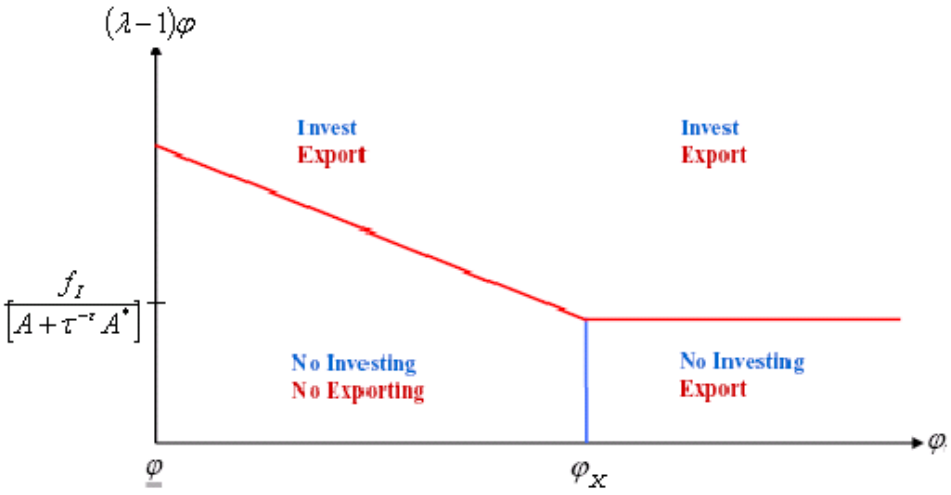
$$\Delta\pi = \pi_T(1) - \pi(0) \Rightarrow$$

$$\Delta\pi = \left[\phi\tau^{-\varepsilon}A^* - f_X\right] + \left[(\lambda-1)\phi A - f_I\right] + \left[(\lambda-1)\phi\tau^{-\varepsilon}A^*\right] \quad (2.4)$$

This expression illustrates that the increase in profits is explained by the following three choices: (i) exporting without investing (first term in brackets), (ii) investing without exporting (second term in brackets), and (iii) exporting and investing (third term in brackets). A firm chooses to export if $\varphi_X > \frac{f_X}{\tau^{1-\varepsilon} A^*}$, which is represented by the vertical line in Figure 2.2. Given that the firm is exporting, it decides to invest if the productivity gains are above the cut-off point $\phi_T(\lambda - 1) > \frac{f_I}{\left[A + \tau^{-\varepsilon} A^*\right]}$. This cut-off point is represented by the horizontal line in Figure 2.2. The region of interest for Lileeva and Trefler (2010) is where it is not profitable for the firm to export without investing or invest without exporting, so that the first two terms in Equation 2.4 are negative. Firms that are indifferent between exporting and investing and neither exporting nor investing are located along the downward-sloping equation line in Figure 2.2 which can be expressed as:

$$(\lambda - 1)\phi = -\phi \frac{\tau^{-\varepsilon} A^*}{(A + \tau^{-\varepsilon} A^*)} + \frac{f_X + f_I}{(A + \tau^{-\varepsilon} A^*)} \tag{2.5}$$

Figure 2.2: Optimal choices of exporting and investing



Adopted from Lileeva and Trefler (2010)

Our econometric model described in the next section extends this analysis by including the firm's decision to invest abroad and by examining the individual and combined effects of exporting and outward FDI on firms' willingness to upgrade their technological base. Also unlike most theoretical models that express technology investment as a binary choice for the sake of mathematical tractability, we employ continuous measures of technology investment which correspond more closely to the notion of technology upgrading. Furthermore, we consider the more realistic case of heterogeneous technology by distinguishing between investment in physical and knowledge capital.

2.3. Empirical approach

In this section, we describe our empirical approach to identify the individual and combined effects of exporting and outward FDI on the rate of technology adoption. We specify the following dynamic panel data model of technology investment that relates current period technology investment in terms of previous period's firm characteristics:

$$\left(\frac{I}{K}\right)_{it} = \alpha\left(\frac{I}{K}\right)_{it-1} + \beta_1 PROD_{it-1} + \beta_2 SIZE_{it-1} + \beta_3 AGE_{it} + \beta_4 FIN_{it-1}$$

$$+ \beta_5 EXP_{it-1} + \beta_6 FDI_{it-1} + \beta_7 (EXP * MNE)_{it-1} + f_i + D_t + \varepsilon_{it} \qquad (2.6)$$

where *i* and t index firms and time periods respectively. The dependent variable is log of technology investment (I) normalized by total assets (K)[5], *f* denotes time-invariant firm-specific heterogeneity, D is a vector of time dummies and ε is a random error term. In the above model *FDI* comprises of two variables capturing outward and inward foreign direct investment. The export intensity (*EXP*) is interacted with the firm's multinational status (*MNE*) to allow for the fact that the investment-export nexus is likely to differ for multinational and non-multinational companies.

[5] Detail of the construction of the variables used in the empirical analysis is discussed in the next section and summarised in Appendix A.2.1.

Various strands of the endogenous growth literature agree that innovation and technological change are the chief sources of economic progress. There is however disagreement regarding the importance of persistence in innovation. On the one hand, there is the view that technological change is largely due to the process of creative destruction (e.g. Aghion and Howitt, 1992) suggesting low level of firm-level persistence and perpetual renewal of innovators. On the other hand, some scholars emphasise that persistent innovators are at the heart of a bulk of technical innovation (e.g. Romer, 1990). In terms of our empirical model, the lower (higher) the level of persistence in technology investment, the closer the parameter α is to zero (one). In the presence of high level of persistence in technology investment, a one-off policy measure designed to stimulate firms' technological efforts will have longer lasting effects. In order to design optimal technology policy, however, it is important to make sure that persistence, if any, is due to true state dependence rather than unobserved firm heterogeneity or other firm-specific characteristics. It is this consideration which motivated us to specificity a dynamic panel data model with unobserved firm-specific heterogeneity as well as a host of control variables which includes productivity (PROD), size, age and firms' access to external finance (FIN).

Firm age captures learning-by-doing effects, whereas firm size reflects the extent to which economies of scale enhance firms' ability to undertake performance-enhancing investment. Another important control variable we deploy is the lagged value productivity. Productivity is hypothesised to impact on the rate of technology adoption in two opposing ways. On the one hand, more productive firms are more likely to afford investing in further productivity

improvements (cf. Bustos, 2007). On the other hand, least productive firms deciding not to exit the market are likely to accelerate their rate of technology investment in order to catch-up with their competitors, which is consistent with the notion of firm level productivity-convergence (e.g. Bernard and Jones, 1996).

In order to obtain consistent and efficient estimators of our model parameters, we employ the dynamic panel data estimator due to Blundell and Bond (1998). This estimator has three distinct features that are suitable to our model. First, it controls for firm-specific effects and helps distinguish true state dependence driving the dynamics of technology investment from unobserved heterogeneity. Second, it allows for the endogeneity of the model regressors, providing a more accurate description of the causal effect of the choice of foreign market participation on the rate technology adoption. Third, the technique estimates simultaneously level and first-differenced models within a GMM framework using lagged values of the dependent variables and other endogenous regressors. This ensures that the estimator does not suffer from problems of weak instruments, especially in cases where the dependent variable is highly persistent. We test the appropriateness of this estimator for our model and data via two routine tests applied in the literature: the Hansen-Sargan test for the validity of the overidentifying restrictions and the Arellano and Bond (1991) test for the absence of serial correlation in the equation error.

2.4. Dataset description and sample characteristics

As mentioned in the Introduction of this thesis, we draw on the Prowess database compiled from audited company balance sheets and income statements by the Centre for Monitoring the Indian Economy, which is an independent economic think-tank headquartered in Mumbai. In this chapter we focus on two highly-globalised sectors in India, software services and pharmaceutical industries, and study the determinants of technology investment over the period 1999-2007.

During 2000–2004 export earnings by Indian pharmaceutical firms was a staggering $8.7 billion (Pradhan and Alakshendra, 2011). Foreign multinationals have also been attracted to the sector as witnessed by $700 million worth of investment during 2000-2005 alone. This surge in FDI is arguably helped by investors' perception of improved intellectual property rights and patent regimes in India (Pradhan and Alakshendra, 2011). Parallel to this development and taking advantage of the investment liberalisation policy of the government, Indian pharmaceutical firms have been busy in overseas markets having invested $1.3 billion in transnational acquisitions, with the view to exploiting firm-specific assets such as research and technological capabilities (Pradhan and Alakshendra, 2011). The above discussion strongly suggests that the Indian pharmaceutical industry is an ideal test case to study the relationship between exporting, FDI and technology adoption.

The Indian software services industry is also an equally interesting test bed for studies of firm level adjustment to globalisation, apart from offering a nice contrast to the pharmaceutical industry which is predominantly manufacturing-based. Software exports from India have grown from $105 million in 1989 to $32 billion in 2007, making them the chief exports revenue earner for the country (Niosi and Tschang, 2008). The software industry also contributes the lion's share of service FDI from India. It is well-documented that much of Indian software firms' overseas acquisition is driven by their need to get access to specific knowledge and assets (Niosi and Tschang, 2008).

Table 2.1 gives the frequency distribution of the firms in the sample by year, ownership and industry. The number of Indian multinational companies started to show a marked increase after 2000. As mentioned in the Introduction of this thesis, this increase is largely due to significant improvements in the regulatory framework governing Indian outward investment. For example, since 2000 Indian companies have been allowed to make overseas investments by market purchases of foreign exchange without the approval of the Reserve Bank of India up to 400% of their net worth, compared to the previous limit of 50%[6] (see appendix A.1.2).

[6] UNCTAD's report at: http://www.unctad.org/sections/dite_dir/docs//diteiiab20041_en.pdf

Table 2.1: Frequency distribution of firms by year, ownership and industry

	Software services				Pharmaceutical industry			
year	Non-MNEs	Indian MNEs	Foreign MNEs	Total	Non-MNEs	Indian MNEs	Foreign MNEs	Total
1999	211	2	12	225	238	2	27	267
2000	263	21	18	302	253	4	29	286
2001	245	55	21	321	223	20	31	274
2002	235	90	27	352	212	25	29	266
2003	285	91	30	406	243	29	26	298
2004	319	93	32	444	260	31	27	318
2005	263	106	28	397	236	33	27	296
2006	223	90	46	359	204	38	37	279
2007	154	87	47	288	152	36	34	222
Total	2,441	637	278	3,356	2,459	221	317	2,997

The variables used in the regression analysis are defined in appendix A.2.1 and their summary statistics are given in Table 2.2. Technology investment, defined as the log the total expenditures on own R&D, royalty fees, computers, software and the imports of capital goods, has shown marked increase in the second half of the sample (2003-2007) in both sectors under consideration. In the case of pharmaceutical firms the increase in knowledge capital investment is particularly marked during the second half of the period, probably as a result of the adoption of a stronger intellectual property regime since 2005[7]. Table 2.2 also shows that a substantial fraction of firms in both

[7] As mandated by the WTO, in 2005 India migrated from a soft patent regimen that allowed patenting the manufacturing process instead of final products towards a stronger regime that recognises product patents in drugs, food and chemicals and extends the term of patenting from 7 to 20 years.

sectors are involved in exporting. Software service firms are more export-oriented reaching an export intensity of 72.4% during the period 2003-2007. Table 2.2 also reveals that the overseas investments by Indian firms as a proportion of their sales is substantially higher in the software industry compared to the pharmaceutical industry. On the other hand, foreign multinationals in both sectors are majority investors in their Indian subsidiaries, as measured by the average share of foreign capital in firms' total equity.

Table 2.2: Summary statistics of main variables of interest

	Software services				**Pharmaceutical industry**			
	1999-2002		**2003-2007**		**1999-2002**		**2003-2007**	
	mean	Std dev.	Mean	Std dev.	mean	Std dev.	mean	Std dev.
Total technology investment	-2.292	1.44	-1.968	1.749	-2.868	1.176	-2.621	1.33
Knowledge capital investment	-2.548	1.597	-2.153	1.878	-2.935	1.194	-2.737	1.377
Physical technology investment	-2.532	1.558	-2.407	1.891	-3.256	1.419	-3.117	1.623
Size	2.679	1.769	2.469	2.237	3.325	1.575	3.297	1.992
TFP	-3.68	1.469	-3.423	1.631	-4.663	1.288	-4.232	1.54
Finance	0.325	3.59	-0.092	21.795	0.763	10.18	0.662	9.638
Age	9.802	6.523	12.127	6.761	21.759	17.72	24.363	17.51

*Conditional on non-zero values
Note: see Appendix A.2.1 for the exact definition of the variables.

Table 2.2: Summary statistics of main variables of interest (cont.)

	Software services				Pharmaceutical industry			
	1999-2002		2003-2007		1999-2002		2003-2007	
	mean	Std dev.	Mean	Std dev.	mean	Std dev.	mean	Std dev.
Exports dummy	0.54	0.499	0.563	0.496	0.609	0.488	0.607	0.489
Export intensity*	0.618	0.384	0.724	1.232	0.243	0.284	0.283	0.269
Outward FDI (dummy)	0.163	0.37	0.311	0.463	0.048	0.213	0.137	0.344
Outward FDI intensity*	1.532	8.909	4.451	31.863	0.064	0.13	0.121	0.253
Inward FDI (dummy)	0.065	0.247	0.097	0.296	0.106	0.308	0.107	0.309
Inward FDI intensity*	0.544	0.374	0.524	0.37	0.613	0.376	0.529	0.394

*Conditional on non-zero values
Note: see Appendix A.2.1 for the exact definition of the variables.

To gain a preliminary idea of the relationship between exporting, FDI and technology upgrading, Table 2.3 shows the average technology adoption premia to firms engaged in exporting according to their multinational status. Exporting Indian multinational firms enjoy significantly higher rates of technology adoption. It is interesting to note that exporting foreign investors do not appear to have significantly different rates of technology investment. The figures in Table 2.3 should of course be interpreted with caution since they are based on simple pairwise t-tests without adequate control variables.

Table 2.3: Growth in technology adoption: Premia to exporting and FDI

	Software services			Pharmaceutical industry		
	Technology investment	Knowledge investment	Physical investment	Technology investment	Knowledge investment	Physical investment
Exporting-Non MNEs	0.064**	0.033*	0.034**	0.051***	0.048***	0.016
Exporting-Indian MNEs	0.147***	0.161***	0.044*	0.237***	0.226***	0.112***
Exporting-Foreign MNEs	0.063	0.110	0.025	0.026	0.039	-0.002

Notes:

a. The base group consists of non-exporters.

b. * significant at 10%; ** significant at 5%; *** significant at 1%

Figures 2.3 and 2.4 depict the share of firm-year observations and technology investment by exporting and FDI status for the software and pharmaceutical industries respectively. It is striking that firms engaged in both exporting and outward FDI enjoy a disproportionately high share of the value technology investment, while the contribution of exporting inward FDI firms is not overly impressive. This appears to reinforce the idea that export-oriented Indian multinationals appear to be most conducive to the development of firms' technological capabilities.

Figure 2.3: Technology investment and firm-year observations

Software services

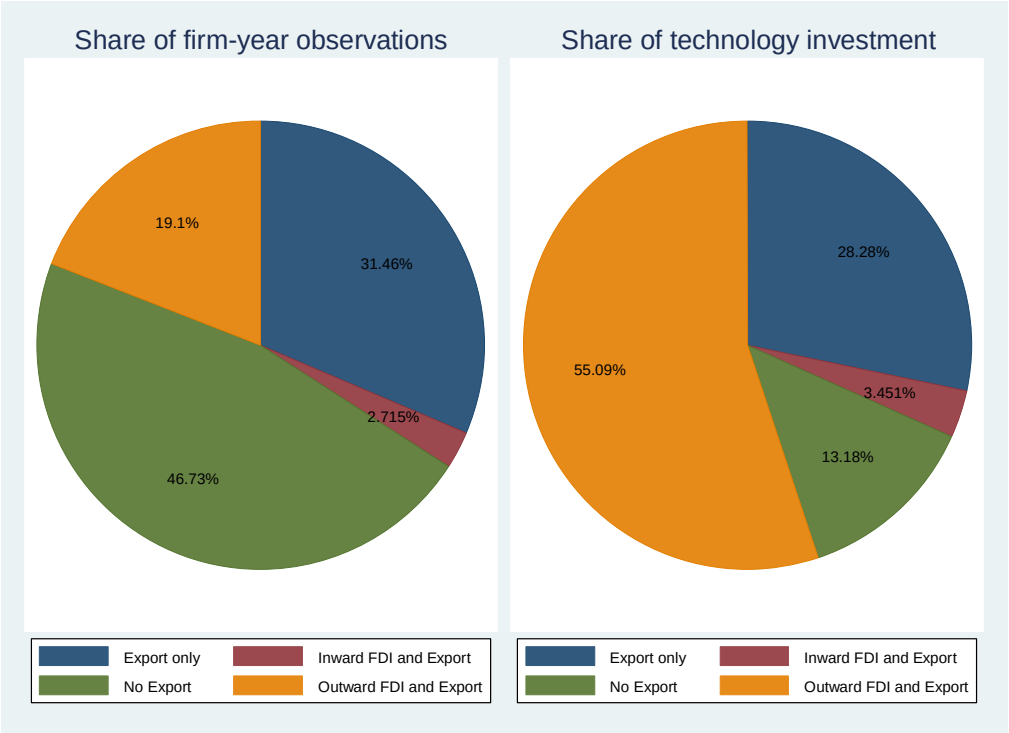
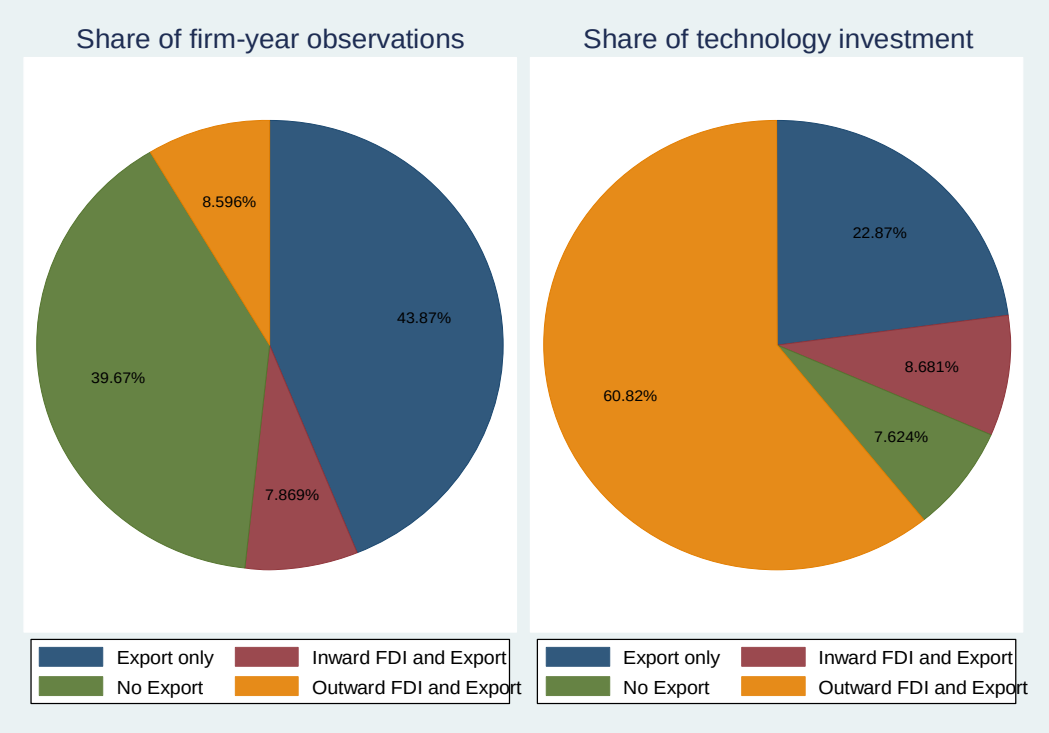


Figure 2.4: Technology investment and firm-year observations: Pharmaceutical industry



In order to isolate the causal effects of exporting and FDI on the rate of technology adoption, as well as to evaluate the interaction between them, it is important to control for a host of observable and unobservable firm characteristics. This is achieved within the dynamic panel data regression framework described in the previous section. We now turn our attention to the discussion of the regression results.

2.5. Empirical findings

The dynamic panel data model estimates based on total technology investment are reported in Table 2.4. It is reassuring to confirm that the GMM estimator is appropriate in this context as the diagnostic tests show the validity of the overidentifying restrictions and the absence of serial correlation in the equation error.

Table 2.4: Rate of technology adoption, exporting and FDI

Dependent variable: technology investment

	Baseline model		**Model with FDI-export interaction**	
	Software services	**Pharmaceutical industry**	**Software services**	**Pharmaceutical industry**
Lagged technology investment	0.473***	0.638***	0.418***	0.575***
	(0.0080)	(0.0108)	(0.0112)	(0.0057)
Size	-0.170***	-0.118***	-0.241***	-0.116***
	(0.0150)	(0.0099)	(0.0130)	(0.0106)
Productivity	0.271***	0.088***	0.312***	0.113***
	(0.0164)	(0.0110)	(0.0111)	(0.0107)
Finance	-0.038***	0.008*	-0.011	0.011***
	(0.0093)	(0.0036)	(0.0110)	(0.0028)
Age	-0.006	-0.013***	0.015*	-0.017***
	(0.0049)	(0.0019)	(0.0051)	(0.0014)
Serial correlation test (p-value)	0.967	0.936	0.967	0.657

Notes:
a. All results based on the "system-GMM " dynamic panel data estimator
b. Standard errors in parentheses
c. *significant at 10%; ** significant at 5%; *** significant at 1%
d. All specifications include the full set of time dummies

Table 2.4: Rate of technology adoption, exporting and FDI (cont.)

Dependent variable: technology investment

	Baseline model		**Model with FDI-export interaction**	
	Software services	**Pharmaceutical industry**	**Software services**	**Pharmaceutical industry**
Exports	0.147***	0.366***	0.041	0.122
	(0.0364)	(0.0640)	(0.0319)	(0.0717)
Outward FDI	-0.001*	-1.487***	-0.002***	-1.697***
	(0.0003)	(0.0275)	(0.0002)	(0.0708)
Inward FDI	0.675***	-0.406**	0.254***	0.082
	(0.0536)	(0.1356)	(0.0420)	(0.1026)
Export * Indian MNEs			0.346***	0.898***
			(0.0373)	(0.0141)
Export * Foreign MNEs			0.522***	0.096
			(0.0362)	(0.0694)
Total observations	1560	1482	1560	1482
Number of firms	433	336	433	336
Sargan test (p-value)	0.129	0.625	0.293	0.786
Serial correlation test (p-value)	0.967	0.936	0.967	0.657

Notes:
a. All results based on the "system-GMM " dynamic panel data estimator
b. Standard errors in parentheses
c. *significant at 10%; ** significant at 5%; *** significant at 1%
d. All specifications include the full set of time dummies

We find that technology investment is persistent in both sectors. The point estimates of the parameters on the lagged technology investment variables show evidence of conditional convergence, with slightly faster convergence rates for the software industry. Thus it seems that less technology-intensive firms invest *relatively* more in technology improvement, possibly in order to catch-up with their industry competitors.

Initial level of productivity has positive effects on the rate of technology adoption in the two sectors. This is consistent with theoretical models discussed

in Section 2.2 which stipulate that firms need to achieve a certain threshold of productivity to be able to afford investing in technology. It is worth noting that the effect of productivity on technology investment is stronger in the software industry. According to the point estimates from the dynamic panel data model, increasing productivity by 10 percentage has the effect of increasing the annual rate of technology adoption by 2.71 to 3.12 percentage points in the short run alone. This is an economically significant effect indeed.

In contrast to the role of productivity, firm size is negatively associated with the pace of technology upgrading. Keeping productivity and other firm level characteristics constant, smaller firms have more scope for technology upgrading. Similarly, we find evidence that younger firms in the pharmaceutical industry invest more than otherwise equivalent firms, indicating greater scope for learning for this group of firms. Also for the pharmaceutical industry, we uncover evidence that access to external finance in the form of bank loans exerts a positive influence on firms' ability to engage in technology adoption. By contrast, more heavily leveraged software firms invest less in technology, all else constant.

Our results also indicate that the role of inward FDI varies according to the sector in question. For pharmaceutical industry firms, the higher the share of foreign capital, the lower the rate of technology investment, all else constant. This would appear to suggest that inward FDI is unlikely to be a source of automatic or unconditional technology spillover in this industry. In contrast,

our results confirm that inward FDI stimulates the rate of domestic technology adoption in the software sector.

2.5.1. The individual effects of exporting and outward FDI

Starting with the relationship between exporting and technology investment, the results of our baseline model reported in columns 1 and 2 in Table 2.4 show that exporting intensity has a robust positive impact on the technology effort of firms in both sectors. A 10 percentage points change in the intensity of exports would induce software (pharmaceutical) firms to increase their rate of technology investment by about 1.47 (3.66) percentage points. This is an economically significant effect which is consistent with the notion that exporting is a channel of technology transfer. Interestingly and by contrast, outward FDI appears to be a substitute rather than a complement to domestic technology upgrading efforts. These substitutive effects are particularly strong in the pharmaceutical sector, where a 1 percentage point increase in the intensity of overseas investments reduces the rate of technology investments by 1.48 percentage points. This result is consistent with the notion of technology-seeking multinational firms devoting their resources to accessing existing technology abroad.

2.5.2. The complementary effects between exporting and outward FDI status

To allow for the fact that the investment-export nexus is likely to differ for multinational and non-multinational companies, in columns 3 and 4 in Table 2.4 we interact the export intensity with the multinational status of the firm. While we confirm our previous finding that outward FDI substitutes domestic technology activity in both sectors, the results from this exercise evidence the existence of heterogeneous technology-effects from exporting according to firm's multinational status. On one hand, we uncover strong evidence of a positive relationship between the export intensity of Indian Multinationals and their technology investment at home, a finding that is consistent with the notion of market-seeking exporting Indian multinational firms being induced to invest in technology at home in order to be more competitive in international markets. We also find that the exports of foreign multinationals operating in the service sector are positively correlated with their technology investments in India, but we fail to find evidence of a significant unconditional correlation between exporting and the rate of technology investments amongst non multinational firms operating in both sectors.

Overall, these results highlight the importance of taking the interaction between exporting and FDI status into account and suggest that incurring the fixed cost of investing in technology is only attractive for exporting firms that

have become multinationals in recent years, probably due to the larger sales in foreign markets that come with their overseas investments. The lack of evidence of technology enhancing effects from exporting amongst non-multinational firms suggests that possibly these firms were induced to invest in technology in the past, when they started to export, but now, with less scope to improve foreign markets access, they have less incentive to upgrade their technological base. The fundamental link between outward FDI –in particular, the increase in foreign market access that comes with overseas investments- has been absent from the existing work on trade and technology investments.

