Theories and Empirics of Firm Export Behavior: Revisiting the Home Market Hypothesis

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DECLARATION

I declare that the thesis entitled **"Theories and Empirics of Firm Export Behavior: Revisiting the Home Market Hypothesis"** submitted by me for the award of the degree of **Doctor of Philosophy** of Jawaharlal Nehru University is my own work. The dissertation has not been submitted for any other degree of this University or any other university.

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CERTIFICATE

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CHAPTER 1: Introduction

1.1 Background

In the last two decades, with the advent of firm-level data, the focus of international trade theories has shifted from industries to firms. This was led by the findings that the same industry consists of heterogeneous firms with differential export performance. In a theoretical and empirical analysis Hirsch and Adar (1974) showed that the share of export in total sale is more for large firms than small firms. The opposite was found in Glesjer et al. (1980) where it was empirically shown that the share of export has a negative relationship with domestic sales. Empirical studies have also found that there are significant differences between an exporting and a non-exporting firm. Exporting firms are large, more capital and skill intensive and more productive as compared to the non-exporting firms and productive firms self-select into the export market (Bernard and Jensen 1995, 1999)[1]. This was explained in Melitz (2003) which argued that only productive firms can enter into the foreign market since they can make sufficient profits to cover the large fixed costs of operations in the foreign market. Bernard et al. (2003) showed that productive firms can bear the cost of shipping goods in international market. Barua and Agarwal (1993, 1994) argued efficiency determines the export of a firm and showed that efficient firms produce more and sell more in the foreign market.

Although the importance of productivity in export entry decision is well documented in the literature, less attention has been paid on the endogenous nature of productivity while explaining export market entry behaviour of firms. The models by Melitz (2003), Bernard et al. (2003) assumed firms draw productivity from an exogenously given productivity distribution function. However, productivity level of a firm is

[1] Superiority of exporters over non-exporters is a worldwide phenomenon. Clerides et al. (1998) for Columbia and Morocco, Van Biesbroeck (2005) for Sub-Saharian African countries, Bigstein and Gebreeyesus (2009) for Ethiopia, Haider (2012) for India are just to name a few.

endogenously determined by the actions taken by the firm, and it evolves through time. This requires an extensive study of the pattern through which a firm evolves. In the context of firm evolution, Linder (1961) and Vernon (1966) underscores home market's role in export of firms. Linder hypothesised that existence of a home market is a pre-requisite for selling abroad and range of exportable products is determined by home demand. The Linder hypothesis later came to be known as "Home market Hypothesis". His argument behind the home market hypothesis was that the uncertainty and imperfect information about the foreign market induces an entrepreneur to start production in the home market. Export begins later only when home market becomes insufficient for the expansion of the entrepreneur. Following Linder's argument, Vernon (1966) described a "Product Cycle Model" where it is argued that in the early stage of production a firm needs to have close connection with the market (it serves) so that information can be channelled quickly between producers and consumers and changes can be made (subsequently). At the beginning of production, close connection is possible only with the local market, and therefore production starts aiming the domestic market. Later, when the product gets standardised (matured), economies of scale arise, the firm goes for mass production and exports the surplus to the foreign country.

1.2 The Objective of the Study

The traditional Home Market Hypothesis, as proposed by Linder (1961) and Vernon (1966) was in the context of a developed country, in relation to the production of a new product. However, the context of developing countries is very different. Firms in a developing country, majorly are producers of primary and homogenous products. Does that mean Home market Hypothesis is not applicable for developing countries? It is argued in this thesis that the existence of home market is relevant for export participation of firms for developing counties as well. Unlike developed countries, firms in developing countries do not have access to technology. In the absence of better technology they cannot sell in the export market since possession of superior technology determines comparative advantage in international market (Posner, 1961, Cheng, 1984, Grossman and Helpman, 1994). Technology cannot be purchased since technology market is imperfect. Foreign firms are unlikely to share their technology because it is the source of their competitive advantage. Therefore, domestic firms in developing countries themselves need to acquire the required technology through learning and innovation. Home market may provide that space to domestic firms to learn and innovate and become efficient enough to penetrate the international market.

As there is a dearth of essential technologies, a domestic firm at its infant stage does not have the required efficiency level to sell in the world market. Under free trade, it cannot even sell in the domestic market as they compete with foreign rivals. However, protection from foreign competition provides opportunities to the newly established local firms to learn, develop potential, gain confidence, invest in technology and gradually become productive to compete with efficient foreign firms. This also eventually enables domestic firms to enter the world market. The argument is same as infant industry argument developed by List (1841) according to which in the early stage, the cost of production is high and therefore if protection is not given to the domestic firm, entire market would be captured by the efficient foreign firms. Thus, firm's entry into the export market can be considered as a dynamic process that combines several interlinked events. Protection at its infant stage is linked with firm's successful establishment in the home market which is again linked with the attainment of high productivity level. Finally, the high productivity level is linked with the decision to enter into the foreign market. A dynamic model of a firm's behaviour can well capture this entire process of firm evolution.

The thesis develops a dynamic model of firm evolution, capturing the role of protection, home market and firm productivity and their linkages in determining a firm's decision to enter into the foreign market.

The theoretical model argues that the domestic demand makes a firm productive and that in turn induces a firm to enter into the foreign market. From an empirical point of view, this implies if firms are tracked since their incorporation, one would see domestic market operation precedes export entry. However, home market operation alone does not ensure participation in the export market. It is expected that firms that perform well in the home market prior to their entry in the export market eventually become exporters. While previous researches have shown past presence in the foreign market positively influence the present choice of export (Robert & Tybout, 1997; Silvente, 2005; Alvarez et al., 2013), no attention is provided on the plausible role of past behaviour in home market on the choice of export. In this regard, the first empirical analysis of this thesis analyses the role of past performance in the home market in helping firms to begin export.

For the empirical analysis, the case of Indian Manufacturing sector has been considered. Economic policies in India have seen a structural shift since the mid-1980s when the government of India took steps in moving towards an open economy from a protected self-oriented closed market. Two major policy shifts have taken place – deregulation of industries by abolishing licensing system and liberalization of trade by removing trade barriers. Prior to liberalization in a protected environment, majority of Indian manufacturing firms operated in the home market. In the post liberalization period, condition in the home market changed. The level of competition increased in the home market with more foreign firms coming