2.5.3. Does the type of technology investment matter?

The previous analysis didn't make a distinction between investment in physical technology and disembodied knowledge capital. To probe our findings further and gain a more nuanced insight on the importance of the type of technology investment, we estimate separate models using knowledge investment and physical technology investment as dependent variables[8]. The findings from this experiment are reported in Tables 2.5 and 2.6.

[8] See Appendix A.2.1 for a definition of these variables

Table 2.5: Rate of technology adoption, exporting and FDI

Dependent variable: knowledge investment

	Baseline model		**Model with FDI-export interaction**	
	Software services	**Pharmaceutical industry**	**Software services**	**Pharmaceutical industry**
Lagged knowledge investment	0.574***	0.785***	0.518***	0.701***
	(0.0079)	(0.0099)	(0.0039)	(0.0044)
Size	-0.235***	-0.125***	-0.278***	-0.143***
	(0.0098)	(0.0106)	(0.0074)	(0.0081)
Productivity	0.254***	0.024**	0.260***	0.040***
	(0.0128)	(0.0091)	(0.0065)	(0.0061)
Finance	-0.039***	0.007*	-0.023***	0.006***
	(0.0093)	(0.0031)	(0.0023)	(0.0018)
Age	0.022***	-0.007***	0.016***	-0.009***
	(0.0040)	(0.0016)	(0.0026)	(0.0010)
Exports	0.091**	0.178***	-0.010	0.067
	(0.0334)	(0.0504)	(0.0180)	(0.0445)
Outward FDI	-0.001***	-1.679***	-0.003***	-1.678***
	(0.0002)	(0.0500)	(0.0002)	(0.0372)
Inward FDI	0.388***	-0.149	0.384***	0.160**
	(0.0300)	(0.0804)	(0.0316)	(0.0548)
Export * Indian MNEs			0.544***	0.524***
			(0.0297)	(0.0204)
Export * Foreign MNEs			0.205***	-0.253***
			(0.0244)	(0.0314)
Total observations	1594	1504	1594	1504
Number of firms	437	337	437	337
Sargan test (p-value)	0.254	0.224	0.605	0.586
Serial correlation test (p-value)	0.484	0.410	0.431	0.478

Notes

a. All results based on the "system-GMM " dynamic panel data estimator
b. Standard errors in parentheses
c. *significant at 10%; ** significant at 5%; *** significant at 1%
d. All specifications include the full set of time dummies

Table 2.6: Rate of technology adoption, exporting and FDI

Dependent variable: physical technology investment

	Baseline model		**Model with FDI-export interaction**	
	Software services	**Pharmaceutical industry**	**Software services**	**Pharmaceutical industry**
Lagged physical investment	0.406***	0.557***	0.374***	0.520***
	(0.0078)	(0.0050)	(0.0061)	(0.0056)
Size	-0.246***	-0.215***	-0.292***	-0.234***
	(0.0120)	(0.0072)	(0.0085)	(0.0050)
Productivity	0.265***	0.131***	0.243***	0.143***
	(0.0094)	(0.0083)	(0.0052)	(0.0055)
Finance	-0.045***	-0.007*	-0.037***	-0.002
	(0.0056)	(0.0033)	(0.0035)	(0.0013)
Age	-0.033***	-0.010***	-0.040***	-0.009***
	(0.0036)	(0.0015)	(0.0024)	(0.0009)
Exports	0.025	-0.040	-0.044**	-0.257***
	(0.0222)	(0.0494)	(0.0148)	(0.0344)
Outward FDI	0.002***	-0.822***	0.002***	-0.597***
	(0.0002)	(0.0381)	(0.0001)	(0.0205)
Inward FDI	0.803***	-0.150	0.483***	-0.232***
	(0.0413)	(0.1037)	(0.0156)	(0.0294)
Export * Indian MNEs			0.252***	0.166***
			(0.0186)	(0.0243)
Export * Foreign MNEs			0.287***	0.798***
			(0.0100)	(0.0252)
Total observations	1560	1482	1560	1482
Number of firms	433	336	433	336
Sargan test (p-value)	0.265	0.462	0.540	0.819
Serial correlation test (p-value)	0.602	0.173	0.629	0.196

Notes

a. All results based on the "system-GMM " dynamic panel data estimator
b. Standard errors in parentheses
c. *significant at 10%; ** significant at 5%; *** significant at 1%
d. All specifications include the full set of time dummies

In general, the type of technology investment matters for the magnitude and sometimes for the sign of the estimated impact of exporting and outward FDI. Our results confirm that there is a good deal of statistical evidence that export intensive Indian multinationals in both sectors invest more in knowledge and physical capital. Other noteworthy findings uncover by this analysis include the negative relationship between exporting and physical investments amongst

non multinational firms operating in both sectors and the positive (although small) impact of outward FDI on the rate of physical technology investments in the software sector.

2.6. Further analysis

2.6.1. Outward FDI and technology investment: reverse causality?

A number of theoretical models – old and new- predict that the possession of firm-specific superior assets is the predominant force behind the decision to invest abroad (Hymer, 1976 and Chen et al, 2008). We probe our findings in this prediction by checking whether previous levels of technology investment and productivity can explain the pattern of outward FDI. If so, it is possible that our results might be contaminated by the problem of reverse causality, notwithstanding our GMM estimation approach.

In order to investigate this possibility, we model the determinants of outward FDI activity (which is a heavily censored variable), paying particular attention to the role of previous levels of technology investment and TFP. Specifically, we start off with an empirical model where a firm *i* either engage in OFDI at time *t* with a positive OFDI, $OFDI_{it} > 0$ or it does not invest abroad ($OFDI_{it} = 0$) and formulate a Tobit model in terms of a latent variable model as follows:

$$
\begin{aligned}
OFDI_{it}^{*} &= \beta_1 \left(\frac{I}{K} \right)_{it-1} + \beta_2 TFP_{it-1} + \gamma X_{it-1} + \varepsilon_{it} \\
OFDI_{it} &= OFDI_{it}^{*} \qquad \text{if} \quad OFDI_{it}^{*} > 0 \\
OFDI_{it} &= 0 \qquad \text{Otherwise}
\end{aligned}
\tag{2.7}
$$

where the X vector consists of exporting, access to external finance, firm size, age and the full set of time dummies. The parameters of the Tobit model are estimated with robust standard errors allowing for arbitrary within-firm serial correlation. We then compute the marginal effects of technology investment and TFP on the amount of outward FDI, given the decision to invest abroad. These results are reported in Table 2.7. A striking result from these experiments is that previous levels of technology investment do not affect the decision to invest abroad. This, combined with the fact that our GMM estimator addresses the potential endogeneity of the regressors, reassures us that reverse causality is unlikely to have driven our results. In other words, outward FDI appears to be technology-sourcing rather than firm-specific assets driving the decision to invest abroad.

The above message is reinforced when one consider the predicted probabilities of OFDI from the Tobit models and plot them against previous levels of technology investment, productivity, size and access to finance. Figure 2.5 depict the nonparametric regression lines of the probability of OFDI on the lagged firm characteristics, and they show that high productivity firms exhibit

lower likelihood to invest abroad. Moreover there is no discernible pattern between the probability of engaging in OFDI and the level of technology investment in the previous year. It is worth noting that firm size is the only robust predictor of the probability to engage in OFDI.

Table 2.7: Marginal effects from Tobit model of the decision to engage in outward FDI

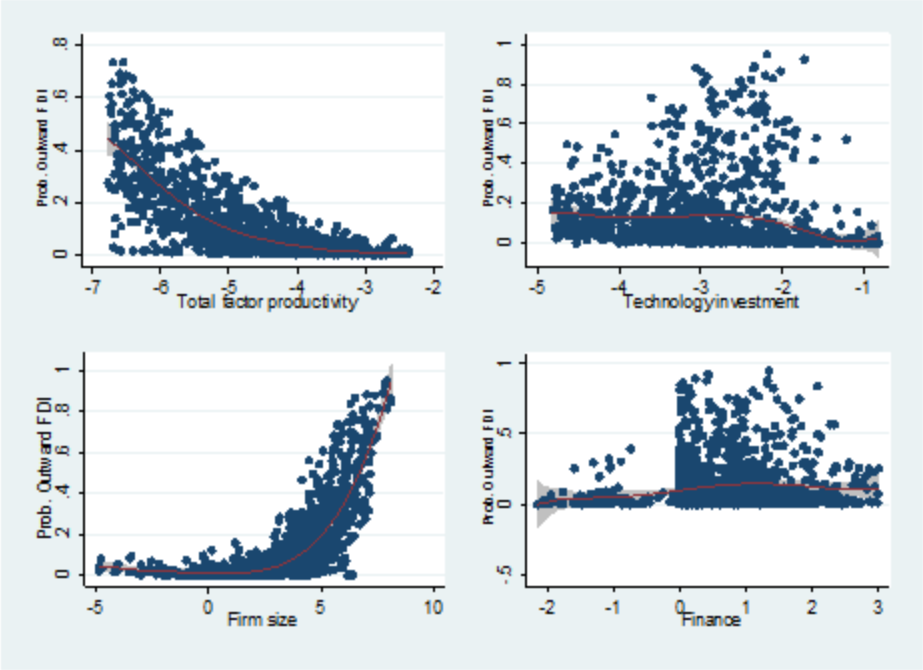
	Software			**Pharmaceutical**		
	Technology investment	Knowledge technology investment	Physical technology investment	Technology investment	Knowledge technology investment	Physical technology investment
Lagged Technology investment	-1.672	-1.575	-2.528	0.002	0.001	-0.039
	(1.172)	(1.109)	(1.510)	(0.016)	(0.017)	(0.031)
Lagged Exporting	1.782	1.736	1.840	0.228*	0.235*	0.259*
	(1.487)	(1.440)	(1.525)	(0.114)	(0.119)	(0.119)
Size	1.276**	1.113**	0.680*	0.075***	0.076***	0.068**
	(0.464)	(0.386)	(0.306)	(0.021)	(0.022)	(0.021)
Productivity	-0.680	-0.512	-0.349	-0.071**	-0.071**	-0.053**
	(0.472)	(0.396)	(0.361)	(0.023)	(0.023)	(0.020)
Finance	0.139	0.138	0.141	-0.004	-0.004	-0.004
	(0.088)	(0.087)	(0.088)	(0.002)	(0.002)	(0.002)
Age	0.113	0.131	0.087	-0.001	-0.001	-0.001
	(0.132)	(0.135)	(0.123)	(0.001)	(0.001)	(0.001)
Observations	1577	1594	1577	1491	1504	1491
Uncensored observations	545	551	545	211	212	211
Log likelihood	-2462.003	-2488.265	-2455.269	-165.187	-166.318	-162.519

Notes

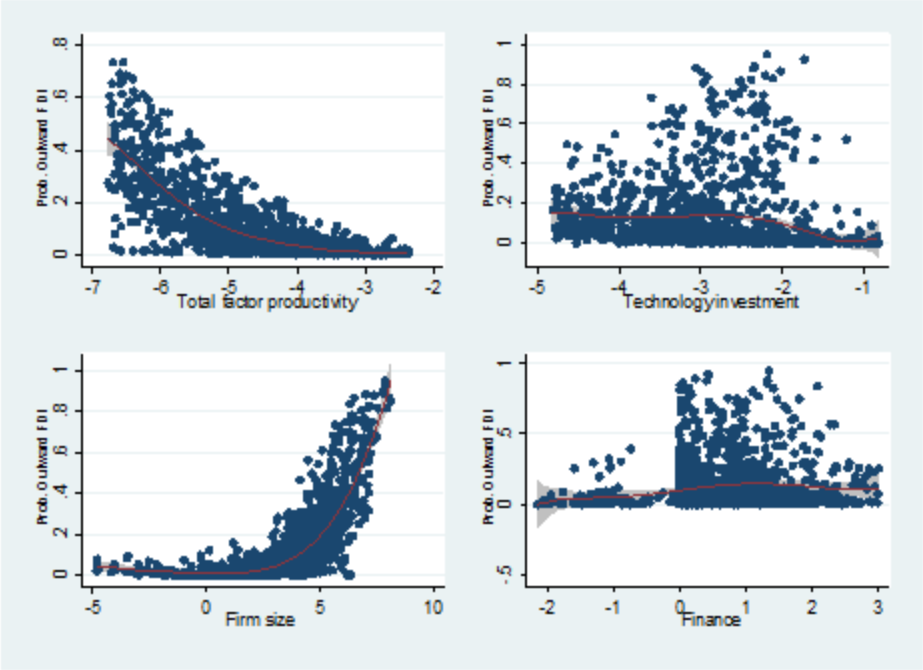
a. Robust firm-clustered standard errors in parentheses
b. significant at 10%; ** significant at 5%; *** significant at 1%
c. All specifications include the full set of time dummies

Figure 2.5: Nonparametric regression of the probability of outward FDI on lagged firm characteristics

Sofware industry



Pharmaceutical industry



2.6.2. The returns to technology investment: Are Indian multinational firms different?

A striking result that emerges from our analysis is the absence of a universally positive relationship between outward FDI and technology upgrading, once observed and unobserved firm characteristics are controlled for. Does this result, which runs counter to some of the recent theoretical models and empirical evidence from more developed economies, imply that Indian policy makers should perhaps not overemphasise the importance of firms' internationalization? Answering this question is beyond the scope of this paper. However, one way the benefits of internationalization may yet materialize is through a more efficient utilization of and higher returns to technology investment. This might happen, for example, if multinational firms choose more appropriate technologies or have the right personnel and marketing tools to employ those technologies in a most productive or profitable way.

In order to shed some light on this issue and put our results into sharper perspectives, we decompose profitability differences between multinational and non-multinational firms into those due to differences in the distribution of technology investment and those resulting from differences in returns to technology investment. This approach borrows from the labour economics literature (e.g. Melly, 2005 and Oaxaca, 1973) where, for example, female-male wage differentials are decomposed into differences in covariates (e.g. education) and returns to the covariates.

The results from the decomposition of multinational and non-multinational firms' profitability differential at various quartiles of the profitability distribution are reported in Table 2.8. There is suggestive evidence that a substantial fraction of the profitability differential in the software sector is due to the returns to technology investment rather than differences in the amount of technology invested. This is generally true at the median and upper quartiles of the profitability distribution. To take an example, the median profitability difference between Indian multinationals and non-multinational firms in the software industry is 0.067 units, and 72% (0.048/0.067) of this difference is due to higher returns to technology investment amongst multinational firms. Overall this exercise offers a cautionary tale that an effective technology policy should also deal with issues of reasons efficient technology utilisation and not just the volume of acquired technology. This would help the country reap the maximum benefit from its technology investment.

Table 2.8: Decomposition of profitability differential multinational and non multinational firms: The role technology investment

	Software services		**Pharmaceutical industry**	
	Indian FDI vs.non-FDI firms		**Indian FDI vs. non-FDI firms**	
Lower quartile	**Value**	**t-ratio**	**Value**	**t-ratio**
Raw difference	0.108	3.04	0.075	5.46
Technology difference	0.056	2.53	0.051	6.04
Returns to technology difference	0.052	2.19	0.023	2.64
Median				
Raw difference	0.067	7.00	0.081	15.93
Technology difference	0.020	4.12	0.087	10.64
Returns to technology difference	0.048	4.42	-0.005	-0.74

Notes:

a) Profitability is defined as after tax profits divided by sales.
b) Raw difference refers to the unconditional difference in profitability at the specific quantile.
c) The base group consists on non-FDI firms.

Table 2.8: Decomposition of profitability differential multinational and non multinational firms: The role technology investment (cont.)

	Software services		Pharmaceutical industry	
	Indian FDI vs.non-FDI firms		Indian FDI vs. non-FDI firms	
Upper quartile	**Value**	**t-ratio**	**Value**	**t-ratio**
Raw difference	0.053	3.36	0.076	9.52
Technology difference	0.018	1.38	0.095	9.68
Returns to technology difference	0.036	1.92	-0.019	-1.82

Notes:

a) Profitability is defined as after tax profits divided by sales
b) Raw difference refers to the unconditional difference in profitability at the specific quantile.
c) The base group consists on non-FDI firms.

2.6.3. Exporting, FDI and technology investment in other industries

Our analysis has focused on the software services and pharmaceutical industries. As we argued in Section 2.4, we have very good reasons for the choice of these two industries. Nonetheless, it might be interesting gauge the extent to which our main conclusion can be generalised to other industries.

In our dataset, most industries do not have sufficient number of multinational firms to carry out meaningful econometric analysis. So we only consider industries other than software services and pharmaceutical, for which there are at least 30 *firm-year* observations with positive outward FDI values. We then group them into manufacturing and service industries, and estimate separate dynamic panel data models of technology investment. Our investigation shows that a first-order autoregressive model works reasonably well in terms of the regression diagnostics (i.e. validity of instruments and absence of serial correlation) even with the pooled industries. Table 2.9 reports the resulting econometric estimates.

Very much in line with the sector-specific analysis presented in the previous sections, we confirm the persistent nature of technology investment as well as the theoretical prediction that more productive firms have a higher rate of technology adoption. Also export-oriented Indian multinationals invest more in technology, these effects being more pronounced in the service sector. The unconditional effects of outward FDI is negative, consistent with the existence of technology-sourcing outward FDI, while the unconditional effects of exporting on non-multinationals' technology efforts is confined to the service sector.

Table 2.9: Rate of technology adoption, exporting and FDI in other sectors:

Dependent variable:

	Technology investment		**Knowledge investment**		**Physical technology investment**	
	Manuf.	Services	Manuf.	Services	Manuf.	Services
Lagged dependent variable	0.351***	0.712***	0.890***	0.813***	0.385***	0.696***
	(0.0264)	(0.0021)	(0.0192)	(0.0027)	(0.0212)	(0.0025)
Size	-0.213***	-0.224***	-0.124***	-0.150***	-0.237***	-0.230***
	(0.0138)	(0.0021)	(0.0128)	(0.0020)	(0.0187)	(0.0009)
Productivity	0.324***	0.097***	0.011	0.074***	0.305***	0.138***
	(0.0212)	(0.0029)	(0.0115)	(0.0020)	(0.0182)	(0.0025)
Finance	-0.0001	0.0001	-0.0001	0.001***	-0.00001	0.00001***
	(0.0003)	(0.0001)	(0.0001)	(0.0001)	(0.0003)	(0.0001)
Age	0.008**	-0.001	0.006***	-0.003***	-0.001	0.002***
	(0.0027)	(0.0005)	(0.0012)	(0.0003)	(0.0020)	(0.0003)

Notes

a. All results based on the "system-GMM " dynamic panel data estimator
b. Standard errors in parentheses
c. significant at 10%; ** significant at 5%; *** significant at 1%
d. All specifications include the full set of time dummies

Table 2.9: Rate of technology adoption, exporting and FDI in other sectors (cont.)

Dependent variable:

	Technology investment		Knowledge investment		Physical technology investment	
	Manuf.	Services	Manuf.	Services	Manuf.	Services
	(0.0027)	(0.0005)	(0.0012)	(0.0003)	(0.0020)	(0.0003)
Exports	0.066	0.046***	-0.009	0.037***	0.087	0.036***
	(0.1301)	(0.0117)	(0.0565)	(0.0074)	(0.0912)	(0.0072)
Outward FDI	-1.012***	-0.004***	-0.286***	-0.003***	-1.738***	-0.004***
	(0.2262)	(0.0001)	(0.0861)	(0.0000)	(0.2049)	(0.0000)
Inward FDI	-0.422*	-0.398***	-0.163*	-0.456***	-0.104	-0.049**
	(0.1736)	(0.0103)	(0.0689)	(0.0108)	(0.1144)	(0.0174)
Export * Indian MNEs	0.299**	0.518***	-0.003	0.434***	0.262***	0.185***
	(0.1007)	(0.0126)	(0.0338)	(0.0067)	(0.0700)	(0.0050)
Export * Foreign MNEs	0.364***	-0.078***	0.062	0.008	0.252***	-0.256***
	(0.0875)	(0.0062)	(0.0413)	(0.0057)	(0.0743)	(0.0077)
Total observations	8063	5163	8212	5289	8062	5163
Number of firms	1926	1532	1932	1546	1926	1532
Sargan test (p-value	0.399	0.584	0.484	0.671	0.080	0.543
Serial correlation test (p-value)	0.050	0.235	0.633	0.849	0.070	0.385

Notes

a. All results based on the "system-GMM " dynamic panel data estimator
b. Standard errors in parentheses
c. significant at 10%; ** significant at 5%; *** significant at 1%
d. All specifications include the full set of time dummies

2.7. Conclusion

An emerging body of research in economics is seeking to better understand the sources of firm heterogeneity and their relationship to the choice of foreign market participation. Using firm-level data from the software services and pharmaceutical industries in India, this chapter has contributed to this literature by providing a systematic empirical analysis of the impact of exporting and investing abroad on the rate of technology adoption, a key driver of firm heterogeneity. The analysis accounts for unobserved firm heterogeneity and the endogeneity of the model regressors. The theoretical prediction that more productive firms display higher rates of technology adoption enjoys robust and almost universal support. Another major conclusion is that the exporting

activities of Indian multinationals are more effective vehicles to induce domestic technology improvement than their overseas investments, which instead act as substitutes for such efforts. However, we caution that outward-oriented firms may have higher returns to technology investment, and this should be taken into account when designing technology policies.

On the other hand, we did not find evidence that exporting non multinational firms always invest more in technology than non-exporting ones. Rather the nature of this association varies according to the sector and type of technology.

We have conducted further robustness analysis and confirmed that our conclusion that export-oriented Indian Multinationals are an effective channel of technology transfer to the local economy is not driven by reserve causality problem. We also conclude that this finding is unlikely to be driven by the choice of industries this study has focused on.

Overall, this study has contributed to academic efforts that seek to pin down the channels through which the choice of foreign market participation shapes firms' competitive advantages.

Appendix A.2.1: Definition of variables

Variable	Definition
Technology investment	The sum of real expenditures on own R&D, computers and software, royalty fees and imports of capital goods scaled by total assets (in logs)
Knowledge investment	The sum of real expenditures on own R&D, software and royalty fees scaled by total assets (in logs).
Physical technology investment	The sum of real expenditure on computers and imports of capital goods scaled by total assets (in logs)
Size	Log of total sales
Total factor Productivity	Log of total factor productivity estimated based on 3-input (labour cost, value of fixed capital and cost of intermediate material inputs) production function using the Levinshon-Petrin (2003) technique which accounts for the endogeneity of inputs.
Profitability	After tax profits divided by sales
Age	Firm age since incorporation.
Exports intensity	Exports/total sales
Finance	Measure of external finance : total bank loans divide by total assets
Outwards FDI	Investment by Indian multinationals in their overseas subsidiaries divided by total sales.
Inwards FDI	The share of foreign finance in the firms' total equity.

Chapter 3

Innovation and technological convergence: the role of technology investments and international activities

Technological transfer is considered an important source of productivity growth for countries and firms lagging behind the technological frontier. In this chapter we borrow a model of technological convergence from the macroeconomic literature of economic growth to examine the process of productivity growth amongst Indian manufacturing and service firms. We examine the individual and complementary roles of technology investments and international activities in stimulating innovation and technological convergence; two potential sources of firm's productivity growth.

3.1. Introduction

It is now well-understood that technological progress is the most significant determinant of long-run economic growth and welfare. For most nations, this process requires not only the development of in-house technological improvements but also, and perhaps more importantly, the acquisition of foreign technology. The fact that only few countries are responsible for the bulk

of knowledge creation in the world[9], and that even within these countries a very small proportion of companies are responsible for the lion's share of research and development (R&D) activities[10] illustrates the importance of international technological transfer for countries and firms lagging behind the technology frontier. With the view of facilitating foreign technology transfer and allowing domestic firms to catch up to the technological frontier, during the past three decades policy makers from a number of developing countries have undertaken outward-oriented economic reforms and strengthened links with international markets. Alongside liberalization reforms, governments from these countries have also acknowledged the importance of developing local absorptive capacity through active science and technology policies. Yet, despite these well known efforts, the analysis of the *relative* importance of international linkages and in-house technology investments as vehicles of firms' technology transfer have received little attention in the literature. This chapter contributes to filling this gap by examining in a single framework the contribution of these activities in stimulating the process of productivity growth at the firm level. Borrowing from the macroeconomic literature of economic growth, this chapter employs a convergence model that jointly accounts for innovation and technological convergence as the main sources of productivity growth[11]. In contrast with

[9] Only five of the richest countries accounted for more than 87% of all patents granted between 1963 and 2008 by United States Patent and Trademark Office, the largest recipient of patent filings (USPTO, 2008).

[10] According to data compiled by the United Kingdom's Department Business Innovation and Skills, the largest 1000 firms – most of which are multinational companies (MNCs)- spent £395 billion on R&D in 2008 alone (http://www.innovation.gov.uk/rd_scoreboard/?p=38)

[11] Classic references examining convergence at the aggregate level include Baumol, 1986; Baumol and Wolff, 1988; Dollar and Wolff, 1988, 1994; Dowrick and Nguyen, 1989; Barro and Sala-i-Martin, 1992, 1995, 2003; Bernard and Durlauf, 1995, 1996; Ben-David, 1993, 1994, 1996; Cheung and Pascual, 2004; Bernard and Jones, 1996; Pascual and Westermann, 2002; and Cameron et al., 2005).

abundant work at the country and industry levels, the simultaneous analysis of the process of innovation and technology transfer at the firm level has received little attention in the empirical literature, despite the acknowledged importance of firms as main agents of technological progress.[12] Examining productivity convergence at the firm level is, therefore, of utmost importance to understanding the macroeconomic processes of international technology diffusion. In addition, notwithstanding the conventional wisdom that international activities (such as trade and FDI) and technology investments speed up the rate of innovation and facilitate convergence, so far little has been researched in this direction at the firm level[13]. We examine the *individual* and *complementary* roles of technology investments and international activities in stimulating the rates of innovation and technology transfer[14]. For policy makers, a clear understanding of the relative roles of in-house technological efforts and the acquisition of foreign technology through global linkages is central for the efficient allocation of scarce resources towards more effective channels of economic growth.

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[12] Some empirical works examining productivity growth and convergence at the firm level include Nishimura. et. al., 2005a 2005b; Chevalier. et. al., 2009; Girma and Kneller, 2006; and Griffith, et. al. (2009).

[13] At the aggregate level some empirical papers analysing the role of trade and FDI on convergence include: Ben-David, 1993, 1994, 1996; Ben-David and Loewy, 1998; Edwards, 1993; Keller, 1998; Frankel and Romer, 1999; Lawrence and Weinstein, 1999; Lichtenberg and la Potterie, 1996; Borensztein et al., 1998; Xu, 2000; Fosfuri et al., 2001, Cameron et.al., 2005; Lee, 2009.

[14] The few empirical works examining productivity growth and convergence simultaneously at the firm level have focused on evaluating the role of some technology investments or some international linkages independently, without taking into account possible interrelations between them. However, as mentioned in the previous chapter, recent developments in international trade theory have pointed out the complementary effects of trade and technology investments in stimulating firms' productivity growth. Scholars from the international business literature have also hypothesized the potential complementary between the firm's choice to invest abroad and its decision to upgrade its technological capability (see for example Cantwell and Piscitello, 2005).

By examining the roles of technology investments and international activities in stimulating innovation and technological transfer, this chapter is related to a larger body of literature addressing the importance of technology investments in directly stimulating firm's productivity growth [15] and the works that also emphasize their role in strengthening firm's absorptive capacity to assimilate external knowledge (e.g. Levin et al., 1987 and Cohen and Levinthal, 1989). It also relates to the extensive body of empirical work examining the role of trade and FDI as channels for international technology transfer[16].

Controlling for unobserved firm heterogeneity, the endogeneity of some model regressors and the potential sample selection problem, our analysis yields the following core five results. First, technological convergence is an important source of productivity growth for firms lagging behind the technological frontier. Thus, the greater the productivity distances from the frontier, the higher the rate of productivity growth. Interestingly, service firms converge faster than manufacturing firms. Second, in line with our findings from the first chapter, we also find that the productivity-export nexus differ for multinational and non multinational companies. Thus, in the case of Indian multinational firms exporting exerts a positive direct impact on firm's productivity growth by stimulating the rate of innovation, whereas in the case of non-multinational companies it plays an indirect positive role by accelerating the process of technological convergence. Third, Indian multinationals with high levels of

[15] See Mohnen (1996) for a survey of this literature.

[16] We refer to Keller (2004) for a review of this literature.

outward FDI converge faster to the technological frontier than firms with no or low overseas investments. Finally, we find important synergistic effects between firms' technological and international activities in stimulating productivity growth either through innovation or technological convergence. In the case of the manufacturing sector, there are important innovation-enhancing effects from investing in technology and participating in global markets via exports, overseas investments or inward FDI, whereas service firms that invest in technology and invest abroad or received foreign investments converge faster to the technological frontier.

The remainder of this chapter is structured as follows. Section 3.2 describes the model of productivity growth and technological convergence used in this paper. Section 3.3 presents the empirical model. Section 3.4 describes the dataset and sample characteristics. Section 3.5 discusses the main findings and section 3.6 concludes.

3.2. A model of productivity growth and technological convergence

As mentioned in the introduction of this chapter, our main interest lies in examining innovation and technological convergence at the firm level and evaluating the roles of technology investments and international activities in determining these processes. To this aim, we borrow from the macroeconomic literature of economic growth a convergence model that jointly accounts for innovation and technological convergence, two main sources of productivity

growth (i.e. Bernard and Jones, 1996). The application of this approach to the firm level allows us to capture differences in the level of productivity across firms, productivity persistence over time and firm's technological convergence. For a follower firm, *i,* productivity evolves according to Equation 3.1:

$$\ln \varphi_{i,t} = \gamma_i + \ln \varphi_{i,t-1} + \lambda \ln D_{i,t-1} + \ln \varepsilon_{it} \quad (3.1)$$

Where:

$$\ln D_{i,t-1} = \ln \varphi_{F,t-1} - \ln \varphi_{i,t-1}$$

In Equation 3.1 $\ln \varphi_{i,t}$ is the logarithm of firm's *i* productivity level in time *t.* Persistence is captured by including firm's previous productivity level, $\ln \varphi_{i,t-1}$, as a determinant of current productivity. The parameter γ_i captures firm *i*'s own rate of innovation generated by its underlying specific efficiency level. The technological gap or *potential* for technological convergence is denoted by $\ln D_{i,t-1}$ and is defined as the distance in productivity between firm *i* and the firm with the highest productivity level in the industry, F. The speed of convergence, defined as the average year by year reduction in the productivity gap, is capture by the parameter λ. Finally, $\ln \varepsilon_{it}$ measures the error term.

By definition, for the frontier firm, *F*, innovation constitutes the sole source of productivity growth. Hence the technological gap term is excluded from its productivity equation:

$$\ln \varphi_{F,t} = \gamma_F + \ln \varphi_{F,t-1} + \ln \varepsilon_{Ft} \quad (3.2)$$

Combining Equations 3.1 and 3.2, the evolution of productivity for a non-frontier firm *i relative* to that of the industry frontier, $\varphi^*_{i,t} = \varphi_{i,t} / \varphi_{F,t}$, can be expressed (in logarithms) as:

$$\ln \varphi^*_{i,t} = \gamma^*_i + (1-\lambda)\ln \varphi^*_{i,t-1} + u_{i,t} \tag{3.3}$$

Where:

$$\ln \varphi^*_{i,t} = \ln \varphi_{i,t} - \ln \varphi_{F,t}$$

$$\ln \varphi^*_{i,t-1} = \ln \varphi_{i,t-1} - \ln \varphi_{F,t-1} = -\ln D_{i,t-1}$$

$$\gamma^*_i = \gamma_i - \gamma_F$$

$$\ln \varepsilon^*_{it} = \ln \varepsilon_{it} - \ln \varepsilon_{Ft}$$

Thus, in Equation 3.3 $\ln \varphi^*_i$ is the logarithm of firm's *i relative* productivity level; γ^*_i captures its *relative* efficiency level, $\ln \varphi^*_{i,t-1}$ measures its productivity gap or potential for catching up, and $\ln \varepsilon^*_{it}$ is a transformed measure of the error term.

3.2.1. Annual relative productivity growth rate

Rearranging Equation 3.3, firm's *i* relative productivity growth rate between the years *t* and *t-1* can be expressed as:

$$\Delta \ln \varphi^*_{i,t} = \ln \varphi^*_{i,t} - \ln \varphi^*_{i,t-1} \Rightarrow$$

$$\Delta \ln \varphi^*_{i,t} = \gamma^*_i - \lambda \ln \varphi^*_{i,t-1} + \ln \varepsilon^*_{it} \tag{3.4}$$

Equation 3.4 constitutes the baseline specification for most of our econometric estimations, but we also consider a number of generalizations in our empirical approach. Positive and significant values of λ are interpreted as evidence of technological convergence, indicating that lagged productivity gaps between firms increase the productivity growth rate of the less productive firms. In the particular case when the rates of innovation between firm *i* and the frontier are the same (i.e. $\gamma_i^* = \gamma_i - \gamma_F = 0$) positive and significant values of λ can be interpreted as a tendency for firms to converge to the same productivity levels. However, the existence of differences in firms' underlying capabilities ($\gamma_i \neq \gamma_F$) imply that this convergence is *conditional* rather than absolute. That is, firms converge to their own steady-state levels of efficiency without necessarily catching up with the industry leader. Thus, differences in firms' specific efficiency levels reconcile productivity convergence with the well documented stylized fact of productivity dispersion across firms within the industry.

3.2.2. Average annual relative productivity growth rate

Equation 3.3 may also be used more generally to solve for *higher-order difference equations*. Taking the difference equation in Equation 3.3 and solving for t = T yields:

$$\ln \varphi_{i,T}^* = \sum_{s=0}^{T} (1-\lambda)^{T-s} (\gamma_i - \gamma_F) + (1-\lambda)^T \ln \varphi_{i,0}^* + \sum_{s=0}^{T} (1-\lambda)^{T-s} \ln \varepsilon_{i,s}^* \qquad (3.5)$$

From Equation 3.5, the *average annual relative productivity growth rate* between time 0 and T, $\Delta\varphi^{*}_{i,T} = \dfrac{\ln\varphi^{*}_{i,T} - \ln\varphi^{*}_{i,0}}{T}$, can be expressed as:

$$\Delta\varphi^{*}_{i,T} = \frac{1}{T}\sum_{s=1}^{T}(1-\lambda)^{T-s}(\gamma_i - \gamma_F) - \frac{1-(1-\lambda)^{T}}{T}\ln\varphi^{*}_{i,0} + \frac{1}{T}\sum_{s=1}^{T}(1-\lambda)^{T-s}\ln\varepsilon^{*}_{i,s} \quad (3.6)$$

Equation 3.6 has been extensively used to estimate long run productivity growth rates and convergence. The procedure commonly involves setting T large enough and conducting *cross sectional estimations* of the average annual relative productivity growth rate between year 0 and year T on initial relative productivity level.

To make our results comparable with previous research, we start our empirical approach estimating Equation 3.6 using information for the years 1999 and 2007. However, estimating firm's productivity growth and convergence using cross-sectional analysis has several drawbacks. A major problem is the difficulty in accounting for firm's unobserved underlying capabilities. In addition, cross-sectional analyses commonly ignore the role played by firms that started their business operations after the initial period, which are likely to affect the process of productivity growth and convergence. Moreover, an important characteristic of Indian business activity in recent years has been the *gradual* process of internationalization and technology upgrading undertaken by Indian firms in response to ongoing trade and FDI liberalization. To take into account new entries, and to fully capture the effects of gradual internationalization and technological upgrading on firms' productivity growth, most of our empirical

analysis focuses on estimating Equation 3.4 using our whole panel of firms during the period 1999-2007.

3.3. Empirical strategy

To evaluate the patterns of firm's productivity growth, we employ relative total factor productivity (TFP_i^*) as a measure of firm's productivity[17]. We start estimating Equations 3.4 and 3.6 assuming that innovation and convergence occur *passively* without any effort by firms to speed them up. Then, we extend our analysis to allow international and technological activities to play an *active role* in stimulating both rates of innovation and technological convergence. Finally, we consider a number of robustness tests to address potential econometric concerns.

3.3.1. Passive technological convergence: baseline models

a) Firm's average annual relative productivity growth rate: cross sectional analyses

We start estimating Equation 3.6 for the years 1999 and 2007 using cross sectional analyses. Since we can only observe the dependent variable, $\Delta\varphi_{i,T}^*$, for

[17] We discuss our approach to constructing TFP in the next section.

firms that survived between 1999 and 2007 it is necessary to control for *sample selection* because firms' exit decisions are likely to be correlated with their productivity levels (Nishimura and Kiyota, 2005). Thus, if the missing data in our dataset results from self-selection, then, applying standard methods may lead to inconsistent estimations. In our empirical approach, we use the Heckman two-steps estimator to correct for sample selection[18]. We simplify Equation 3.6 as follows:

$$\Delta TFP^{*}_{i,T} = \beta_0 + \beta_1 \ln TFP^{*}_{i,0} + \omega_{i,T1} \tag{3.7}$$

Where:

$$\beta_1 = -\frac{1-(1-\lambda)^T}{T}$$

$$w_{i,T1} = \frac{1}{T}\sum_{s=0}^{T}(1-\lambda)^{T-s}(\gamma_i - \gamma_F + \ln \varepsilon^{*}_{i,s})$$

$$w_{i,T1} \sim N(0, \sigma^2)$$

$$Cov(\ln \varphi^{*}_{i0}, w_{iT1}) = 0$$

The initial period (t=0) corresponds to the year 1999 and the final period (t=T) to 2007. Equation 3.7 implies an implicit speed of convergence $\lambda = 1-(\beta_1 T + 1)^{1/T}$. Negative and significant values of β_1 are interpreted as evidence of *conditional* technological convergence (or β *-convergence*). As mentioned in the previous section, only when firm *i*'s rate of innovation equals

[18] For comparison purposes, we also estimate Equation 3.6 using the Heckman Maximum Likelihood estimator. The results resulting from this estimator (no reported here) are similar to those obtained from using the Heckman two-steps estimator.

that of the frontier firm, do negative values of β_1 provide evidence of absolute convergence. In our cross-sectional approach we collapse firm's relative efficiency into the error term and assume that this term is not correlated with firm's initial productivity level. Our baseline speed of convergence Equation 3.7 is estimated controlling for firm size and a set of industry dummies.

To control for sample selection, we estimate Equation 3.7 jointly with the following selection model describing firm's survival between time 0 and time T, s_{iT} :

$$s_{iT} = 1[s_{iT}^{*} > 0] = 1[z_{i0}\delta_0 + w_{i,T2}] > 0] \quad (3.8)$$

Where:

$$s_{iT}^{*} = z_{i0}\delta_0 + w_{i,T2}$$

$$w_{i,T2} \sim N(0,1)$$

$$E(w_{i,T2} \mid z_{i0}) = 0$$

The selection indicator, s_{iT} , is equal to one if $\Delta \ln TFP_{i,T}^{*}$ is observed. Survival is determined by the latent variable, s_{iT}^{*} , whose realization depends on a vector of firm characteristics identified in the literature as key determinants of firm survival, z_{i0} . Variables in z_{i0} include firm productivity, size, ownership structure, the log of total capital, technology investments and international market activities. A significant correlation between the errors in the survival and productivity growth equations points to evidence of the existence of a sample

selection bias and hence, the necessity of incorporating the selection equation into the analysis.

b) Firm's annual relative productivity growth rate: panel data analyses

As mentioned in section 3.2, estimating firm's productivity growth and convergence using cross-sectional analysis as described previously has several drawbacks, including the limitation in dealing with firms' unobserved efficiency, the difficulty in capturing the effects of firms that entered the market after 1999 and the role of the gradual process of internationalization and technological upgrading recently undertaken by Indian firms in response to ongoing trade and FDI liberalization. In order to deal with these issues, we estimate Equation 3.4 using our whole panel of firms during the period 1999-2007. In our empirical approach we express Equation 3.4 as follows:

$$\Delta \ln TFP^{*}_{i,t} = \beta \ln TFP^{*}_{i,t-1} + f_i + u_{i,t1} \tag{3.9}$$

$$\beta = -\lambda$$

We control for firm's specific efficiency by including an unobserved firm effect, f_i, which may be correlated with $\ln TFP^{*}_{i,t-1}$ (and with other explanatory variables in extended versions of Equation 3.9). We start estimating the baseline specification 3.9 controlling for firm size only. Again, negative and significant values of β are interpreted as evidence of conditional convergence (or β-convergence).

We estimate Equation 3.9 using the dynamic panel data estimator due to Blundell and Bond (1998). This estimator allows us to address potential econometric concerns such as endogeneity of the model regressors, unobserved firm heterogeneity and serial correlation of the error term. It also helps us deal with potential spurious regressions due to measurement errors in relative TFP. Since $\ln TFP_i^*$ appears on both the right and left hand sides of our regression specification, measurement errors in $\ln TFP_i^*$ could induce spurious contemporaneous correlation between $\Delta \ln TFP_{i,t}^*$ and $\ln TFP_{i,t-1}^*$. The system-GMM estimator helps us address this problem by instrumenting relative TFP using lagged values of the TFP gap term. Finally, to deal with the potential sample selection problem discussed previously, we adapt the parametric estimation procedure developed by Semykina and Wooldridge (2010) to estimate panel data models with sample selection in the presence of endogenous regressors and unobserved heterogeneity. Briefly, the application of this procedure to our analysis consists of: i) introducing and estimating a survival equation for each period of time using Probit models, ii) calculating the inverse Mills ratios using the estimate results from these period-specific Probit regressions and iii) estimating Equation 3.9 including the inverse Mills ratios as additional right-hand side variables.

In our empirical approach we employ the following selection model of firm survival between time *t* and *t-1*:

$$s_{it} = 1[s_{it}^{*} > 0] = 1[z_{it}\delta_t + \alpha_i + u_{i,t2}] > 0] \quad (3.10)$$

$$s_{it}^{*} = z_{it}\delta_t + \alpha_i + u_{i,t2}, \quad t = 1,.....T$$

Where s_{it} is equal to 1 if the firm survives between *t* and *t-1*. Survival depends on a vector of observed firm characteristics z_{it}, an unobserved firm effect, α_i, and an idiosyncratic error term, $u_{i,t2}$. As before, variables in z_{it} include firm productivity, size, ownership structure, the log of total capital, technology investments and international market activities.

Estimating Equation 3.10 with probit models in the presence of unobserved firm effects yields inconsistent estimates because of the incidental parameter when the year dimension is smaller than the firm dimension. Instead, Semykina and Wooldridge (2010) assume that the unobserved effect can be modelled as a linear function of the average of the variables in z_{it}:

$$\alpha_i = \bar{z}_i\xi_t + a_i \quad (3.11)$$

$$\bar{z}_i = T^{-1}\sum_{t=1}^{T} z_{it}$$

Where a_i is a well-behaved error term. Combining Equations 3.10 and 3.11 gives:

$$s_{it} = 1[z_{it}\delta_t + \bar{z}_i\xi_t + v_{i,t2} > 0] \quad (3.12)$$

$$v_{i,t2} = a_i + u_{i,t2}$$

Thus, to correct for selection bias in our unbalanced panel data set, we first use the probit model to estimate the probability of survival in each period of time *t*:

$$P(s_{it} = 1 | z_{it}) = \Phi[z_{it}\delta_t + \bar{z}_i\xi_t] \quad (3.13)$$

Then, we calculate the inverse Mills ratios, $\hat{\Omega}_{i,t} = \Omega[z_{it}\hat{\delta}_t + \bar{z}_i\hat{\xi}_t]$ using the estimated coefficients from the above Probit regressions[19]. Finally, we include $\hat{\Omega}_{i,t}$ in our GMM estimation of Equation 3.9 as additional right hand-side variables[20].

3.3.2. Active convergence: the role of international activities and technology investments

Equation 3.4 treats γ_i^* and λ as parameters. However, firms' technology investments and international activities may affect firms' productivity growth directly (i.e. through rates of innovation) or indirectly (i.e. through their ability to catch up with the technological frontier). To capture these effects, we extend

[19] For each year, the inverse Mills ratio is calculated as the ratio between the normal distribution density function and the standard cumulative normal distribution, $\Omega(.) = \phi(.)/\Phi(.)$.

[20] While, the correction procedure for sample selection proposed by Semykina and Wooldridge (2010) was based on the pooled two stages least squares estimator, their approach can be extended to more efficient GMM estimators (See Semykina and Wooldridge, 2010. P. 378).

our analysis to allow both innovation and technological convergence to be functions of firm's international and technological activities:

$$\gamma_i^* = \eta_i + \psi x_{i,t-1} \tag{3.14}$$

$$\lambda = b + \xi x_{i,t-1} \tag{3.15}$$

Where $x_{i,t}$ is a vector including firms' technology investments, exporting and outward and inward FDI. Substituting Equations 3.14 and 3.15 into Equation 3.4 yields:

$$\Delta \ln \varphi_{i,t}^* = \eta_i + \psi x_{i,t-1} - (b + \xi x_{i,t-1}) \ln \varphi_{i,t-1}^* + u_{i,t} \tag{3.16}$$

In our empirical approach we estimate Equation 3.16 as:

$$\Delta \ln TFP_{i,t}^* = \psi x_{i,t-1} + b \ln TFP_{i,t-1}^* + \xi x_{i,t-1} \ln TFP_{i,t-1}^* + f_i + u_{i,t} \tag{3.17}$$

Thus, Equation 3.17 is simply an extension of Equation 3.9, allowing technology investments and international activities to affect both rates of innovation and technological convergence. The term $\psi x_{i,t-1}$ is an indicator of the direct impact of variable $x_{i,t-1}$ on firm productivity through innovation. If the variable $x_{i,t-1}$ increases productivity growth through innovation, the coefficient ψ should be significantly positive. The coefficient b measures firm's "autonomous" technological convergence (i.e. through learning by doing) and the term $\xi x_{i,t-1}$ captures the effects of $x_{i,t-1}$ on the speed of technological convergence (i.e. through increasing firm's absorptive capacity to assimilate

technology). If $\xi < 0$ we say that the speed of technological convergence is increasing in $x_{i,t-1}$. In other words, $x_{i,t-1}$ contributes to accelerating the process of convergence of firms further behind the industry frontier. We estimate Equation 3.17 using the system-GMM estimator controlling for sample selection, as described previously.

3.3.3. Robustness tests

We consider a number of robustness tests to address potential econometric concerns. First, we check the robustness of our results to time, as the literature on productivity convergence has shown that the speed of convergence might be sensitive to time. Another important concern when estimating speed of convergence equations is to obtain accurate measures of firm's productivity level. As we have mentioned, since ln*TFP** appears on both the right and left hand sides of the equation, measurement errors in ln*TFP** could induce spurious correlation between productivity growth and past productivity levels. The system-GMM estimator helps us deal with this problem by instrumenting ln*TFP** using lagged values of this term. However, we further address potential measurement errors in relative TFP by substituting our technological gap term with a series of dummies using the quintiles of the productivity distribution where a firm lies. As noted by Griffith, et al. (2009) while it may be difficult to measure the exact levels of firms' productivity, the quintile of the productivity distribution to which they belong should involve less measurement error.

Finally, we employ an alternative measure of productivity (i.e. labour productivity) to verify the hypothesis of technological convergence.

3.4. Dataset description and sample characteristics

From the Prowess database we use a longitudinal panel of service and manufacturing firms for the years from 1999 to 2007. We delete the upper and lower 0.5% quintile of the variables used in the regression to control for outliers. This leads us to an unbalanced panel of 9,855 firm-year observations belonging to the service sector and 26,641 firm-year observations operating in the manufacturing sector.

In this paper we use the Levinshon-Petrin (2003) technique to estimate TFP. An important advantage of this technique over other traditional econometric estimations lies in its ability to control for the well known problems of simultaneity [21] and selection bias [22] that arise when estimating TFP. Our estimations of TFP are based on a three-input (labour, fixed capital and material inputs) production function. Since the PROWESS dataset does not have a full

[21] The problem of simultaneity occurs when firms (knowing their productivity level) increase the use of their inputs as a result of positive productivity shocks. Hence, avoiding biased estimated parameters requires controlling for unobserved productivity shocks. As opposed to traditional fixed effect production function estimations, the Levinshon-Petrin (2003) technique controls for time-variant productivity shocks that are correlated with the inputs. Firm's investments are used to proxy for these unobserved time-varying productivity shocks.

[22] Selection bias occurs if the probability that a firm exits the market is negatively related to its capital stock. Thus, in the presence of a negative productivity shock firms with lower capital stocks are more likely to exit the market than firms with larger capital stocks. To control for this selection bias, Levinshon-Petrin (2003) use survival probabilities in the estimation procedure.

set of labour input figures (e.g. number of total employees) we proxy this variable with the total wage bill paid to employees. In order to check the sensitivity of our results to the construction of TFP, we use an alternative measure of productivity, the log of value added per wage (a proxy of labour productivity). The other main variables used in the regression analysis are defined in Appendix A.3.1.

3.4.1. Productivity gap and productivity growth rate

Tables 3.1 and 3.2 present the average productivity gap and the average annual productivity growth rate for the manufacturing and service sectors during the period 1999-2007. The scope for catching up was, in general, higher amongst service firms operating across different economic activities. In addition, the annual productivity growth rate was, on average, higher in the service sector, with the TFP growing at an average annual rate of 10% compared to 2% in the manufacturing sector. It is also worth noting the substantial dispersion in the scope for catching up and the productivity growth rates across firms in both sectors, as judged by the high levels of the standard deviations of these two variables. A comparison of the levels of dispersion across different economic activities in both sectors indicates that the level of dispersion was in general higher amongst service firms. Similar patterns can be observed by examining the Kernel density distribution of relative TFP and TFP growth plotted in Figures 3.1 and 3.2.

Table 3.1. Average productivity gap and average productivity growth rate by economic activity

Manufacturing sector

Period 1999-2007

Activity	Gap		Growth rate	
	Mean	Std. Dev.	Mean	Std. Dev.
Vegetable oils and products	4.7	1.6	-0.03	0.52
Products of food, beverages and tobacco	4.4	1.7	0.00	0.52
Textile and cloth	4.1	1.4	0.01	0.51
Footwear and other leather products	2.2	1.2	0.02	0.47
Wood	2.0	1.2	0.02	0.65
Paper and Paper products	3.3	1.3	0.02	0.34
Chemical and pharmaceutical products	5.1	1.5	0.02	0.46
Plastic and rubber products	3.0	1.4	0.02	0.43
Cement and other non-metallic mineral	5.8	1.7	0.04	0.77
Metal products	5.2	1.7	0.01	0.52
Machinery and equipment	3.9	1.4	0.00	0.53
Electrical machinery	2.8	1.3	0.02	0.39
Electronics	4.8	1.7	0.05	0.66
Vehicles and transport equipment	3.8	1.5	-0.01	0.31
Misc. manufactured articles	3.3	1.6	0.04	0.60
Average/total	**4.3**	**1.8**	**0.02**	**0.50**

Table 3.2. Average productivity gap and average productivity growth rate by economic activity

Service sector

Period 1999-2007

Activity	Productivity Gap		Growth Rate	
	Mean	Std. Dev.	Mean	Std. Dev.
Air transport	4.9	1.7	-0.03	0.63
Animation content provider	5.4	2.3	0.40	1.09
Banking services	9.0	2.0	0.14	0.76
Brokers	7.4	2.2	0.42	1.39
Business consultancy	4.8	1.8	0.08	0.88
Commercial complexes	5.2	2.0	0.20	1.42
Computer software	4.0	1.6	0.03	1.03
Courier services	3.9	1.6	0.00	0.41
ITES	4.4	1.5	0.26	0.94
Media-broadcasting	4.6	1.4	0.03	1.04
Media-content	4.5	1.6	0.21	1.27
Non-banking financial corp.	6.9	2.1	0.20	1.43
Other financial services	6.6	2.1	0.15	1.18
Production, distribution & exhibition of films	4.5	1.6	0.04	1.29
Securities and stock traders	6.8	2.0	0.12	1.05
Shipping	5.7	1.9	-0.09	0.95
Telecommunication services	5.5	2.1	0.08	1.14
Tourism	4.1	1.3	-0.16	0.52
Transport support services	4.1	1.7	0.07	0.79
Other misc services	4.7	1.7	0.09	0.77
Average/total	**5.4**	**2.2**	**0.10**	**1.07**

Figure 3.1: Distribution of relative TFP

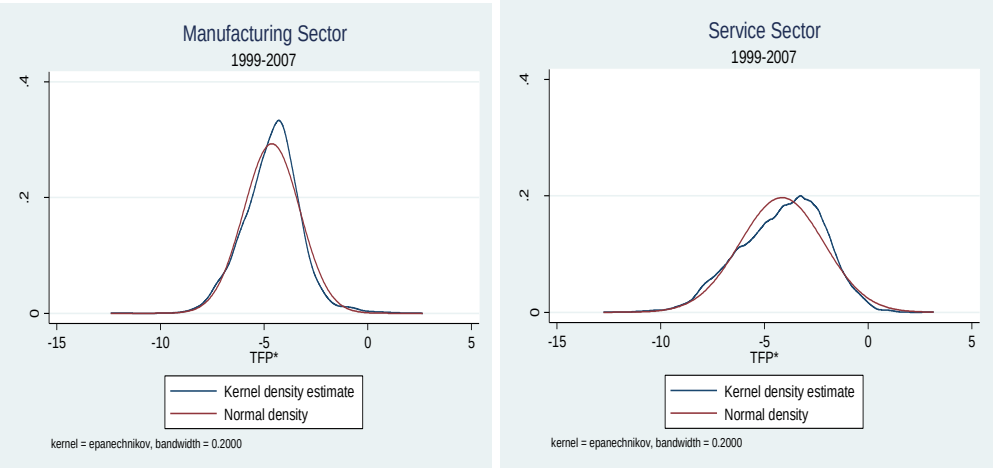
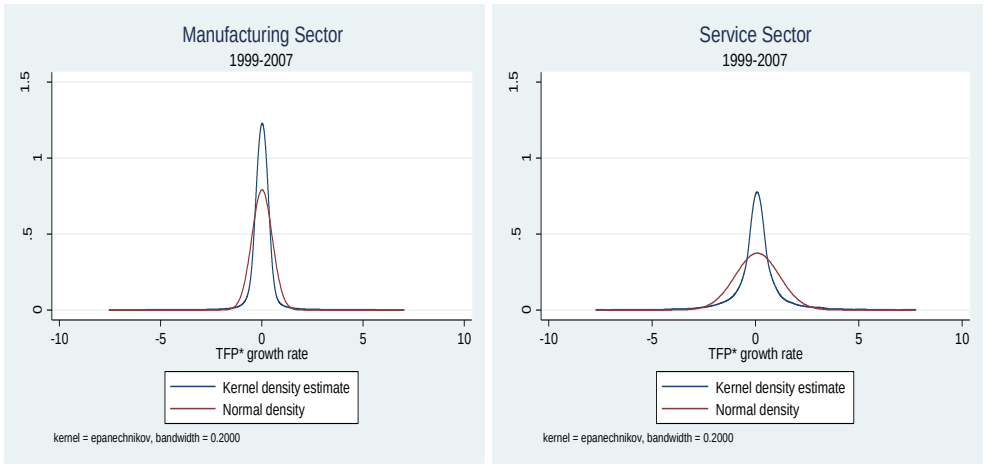


Figure 3.2: Distribution of relative TFP growth



3.4.2. Productivity dynamics

While our data shows substantial variation in firms' productivity gaps and productivity growth rate, we also find important transitions in firms' productivity levels, in particular in the service sector. Table 3.3 presents the proportion of firms that transited between quintiles within their industry TFP

distribution from 1999 to 2007. It can be observed that the fraction of firms moving up or down the TFP distribution was higher amongst service firms. It is also worth noting that, in general, firms with intermediate productivity levels in both sectors were more likely to transit from one TFP quintile to another, whereas, firms in the extremes of the distribution displayed higher degrees of persistence in their productivity levels.

Table 3.3: Transition Matrices

Period: 1999-2007

Manufacturing Sector

Percentage

Quintile of TFP distribution in 1999	**Quintile of TFP distribution in 2007**				
	1	2	3	4	5
1	87	10	1	1	1
2	9	75	14	1	1
3	1	12	69	17	2
4	1	2	12	70	16
5	1	1	2	10	87

Service sector

Percentage

Quintile of TFP distribution in 1999	**Quintile of TFP distribution in 2007**				
	1	2	3	4	5
1	73	17	5	3	2
2	13	60	18	6	3
3	3	15	57	20	5
4	2	5	15	59	20
5	1	3	5	14	77

We also examine the transition matrices for groups of firms classified according to their participation in international activities and their technology investment status. Table 3.4 shows the percentage of firms that moved up, down, or remained in the same productivity quintile according to their international activities and Table 3.5 reports similar results for groups of firms classified according to their technology investments. From Table 3.4 it can be observed that domestic manufacturing firms without any type of international engagement in 1999 were more likely to move up in the productivity distribution, whereas a large percentage of firms with global linkages were more likely to stay in the same quintile. Interestingly, an important fraction of non-exporting Indian multinationals moved down in the distribution. In the service sector there was a more homogeneous pattern of productivity transition across firms with different global status. However, it is also worth noticing the large fraction of non exporting Indian multinationals that dropped in their productivity distribution.

Table 3.4: Transition Matrices by International Activities

Period: 1999-2007

Manufacturing Sector

Percentage

International status in 1999	Stay	Move up	Move down	Total
Domestic firms	74	15	11	100
Exporters	80	11	9	100
Exporters Multinationals	89	4	6	100
Multinationals non exporters	87	3	11	100
Foreign firms	82	11	7	100

Service Sector

Percentage

International status in 1999	Stay	Move up	Move down	Total
Domestic firms	65	21	15	100
Exporters	69	17	13	100
Exporters Multinationals	68	17	16	100
Multinationals non exporters	68	14	18	100
Foreign firms	64	20	15	100

Table 3.5 shows that manufacturing firms that were not engaged in any technological investments in 1999 were more likely to transit up and down in their probability distribution, whereas most firms that had already invested in technology remained in the same position. In line with our previous results, Table 3.5 also shows that the pattern of productivity transition according to firms' productivity status was more homogeneous in the service sector.

Table 3.5: Transition Matrices by Technological Status

Period: 1999-2007

Manufacturing Sector

Percentage

Technological status in 1999	Stay	Move up	Move down	Total
Did not invest in technology	74	16	11	100
Invested in technology	82	10	9	100

Service Sector

Percentage

Technological status in 1999	Stay	Move up	Move down	Total
Did not invest in technology	65	20	15	100
Invested in technology	68	16	16	100

3.4.3. Productivity dispersion

As commented in the previous section, our model of convergence allows us to test the hypothesis of conditional convergence (or β-convergence). That is, the hypothesis that firms with greater productivity gaps or *potential* for catching up display higher productivity growth rates. However, a verification of this hypothesis does not necessarily imply that there will be a decrease in the dispersion in the levels of productivity across firms. A confirmation of the hypothesis of conditional convergence might simply indicate that firms are closing the gap between their current positions and their own steady-state level of productivity relative to the industry frontier. As such, conditional convergence is perfectly compatible with divergence in the levels of productivity. Anything that drives apart the efficiency levels in low and high productive firms will lead to an increase in productivity dispersion.

The notion that low productive firms will catch up with the productivity *levels* of the most productive firms is referred in the growth literature as *absolute* convergence or σ-convergence. Absolute convergence implies that there will be a decrease in the dispersion in the levels of productivity across firms over time[23]. An inspection of the evolution of the standard deviation of TFP during 1999 and 2007, plotted in Figure 3.3, indicates that there has been an increase in the dispersion in the productivity levels across manufacturing firms, whereas in the case of the service sector such dispersion has slightly decreased during the

[23] For an extensive discussion about β-convergence and σ-convergence we refer to Barro and Sala-i-Martin (1995) and Temple (1999).

period of analysis. An examination of changes in productivity dispersion across industries in both sectors reported in Tables 3.6 and 3.7 also indicates that while there was a generalized increase in productivity variability across most industries in the manufacturing sector, the average standard deviation of TFP decreased in a number of industries in the service sector. These trends suggest that any evidence supporting the hypothesis of β-convergence amongst manufacturing firms would indicate that a large fraction of firms have been converging to their own steady state levels of efficiency without necessarily catching up with the productivity levels in the frontier. As for the case of the service sector, a confirmation of the hypothesis of conditional convergence would indicate that firms in some industries might have also been catching up with the frontier.

Figure 3.3: Evolution of Productivity Dispersion
1999-2007

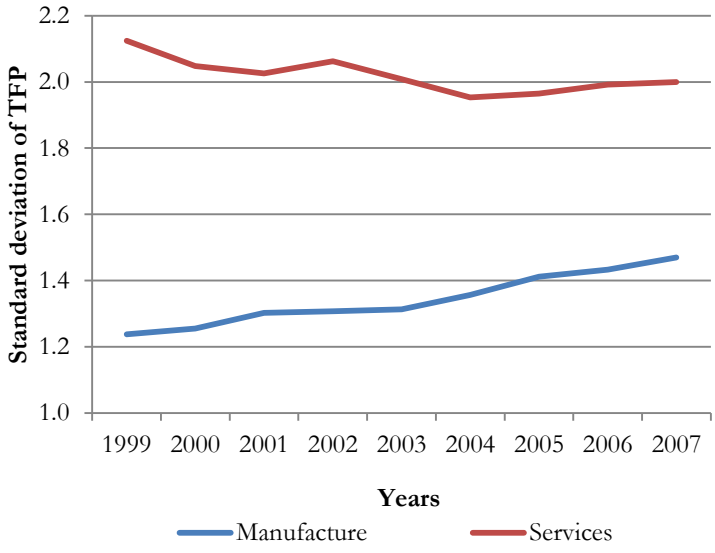


Table 3.6: Change in productivity dispersion 1999-2007

Manufacturing Sector

TFP standard deviation

Activity	1999	2007	Change
Vegetable oils and products	1.06	1.58	0.51
Products of food, beverages and tobacco	1.16	1.49	0.33
Textile and Cloth	1.14	1.52	0.38
Footwear and other leather products	0.91	1.21	0.30
Wood	1.23	1.15	-0.07
Paper and Paper products	1.27	1.41	0.14
Chemical and pharmaceutical products	1.31	1.41	0.10
Plastic and rubber products	1.07	1.35	0.28
Cement and other non-metallic mineral	1.46	1.73	0.27
Metal products	1.16	1.45	0.30
Machinery and equipment	1.40	1.40	0.00
Electrical machinery	1.13	1.23	0.10
Electronics	1.62	1.67	0.05
Vehicles and transport equipment	1.08	1.29	0.20
Misc. manufactured articles	0.93	1.49	0.55
Average	**1.24**	**1.47**	**0.23**

To formally test the hypothesis of technological convergence and to examine the impact of international activities and technology investments on firm's productivity growth, we now turn our attention to estimate our models of technological convergence using the econometric techniques discussed in the previous section.

3.5. Empirical results

We start examining the hypothesis of passive technological convergence by estimating the relationship between a firm's relative TFP growth and its distance

to the industry TFP frontier. Then, we extend our baseline model to examine the effects of international activities and technology investments in actively affecting firms' productivity growth through innovation and technological convergence. Finally, we consider a number of robustness tests to address potential econometric concerns.

3.5.1. Passive technological convergence

a) Firm's average annual relative productivity growth rate: cross sectional analyses

To make our results comparable with previous research, we start estimating Equation 3.7 with and without selection. We use OLS to estimate the model without selection and the Heckman two-step estimator to control for sample selection. We estimate the baseline model controlling only for firm size and industry specific fixed effects. These results, reported in Table 3.8, support the hypothesis of β-convergence. It can be observed that the productivity gap term is negative and significant in both sectors, indicating that firms further behind the leader in 1999 grew faster between 1999 and 2007 than firms that were closer to the frontier that year. We find that service firms converged faster than manufacturing firms. While the speed of convergence amongst service firms ranged between 11.1% and 11.7% per year, manufacturing firms converged at an

average annual rate of between 7.6% and 8.0% during 1999-2007[24]. These results suggest that the diffusion of technological knowledge is faster in the service sector. As conjectured by Girma and Kenell (2006) and Bernard and Jones (1996) fast convergence amongst service firms might occur because they use similar technologies. We also find that firm size is negatively associated with firm's productivity growth rate, indicating that smaller firms have more scope for productivity improvements than larger firms.

It is worth noticing that the Heckman estimator indicates the necessity of controlling for sample selection, as judged by the negative and significant values of the Mills ratio term. Also, note that the OLS estimator uses only firms that survived between 1999 and 2007, so that it loses 1,644 manufacturing and 316 service firms that exited the market during this period. A main advantage of the Heckman estimator is that it uses both censored and uncensored observations to estimate the speed of convergence.

[24] To obtain the speed of convergence we use the relationship between β_1^l and λ described by Equation 3.7.

Table 3.8: Average Annual Productivity Growth Rate and Convergence

Period: 1999-2007 (Base year = 1999)

Dependent variable: Average annual relative TFP growth rate

	Cross Sectional Analysis			
	OLS		Heckman two-steps estimator	
	Manufacture	Services	Manufacture	Services
Productivity gap	-0.061***	-0.083***	-0.063***	-0.080***
	(0.004)	(0.016)	(0.004)	(0.016)
Size	-0.048***	-0.038***	-0.053***	-0.047***
	(0.003)	(0.011)	(0.003)	(0.011)
Mills-lambda			-0.068***	-0.184*
			(0.019)	(0.090)
Speed of convergence (λ)	7.6%	11.7%	8.0%	11.1%
Number of observations	1,284	187	2,928	503
Censored observations			1,644	316
Uncensored obs.			1,284	187

Notes:

a. Standard errors in parentheses
b. *significant at 10%; ** significant at 5%; *** significant at 1%
c. All specifications include the full set of sectoral dummies

b) Firm's annual relative productivity growth rate: panel data analyses

As we have mentioned, a disadvantage of using cross-sectional analyses to calculate the year-by-year speed of convergence is that the effects of entry are ignored. Our Heckman estimator only uses firms that survived and exited the market during the years 1999 and 2007. But, firms that started their business operations after 1999 are also likely to affect the process of innovation and convergence. To take into account these new entries, we now turn our analysis to estimate the speed of convergence Equation 3.9 using the whole unbalanced panel of firms during the period 1999-2007. This analysis allows us to directly obtain the year-by-year speed of convergence from these estimations. It also

allows us to examine the effects of the *gradual* process of internationalization and technology upgrading recently undertaken by Indian firms. We also take advantage of the panel structure of our dataset to address other econometric concerns mentioned in section 3.3, such as firm heterogeneity, endogeneity, serial correlation in the error term and potential spurious contemporaneous correlation due to measurement errors in TFP.

In Columns 1 and 2 in Table 3.9, we start reporting the estimates from pooled OLS estimations controlling for firm size, year effects and industry specific fixed effects. The speed of convergence resulting from these estimations is significantly faster than the implied speed of convergence reported in Columns 1 and 2 in Table 3.8, suggesting that new entrants play an important role in speeding up the rate of technological convergence.

Table 3.9: Annual Productivity Growth Rate and Convergence

Period: 1999-2007

Dependent variable: Annual relative TFP growth rate

	Panel Data Analysis					
	OLS		**System-GMM**		**System-GMM**	
	Manuf.	**Services**	**Manuf.**	**Services**	**Manuf.**	**Services**
Productivity Gap	-0.097***	-0.161***	-0.055**	-0.102***	-0.070**	-0.144***
	(0.0030)	(0.0087)	(0.0188)	(0.0230)	(0.0242)	(0.0433)
Size	-0.067***	-0.050***	-0.095***	-0.059**	-0.095***	-0.059**
	(0.0021)	(0.0061)	(0.0222)	(0.0200)	(0.0218)	(0.0194)
Inv. Mills ratio					-0.223	0.254
					(0.2247)	(0.2763)
_cons	-0.043	-0.474**				
	(0.0245)	(0.1594)				
Observations	19,728	6,462	19,728	6,462	19,689	6,462
Firms			5,072	2,217	5,066	2,217
Sargan			0.4866	0.3040	0.4608	0.1933
ARtest			0.3041	0.3210	0.3117	0.3253

Notes:

a. Standard errors in parentheses
b. *significant at 10%; ** significant at 5%; *** significant at 1%
c. OLS specifications include the full set of sectoral and time dummies. GMM specifications include the full set of time dummies.

To account for unobserved firm efficiency, we also estimate Equation 3.9 using the system-GMM dynamic panel data estimator due to Blundell and Bond (1998). The results from these estimations with and without controlling for sample selection are reported in Columns 3 to 6 in Table 3.9. The Hansen-Sargan test confirms the validity of the instruments and the Arellano and Bond (1991) test indicates the absence of serial correlation in the equation error. Similar to our previous findings, we find that service firms converged faster than manufacturing firms during the period of analysis.

3.5.2. Active technological convergence: the role of technology investments and international activities

a) Individual effects

As mentioned in the introduction of this chapter, our main purpose is to examine the importance of technology investments and international activities in stimulating firms' productivity growth. In Table 3.10 we extend our speed of convergence Equation 3.9 to introduce a role for these activities. We start examining the individual effects of technology investments and international activities in determining both rates of innovation and technological convergence. This exercise is motivated by the common belief that these activities directly affect the rate of productivity growth and facilitate the convergence process. We also control for other firms' characteristics such the age of the firm and access to external finance. Six notable findings stand out from this analysis:

First, when we augment the baseline specification to include other firms' characteristics, there is a considerable increase in the speed of convergence by comparison with the results reported in Table 3.9. This increase is particularly notorious in the case of the service sector, where firms now appear to catch up at a rate of 37% per year. This result shows that omitting firms' characteristics that affect firms' productivity would lead to negative bias in the speed of convergence.

Second, we confirm that smaller firms grow faster. Similarly, we find evidence that younger firms have greater scope for productivity growth, whereas access to external finance in the form of bank loans does not appear to affect the pace of productivity growth.

Third, the exporting intensity of service firms has a strong positive direct impact on productivity growth by speeding up their innovation rates. One percentage point change in the intensity of exports would induce service firms to increase their productivity growth rate by 0.36 percentage points. In contrast, we fail to find evidence of any significant productivity-enhancing effect from exporting amongst manufacturing firms.

Fourth, there is a negative relationship between outward FDI and firm's innovation rate. One percentage point increase in the intensity of overseas investments reduces the productivity growth rate of manufacturing (service) firms by 0.84 (0.12) percentage points. However, our results show that outward FDI has an indirect positive impact on firm's productivity growth through technological catching up, that is the higher the intensity of overseas investments of Indian multinationals, the faster the rate of technological convergence.

Fifth, service firms with high shares of foreign capital display significantly lower rates of innovation, whereas in the case of the manufacturing sector we fail to find a significant association between inward FDI and firm's productivity growth.

Sixth, contrary to what might have been expected, we fail to find evidence of unconditional positive effects from technology investments on the rate of innovation amongst manufacturing or service firms. However, technology investments play a positive role in facilitating the speed of technological convergence in the service sector.

Table 3.10: Annual Productivity Growth Rate and Convergence

The individual role of technology investments and international activities

Period: 1999-2007

Dependent variable: Annual relative TFP growth rate

	System-GMM	
	Manufacture	**Services**
Productivity gap	-0.133***	-0.370***
	(0.0221)	(0.0097)
Size	-0.139***	-0.126***
	(0.0144)	(0.0078)
Finance	0.001	-0.005
	(0.0059)	(0.0060)
Age	-0.089**	-0.045***
	(0.0319)	(0.0026)
Innovation effects		
Exporting	-0.051	0.364***
	(0.2652)	(0.0669)
Outward FDI	-0.835***	-0.117***
	(0.0677)	(0.0066)
Inward FDI	0.120	-0.433***
	(0.2302)	(0.0538)
Technology Investments	-0.137*	-0.196***
	(0.0686)	(0.0244)

a. Standard errors in parentheses
b. *significant at 10%; ** significant at 5%; *** significant at 1%
c. All specifications include the full set of time dummies.

Table 3.10: Annual Productivity Growth Rate and Convergence

The individual role of technology investments and international activities (cont.)

Period: 1999-2007

Dependent variable: Annual relative TFP growth rate

	System-GMM	
	Manufacture	**Services**
Convergence effects		
Exporting*Gap	-0.064	0.027
	(0.0500)	(0.0177)
Outward FDI*Gap	-0.122***	-0.018***
	(0.0110)	(0.0013)
Inward FDI*Gap	0.029	0.018
	(0.0408)	(0.0157)
Technology Investments*Gap	-0.018	-0.023***
	(0.0098)	(0.0037)
Invmills	0.008	0.687***
	(0.0766)	(0.0392)
Obs	19,536	6,424
Firms	5,066	2,217
Sargan	0.1501	0.1622
ARtest	0.3043	0.3992

a. Standard errors in parentheses
b. *significant at 10%; ** significant at 5%; *** significant at 1%
c. All specifications include the full set of time dummies.

b) Complementary effects between exporting and outward FDI

In Table 3.11 we introduce interaction terms between exporting and firm's multinational status, and evaluate their effects on both rates of innovation and technological convergence. This experiment is motivated by the complementary effects between exporting and outward FDI in stimulating firm's technology efforts found in chapter 1. The experiment here also uncovers evidence of strong innovation-enhancing effects from exporting amongst Indian multinationals in both sectors. One percentage point change in the intensity of exports would induce Indian manufacturing (service) multinationals to increase their productivity growth rate by 0.61 (1.31) percentage points. In contrast, we

find that the export intensity of foreign multinationals operating in the service sector negatively impacts their innovation rates. We also uncover a negative relationship between exporting and firm's innovation rates amongst no multinational firms operating in both sectors. In terms of the effects on firm's technological convergence we find that exporting speeds up the rate of convergence amongst non-multinational firms but reduces the speed of catching up of Indian multinationals. Possibly, the technology gap from the frontier is narrower amongst highly export-intensive Indian multinationals and hence, their scope for catching up is limited.

Table 3.11: Annual Productivity Growth Rate and Convergence: the Complementary Role between Exporting and Multinational Status

Period: 1999-2007

Dependent variable: Annual relative TFP growth rate

	System-GMM	
	Manufacture	**Services**
Productivity gap	-0.122***	-0.405***
	(0.0204)	(0.0138)
Size	-0.125***	-0.123***
	(0.0133)	(0.0081)
Finance	0.010*	-0.013*
	(0.0047)	(0.0067)
Age	-0.065*	-0.048***
	(0.0301)	(0.0030)
Innovation effects		
Exporting	-0.413*	-0.561***
	(0.1960)	(0.1068)
Outward FDI	-1.010***	-0.094***
	(0.0601)	(0.0064)
Inward FDI	-0.050	-0.312**
	(0.2021)	(0.0985)
Technology Investments	-0.285***	-0.286***
	(0.0437)	(0.0193)
Exporting*Indian MNEs	0.610***	1.312***
	(0.1674)	(0.1048)
Exporting*Foreign MNEs	0.550*	-0.584***
	(0.2750)	(0.1349)

a. Standard errors in parentheses
b. *significant at 10%; ** significant at 5%; *** significant at 1%
c. All specifications include the full set of time dummies.

Table 3.11: Annual Productivity Growth Rate and Convergence: the Complementary Role between Exporting and Multinational Status (cont.)

Period: 1999-2007

Dependent variable: Annual relative TFP growth rate

	System-GMM	
	Manufacture	**Services**
Convergence effects		
Exporting*Gap	-0.111**	-0.159***
	(0.0402)	(0.0254)
Outward FDI*Gap	-0.151***	-0.013***
	(0.0099)	(0.0012)
Inward FDI*Gap	0.005	-0.039*
	(0.0360)	(0.0174)
Technology Investments*Gap	-0.037***	-0.044***
	(0.0063)	(0.0036)
Exporting*Indian MNEs*Gap	0.092**	0.307***
	(0.0331)	(0.0210)
Exporting**Foreign MNEs*Gap	0.058	-0.050*
	(0.0593)	(0.0253)
Invmills	-0.086	0.770***
	(0.0650)	(0.0286)
Obs	19,536	6,424
Firms	5,066	2,217
Sargan	0.2261	0.9307
ARtest	0.2887	0.2978

a. Standard errors in parentheses
b. *significant at 10%; ** significant at 5%; *** significant at 1%
c. All specifications include the full set of time dummies.

c) Complementary effects between international activities and technology investments

So far we have examined the effects of technology investments and international activities separately. However, several strands of the literature have pointed to the necessity of taking into account the complementary effects of these decisions when evaluating firm productivity. Recent developments in the literature of international economics have highlighted the complementary effect of exporting and investing in technology in determining firms' productivity growth. The joined role of investing abroad and investing in technology is also

implicit in the hypothesis of market-seeking motivation for outward FDI. More generally, a widespread idea in the economic literature is that firms undertake deliberate efforts to enhance their capacity to absorb international knowledge. We test these theoretical predictions by introducing interaction terms between firms' technology investments and foreign market participation in our model. Our results, reported in Table 3.12, show that these activities play a synergistic role in stimulating firms' productivity growth either through innovation and/or technological transfer. In the case of the manufacturing sector, we find important innovation-enhancing effects from investing in technology and participating in global markets via exports, overseas investments or inward FDI. However, we find that manufacturing firms that simultaneously invest in technology and participate in international markets converge at a lower rate than firms that lack these activities. In contrast, we find that service firms that invest in technology and invest abroad or received foreign investments converge faster, but innovate at a slower rate.

Overall, our results indicate that usually firm characteristics that directly raise the level of productivity via innovation will be negatively correlated with the productivity gap term, suggesting that firms with these innovation-enhancing characteristics are more likely to be nearer to the technological frontier than other firms and therefore, converge slower.

Table 3.12: Annual Productivity Growth Rate and Convergence

The Complementary roles of Technology Investments and International Activities

Dependent variable: Annual relative TFP growth rate

	System-GMM	
	Manufacture	**Services**
Productivity gap	-0.114***	-0.411***
	(0.0144)	(0.0028)
Size	-0.109***	-0.129***
	(0.0098)	(0.0026)
Finance	0.004	-0.016***
	(0.0046)	(0.0032)
Age	-0.033	-0.050***
	(0.0193)	(0.0022)
Innovation effects		
Exporting	-1.136***	-0.102***
	(0.2124)	(0.0279)
Outward FDI	-1.095***	-0.086***
	(0.0396)	(0.0018)
Inward FDI	-0.744***	-0.635***
	(0.1588)	(0.0188)
Technology Investments	-0.789***	-0.175***
	(0.0501)	(0.0111)
Exporting* Technology Investments	1.605***	-0.013
	(0.1931)	(0.0124)
Outward FDI* Technology Investments	1.832***	-0.142***
	(0.3506)	(0.0024)
Inward FDI* Technology Investments	0.791***	-0.122***
	(0.0742)	(0.0121)
Convergence effects		
Exporting*Gap	-0.220***	-0.034***
	(0.0372)	(0.0038)
Outward FDI*Gap	-0.166***	-0.012***
	(0.0064)	(0.0003)
Inward FDI*Gap	-0.134***	0.040***
	(0.0275)	(0.0042)
Technology Investments*Gap	-0.115***	-0.021***
	(0.0064)	(0.0024)
Exporting* Technology Investments*Gap	0.237***	-0.000
	(0.0302)	(0.0026)
Outward FDI* Technology Investments*Gap	0.284***	-0.042***
	(0.0548)	(0.0005)
Inward FDI* Technology Investments*Gap	0.102***	-0.056***
	(0.0104)	(0.0023)
Invmills	0.289***	0.812***
	(0.0445)	(0.0058)
Obs	19,536	6424
Firms	5,066	2217
Sargan	0.4628	0.9627
ARtest	0.2710	0.3177

a. Standard errors in parentheses
b. *significant at 10%; ** significant at 5%; *** significant at 1%
c. All specifications include the full set of time dummies.

3.5.3. Robustness test

a) Change of initial year

In the literature of productivity convergence it has been observed that the speed of convergence might be sensitive to the choice of the base year. To check the robustness of our results to time we perform our cross-sectional estimation of Equation 3.7 changing the base year from 1999 to 2000. The results from this experiment are reported in Table 3.13. Our estimations are very similar to those reported in Table 3.8, indicating that the speed of convergence obtained from long run productivity regressions are not very sensitive to the choice of the base year.

Similarly, in Table 3.14 we re-estimate Equation 3.9 for the period 2000-2007 instead of 1999-2007 using OLS and the system-GMM estimator. Our estimations are also close to those reported in Table 3.9 and we confirm that our results supporting the hypothesis of technological convergence are robust to the chosen initial period.

Table 3.13: Average Annual Productivity Growth Rate and Convergence

Period: 2000-2007 (Base year = 2000)

Dependent variable: Average annual relative TFP growth rate

	Cross Sectional Analysis			
	OLS		Heckman two-steps estimator	
	Manufacture	Services	Manufacture	Services
Productivity gap	-0.052***	-0.079***	-0.054***	-0.074***
	(0.004)	(0.013)	(0.004)	(0.013)
Size	-0.044***	-0.039***	-0.051***	-0.049***
	(0.003)	(0.010)	(0.003)	(0.011)
Mills-lambda			-0.076***	-0.159*
			(0.018)	(0.077)
Speed of convergence (λ)	6.3%	10.9%	6.6%	9.9%
Number of firms	1,373	257		
Number of observations			3,150	708
Censored observations			1,177	451
Uncensored obs.			1,373	257

Notes:

a. Standard errors in parentheses
b. *significant at 10%; ** significant at 5%; *** significant at 1%
c. All specifications include the full set of sectoral dummies

Table 3.14: Annual Productivity Growth Rate and Convergence

Period: 2000-2007

Dependent variable: Annual relative TFP growth rate

	Panel Data Analysis					
	OLS		**System-GMM**		**System-GMM**	
	Manuf.	**Services**	**Manuf.**	**Services**	**Manuf.**	**Services**
Productivity Gap	-0.095***	-0.153***	-0.066**	-0.099***	-0.085**	-0.114***
	(0.0032)	(0.0089)	(0.0207)	(0.0187)	(0.0270)	(0.0317)
Size	-0.066***	-0.047***	-0.088***	-0.051**	-0.091***	-0.037**
	(0.0022)	(0.0063)	(0.0241)	(0.0166)	(0.0238)	(0.0158)
Inv. Mills ratio					-0.340	0.172
					(0.3178)	(0.2358)
_cons	-0.037	-0.425**				
	(0.0264)	(0.1633)				
Observations	17,251	6,116	17,251	6,116	17,212	6,116
Firms			4,767	2,171	4,761	2,171
Sargan			0.6946	0.1628	0.6814	0.1201
ARtest			0.2681	0.4752	0.2774	0.4751

a. Standard errors in parentheses
b. *significant at 10%; ** significant at 5%; *** significant at 1%
c. OLS specifications include the full set of sectoral and time dummies. GMM specifications include the full set of time dummies.

b) Measurement errors

As mentioned in Section 3.3, an important concern when estimating Equation 3.9 relates to measurement errors in relative total factor productivity. To check for robustness to measurement error, in Table 3.15 we substitute our technology gap indicator with a series of dummies of the quintiles of the productivity distribution where a firm lies. As mentioned in Section 3.3, productivity quintiles should involve less measurement error than productivity levels. In Table 3.15 we use the fifth quintile of productivity as the base category. Therefore, the estimate coefficients should be interpreted as the growth rate of firms in each quintile

relative to that of firms in the fifth quintile. As can be observed, all the estimate coefficients are positive and decreasing in the quintiles of productivity. That is, firms in the lowest quintiles grow at a faster rate than firms in the highest quintile in the productivity distribution. These results confirm the hypothesis of productivity convergence. In line with our previous estimations, we find that the differences in productivity growth across productivity quintiles are significantly higher amongst service firms.

Table 3.15: Annual Productivity Growth Rate by Quintiles of Productivity

Period: 1999-2007

Dependent variable: Annual relative TFP growth rate

	System-GMM	
	Manufacture	**Services**
Quintile 1	0.489***	2.681***
	(0.0933)	(0.3462)
Quintile 2	0.448***	1.839***
	(0.0689)	(0.2074)
Quintile 3	0.311***	1.094***
	(0.0598)	(0.1811)
Quintile 4	0.098	0.369*
	(0.0509)	(0.1547)
Size	-0.113***	-0.036
	(0.0155)	(0.0538)
Invmills	0.001	0.462
	(0.1011)	(0.2781)
Obs	19,691	6,472
firms	5,067	2,219
Sargan	0.1600	0.2339
ARtest	0.3218	0.1699

a. Standard errors in parentheses
b. *significant at 10%; ** significant at 5%; *** significant at 1%
c. All specifications include the full set of time dummies.

c) Alternative measure of productivity

In order to check the sensitivity of our results to the measure of productivity we re-estimate our baseline models using labor productivity (calculated as the logarithm of the sales to wages ratio) instead of TFP. These estimations are reported in Tables 3.16 and 3.17. The hypothesis of technological convergence is robust to the measure of productivity. However, in general firms converge faster in their labour productivity than in their TFP.

Table 3.16: Average Annual Productivity Growth Rate and Convergence

Period: 1999-2007 (Base year = 1999)

Dependent variable: Average annual relative labour productivity growth rate

	Cross Sectional Analysis			
	OLS		**Heckman two-steps estimator**	
	Manufacture	**Services**	**Manufacture**	**Services**
Productivity gap	-0.053***	-0.092***	-0.052***	-0.092***
	(0.004)	(0.012)	(0.004)	(0.011)
Size	0.002	-0.009	-0.002	-0.015
	(0.002)	(0.011)	(0.003)	(0.012)
Rho				
Mills-lambda			-0.026	-0.083
			(0.017)	(0.076)
Speed of convergence (λ)	6.4%	13.7%	6.3%	13.7%
Number of firms	1,197	209		
Number of observations			2,800	595
Censored observations			1,603	386
Uncensored observations			1,197	209

a. Standard errors in parentheses
b. *significant at 10%; ** significant at 5%; *** significant at 1%
c. All specifications include the full set of sectoral dummies

Table 17: Annual Productivity Growth Rate and Convergence

Period: 1999-2007

Dependent variable: Annual relative labour productivity growth rate

	System-GMM	
	Manufacture	**Services**
Productivity gap	-0.163***	-0.428***
	(0.0415)	(0.0424)
Size	0.121**	0.129***
	(0.0382)	(0.0227)
Invmills	0.141	-0.000
	(0.1466)	(0.0000)
Obs	17,217	5,513
Firms	4,744	1,951
Sargan	0.1189	0.4926
ARtest	0.7655	0.8936

a. Standard errors in parentheses
b. *significant at 10%; ** significant at 5%; *** significant at 1%
c. All specifications include the full set of time dummies.

d) Year by year technological convergence

Previously, we tested the hypothesis of technological convergence over the whole period 1999-2007. In doing so, we assumed that convergence occurs at the same rate in all years. In order to verify if this is the case we now turn to analyse the convergence process on a year-by-year basis. To this end we perform cross-sectional analysis using the Heckman two-steps estimator. The results from this exercise are reported in Tables 3.18 and 3.19 and show that there has been a decline in the speed of convergence over time, especially in the service sector. Possibly, the reduction in productivity dispersion reported in section 3.2 has led service firms with less scope for catching up in recent years.

Table 3.18: Evolution of the Rate of Technological Convergence in the Manufacturing Sector

Dependent variable: Relative TFP growth rate

		Cross Sectional Analysis: Heckman two-steps estimator						
	2000/01	**2001/00**	**2002/01**	**2003/02**	**2004/04**	**2005/04**	**2006/05**	**2007/06**
Productivity gap	-0.126***	-0.125***	-0.152***	-0.160***	-0.108***	-0.061***	-0.110***	-0.065***
	(0.010)	(0.021)	(0.017)	(0.016)	(0.010)	(0.009)	(0.009)	(0.009)
Size	-0.092***	-0.104***	-0.095***	-0.103***	-0.081***	-0.049***	-0.086***	-0.090***
	(0.007)	(0.016)	(0.012)	(0.012)	(0.007)	(0.006)	(0.006)	(0.007)
Invmills	-0.594***	-1.253***	-0.942***	-0.938***	-0.648***	-0.346***	0.195	-0.383***
	(0.097)	(0.241)	(0.164)	(0.162)	(0.136)	(0.099)	(0.115)	(0.088)

a. Standard errors in parentheses
b. *significant at 10%; ** significant at 5%; *** significant at 1%
c. All specifications include the full set of sectoral dummies

Table 3.19: Evolution of the Rate of Technological Convergence in the Service Sector

Dependent variable: Relative TFP growth rate

	Cross Sectional Analysis: Heckman two-steps estimator						
	2001/00	**2002/01**	**2003/02**	**2004/04**	**2005/04**	**2006/05**	**2007/06**
Productivity gap	-0.200***	-0.208***	-0.207***	-0.115***	-0.152***	-0.015***	-0.094***
	(0.033)	(0.033)	(0.024)	(0.025)	(0.020)	(0.004)	(0.025)
Size	-0.086***	-0.041	-0.043*	-0.073***	-0.036**	-0.016***	-0.106***
	(0.025)	(0.028)	(0.017)	(0.019)	(0.013)	(0.003)	(0.022)
Invmills	-0.829*	-0.940*	-1.083***	-0.800*	-0.145	-0.152**	-1.038**
	(0.386)	(0.456)	(0.320)	(0.338)	(0.226)	(0.050)	(0.330)

a. Standard errors in parentheses
b. *significant at 10%; ** significant at 5%; *** significant at 1%
c. All specifications include the full set of sectoral dummies

3.6. Conclusions

In this chapter we have examined the process of innovation and technological convergence across Indian manufacturing and service firms. We evaluated the roles of technology investments and international activities in determining these processes. We have confirmed that technology diffusion is an important engine

of productivity growth in India. While the hypothesis of technological convergence was confirmed in both sectors, we found that service firms converged faster than manufacturing firms, suggesting that the diffusion of technological knowledge has occurred faster in the Indian service sector.

We also found that there has been an increase in productivity dispersion amongst manufacturing firms, indicating that these firms have been converging to their own steady state levels of efficiency without necessarily catching up with their industry leader. In contrast, the reduction in productivity dispersion across service firms in some industries indicates that firms in these industries might have also been catching up with the frontier. This result is consistent with the finding that the speed of technological convergence amongst service firms has significantly decreased over the period of analysis, suggesting that service firms have reduced their scope for catching up over time.

Regarding the role of international activities and technology investments in affecting productivity growth, our results indicate that in general firm characteristics that directly raise the level of productivity via innovation, will be negatively correlated with the productivity gap term. This suggests that firms with these innovation-enhancing characteristics are more likely to be nearer to the technological frontier than other firms and so, converge slower. For instance, exporting intensity increases the rate of innovation amongst Indian multinational firms, but slows down their speed of technological convergence. In contrast, the rate of innovation is negatively correlated with firms' outward

FDI, but such investments help firms to catch up quicker. Similarly, the exports of non-multinational firms speed up their convergence rates, but slow down their innovation activity.

We also found important complementary effects between international and technological activities in stimulating firm's productivity growth either through innovation or technological convergence. In the case of the manufacturing sector, there are important innovation-enhancing effects from investing in technology and participating in global markets via exports, overseas investments or inward FDI, whereas service firms that invest in technology and invest abroad or received foreign investments converge faster to the technological frontier.

Appendix A.3.1: Definition of variables

Variable	Definition
Labour productivity	Log of value added divided by total wage bills.
Total Factor Productivity	Log of total factor productivity estimated based on 3-input (labour, fixed capital and material inputs) production function using the Levinshon-Petrin (2003) technique.
Size	Log of total sales
Age	Log of firm age since incorporation.
Finance	Total bank loans divide by total assets
Technology investment	The sum of real expenditures on own R&D, computers and software, royalty fees and imports of capital goods.
Export intensity	Total exports divided by total sales
Outward FDI intensity	Investment by Indian multinationals in their overseas subsidiaries divided by total sales
Inward FDI intensity	Share of foreign finance in the firms' total equity.

Chapter 4

Does finance play a role in exporting for Indian service firms?

The importance of finance for exporting goods is well understood in the literature. Yet, despite the growing magnitude and importance of services exports, the question whether service firms rely on external finance for exporting remains unanswered by the existing literature. In this chapter we address this overlooked area by studying whether long and short term borrowing matters for the exporting decisions and the levels exported by Indian service firms.

4.1. Introduction

Trade in services has shown a sharp global growth over the last three decades and now spans a wide spectrum from travel, tourism and recreational activities to education, training, financial and professional services. Yet, despite the growing magnitude and importance of trade in commercial services, we know remarkably little about the underlying forces that stimulate service firms' ability to export. With the exception of some recent papers that analyze the characteristics and performance of service exporters (Breinlichy and Criscuolo

2011; and Vogel and Wagner 2010 amongst others), the service sector remains underexplored in the international trade literature[25].

We aim to contribute to this emerging field of research by studying the role of finance in exporting for service firms, an issue that has not been previously explored. From an academic and policy perspective, the relevance of answering this questions stems from the fact that some economists see financial development as being crucial for export promotion. Moreover, as a result of the recent collapse of global exports in the aftermath of the 2007/09 global financial crisis, the relationship between trade and finance has reaped attention from scholars and policy makers who have been trying to better understand the financial-channel mechanisms behind such falls in exports. The chapter therefore has important policy implications as the provision of financial assistance is one of the tools employed by policy makers around the world to promote exports. Yet, there is no evidence whether these measures are effective in the case of service exports.

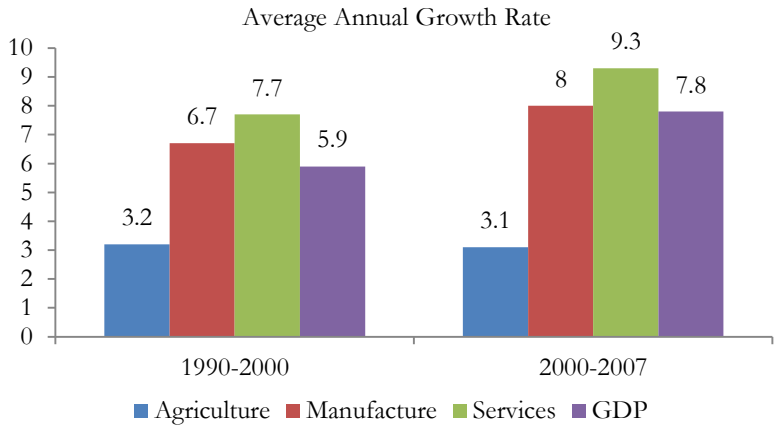
We study the exporting behaviour of Indian service firms between 1999 and 2007 using the Prowess data set compiled by the Centre for Monitoring the Indian Economy. We evaluate whether long and short term borrowing matter for the decision to export and the volume exported. To this end, we employ non linear dynamic panel data techniques where we control for unobserved heterogeneity and the potential endogeneity in the initial condition.

[25] We refer to Francois and Hoekman (2010) for a review of the literature on services trade.

4.1.1. Context

The remarkable dynamism of India's service sector and the positive linkages between services exports and economic growth makes it an excellent case study to examine the determinants of service exports. Between 2000 and 2007, the Indian service sector grew at an average annual rate of 9.3%, becoming the key driver of India's notable economic growth in recent years (Figure 4.1). Moreover, during the same period, India's exports of services grew even faster than the overall services output, displaying one of the fastest rates of growth in the world (Figure 4.2). Thus, examining whether access to external finance plays a role in facilitating service exports, has important policy implications, especially for developing countries with the potential to promote growth through service exports[26].

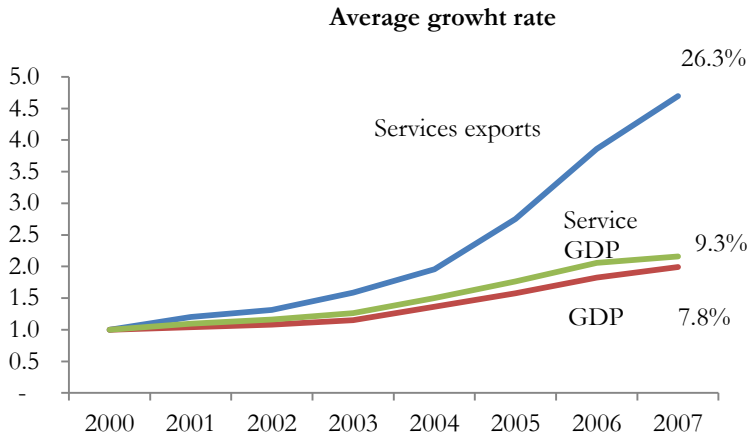
Figure 4.1: Main drivers of Indian economic growth by sector



Source: World Bank Development Indicators 2009. Available at: http://www.workinfo.com/Workforce/20997_devindicators.pdf

[26] Empirical studies have shown that many developing countries have "revealed comparative advantage" in services (Francois and Hoekman, 2010) and therefore the potential to rely on service exports for economic growth.

Figure 4.2: Evolution of Indian service exports versus service and total output



2000 values are indexed to 1.

Sources: Ministry of Finance, Economic Surveys. Reserve Bank of India, Bulletins

The rapid expansion of Indian service exports has been attributable, in significant part, to the gradual liberalization and desregulation of the sector, where reforms have taken place more deeply than in other parts of the economy. Information technology, telecommunications and tourism are some of the industries that have seen substantial trade and investment liberalization and are subject to few regulatory barriers (World Bank, 2004). An addition, as mentioned in the introduction of this thesis, the Indian Government has put in place a series of export promotion schemes to stimulate Indian international expansion (see appendix A1.1). Some service industries have also received additional exporting assistance. For instance, the IT software services industry has benefited from tax holidays provided by the Software Technology Parks (STPs) of India[27] and from priority sector lending[28].

[27]The STPs is an export oriented scheme that has been in operation since 1991. Units operating under this scheme have enjoyed duty-free access to imports, 100 percent exemption from excise duty on domestic procurement, and 100 percent exemption from payment of income tax on

4.1.2. The role of finance for exporting goods

The importance of finance for exporting goods is well understood in the international trade literature. At the macroeconomic level, theoretical and empirical studies reveal that countries with well developed financial systems tend to export goods produced in industries that use external finance effectively (i.e. Beck, 2002, 2003; and Svaleryd and Vlachos, 2005). At the firm level, the literature suggests that the main reasons why finance matters for exporting are related to the existence of sunk and fixed costs of serving foreign markets. Empirical evidence has shown that the costs of starting to export are considerably high (i.e. Das et al., 2007) and this fact has been incorporated in recent theoretical models of international trade where access to finance is considered most relevant for the payment of sunk costs at the time of entering the export markets (i.e. Chaney, 2005; Manova, 2008; Muûls, 2008).

Moreover, access to external finance proves important for covering the ongoing costs of exporting, since it is common for firms to struggle with meeting the short term liquidity needs associated with exporting. It has been shown that the international transaction of goods takes significantly longer to be executed compared to domestic trade, and payments occur with a lag of 180 days after delivery. As such, exporters must rely on short term external finance

export profits (WTO, 2007). According to WTO (2007), about 98% of total exports of IT software and services were exported under the STP scheme in 2005/06.

[28] All domestic and foreign commercial banks in India are required to allocate a certain percentage of net lending to priority sectors, including agriculture, small-scale industries, retail trade and the software industry (WT0, 2007).

to cover the variable costs of trade and production during these term gaps (Amiti and Weinstein, 2009)[29].

Empirical studies that examine the role of finance in the decision to export and the amount exported take different approaches and provide mixed results. For instance, Bellone et al., (2010); Berman and Hericourt (2010) and Muûls (2008) find that firms with better financial health are more likely to become exporters, while Stiebale (2011) finds that financial constraints have no direct impact on foreign market participation once appropriate controls are accounted for. Similarly, Greenaway et al. (2007) suggest that the causation runs from exporting to finance where exporting has an *ex-post* positive impact on a firm's financial health. Focusing on the effect of finance upon export intensity, Berman and Hericourt (2010) and Stiebale (2011) show that better financial health does not affect firms' export share, whereas Du and Girma (2007) find that accessing external finance in the form of bank loans has a positive effect on the volume exported by Chinese private firms.

Despite the abundance of literature on the role of finance for the exports of goods, the question of 'whether services firms also rely on external finance for exporting' remains unanswered in the existing literature. In exploring the role of finance in the export of services, one should consider the different nature of costs exhibited by service exports. While some sunk costs of exporting services (e.g. gathering information about foreign markets, learning bureaucratic procedures etc.) might be similar to those of exporting goods; other sunk costs

[29] Available data suggests that 90% of trade transactions involve some form of credit, insurance or guarantee issued by a bank or other financial institution (Auboin, 2009).

should be clearly negligible (e.g. setting up new distribution channels and adapting packaging to foreign markets). Additionally, we expect the variable costs of exporting services (i.e. freight and transportation costs) to be substantially lower than those of exporting goods. For instance, some services, such as software, can quickly be shipped by e-mail at a very low trade cost. As such, finance should be less relevant for exporting services than is the case with goods.

Our results confirm these hypotheses. After controlling for past exporting behaviour and unobserved firm heterogeneity, we fail to find evidence that access to any particular source of finance influences the decision to export or the amount exported amongst Indian service firms.

This chapter is structured as follows: Section 4.2 describes the empirical approach employed, Section 4.3 describes the data and methodology, Section 4.4 is an analysis of the results and Section 4.5 is a conclusion.

4.2. Empirical approach

As described earlier, our main objective is to test whether access to external finance matters for the decision to export and the amount exported by Indian service firms. In particular, we examine the impact of long and short term borrowing upon firms' exporting behaviour. To this end, we explicitly account for firms' path-dependent exporting behaviour and for other unobserved and

observed firm characteristics that affect exports. These features motivate us to employ non linear dynamic panel data techniques with unobserved heterogeneity as our preferred estimation method. We use a dynamic Probit model of export market participation (Equation 4.1) and a dynamic Tobit model of export intensity (Equation 4.2) to examine the role of finance on the extensive (i.e. the decision to export) and the intensive (i.e. the amount exported) margins of trade respectively:

$$P(Exp_{it} = 1 | (Exp_{it-1}, Fin_{it-1}, X_{it-1}, D_i, c_i))$$

$$= \Phi(\gamma_1 Exp_{it-1} + \gamma_2 Fin_{it-1} + \gamma_3 X_{it-1} + \gamma_4 D_{it} + c_i) \quad (4.1)$$

$$Exp_{it} = \max(0, \delta_1 Exp_{it-1} + \delta_2 Fin_{it-1} + \delta_3 X_{it-1} + \delta_4 D_{it} + c_i) \quad (4.2)$$

where *i=1*…n indexes firms and *t=1*…*T* indexes time periods. The dependent variable, Exp_{it} is defined in two alternative ways: either a dummy binary variable indicating whether company *i* has exported at time t (Equation 4.1) or the actual amount exported (Equation 4.2). A large body of empirical literature have shown that recent history of exporting is a very important determinant of current exporting performance (i.e. Bernard and Wagner, 1997; Roberts and Tybout, 1997). We, therefore, include the firm's previous exporting behaviour, Exp_{it-1} to account for the state dependence in exporting. Fin_{it-1} comprises of two variables capturing long and short term borrowing in time *t-1*. The long term borrowing is calculated as the *stock* of long term debt normalized by total assets. In line with the literature on finance and exporting, we consider the indebtness level as an indicator of the firm's financial situation. A negative and significant coefficient on long term borrowing is interpreted as evidence of

financial heath for the exporting firms. The short term borrowing, on the other hand, is measured as the *flow* of short term borrowing normalized by total assets. A positive and significant coefficient on this variable indicates that access to short term external finance enhances firm's export market orientation. X_{it-1} is a vector of firm characteristics identified in the theoretical and empirical literatures as key determinants of exporting behaviour. These characteristics include the age of the firm since incorporation, its size, productivity and technology investments. We use the logarithm of total sales as a proxy of firm size and Total Factor Productivity (TFP) as an index of productivity[30]. Similar to what we have done in the previous chapters, we calculate the firm's technology investments as the sum of real expenditures on R&D, computers and software, royalty fees and imports of capital goods[31]. D is a full set of time, industry and ownership dummy variables and c_i denotes time-invariant firm-specific effects, capturing the unobserved firm heterogeneity[32].

The treatment of unobserved firm-specific effects and their relation to covariates constitutes an important concern when estimating Equations 4.1 and 4.2. In nonlinear panel data models with small T, it is not possible to treat the unobservables as fixed parameters to be estimated by standard maximum

[30] We estimate TFP based on a three-input (labour, fixed capital and material inputs) production function using the Levinshon-Petrin (2003) technique. As mentioned in previous chapters, this technique has the advantage over more traditional fixed effect production function models in its ability to control for time-variant productivity shocks that are correlated with the inputs.

[31] As we have done in previous chapters, we combine these expenditures into one variable because only small groups of service firms in each year chose to invest in one of these activities, and thus it is difficult to identify the separate effects of each technology investment in the empirical models.

[32] Details of all variables used in our estimations are provided in appendix A.4.1

likelihood methods since the inconsistency of these estimates (i.e.the incidental parameter problem) is transmitted to the parameters of interest. Instead, several approaches suggest integrating out the unobserved effects from the model. Non parametric approaches suggest finding an objective function that does not depend on c_i but still identifies the parameters of interest (Wooldridge, 2008)[33]. Although non parametric approaches allow the unobserved effects and the covariates to be freely correlated, we do not follow this route because the partial effects of the explanatory variables are generally unidentified. Instead, we follow the alternative approach of imposing a parametric specification for the distribution of c_i in order to sweep this term out of the model. Correlations between c_i and the covariates are allowed but *restricted* by the chosen parametric form. Particularly, potential correlation between past export status and unobserved heterogeneity in Equations 4.1 and 4.2 that causes the well documented initial conditions problem requires making some assumptions about c_i and the initial observation (Wooldridge,2009). In this paper we follow Wooldridge (2005) who suggests modelling the distribution of the unobservables conditional upon the initial condition and the observed history of the exogenous explanatory variables. However, we do not follow the common approach of including *all* the history of the covariates (i.e. all their leads and lags or their time averages) since it causes high levels of multicolinearity between the variables, with the consequence of rendering some variables statistically insignificant even though they are important in the model. Instead, assuming that the relationship

[33] This leads to "conditional MLE" if there is a sufficient statistic, s_i , for c_i such that the distribution of data conditional on s_i does not depend on c_i (Wooldridge, 2009).

between unobserved heterogeneity and firm's characteristics remains constant over time, we specify the unobserved heterogeneity as a linear function of the *initial values* of both the exporting variable and the covariates[34]:

$$c_i = \varsigma_0 + \varsigma_1 Exp_{i1} + \varsigma_2 Fin_{i1} + \varsigma_3 X_{i1} + a_i \tag{4.3}$$

Where $a_i \mid (Exp_{i1}, Fin_{i1}, X_{i1}) \sim Normal(0, \sigma_a^2)$

Substituting Equation 4.3 into equations 4.1 and 4.2 yields:

$$P(Exp_{it} = 1 \mid (Exp_{it-1}, Fin_{it-1}, X_{it-1}, Exp_{i1}, Fin_{i1}, X_{i1}, D_i, a_i)) =$$

$$= \Phi\begin{pmatrix} \gamma_1 Exp_{it-1} + \gamma_2 Fin_{it-1} + \gamma_3 X_{it-1} + \gamma_4 D_{it} + \varsigma_0 + \varsigma_1 Exp_{i1} \\ + \varsigma_2 Fin_{i1} + \varsigma_3 X_{i1} + a_i \end{pmatrix} \tag{4.4}$$

$$Exp_{it} = \max\begin{pmatrix} 0, \delta_1 Exp_{it-1} + \delta_2 Fin_{it-1} + \delta_3 X_{it-1} + \delta_4 D_{it} + \varsigma_0 \\ + \varsigma_1 Exp_{i1} + \varsigma_2 Fin_{i1} + \varsigma_3 X_{i1} + a_i \end{pmatrix} \tag{4.5}$$

Thus, we add Exp_{i1}, Fin_{i1} and X_{i1} as additional explanatory variables and estimate Equations 4.4 and 4.5 using standard pooled Probit and Tobit models with robust standard errors and allowing for arbitrary within-firm serial correlation[35]. We then compute the marginal effects of the regressors on both i)

[34] In our sample, the initial period (t=1) corresponds to 1999.

[35] For comparison purposes, we also estimate Equations 4.4 and 4.5 using Probit and Tobit random effects models assuming independence of observations across time conditional on unobserved heterogeneity. The average partial effects resulting from these models are similar to our results using pooled Probit and Tobit models with robust firm-clustered standard errors.

the expected probability of exporting and ii) the expected amount exported given that the firm is participating in the export market.

A potential problem of our estimation procedure is that it relies on the assumption of strict exogeneity conditional on the unobserved effects. But arguably some of our explanatory variables (i.e. long and short term borrowing, size, technology investments and productivity) are contemporaneously determined with, or even impacted by exporting. In our specifications we include lagged values of the covariates to minimize the potential problem of contemporaneous endogeneity. However, to formally check whether our results are robust to the assumption of strict exogeneity, we estimate Equations 4.1 and 4.2 using the instrumental variables Probit and Tobit estimatior due to Smith and Blundell (1986) and the system-GMM estimator due to Blundell and Bond (1998). We also examine the relationship between finance and exporting using bivariate probit models, which allow us to account for the possibility that these decisions might be jointly determined, as suggested by recent theoretical models in international economics (i.e. Bustos, 2007; Lileeva and Trefler, 2010;Constantini and Melitz, 2008;).

Following the Smith and Blundell (1986) technique we estimate Equations 4.1 and 4.2 as follows: first, we generate the residual terms from linear regressions of each hypothesised endogenous variable on their lagged values (which are used as instruments) and all other exogenous and endogenous regressors. Then, we estimate our Probit and Tobit models including these

residual terms in the list of covariates. Finally, we test the hypothesis of strict exogeneity by examining the significance of the coefficients on the residuals[36] and perform an Amemiya-Lee-Newey test for the validity of the instruments.

As a further robustness check, we estimate Equations 4.1 and 4.2 using the system-GMM estimator due to Blundell and Bond (1998) in an attempt to control for potential two-way feedback effects between exporting and firm characteristics. This technique has the advantage of allowing the model regressors to be endogenous. It also deals with firm heterogeneity without imposing a specific parametric specification on the distribution of c_i. Hence, it allows us to test whether our results are robust to the imposed restriction on c_i, since misspecification of Equation 4.3 may well lead us to incorrect conclusions. Finally, the system-GMM estimator helps us to distinguish the true state dependence driving the exporting dynamics from unobserved heterogeneity. However, this technique has two major drawbacks. i) it ignores the binary nature of the export decision, predicting probabilities outside the range [0,1] and ii) and it does not take into account the censoring of the data in the case of the amount exported, generating biased and inconsistent estimations. Since we estimate Equation 4.2 on the non limit observations only (i.e. on firm-year observations with positive export values), we correct for possible bias due to sample selection using the Semykina and Wooldridge (2010) parametric estimation procedure described in chapter 3 (session 3.3). That is, we augment our equation with the inverse Mill ratios obtained from probit regressions of export market

[36] The hypothesis of strict exogeneity is rejected if the coefficients on the residuals are significantly different from zero.

participation in each period[37]. We test for the validity of the instruments using the Hansen-Sargan test and use the Arellano and Bond (1991) test for the absence of serial correlation in the equation error.

Finally, to probe our findings further, we also examine the relationship between finance and exporting allowing for the potential simultaneity between exporting and investing in technology. As mentioned in chapter 1, a recent body of work in international trade and industrial organisation has introduced productivity-enhancing investments (such as technology investments) as a complementary activity to the firm's decision to export, suggesting that these decisions might occur simultaneously. To account for this potential simultaneity, we estimate the firm's discrete decisions to export and invest in technology using bivariate probit models. The use of joint estimations should improve our estimations if these choices are indeed simultaneously determined.

4.3. Database description

This chapter also draws on the Prowess database compiled by the *Centre for Monitoring the Indian Economy*. To examine the role of finance in promoting services exports, we use a longitudinal unbalanced panel of service firms for the years from 1999 to 2007. For comparative purposes, we also perform equivalent analysis using manufacturing firms from the same dataset. We exclude industries

[37] The model of export market participation in each period is estimated using the same explanatory variables defined in Equation 4.1.

with very low export intensity and insufficient number of exporters (i.e. industries with less than 30 firm-year observations with positive export values). To identify the differential impact of finance on goods and services exports, we exclude service firms that export goods (nearly 5% of service firms) and manufacturing firms that export services (approximately 8% of manufacturing companies). Finally, to control for outliers we delete the upper and lower 0.5% quintile of the variables used in the regression. After the data cleaning process, an unbalanced panel of 9,840 firm-year observations belonging to the service sector and 26,641 firm-year observations operating in the manufacturing sector is left for our econometric analysis.

Table 4.1 gives a description of the service industries used in our empirical analysis for 1999-2007. Columns 2 and 3 show the contribution of each industry to total services sales and exports. It is striking that the software industry enjoys a disproportionately high share of the service sector sales and exports, with averages shares of 36.2% and 72.9% respectively. Shipping and telecommunication services also account for an important fraction of total sales (about 11% each) and ITES makes up 7.4% of the total exports. Columns 4 and 5 show the average fraction of exporters and the exporting intensity by industry respectively. On average 23% of service firms export and 31% of total service output is exported. There is, however, a high level of heterogeneity across industries, with some industries being highly export-oriented (i.e. computer software, ITES, and animation content providers) and others more focused on the domestic market.

Table 4.1: Summary statistics of the industries in the service sector used in the regressions

Period 1999-2007

Industries included in our estimations	Share		Exporters	Export intensity
	Output	Exports		
Computer software	36.2%	72.9%	55.7%	69.5%
ITES	3.0%	7.4%	62.7%	75.6%
Shipping	11.5%	6.4%	33.1%	17.2%
Telecommunication services	11.1%	1.9%	34.2%	5.1%
Media-broadcasting	3.7%	1.7%	51.6%	14.2%
Animation content provider	0.6%	1.7%	64.7%	87.6%
Business consultancy	4.9%	1.7%	21.9%	10.5%
Transport support services	7.5%	1.2%	29.7%	5.0%
Other misc services	2.5%	0.6%	17.6%	6.7%
Production, distribution and exhibition of films	1.0%	0.4%	20.0%	11.6%
Media-content	0.8%	0.3%	30.7%	12.9%
Tourism	0.5%	0.3%	44.4%	18.7%
Air transport	3.0%	0.3%	55.7%	2.9%
Others	8.3%	0.2%	3.6%	0.9%
Courier services	1.6%	0.1%	47.7%	1.3%
Total	**100.0%**	**100%**	**23.0%**	**31.0%**

*Authors' calculations based on the database used in this paper.

Table 4.2 provides a comparable set of summary statistics of the exporting and financial variables used in the regression analysis for manufacturing and service sectors. On average, the fraction of firms engaged in international trade was higher amongst manufacturing companies (51% vs 23%). However, on average, service traders exported a higher percentage of their total sales (48% vs 25%). In terms of the financial variables, Table 4.2 shows that most manufacturing firms relied on external finance during the period of analysis, with 93% of firms using long or short term borrowing. In contrast, the fraction of service firms that borrowed from external sources was significantly lower: 60% of service firms utilized long term debt and 64% had access to short term borrowing. Most

manufacturing and service firms relied on private local institutions to secure their short term financial needs (93% and 64%, respectively), whereas only a small fraction of firms accessed State and foreign borrowing. Table 4.2 also shows that manufacturing firms were on average more leveraged than service firms, as judged by the higher intensities of long and short term borrowing.

Table 4.2: Summary Statistics of the variables used in the regressions by sector

Period 1999-2007				
Variable	**Manufacture**		**Service**	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**
Export dummy	0.51	0.50	0.23	0.42
Export intensity	0.25	0.29	0.48	0.39
		Financial variables		
Dummies				
Long term debt	0.93	0.26	0.60	0.49
Short term debt	0.93	0.25	0.64	0.48
State borrowing	0.09	0.29	0.01	0.08
Foreign borrowing	0.06	0.24	0.02	0.13
Private local borrowing	0.93	0.25	0.64	0.48
Intensities (% of total assets)				
Long term debt	1.82	3.81	1.55	4.47
Short term debt	0.34	0.19	0.23	0.23
State borrowing	0.08	0.10	0.12	0.10
Foreign borrowing	0.10	0.09	0.14	0.12
Private local borrowing	0.32	0.19	0.23	0.23
Number of observations	**26,641**		**9,840**	

A comparison between exporters and non exporters is presented in Table 4.3. It can be observed that a larger proportion of exporters in both sectors used external finance, but on average they were less leveraged than their

domestic counterparts. In terms of non financial variables, Table 4.3 also shows that both the fraction of firms undertaking technology investments and the amounts invested in such technological improvements were higher amongst the group of exporting firms in both sectors. Also, on average, exporting firms were larger and more productive than non exporters. In terms of ownership structure, we find more presence of multinational firms (both Indian and foreign subsidiaries) in the group of exporting firms. The fraction of firms belonging to economic groups was also higher amongst exporting firms whereas non-affiliated Indian firms were more common in the group of non exporters.

Table 4.3: Summary Statistics of the variables used in the regressions

Split by Exporters and Non-exporters

Period 1999-2007

Variable	Manufacturing sector				Service sector			
	Exporters		Non exporters		Exporters		Non exporters	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
	Financial variables							
Dummies								
Long term debt	0.96	0.20	0.90	0.30	0.68	0.47	0.58	0.49
Short term debt	0.96	0.19	0.90	0.30	0.75	0.44	0.61	0.49
State	0.10	0.31	0.08	0.27	0.01	0.09	0.01	0.08
Foreign	0.10	0.29	0.03	0.16	0.04	0.20	0.01	0.10
Private local	0.96	0.19	0.90	0.30	0.74	0.44	0.60	0.49
(% of total assets)								
Long term debt	1.75	3.56	1.90	4.08	1.12	3.95	1.71	4.63
Short term debt	0.35	0.18	0.33	0.20	0.19	0.19	0.25	0.24
State	0.06	0.08	0.11	0.11	0.10	0.10	0.17	0.16
Foreign	0.10	0.09	0.11	0.10	0.14	0.12	0.13	0.12
Private local	0.33	0.18	0.32	0.20	0.18	0.19	0.25	0.24

				Technology investments				
Dummy	0.67	0.47	0.32	0.46	0.57	0.50	0.18	0.38
Amount (log)	0.90	0.97	0.49	0.71	1.26	1.26	0.60	0.94
				Other non financial variables				
Total Factor Productivity	0.02	3.52	0.01	3.85	0.03	4.58	0.01	8.14
Size	3.96	1.41	2.58	1.57	3.50	1.89	1.83	2.16
Age	2.99	0.72	2.76	0.76	14.1	12.5	18.9	17.6
				Ownership structure				
Dummies								
Foreign MNEs	0.11	0.32	0.03	0.18	0.11	0.31	0.02	0.14
Private Indian	0.57	0.50	0.74	0.44	0.50	0.50	0.71	0.46
Private Indian Group	0.37	0.48	0.23	0.42	0.35	0.48	0.23	0.42
Indian MNEs	0.07	0.25	0.01	0.09	0.28	0.45	0.02	0.15
observations	**13,654**		**12,987**		**2,322**		**7,518**	

4.4. Findings

In order to make our work comparable with previous research, we start by presenting the findings from static and dynamic nonlinear models without accounting for firm heterogeneity. Then, we concentrate on the estimates from the dynamic Probit and Tobit models controlling for firm heterogeneity, as described in section 4.2. Finally, we check whether our results are robust to the assumption of strict exogeneity we estimate Equations 4.1 and 4.2 using the instrumental variables Probit and Tobit estimatior due to Smith and Blundell (1986) and the system-GMM estimator due to Blundell and Bond (1998). As a further robustness test, we examine the relationship between finance and exporting using bivariate probit models for the simultaneous decision to export and invest in technology.

4.4.1. Results without accounting for firm's heterogeneity

Table 4.4 reports the results from *static* Probit and Tobit models without accounting for firm heterogeneity. The first two columns show the marginal effect on the expected probability of exporting for manufacturing and service firms respectively. The coefficients on the control variables are in line with the theoretical predictions and empirical evidence from the international trade literature. Firm size, TFP and technology investments are three key factors positively affecting firms' exporting decisions in both sectors. Ownership characteristics also appear to impact upon the exporting decisions of manufacturing and service firms, where being part of a multinational company (either domestic or foreign) increases the probability to export. In the case of the service sector, Indian private companies affiliated to an economic group are also more likely to export. Together, these results suggest that many of the non financial determinants of firms' exporting decisions are similar for both services and manufacturing companies. However, in contrast to manufacturing firms we fail to find any evidence that either short or long term borrowing are effective in motivating service firms' decision to export. In the case of the manufacturing sector we found that less leveraged firms (i.e firms with lower stocks of long term debt) are more likely to export, whereas access to short term borrowing exerts a positive influence on firms' ability to export. These results are consistent with previous research on goods exports using similar econometric techniques.

Next, we investigated the determinants of export intensity using a static pooled Tobit model. The marginal effects on the expected amount exported are

reported in columns 3 and 4 of Table 4.4. Our results show that the determinants of exporting intensity amongst service firms are very similar to those of exporting decisions and similarly, unlike manufacturing firms, finance does not play a role in determining the level of export intensity once the firm has entered the export market.

Table 4.4: Static Pooled Probit and Tobit estimates for export status and export share

Without controlling for firm heterogeneity

Covariates	Probit		Tobit	
	$\Pr(Exp_t > 0)$		$E(Exp \mid Exp > 0)$	
	(1)	(2)	(3)	(4)
	Manufacture	**Services**	**Manufacture**	**Services**
Financial variables				
Short term borrowing	0.129***	-0.009	0.034***	-0.004
	(0.026)	(0.023)	(0.010)	(0.012)
Long term borrowing	-0.003**	-0.001	-0.001***	-0.000
	(0.001)	(0.001)	(0.000)	(0.001)
Non financial variables				
Size	0.134***	0.041***	0.037***	0.023***
	(0.005)	(0.004)	(0.002)	(0.003)
Total Factor Productivity	0.015**	0.030***	0.004**	0.013***
	(0.006)	(0.004)	(0.002)	(0.002)
Technology investments	0.059***	0.057***	0.001*	0.024***
	(0.008)	(0.009)	(0.002)	(0.004)
Age	0.056***	-0.000	0.002	-0.000
	(0.007)	(0.001)	(0.002)	(0.000)
Ownership structure				
Foreign Multinationals	0.077**	0.151***	0.001	0.103***
	(0.029)	(0.029)	(0.010)	(0.016)
Private Group	-0.008	0.056**	-0.015***	0.024*
	(0.013)	(0.018)	(0.005)	(0.011)
Indian Multinationals	0.117***	0.172***	0.030***	0.094***
	(0.029)	(0.022)	(0.007)	(0.012)
Number of Observations	**20,258**	**6,762**	**20,307**	**6,762**

Notes

a. Marginal effects calculated at the sample means of the covariates. (*) dy/dx is for discrete change of dummy variable from 0 to 1.
b. Robust firm-clustered standard errors in parentheses
c. * Significant at 5%; ** significant at 1%; *** significant at 0.1%
d. All specifications include the full set of time and industry dummies

In Table 4.5 we account for the *dynamics* of firm's exporting behaviour. We introduce the 'lagged exporting status' in columns 1 and 2 and the 'lagged

amount exported' in columns 3 and 4 in an attempt to capture path dependence in the decision to export and the amount exported respectively. The significance and magnitude of the lagged exporting status variable suggests that exporting decisions are highly path dependent in both sectors, a fact commonly reported in the literature and believed to result from sunk costs of exporting (i.e.Dixit, 1989;). However, path dependence does not play an important role in determining the export intensity of Indian service firms. After controlling for the path dependent effects of exporting, we find that technology investments, firm size, TFP and ownership effects remain significant in determining both the decision to export and the amount exported of Indian service firms whilst the impact of short and long term finance are still insignificant.

Table 4.5: Dynamic Pooled Probit and Tobit estimates for export status and export share

Without controlling for firm heterogeneity

Covariates	Probit		Tobit	
	$\Pr(Exp_t > 0)$		$E(Exp \mid Exp > 0)$	
	Manufacture	**Services**	**Manufacture**	**Services**
Financial variables				
Short term borrowing	0.039**	0.011	0.016***	-0.003
	(0.012)	(0.011)	(0.005)	(0.011)
Long term borrowing	-0.002**	0.000	-0.001**	-0.000
	(0.001)	(0.001)	(0.000)	(0.001)
Non financial variables				
Size	0.041***	0.014***	0.018***	0.023***
	(0.002)	(0.002)	(0.002)	(0.003)
Total Factor Productivity	0.007**	0.012***	0.004**	0.013***
	(0.003)	(0.002)	(0.001)	(0.002)
Technology investments	0.020***	0.022***	0.002*	0.024***
	(0.004)	(0.004)	(0.001)	(0.004)
Age	0.005	-0.000	0.004***	-0.000
	(0.003)	(0.000)	(0.001)	(0.000)

a. Marginal effects calculated at the sample means of the covariates. (*) dy/dx is for discrete change of dummy variable from 0 to 1.
b. Robust firm-clustered standard errors in parentheses
c. * Significant at 5%; ** significant at 1%; *** significant at 0.1%
d. All specifications include the full set of time and industry dummies

Table 4.5: Dynamic Pooled Probit and Tobit estimates for export status and export share

Without controlling for firm heterogeneity (cont.)

Covariates	Probit		Tobit	
	$\Pr(Exp_t > 0)$		$E(Exp \mid Exp > 0)$	
	Manufacture	**Services**	**Manufacture**	**Services**
Ownership structure				
Foreign Multinationals	0.018	0.053***	0.004	0.098***
	(0.013)	(0.013)	(0.004)	(0.016)
Private Group	-0.014**	0.021**	-0.005**	0.022*
	(0.005)	(0.007)	(0.002)	(0.010)
Indian Multinationals	0.033**	0.047***	0.005	0.090***
	(0.013)	(0.011)	(0.003)	(0.012)
State dependence				
Export participation (t-1)	0.353***	0.263***		
	(0.003)	(0.005)		
Export share (t-1)			0.386***	0.017
			(0.024)	(0.013)
Number of Observations	**20,258**	**6,762**	**20,307**	**6,762**

a. Marginal effects calculated at the sample means of the covariates. (*) dy/dx is for discrete change of dummy variable from 0 to 1.
b. Robust firm-clustered standard errors in parentheses
c. * Significant at 5%; ** significant at 1%; *** significant at 0.1%
d. All specifications include the full set of time and industry dummies

4.4.2. Results controlling for firm's heterogeneity

In Table 4.6 we account for *unobserved firm effects*, as we have described in section 4.2. That is, we express firm heterogeneity as a linear function of the *initial values* of the exporting variable and the covariates (Equation 4.3). The significance of the coefficients on the control variables remains almost unchanged after controlling for unobserved heterogeneity and, as in our earlier findings, the availability of external finance does not seem to boost the exporting performance of service firms. Interestingly, in the case of the manufacturing sector the inclusion of unobserved firm heterogeneity renders insignificant the impact of long term borrowing on both the decision to export and the amount exported. Similarly, the effect of short term borrowing on export intensity becomes insignificant and its impact on the decision to export is now only

significant at the 5% level. These results are similar to those uncovered by Stiebale (2011) using similar techniques on French manufacturing firms. After controlling for unobserved heterogeneity, Stiebale (2011) found that the effects of financial indicators on firm exporting behaviour disappear. This suggests that the treatment of firm heterogeneity is an important issue when evaluating the effects of finance upon firms' exporting activities.

Table 4.6: Dynamic Probit and Tobit estimates for export status and export share

Controlling for firm heterogeneity

	Probit		Tobit	
	$\Pr(Exp > 0)$		$E(Exp \mid Exp > 0)$	
	Manufacture	Services	Manufacture	Services
Financial variables				
Short term borrowing	0.035*	0.013	0.011	0.009
	(0.015)	(0.008)	(0.006)	(0.007)
Long term borrowing	-0.000	0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.000)	(0.000)
Non financial variables				
Size	0.059***	0.018***	0.023***	0.024***
	(0.004)	(0.004)	(0.003)	(0.004)
Total Factor Productivity	0.012***	0.009***	0.007***	0.006*
	(0.003)	(0.003)	(0.002)	(0.003)
Technology investments	0.015***	0.019***	0.002**	0.014**
	(0.004)	(0.005)	(0.001)	(0.004)
Age	0.006	-0.000	0.013***	-0.000
	(0.009)	(0.000)	(0.003)	(0.000)
Ownership structure				
Foreign Multinationals	0.020	0.034*	0.008	0.026*
	(0.014)	(0.014)	(0.004)	(0.013)
Private Group	-0.013*	0.021**	-0.004*	0.011
	(0.005)	(0.008)	(0.002)	(0.008)
Indian Multinationals	0.026*	0.030**	0.004	0.029**
	(0.012)	(0.011)	(0.003)	(0.010)

Notes

a. Marginal effects calculated at the sample means of the covariates. (*) dy/dx is for discrete change of dummy variable from 0 to 1.
b. Robust firm-clustered standard errors in parentheses
c. * Significant at 5%; ** significant at 1%; *** significant at 0.1%
d. All specifications include the full set of time and industry dummies

Table 4.6: Dynamic Probit and Tobit estimates for export status and export share

Controlling for firm heterogeneity (cont.)

	Probit		Tobit	
	$Pr(Exp > 0)$		$E(Exp \mid Exp > 0)$	
	Manufacture	Services	Manufacture	Services
Path dependence				
Export participation (t-1)	0.276***	0.189***		
	(0.005)	(0.007)		
Export share (t-1)			0.274***	0.008
			(0.045)	(0.006)
Initial condition				
Export participation	0.110***	0.107***		
	(0.006)	(0.009)		
Export share			0.153***	0.269***
			(0.039)	(0.013)
Size	-0.028***	-0.007	-0.007**	-0.008*
	(0.005)	(0.004)	(0.002)	(0.004)
Total Factor Productivity	-0.008*	0.001	-0.004	0.006
	(0.004)	(0.003)	(0.002)	(0.003)
Technology investments	0.000	0.002	-0.003*	-0.007
	(0.005)	(0.007)	(0.001)	(0.006)
Short term borrowing	0.013	-0.025	0.007	-0.024
	(0.016)	(0.019)	(0.007)	(0.018)
Long term borrowing	-0.001	0.001	-0.000	0.002*
	(0.001)	(0.001)	(0.000)	(0.001)
Number of observations	**20,193**	**6,760**	**20,242**	**6,760**

Notes

a. Marginal effects calculated at the sample means of the covariates. (*) dy/dx is for discrete change of dummy variable from 0 to 1.
b. Robust firm-clustered standard errors in parentheses
c. * Significant at 5%; ** significant at 1%; *** significant at 0.1%
d. All specifications include the full set of time and industry dummies

As mentioned in section 4.3, a small fraction of firms use short term borrowing from the State and foreign sources. In order to check whether our results are affected by these firms we drop them from our database and estimate Equations 4.4 and 4.5 again. Our results, reported in Table 4.7, remain almost unaffected.

To further explore whether the source of finance matters, in Table 4.8 we report the estimations where we disaggregate short term borrowing with respect to the source of finance (namely State, foreign and private local

borrowing)[38]. The results are very similar to those reported in Tables 4.6 and 4.7 and we can confirm that neither the availability of short term finance, nor the source it is attained from are effective factors in promoting the exporting activity of Indian service firms. Interestingly, access to foreign borrowing has a pronounced positive effect on manufacturing firms' exporting decision.

Finally, it might be possible that Indian service firms use internal sources (potentially generated from operations in domestic markets) to fund the costs of exporting. To check for this possibility we estimate Equations 4.4 and 4.5 adding the cashflow to total assets ratio as a measure of a firm's internal liquidity. The coefficient on this variable, reported in Table 4.9, is statistically insignificant, indicating that neither internal nor external sources of finance affect service firms' exporting behaviour.

[38] It is important to explore whether different sources of finance have a different impact upon exporting since some sources of finance may be effective in driving exports. For example, government loans are often clearly targeted towards boosting exports and may have a direct effect while foreign loans may boost exports due to indirect links they create with the foreign markets.

Table 4.7: Dynamic Probit and Tobit estimates for export status and export share

Excluding firms with foreign and state borrowing

	Probit		**Tobit**	
	$\Pr(Exp > 0)$		$E(Exp \mid Exp > 0)$	
	Manufacture	**Services**	**Manufacture**	**Services**
Financial variables				
Short term borrowing	0.040*	0.012	0.011	0.008
	(0.017)	(0.008)	(0.006)	(0.007)
Long term borrowing	-0.001	0.000	-0.000	-0.001
	(0.001)	(0.001)	(0.000)	(0.000)
Non financial variables				
Size	0.060***	0.018***	0.024***	0.022***
	(0.005)	(0.004)	(0.003)	(0.004)
Total Factor Productivity	0.012***	0.010***	0.008***	0.006*
	(0.004)	(0.003)	(0.002)	(0.003)
Technology investments	0.017***	0.018***	0.003**	0.011*
	(0.005)	(0.005)	(0.001)	(0.004)
Age	0.006	-0.000	0.012***	-0.000
	(0.009)	(0.000)	(0.003)	(0.000)
Ownership structure				
Foreign Multinationals	0.014	0.037**	0.006	0.030**
	(0.015)	(0.013)	(0.004)	(0.011)
Private Group	-0.019**	0.021**	-0.005*	0.012
	(0.006)	(0.008)	(0.002)	(0.008)
Indian Multinationals	0.016	0.035**	0.004	0.032***
	(0.013)	(0.011)	(0.003)	(0.010)
Path dependence				
Export participation (t-1)	0.284***	0.183***		
	(0.005)	(0.008)		
Export share (t-1)			0.257***	0.007
			(0.048)	(0.005)
Initial condition				
Export participation	0.114***	0.109***		
	(0.006)	(0.009)		
Export share			0.156***	0.269***
			(0.041)	(0.013)
Size	-0.029***	-0.006	-0.007**	-0.006
	(0.005)	(0.004)	(0.002)	(0.004)
Total Factor Productivity	-0.008*	0.001	-0.004*	0.006*
	(0.004)	(0.003)	(0.002)	(0.003)
Technology investments	0.000	-0.001	-0.004**	-0.006
	(0.005)	(0.006)	(0.002)	(0.005)
Short term borrowing	0.003	-0.024	0.004	-0.025
	(0.017)	(0.019)	(0.007)	(0.018)
Long term borrowing	-0.001	0.001	-0.000	0.002*
	(0.001)	(0.001)	(0.000)	(0.001)
Number of observations	**17,305**	**6,560**	**17,353**	**6,560**

Notes

a. Marginal effects calculated at the sample means of the covariates. (*) dy/dx is for discrete change of dummy variable from 0 to 1.

a. Robust firm-clustered standard errors in parentheses

b. * Significant at 5%; ** significant at 1%; *** significant at 0.1%

c. All specifications include the full set of time and industry dummies

d. Firms that borrow from the state or foreign sources are excluded

Table 4.8: Dynamic Probit and Tobit estimates for export status and export share

Accounting for the source of short term borrowing

	Probit		Tobit	
	$\Pr(Exp > 0)$		$E(Exp \mid Exp > 0)$	
	Manufacture	Services	Manufacture	Services
Financial variables				
Long term borrowing	-0.000	0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.000)	(0.000)
Short term borrowing				
State	-0.017	-0.006	-0.027	-0.053
	(0.063)	(0.027)	(0.020)	(0.066)
Foreign institution	0.185**	-0.060	0.023	0.072
	(0.061)	(0.090)	(0.021)	(0.086)
Local private institution	0.032*	0.014	0.010	0.010
	(0.016)	(0.008)	(0.006)	(0.007)
Non financial variables				
Size	0.059***	0.018***	0.023***	0.023***
	(0.004)	(0.004)	(0.003)	(0.004)
Total Factor Productivity	0.012***	0.009***	0.007***	0.006*
	(0.003)	(0.003)	(0.002)	(0.003)
Technology investments	0.015***	0.019***	0.002*	0.014**
	(0.004)	(0.005)	(0.001)	(0.004)
Age	0.007	-0.000	0.013***	-0.000
	(0.009)	(0.000)	(0.003)	(0.000)
Ownership structure	0.025			
Foreign Multinationals	0.018	0.034*	0.008	0.026*
	(0.014)	(0.014)	(0.004)	(0.013)
Private Group	-0.013*	0.021**	-0.004*	0.011
	(0.005)	(0.008)	(0.002)	(0.008)
Indian Multinationals	0.024*	0.030**	0.004	0.029**
	(0.012)	(0.011)	(0.003)	(0.010)

Notes

a. Marginal effects calculated at the sample means of the covariates. (*) dy/dx is for discrete change of dummy variable from 0 to 1.
b. Robust firm-clustered standard errors in parentheses
c. * Significant at 5%; ** significant at 1%; *** significant at 0.1%
d. All specifications include the full set of time and industry dummies

Table 4.8: Dynamic Probit and Tobit estimates for export status and export share

Accounting for the source of short term borrowing (cont.)

	Probit		Tobit	
	$\Pr(Exp > 0)$		$E(Exp \mid Exp > 0)$	
	Manufacture	Services	Manufacture	Services
Path dependence				
Export participation (t-1)	0.110***	0.189***		
	(0.006)	(0.007)		
Export share (t-1)			0.274***	0.008
			(0.045)	(0.006)
Initial condition				
Export participation		0.106***		
		(0.009)		
Export share			0.153***	0.269***
			(0.039)	(0.013)
Size	-0.029***	-0.007	-0.007**	-0.007*
	(0.005)	(0.004)	(0.002)	(0.004)
Total Factor Productivity	-0.008*	0.001	-0.004	0.006
	(0.004)	(0.003)	(0.002)	(0.003)
Technology investments	0.000	0.002	-0.003*	-0.007
	(0.005)	(0.007)	(0.001)	(0.006)
Long term borrowing	-0.001	0.001	-0.000	0.002*
	(0.001)	(0.001)	(0.000)	(0.001)
Short term borrowing				
State	(0.058)	-0.316*	0.044*	-0.408*
	0.086	(0.140)	(0.020)	(0.145)
Foreign institution	(0.096)	0.138	0.013	0.143
	0.012	(0.173)	(0.037)	(0.144)
Local private institution	(0.016)	-0.025	0.006	-0.026
		(0.019)	(0.007)	(0.018)
Number of observations	**20,193**	**6,760**	**20,242**	**6,760**

Notes

a. Marginal effects calculated at the sample means of the covariates. (*) dy/dx is for discrete change of dummy variable from 0 to 1.
b. Robust firm-clustered standard errors in parentheses
c. * Significant at 5%; ** significant at 1%; *** significant at 0.1%
d. All specifications include the full set of time and industry dummies

Table 4.9: Dynamic Probit and Tobit estimates for export status and export share

Including internal sources of finance

	Probit		Tobit	
	$\Pr(Exp > 0)$		$E(Exp \mid Exp > 0)$	
	Manufacture	Services	Manufacture	Services
Financial variables				
Short term borrowing	0.036*	0.007	0.011	0.009
	(0.015)	(0.009)	(0.006)	(0.007)
Long term borrowing	-0.000	0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.000)	(0.000)
Cash flow	0.007	0.010	0.001	0.001
	(0.006)	(0.005)	(0.002)	(0.005)
Non financial variables				
Size	0.059***	0.017***	0.023***	0.023***
	(0.004)	(0.004)	(0.003)	(0.004)
Total Factor Productivity	0.012***	0.009***	0.007***	0.006*
	(0.003)	(0.003)	(0.002)	(0.003)
Technology investments	0.015***	0.022***	0.002**	0.017***
	(0.004)	(0.005)	(0.001)	(0.005)
Age	0.005	-0.000	0.013***	-0.000
	(0.009)	(0.000)	(0.003)	(0.000)
Ownership structure				
Foreign Multinationals	0.020	0.032*	0.008	0.026*
	(0.014)	(0.013)	(0.004)	(0.013)
Private Group	-0.013*	0.021**	-0.004*	0.011
	(0.005)	(0.008)	(0.002)	(0.008)
Indian Multinationals	0.026*	0.029**	0.004	0.029**
	(0.012)	(0.011)	(0.003)	(0.010)
Path dependence				
Export participation (t-1)	0.276***	0.184***		
	(0.005)	(0.007)		
Export share (t-1)			0.274***	0.008
			(0.045)	(0.006)

Notes

a. Marginal effects calculated at the sample means of the covariates. (*) dy/dx is for discrete change of dummy variable from 0 to 1.
b. Robust firm-clustered standard errors in parentheses
c. * Significant at 5%; ** significant at 1%; *** significant at 0.1%
d. All specifications include the full set of time and industry dummies

Table 4.9: Dynamic Probit and Tobit estimates for export status and export share

Including internal sources of finance (cont.)

	Probit		Tobit	
	$\Pr(Exp > 0)$		$E(Exp \mid Exp > 0)$	
	Manufacture	Services	Manufacture	Services
Initial condition				
Export participation	0.110***	0.108***		
	(0.006)	(0.009)		
Export share			0.153***	0.271***
			(0.039)	(0.013)
Size	-0.029***	-0.005	-0.007**	-0.007
	(0.005)	(0.004)	(0.002)	(0.004)
Total Factor Productivity	-0.008*	0.001	-0.004	0.006*
	(0.004)	(0.003)	(0.002)	(0.003)
Technology investments	0.000	-0.005	-0.003*	-0.011
	(0.005)	(0.006)	(0.001)	(0.006)
Short term borrowing	0.012	-0.018	0.007	-0.020
	(0.016)	(0.018)	(0.007)	(0.019)
Long term borrowing	-0.001	0.001	-0.000	0.002*
	(0.001)	(0.001)	(0.000)	(0.001)
Cashflow	0.002	-0.002	0.001	0.002
	(0.006)	(0.007)	(0.004)	(0.006)
Number of observations	**20,192**	**6,612**	**20,241**	**6,612**

Notes

a. Marginal effects calculated at the sample means of the covariates. (*) dy/dx is for discrete change of dummy variable from 0 to 1.
b. Robust firm-clustered standard errors in parentheses
c. * Significant at 5%; ** significant at 1%; *** significant at 0.1%
d. All specifications include the full set of time and industry dummies

4.4.3. The role of finance across groups of firms

Our previous results constrain the effect of finance on exporting to be the same for all firms. However, the role of external finance on exporting behaviour might vary according to some observed firms' characteristics that affect their financial performance. For instance, in some contexts multinational firms and business groups have been found to be less dependent on external finance, as they can employ their internal capital markets opportunistically to overcome imperfections in external capital markets (Desay et al., 2004). The size of the firm, its productivity level and the industry in which it operates are also characteristics related to a firm's financial vulnerability (i.e. Rajan and Zingales,

1998; Chaney, 2005), and so they might affect the relationship between finance and exporting. To explore the existence of such heterogeneous effects, we allow the coefficients on our financial variables to vary according to some given characteristics. Tables 4.10 to 4.12 show our estimation results including interaction terms between our financial variables and firm's ownership structure, size and productivity level, respectively. The coefficients on these interaction terms are insignificant confirming that access to external finance is not an important determinant of service firms' exporting behaviour.

Interestingly, as Table 4.10 shows, for the manufacturing sector the exporting-enhancing effects of short term borrowing are only important amongst non multinational Indian firms without any affiliation to business groups. As mentioned previously, it might be possible that multinational corporations and firms affiliated to business groups rely mostly on their internal capital markets to secure funds for their investments, and therefore access external finance does not influences their exporting behavior. Other remarkable results for the manufacturing sector, reported in Tables 4.11 and 4.12, indicate that finance only proves to be effective in stimulating the exporting behaviour of medium sized companies and firms with intermediate levels of productivity. These results are in line with some theoretical predictions that suggest that finance is most relevant for potential exporters with *intermediate* levels of productivity, as financial constraints might prevent them from reaching foreign markets (i.e. Chaney, 2007; Muûls, 2008)[39].

[39] In these models the most productive firms are less dependent on external finance as they are able to generate enough liquidity to cover the cost of exporting, whereas the less productive firms are not profitable enough to export.

Finally, we estimated separate estimations for each industry in each sector. Our results, not reported here, confirm the irrelevance of finance for service exports. For the case of manufacturing firms we found that finance plays a significant role in 17 out of 90 industries. Examples of these industries include automobile ancillaries, polymers, plastics, rubber, fertilizers, and machinery, amongst others.

Table 4.10: Dynamic Probit and Tobit estimates for export status and export share

Effects of finance across firms of different ownership structure

	Probit		Tobit	
	$\Pr(Exp > 0)$		$E(Exp \mid Exp > 0)$	
	Manufacture	Services	Manufacture	Services
Financial variables				
Interaction short term borrowing - ownership structure				
Indian Non affiliated firms	0.037*	0.020	0.013	0.008
	(0.019)	(0.008)	(0.008)	(0.008)
Foreign Multinationals	0.029	-0.113	-0.007	-0.110*
	(0.070)	(0.058)	(0.018)	(0.050)
Private Group	0.005	-0.022	-0.003	-0.002
	(0.029)	(0.017)	(0.009)	(0.015)
Indian Multinationals	0.038	0.096	-0.008	0.081*
	(0.085)	(0.051)	(0.020)	(0.039)
Interaction long term borrowing - ownership structure				
Indian Non affiliated firms	-0.001	-0.001	-0.001	-0.001*
	(0.001)	(0.001)	(0.000)	(0.001)
Foreign Multinationals	-0.001	-0.003	0.000	-0.000
	(0.002)	(0.007)	(0.001)	(0.001)
Private Group	0.001	0.002	0.001	0.001
	(0.002)	(0.001)	(0.000)	(0.001)
Indian Multinationals	-0.004	0.000	-0.002	0.000
	(0.006)	(0.003)	(0.002)	(0.001)
Non financial variables				
Size	0.061***	0.016***	0.024***	0.022***
	(0.005)	(0.004)	(0.003)	(0.004)
Total Factor Productivity	0.012***	0.010***	0.008***	0.006*
	(0.004)	(0.003)	(0.002)	(0.003)
Technology investments	0.017***	0.020***	0.003**	0.013**
	(0.005)	(0.005)	(0.001)	(0.004)
Age	0.006	-0.000	0.013***	-0.000
	(0.009)	(0.000)	(0.003)	(0.000)

Notes

a. Marginal effects calculated at the sample means of the covariates. (*) dy/dx is for discrete change of dummy variable from 0 to 1.
b. Robust firm-clustered standard errors in parentheses
c. * Significant at 5%; ** significant at 1%; *** significant at 0.1%
d. All specifications include the full set of time and industry dummies

Table 4.10: Dynamic Probit and Tobit estimates for export status and export share

Effects of finance across firms of different ownership structure (cont.)

	Probit		Tobit	
	$\Pr(Exp > 0)$		$E(Exp \mid Exp > 0)$	
	Manufacture	Services	Manufacture	Services
Ownership structure				
Foreign Multinationals	0.009	0.052***		0.041***
	(0.023)	(0.014)		(0.012)
Private Group	-0.022*	0.022**		0.011
	(0.010)	(0.008)		(0.009)
Indian Multinationals	0.010	0.022		0.023*
	(0.024)	(0.011)		(0.011)
Path dependence				
Export participation (t-1)	0.284***	0.179***		
	(0.005)	(0.007)		
Export share (t-1)			0.257***	0.008
			(0.048)	(0.005)
Initial condition				
Export participation	0.114***	0.109***		
	(0.006)	(0.009)		
Export share			0.156***	0.271***
			(0.041)	(0.013)
Size	-0.029***	-0.005	-0.007**	-0.006
	(0.005)	(0.004)	(0.002)	(0.004)
Total Factor Productivity	-0.008*	0.001	-0.004*	0.006*
	(0.004)	(0.003)	(0.002)	(0.003)
Technology investments	0.000	-0.005	-0.004**	-0.007
	(0.005)	(0.006)	(0.002)	(0.006)
Short term borrowing	0.003	-0.021	0.004	-0.024
	(0.017)	(0.019)	(0.007)	(0.019)
Long term borrowing	-0.001	0.001	-0.000	0.002*
	(0.001)	(0.001)	(0.000)	(0.001)
Number of observations	**17,305**	**6,434**	**17,353**	**6,434**

Notes

a. Marginal effects calculated at the sample means of the covariates. (*) dy/dx is for discrete change of dummy variable from 0 to 1.
b. Robust firm-clustered standard errors in parentheses
c. * Significant at 5%; ** significant at 1%; *** significant at 0.1%
d. All specifications include the full set of time and industry dummies

Table 4.11: Dynamic Probit and Tobit estimates for export status and export share

Effects of finance across firms of different size

	Probit		**Tobit**	
	$\Pr(Exp > 0)$		$E(Exp \mid Exp > 0)$	
	Manufacture	**Services**	**Manufacture**	**Services**
Non financial variables				
Size	0.052***	0.020***	0.018***	0.017***
	(0.005)	(0.004)	(0.002)	(0.002)
Total Factor Productivity	0.005	0.008**	0.004*	0.009***
	(0.004)	(0.003)	(0.002)	(0.002)
Technology investments	0.017***	0.019***	0.002	0.008**
	(0.005)	(0.005)	(0.001)	(0.003)
Age	0.001	-0.000	0.004***	-0.000
	(0.003)	(0.000)	(0.001)	(0.000)
Financial variables				
Short term borrowing interacted with size quintiles				
Size quintile 1	0.042	0.014	0.007	0.016
	(0.028)	(0.049)	(0.011)	(0.035)
Size quintile 2	0.087***	-0.038	0.018*	-0.019
	(0.023)	(0.055)	(0.008)	(0.037)
Size quintile 3	0.060**	0.023	0.023***	0.002
	(0.022)	(0.054)	(0.007)	(0.038)
Size quintile 4	0.087***	0.020	0.019**	0.022
	(0.023)	(0.060)	(0.007)	(0.042)
Size quintile 5	0.052	-0.062	-0.002	-0.038
	(0.029)	(0.055)	(0.007)	(0.039)
Long term borrowing interacted with size quintiles				
Size quintile 1	-0.004	-0.002	-0.001*	0.001
	(0.002)	(0.003)	(0.001)	(0.002)
Size quintile 2	-0.007***	0.006	-0.001	-0.000
	(0.002)	(0.004)	(0.001)	(0.003)
Size quintile 3	-0.001	0.001	-0.000	-0.003
	(0.001)	(0.004)	(0.000)	(0.003)
Size quintile 4	-0.004**	-0.005	-0.001	-0.010*
	(0.001)	(0.006)	(0.000)	(0.004)
Size quintile 5	-0.000	0.002	0.000	-0.002
	(0.002)	(0.003)	(0.000)	(0.002)

Notes

a. Marginal effects calculated at the sample means of the covariates. (*) dy/dx is for discrete change of dummy variable from 0 to 1.
b. Robust firm-clustered standard errors in parentheses
c. * Significant at 5%; ** significant at 1%; *** significant at 0.1%
d. All specifications include the full set of time and industry dummies

Table 4.11: Dynamic Probit and Tobit estimates for export status and export share

Effects of finance across firms of different size (cont.)

	Probit		**Tobit**	
	Pr(*Exp* > 0)		*E*(*Exp* | *Exp* > 0)	
	Manufacture	**Services**	**Manufacture**	**Services**
Ownership structure				
Foreign Multinationals	0.019	0.032**	0.006	0.017*
	(0.015)	(0.012)	(0.003)	(0.007)
Private Group	-0.010	0.023**	-0.003*	0.010*
	(0.006)	(0.007)	(0.002)	(0.005)
Indian Multinationals	0.030*	0.022*	0.001	0.005
	(0.013)	(0.010)	(0.002)	(0.006)
Path dependence				
Export participation (t-1)	0.289***	0.194***		
	(0.005)	(0.007)		
Export share (t-1)			0.384***	0.279***
			(0.009)	(0.010)
Initial condition				
Export participation	0.095***	0.072***		
	(0.006)	(0.009)		
Export share			0.059***	0.049***
			(0.008)	(0.009)
Size	-0.025***	-0.008*	-0.004*	-0.003
	(0.005)	(0.004)	(0.002)	(0.002)
Total Factor Productivity	-0.005	0.002	-0.002	0.002
	(0.004)	(0.003)	(0.002)	(0.002)
Technology investments	-0.000	-0.007	-0.001	-0.008*
	(0.005)	(0.006)	(0.001)	(0.003)
Short term borrowing	-0.008	-0.003	0.003	-0.012
	(0.019)	(0.020)	(0.006)	(0.014)
Long term borrowing	0.000	0.000	-0.000	0.002*
	(0.001)	(0.001)	(0.000)	(0.001)
Number of observations	**18,873**	**6,324**	**18,873**	**6,324**

Notes

a. Marginal effects calculated at the sample means of the covariates. (*) dy/dx is for discrete change of dummy variable from 0 to 1.
b. Robust firm-clustered standard errors in parentheses
c. * Significant at 5%; ** significant at 1%; *** significant at 0.1%
d. All specifications include the full set of time and industry dummies

Table 4.12: Dynamic Probit and Tobit estimates for export status and export share

Effects of finance across firms of different productivity level

	Probit		Tobit	
	Pr(*Exp* > 0)		*E*(*Exp* | *Exp* > 0)	
	Manufacture	**Services**	**Manufacture**	**Services**
Financial variables				
Short term borrowing interacted with productivity quintiles				
Productivity quintile 1	0.039	0.001	-0.000	-0.007
	(0.029)	(0.035)	(0.007)	(0.023)
Productivity quintile 2	0.077***	-0.028	0.020**	-0.011
	(0.023)	(0.033)	(0.007)	(0.023)
Productivity quintile 3	0.053*	0.024	0.019**	0.028
	(0.022)	(0.043)	(0.007)	(0.027)
Productivity quintile 4	0.079***	0.070	0.021**	0.069
	(0.024)	(0.054)	(0.008)	(0.038)
Productivity quintile 5	0.059*	-0.008	0.007	0.006
	(0.026)	(0.046)	(0.010)	(0.031)
Long term borrowing interacted with productivity quintiles				
Productivity quintile 1	0.001	0.002	0.000	0.000
	(0.003)	(0.002)	(0.000)	(0.001)
Productivity quintile 2	-0.003*	-0.002	-0.001*	-0.001
	(0.001)	(0.002)	(0.000)	(0.001)
Productivity quintile 3	-0.003	-0.006	-0.001	-0.002
	(0.001)	(0.004)	(0.001)	(0.004)
Productivity quintile 4	-0.005**	-0.020*	-0.001	-0.015*
	(0.002)	(0.007)	(0.001)	(0.006)
Productivity quintile 5	-0.002	-0.001	-0.000	-0.001
	(0.001)	(0.003)	(0.001)	(0.002)
Non financial variables				
Size	0.054***	0.018***	0.018***	0.015***
	(0.005)	(0.004)	(0.002)	(0.002)
Total Factor Productivity	0.005	0.008**	0.004*	0.009***
	(0.004)	(0.003)	(0.002)	(0.002)
Technology investments	0.017***	0.018***	0.001	0.008**
	(0.005)	(0.005)	(0.001)	(0.003)
Age	0.001	-0.000	0.003***	-0.000
	(0.003)	(0.000)	(0.001)	(0.000)

Notes

a. Marginal effects calculated at the sample means of the covariates. (*) dy/dx is for discrete change of dummy variable from 0 to 1.
b. Robust firm-clustered standard errors in parentheses
c. * Significant at 5%; ** significant at 1%; *** significant at 0.1%
d. All specifications include the full set of time and industry dummies

Table 4.12: Dynamic Probit and Tobit estimates for export status and export share

Effects of finance across firms of different productivity level (cont.)

	Probit		**Tobit**	
	$\Pr(Exp > 0)$		$E(Exp \mid Exp > 0)$	
	Manufacture	**Services**	**Manufacture**	**Services**
Ownership structure				
Foreign Multinationals	0.019	0.034**	0.006	0.017*
	(0.015)	(0.012)	(0.003)	(0.007)
Private Group	-0.011*	0.023**	-0.003*	0.010*
	(0.006)	(0.007)	(0.002)	(0.005)
Indian Multinationals	0.030*	0.024*	0.000	0.006
	(0.013)	(0.010)	(0.002)	(0.006)
Path dependence				
Export participation (t-1)	0.289***	0.194***		
	(0.005)	(0.007)		
Export share (t-1)			0.385***	0.279***
			(0.009)	(0.010)
Initial condition				
Export participation	0.095***	0.073***		
	(0.006)	(0.009)		
Export share			0.059***	0.050***
			(0.008)	(0.009)
Size	-0.025***	-0.007*	-0.004*	-0.003
	(0.005)	(0.004)	(0.002)	(0.002)
Total Factor Productivity	-0.005	0.002	-0.002	0.002
	(0.004)	(0.003)	(0.002)	(0.002)
Technology investments	-0.001	-0.008	-0.002	-0.008*
	(0.005)	(0.006)	(0.001)	(0.003)
Short term borrowing	-0.006	-0.005	0.003	-0.013
	(0.019)	(0.020)	(0.006)	(0.014)
Long term borrowing	0.000	0.000	-0.000	0.002*
	(0.001)	(0.001)	(0.000)	(0.001)
Number of observations	**18,873**	**6,324**	**18,873**	**6,324**

Notes

a. Marginal effects calculated at the sample means of the covariates. (*) dy/dx is for discrete change of dummy variable from 0 to 1.
b. Robust firm-clustered standard errors in parentheses
c. * Significant at 5%; ** significant at 1%; *** significant at 0.1%
d. All specifications include the full set of time and industry dummies

4.4.4. Robustness checks

a) Instrumental variables Probit and Tobit estimators

As already mentioned, our proposed approach ignores any contemporaneous endogeneity of one or more covariates. To check whether our results are robust to the assumption of strict exogeneity we estimate Equations 4.1 and 4.2 using the instrumental variables (IV) Probit and Tobit estimatior due to Smith and Blundell (1986). We use lagged values of the suspected endogenous variables (i.e. long and short term borrowing, size, technology investments and productivity) as instruments. The marginal effects from these models are reported in Table 4.13. The test for the null hypothesis that the covariates are exogenous is rejected and the Amemiya-Lee-Newey test confirms the validity of the instruments. The results are qualitatively similar to our previous findings. Like manufacturing companies, firm size, total factor productivity and technology investments are important drivers of service firms' exporting performance, but unlike goods exporters financial factors are irrelevant in affecting service firms' exporting decisions.

Table 4.13: IV Probit and IV Tobit estimations

	Probit		Tobit	
	$\Pr(Exp > 0)$		$E(Exp \mid Exp > 0)$	
	Manufacture	**Services**	**Manufacture**	**Services**
Financial variables				
Short term borrowing	0.104**	0.036	0.020	-0.017
	(0.036)	(0.059)	(0.012)	(0.046)
Long term borrowing	-0.007*	-0.001	-0.001	0.001
	(0.003)	(0.004)	(0.001)	(0.003)
Non Financial variables				
Size	0.022***	0.014***	0.011***	0.018***
	(0.003)	(0.003)	(0.002)	(0.004)
Total Factor Productivity	0.009*	0.016***	0.005*	0.020***
	(0.004)	(0.004)	(0.002)	(0.006)
Technology investments	0.042***	0.037***	0.006***	0.026***
	(0.008)	(0.008)	(0.002)	(0.007)
Age	0.019	-0.004	0.012*	-0.010
	(0.013)	(0.009)	(0.005)	(0.012)
Ownership structure				
Foreign Multinationals	0.022	0.036	0.009*	0.041
	(0.014)	(0.021)	(0.004)	(0.029)
Private Group	-0.010	0.016	-0.001	0.005
	(0.006)	(0.012)	(0.002)	(0.017)
Indian Multinationals	0.049***	0.071***	0.005	0.074***
	(0.014)	(0.015)	(0.003)	(0.021)
Path dependence				
Export participation (t-1)	0.365***	0.287***		
	(0.005)	(0.007)		
Export share (t-1)			0.491***	0.208*
			(0.011)	(0.085)
Wald test of exogeneity (p-value)	0.00	0.01	0.00	0.00
Test of overidentifying restrictions (p-value)	0.40	0.1931	0.82	0.74
Number of observations	**11,110**	**2,910**	**11,110**	**2,910**

a. * Significant at 5%; ** significant at 1%; *** significant at 0.1%
b. Endogenous variables lagged up to 3 periods are used as instruments in the IV Probit and Tobit models

b) System-GMM estimator

The international trade literature has also identified some positive feedback from exporting to some of our explanatory variables. For instance, exporting has been found to boost productivity, encourage technology investments and improve a firm's financial health. To further control for

potential two-way feedback effects between exporting and firm characteristics, we estimate Equations 4.1 and 4.2 using the system-GMM estimator due to Blundell and Bond (1998). Columns 1 and 2 of table 4.14 report the results from linear probability models for the probability to export and columns 3 and 4 the estimates from a linear model of export intensity on the subsample of exporting firms, where we correct for sample selection bias as described in section 4.2. As expected, the coefficient on the inverse Mills ratio in the export intensity equations are positive, indicating that firms that survive in the export market have, on average, higher export shares. The diagnostic tests show the validity of the overidentifying restrictions and the absence of serial correlation in the equations error, confirming the appropriateness of the GMM estimators. The results from these estimations corroborate that access to external borrowing is not a significant determinant of Indian service firms' exporting behaviour. Interestingly, the coefficients on the financial indicators in the manufacturing sector are insignificant. These results, together with our previous findings controlling for firm heterogeneity in non linear panel models, confirm that the treatment of firm heterogeneity is an important issue when trying to identify causal effects from finance to firms' exporting activity.

Table 4.14: System-GMM estimations

	Probit		Tobit	
	(1) $\Pr(Exp > 0)$	**(2)** $E(Exp \mid Exp > 0)$	**(3)** $E(Exp \mid Exp > 0)$	**(4)** $E(Exp \mid Exp > 0)$
	Manufacture	**Services**	**Manufacture**	**Services**
Financial variables				
Short term borrowing	-0.133	0.027	-0.015	0.031
	(0.080)	(0.054)	(0.021)	(0.020)
Long term borrowing	0.008	-0.005	0.001	-0.004
	(0.004)	(0.003)	(0.001)	(0.002)
Non financial variables				
Size	0.134*	0.118***	0.038*	0.035***
	(0.059)	(0.020)	(0.017)	(0.001)
Total factor productivity	0.125**	0.087***	0.029**	0.014***
	(0.039)	(0.014)	(0.010)	(0.001)
Technology investments	0.057*	0.113***	0.014*	0.012***
	(0.029)	(0.023)	(0.007)	(0.000)
Age	0.169**	0.001	0.006	0.005***
	(0.058)	(0.004)	(0.014)	(0.000)
State dependence				
Export status (t-1)	0.322***	0.230***		
	(0.046)	(0.024)		
Export share (t-1)			0.388***	0.178***
			(0.045)	(0.022)
Inverse mills ratio			0.098***	0.213***
			(0.026)	(0.029)
Number of observations	17,370	5,556	8,970	1,997
Sargan test (p-value)	0.42	0.8016	0.19	0.102
Serial correlation test (p-value)	0.22	0.5459	0.70	0.2112

Notes

a. * Significant at 5%; ** significant at 1%; *** significant at 0.1%
b. Endogenous variables lagged up to 3 periods are used as instruments in the IV Probit and Tobit models
c. Instruments for the endogenous regressors in GMM models are: i) levels lagged 2 periods and more for the equation in differences and ii) differences lagged one period and more for the equation in levels.

c) Bivariate probit models

To probe our findings further, we now turn to examine the relationship between finance and exporting allowing for the potential complementarities between exporting and investing in technology. We estimate the firm's discrete decisions

to export and invest in technology using bivariate probit models, hence allowing for the possibility that these decisions might be jointly determined. As mentioned in section 4.2, the use of joint estimations should improve our estimations if these choices are indeed simultaneously determined. The estimate parameters from these models, with and without controlling for firm herterogeneity, are reported in Tables 4.16 and 4.17 and the marginal effects are shown in Tables 4.18 and 4.19.

Tables 4.16 and 4.17 show that the decision to export and invest in technology are indeed jointly determined, as judged by the significant cross-equation correlation amongst the bi-probits modeling these choices. We also confirm the theoretical predictions that larger firms are more likely to export and invest in technology. These activities are also highly persistent over time, indicating that they might be subject to high sunk start-up costs, as hypothesized by the recent theoretical work in international trade. We also find evidence to support the hypothesis that the more productive firms self-select into the export market. Finally, in line with our previous findings, we fail to find evidence that finance plays a role for the exports of services.

Table 4.16: Discrete choice of exporting and investing in technology

Without controlling for firm's heterogeneity

	Manufacture		Services	
	Exporting	**Investing in technology**	**Exporting**	**Investing in technology**
Financial variables				
Short term borrowing	0.209**	-0.009	0.088	0.071
	(0.079)	(0.064)	(0.092)	(0.067)
Long term borrowing	-0.005	-0.010**	0.004	-0.004
	(0.004)	(0.003)	(0.006)	(0.005)
Non financial variables				
Size	0.202***	0.197***	0.108***	0.072***
	(0.015)	(0.012)	(0.016)	(0.012)
Total Factor Productivity	0.040**	-0.010	0.091***	0.000
	(0.016)	(0.012)	(0.017)	(0.012)
Age	0.006	-0.002	-0.002	-0.002
	(0.020)	(0.017)	(0.002)	(0.001)
Past export and investment decisions				
Lagged exporting choice	2.375***	0.194***	2.217***	0.304***
	(0.044)	(0.033)	(0.081)	(0.061)
Lagged technology investment choice	0.213***	1.408***	0.263***	1.513***
	(0.040)	(0.037)	(0.078)	(0.058)
Lagged export & technology investment choices	0.092	0.091	0.117	0.057
Ownership structure				
State	-0.463***	0.059	-0.010	0.168
	(0.136)	(0.100)	(0.173)	(0.140)
Foreign Multinationals	0.138**	0.113**	0.090	0.157
	(0.053)	(0.042)	(0.112)	(0.086)
Indian Multinationals	0.262**	0.090	0.438***	0.149*
	(0.084)	(0.059)	(0.086)	(0.074)
Private Group	-0.127***	0.022	0.160**	-0.033
	(0.031)	(0.027)	(0.059)	(0.046)
_cons	-2.104***	-1.557***	-1.394***	-0.995***
	(0.110)	(0.098)	(0.334)	(0.207)
athrho _cons	0.133***		0.139***	
	(0.019)		(0.037)	
Observations	20725		6803	
Firms	5261		2306	
Correlation	0.132		0.138	

Notes:

a. All results based on bivariate probit models
b. Standard errors in parentheses
c. significant at 10%; ** significant at 5%; *** significant at 1%
d. All specifications include the full set of industry and time dummies

Table 4.17: Discrete choice of exporting and investing in technology

Controlling for firm's heterogeneity

	Manufacture		Services	
	Exporting	**Investing in technology**	**Exporting**	**Investing in technology**
Financial variables				
Short term borrowing	0.226*	0.088	0.100	0.047
	(0.106)	(0.088)	(0.077)	(0.070)
Long term borrowing	-0.003	-0.009*	0.006	-0.001
	(0.004)	(0.004)	(0.007)	(0.006)
Non financial variables				
Size	0.375***	0.262***	0.161***	0.061*
	(0.028)	(0.023)	(0.034)	(0.027)
Total Factor Productivity	0.062**	-0.029	0.081**	-0.004
	(0.022)	(0.018)	(0.025)	(0.017)
Age	-0.006	-0.007	-0.002	-0.001
	(0.023)	(0.019)	(0.002)	(0.001)
Past export and investment decisions				
Lagged exporting choice	1.908***	0.082*	1.713***	0.220**
	(0.048)	(0.040)	(0.087)	(0.073)
Lagged technology investment choice	0.133**	1.194***	0.112	1.322***
	(0.043)	(0.037)	(0.083)	(0.059)
Lagged export & technology investment choice	0.095	0.067	0.131	-0.040
	(0.059)	(0.048)	(0.123)	(0.095)
Ownership structure				
State	-0.345*	0.121	0.133	0.100
	(0.153)	(0.100)	(0.212)	(0.136)
Foreign Multinationals	0.070	0.096*	0.013	0.125
	(0.062)	(0.044)	(0.129)	(0.091)
Indian Multinationals	0.209*	0.054	0.356***	0.137
	(0.086)	(0.063)	(0.093)	(0.081)
Private Group	-0.122***	0.020	0.172*	-0.040
	(0.036)	(0.030)	(0.068)	(0.050)

Notes:

a. All results based on bivariate probit models
b. Standard errors in parentheses
c. significant at 10%; ** significant at 5%; *** significant at 1%
d. All specifications include the full set of industry and time dummies

Table 4.17: Discrete choice of exporting and investing in technology

Controlling for firm's heterogeneity (cont.)

	Manufacture		Services	
	Exporting	**Investing in technology**	**Exporting**	**Investing in technology**
Initial condition				
Exporting choice	0.802***	0.109**	0.922***	0.076
	(0.040)	(0.035)	(0.084)	(0.071)
Technology investments choice	0.127***	0.540***	0.199*	0.640***
	(0.038)	(0.030)	(0.088)	(0.068)
Size	-0.242***	-0.113***	-0.073*	-0.004
	(0.030)	(0.026)	(0.035)	(0.027)
Total Factor Productivity	-0.056*	0.019	0.007	0.015
	(0.024)	(0.020)	(0.026)	(0.016)
Short term borrowing	0.081	-0.092	-0.196	-0.043
	(0.110)	(0.092)	(0.173)	(0.121)
Long term borrowing	-0.006	-0.005	0.004	-0.005
	(0.004)	(0.004)	(0.006)	(0.007)
_cons	-2.188***	-1.427***	-1.736***	-0.970***
	(0.128)	(0.106)	(0.407)	(0.202)
athrho _cons	0.115***		0.113**	
	(0.020)		(0.039)	
Obs	20725		6803	
Firms	5261		2306	
Correlation	0.114		0.113	

Notes:

a. All results based on bivariate probit models
b. Standard errors in parentheses
c. significant at 10%; ** significant at 5%; *** significant at 1%
d. All specifications include the full set of industry and time dummies

Table 4.18: Discrete choice of exporting and investing in technology

Without controlling for firm's heterogeneity

Marginal effects

	P(Exporting & Investing in technology)		P(Exporting and not investing in technology)		P(Investing in technology and not exporting)	
	Manuf.	**Service**	**Manuf.**	**Service**	**Manuf.**	**Service**
Financial variables						
Short term borrowing	0.043	0.011	0.039*	0.009	-0.046*	0.014
	(0.023)	(0.009)	(0.020)	(0.013)	(0.020)	(0.018)
Long term borrowing	-0.003**	0.000	0.001	0.001	-0.001	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Non financial variables						
Size	0.088***	0.012***	-0.008*	0.012***	-0.010**	0.013***
	(0.005)	(0.001)	(0.004)	(0.002)	(0.004)	(0.004)
Total Factor Productivity	0.006	0.007***	0.009**	0.013***	-0.010**	-0.007
	(0.005)	(0.001)	(0.004)	(0.003)	(0.004)	(0.004)
Age	0.001	-0.000	0.002	-0.000	-0.002	-0.000
	(0.006)	(0.000)	(0.005)	(0.000)	(0.005)	(0.000)
Past export and investment decisions						
Lagged exporting choice	0.460***	0.269***	0.302***	0.392***	-0.384***	-0.160***
	(0.009)	(0.015)	(0.008)	(0.021)	(0.009)	(0.014)
Lagged technology investment choice	0.336***	0.118***	-0.253***	-0.055***	0.178***	0.425***
	(0.011)	(0.013)	(0.010)	(0.009)	(0.009)	(0.020)
Lagged export & technology investment choice	0.040*	0.013	-0.004	0.014	-0.004	0.007
	(0.018)	(0.013)	(0.015)	(0.020)	(0.015)	(0.030)
Ownership structure						
State	-0.094*	0.008	-0.089***	-0.011	0.117***	0.052
	(0.037)	(0.015)	(0.023)	(0.026)	(0.035)	(0.052)
Foreign Multinationals	0.056***	0.017	-0.003	0.004	-0.012	0.039
	(0.015)	(0.013)	(0.013)	(0.016)	(0.013)	(0.027)
Indian Multinationals	0.077***	0.053***	0.022	0.063***	-0.042*	0.000
	(0.023)	(0.013)	(0.020)	(0.018)	(0.019)	(0.022)
Private Group	-0.023*	0.011	-0.027***	0.026**	0.031***	-0.022
	(0.009)	(0.006)	(0.008)	(0.010)	(0.008)	(0.014)
Observations	20725	6803	20725	6803	20725	6803
Firms	5261	2306	5261	2306	5261	2306
Correlation	0.132	0.138	0.132	0.138	0.132	0.138

Notes:

a. All results based on bivariate probit models
b. Standard errors in parentheses
c. significant at 10%; ** significant at 5%; *** significant at 1%
d. All specifications include the full set of industry and time dummies

Table 4.19: Discrete choice of exporting and investing in technology

Controlling for firm's heterogeneity

Marginal effects

	P(Exporting and investing in technology)		P(exporting and not investing in technology)		P(Investing in technology and not exporting)	
	Manuf.	**Services**	**Manuf.**	**Services**	**Manuf.**	**Services**
Financial variables						
Short term borrowing	0.069*	0.010	0.020	0.012	-0.034	0.006
	(0.031)	(0.008)	(0.026)	(0.011)	(0.027)	(0.019)
Long term borrowing	-0.003*	0.000	0.001	0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Non financial variables						
Size	0.140***	0.016***	0.007	0.021***	-0.037***	0.005
	(0.009)	(0.003)	(0.007)	(0.005)	(0.007)	(0.008)
Total Factor Productivity	0.007	0.006**	0.017***	0.012**	-0.018***	-0.008
	(0.007)	(0.002)	(0.005)	(0.004)	(0.005)	(0.006)
Age	-0.003	-0.000	0.001	-0.000	0.000	-0.000
	(0.007)	(0.000)	(0.006)	(0.000)	(0.006)	(0.000)
Past export and investment decisions						
Lagged exporting choice	0.382***	0.200***	0.274***	0.309***	-0.349***	-0.121***
	(0.011)	(0.016)	(0.010)	(0.023)	(0.011)	(0.018)
Lagged technology investment choice	0.282***	0.085***	-0.230***	-0.059***	0.163***	0.396***
	(0.011)	(0.012)	(0.011)	(0.010)	(0.010)	(0.021)
Lagged export & technology investment choice	0.036*	0.008	0.001	0.023	-0.009	-0.022
	(0.017)	(0.012)	(0.015)	(0.021)	(0.015)	(0.029)
Ownership structure						
State	-0.056	0.017	-0.081**	0.014	0.103**	0.018
	(0.044)	(0.020)	(0.025)	(0.037)	(0.039)	(0.050)
Foreign Multinationals	0.037*	0.008	-0.010	-0.005	0.000	0.037
	(0.017)	(0.013)	(0.014)	(0.018)	(0.016)	(0.029)
Indian Multinationals	0.058*	0.042**	0.022	0.050**	-0.036	0.007
	(0.025)	(0.013)	(0.020)	(0.018)	(0.019)	(0.024)
Private Group	-0.022*	0.011	-0.026**	0.029*	0.030**	-0.025
	(0.010)	(0.006)	(0.009)	(0.011)	(0.009)	(0.015)

Notes:

a. All results based on bivariate probit models
b. Standard errors in parentheses
c. significant at 10%; ** significant at 5%; *** significant at 1%
d. All specifications include the full set of industry and time dummies

Table 4.19: Discrete choice of exporting and investing in technology

Controlling for firm's heterogeneity (cont.)

Marginal effects

	P(Exporting and investing in technology)		P(exporting and not investing in technology)		P(Investing in technology and not exporting)	
	Manuf.	**Services**	**Manuf.**	**Services**	**Manuf.**	**Services**
Initial condition						
Exporting choice	0.194***	0.095***	0.113***	0.165***	-0.151***	-0.068***
	(0.012)	(0.013)	(0.010)	(0.020)	(0.010)	(0.019)
Technology investments choice	0.147***	0.060***	-0.098***	-0.012	0.062***	0.180***
	(0.011)	(0.013)	(0.009)	(0.012)	(0.010)	(0.024)
Size	-0.078***	-0.006	-0.017*	-0.011*	0.033***	0.005
	(0.010)	(0.003)	(0.007)	(0.005)	(0.007)	(0.008)
Total Factor Productivity	-0.008	0.001	-0.014*	0.000	0.015**	0.004
	(0.007)	(0.002)	(0.006)	(0.004)	(0.006)	(0.005)
Short term borrowing	-0.003	-0.017	0.035	-0.027	-0.033	0.003
	(0.032)	(0.016)	(0.028)	(0.026)	(0.028)	(0.037)
Long term borrowing	-0.002*	0.000	0.000	0.001	0.001	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Observations	20725	6803	20725	6803	20725	6803
Firms	5261	2306	5261	2306	5261	2306
Correlation	0.114	0.113	0.114	0.113	0.114	0.113

Notes:

a. All results based on bivariate probit models
b. Standard errors in parentheses
c. significant at 10%; ** significant at 5%; *** significant at 1%
d. All specifications include the full set of industry and time dummies

4.5. Summary and conclusions

In this chapter we have provided systematic evidence on the determinants of services exports with a specific emphasis on the role of finance; a highly underexplored area in the trade literature. We have presented empirical evidence from India, a leading exporter of services, with the aim of understanding whether finance plays a different role in determining the exporting decisions and the levels exported by service firms.

In line with previous research on goods exports, we found that some firm characteristics such as size, TFP and technology investments of firms are significant factors motivating the exporting decisions and the level of exports of Indian service firms. However, in contrast to some findings for the manufacturing industry, the main result emerging from our analysis is that finance is not a significant determinant of Indian service firms' exporting activity. In light of these results, we hypothesise that finance is less important to cover the fixed and variable costs of exporting services than is the case for goods. Possibly the different nature of costs associated with the export of services restrains the impact of finance on service firms' export behaviour. If that is the case, our results suggest that policy measures designed to stimulate a firm's growth, productivity and technology investments are more effective than policies aimed at facilitating access to external finance to directly promote service exports. Thus, the econometric analysis points to the conclusion that access to external finance might have an indirect impact on exporting if service firms use these funds to develop their productive and technological capabilities.

However, an alternative explanation is that financial factors do matter for service exports, but that Indian export promotion policies have been successful in reducing the financial constraints on firms' global expansion. As such, further empirical evidence on the role of finance to promote service exports in different institutional settings is essential to guide future theoretical work on the subject.

Appendix A.4.1: Definition of variables

Variable	Definition
Export variables	
Services exports (dummy)	Equal to 1 if the firm exports, 0 otherwise
Services exports (intensity)	Services exports/total sales
Financial variables	
Total long term borrowing	Stock of long term borrowing normalized by total assets
Total short term borrowing (STB)	The sum of state borrowing, private local borrowing and foreign borrowing normalized by total assets.
State Borrowing (SB)	State borrowing/ total assets
Foreign Borrowing (FB)	Foreign borrowing/ total assets
Private local Borrowing (PLB)	(STB- SB - FB)/ total assets
Non financial variables	
Technology investment	The sum of real expenditures on own R&D, computers and software, royalty fees and imports of capital goods scaled by total assets (in logs)
Size	Log of total sales
Total factor Productivity	Log of total factor productivity estimated based on 3-input (labour cost, value of fixed capital and cost of intermediate material inputs) production function using the Levinshon-Petrin (2003) technique which accounts for the endogeneity of inputs.
Age	Firm age since incorporation.

Chapter 5

Conclusions

In this chapter we present a short summary of the work carried out in the course of this thesis

A key feature of Indian economic reforms since 1991 has been the promotion of exports and outward FDI. These two forms of globalization have been regarded as key policy tools to stimulate greater domestic economic activity, acquire global capabilities, and catch up with the technological frontier. We have explored the existence of such beneficial effects using firm level data from the manufacturing and service sectors, the two main drivers of Indian economic growth and international expansion in recent years. We examined the determinants and effects of exporting and outward FDI on firms' performance during 1999-2007, a period of vigorous international expansion of Indian firms.

We started with an analysis of the individual and complementary effects of exporting and outward FDI in stimulating the development of in-house technological capabilities [first chapter] and improving efficiency levels [second chapter]. A striking result from the first chapter is the *universal negative relationship between outward FDI and firms' domestic technology investments*. While this result might raise concerns about the diversion of national resources that could otherwise be invested in creating technological capabilities at home, we have shown that

Indian multinational firms make a more efficient use of their technology investments. As such, public policies should not just be concerned with the volume of technology investments, but also with the efficient utilization of such investments.

This thesis has also shown that *exporting has been an important channel through which Indian multinational expansion has encouraged greater domestic economic activity* in recent years. Results from the first and second chapters offer a good deal of universal statistical evidence supporting the hypothesis of *technology-enhancing and productivity-improvement effects from exporting amongst Indian multinationals*. It is likely that the recent internationalization process of Indian firms in the form of outward FDI has provided them with a new impetus to export and the incentive to undertake costly productivity-enhancing investments. As such, an interesting area of future theoretical research is to better understand the complementarities between exporting and investing abroad in stimulating firm's technological effort and efficiency. More generally, while FDI has been considered a main indicator of firms' multinational activity, results from this thesis highlight the necessity of evaluating different dimensions through which firms' multinational expansion affects domestic economic activity.

In contrast to the universal finding regarding the beneficial effects from exporting amongst Indian multinationals, *there is no absolute evidence regarding the unconditional positive role of exporting in stimulating non multinational firms' technological effort and efficiency*. Our results have painted a differentiated picture of the

individual impact of exporting amongst non multinationals depending on the sector under consideration.

Another interesting result emerging from the second chapter is the *complementary effects of firms' international activities and technological investments in enhancing firms' productivity growth either through innovation or technological transfer*. These results illustrate the importance of strengthening firms' technological capacity to assimilate knowledge and expertise from foreign sources. From a policy perspective, these findings emphasize the relevance of helping indigenous firms to upgrade their technological base in order to reap the benefits of internationalization. Coherence and consistency between foreign, and science and technology policies are therefore important for maximizing the benefits of liberalization.

In the last empirical chapter we have provided insights on the role of financial factors in facilitating service exports. In contrast to some findings for the manufacturing industry, the main result emerging from the third chapter of this thesis is that *access to external finance is not a significant determinant of Indian service firms' exporting activity*. The different nature of costs associated with the export of services appears to lessen the impact of external finance. An alternative explanation is that financial factors do matter for service exports, but that Indian export promotion policies have been successful in reducing the financial constraints on firms' global expansion. As such, in order to guide future

theoretical work on the subject, this thesis calls for further empirical work on the role of finance for service firms in different institutional settings.

Overall, the main contribution of this thesis has been substantive in nature, as it has provided a detailed empirical analysis of the forces underlying firm's global strategies in the form of exporting and outward FDI and the role of these activities in generating greater domestic economic activity in India. However, the policy implications of this research are by no means limited to India. It is our hope that the results emerging from this thesis can inform policy makers from other developing countries in their endeavor to promote economic growth and facilitate international technological transfer through outward-oriented economic reforms.

In addition, by performing the analysis in the context of a major emerging economy with a changing business environment, this research also aims to contribute to the growing interest in understanding the competitive strategies of firms as they respond to ever-changing institutional contexts and begin to compete in global markets. This is particularly relevant to inform future theoretical work in the fields of international economics and international business where mainstream theories have been mainly confined to studying internationally established firms from developed countries rather than emerging firms from developing countries that are still building their international presence.

Several areas of future research are very promising. For instance, as mentioned in Chapter 2 recent theoretical developments in the field of international economics have hypothesized that firm heterogeneity is an important predictor of the prevalence of alternative forms of organizing production and distribution internationally. Subject to the availability of data on intra-firm transactions, one interesting avenue of future research would be to extend the analysis from Chapter 2 and evaluate the relationship between firms' technology adoption (a source of firm heterogeneity) and more complex forms of international production organization (such as international outsourcing and off-shoring). Evaluating these relationships is of utmost importance to understanding new patterns in the structure of international trade, characterized by a fast expansion of intra-firm trade in intermediate inputs and services and a growing fragmentation of production worldwide (Helpman, 2006).

Another possible direction for future research is to extend the Second chapter to evaluate the impact of the destination of trade and FDI on firms' innovation and technological convergence. It is likely that the learning effects and therefore the links between firm's international activities and their ability to innovate and catch up with the technological frontier may differ according to the destination of their exports and outward investments. With available data in the future, we could perform this analysis in the context of India.

Finally, other useful avenue of research emerging from the third chapter would be the evaluation of the differential impact of the credit crush on the export growth of goods and services. A recent body of work has suggested that large drops in trade finance have been an important channel through which the recent financial crisis led to larger drops in exports relative to production. With an extension of the Prowess dataset with current years, we would be able to test this hypothesis in India.

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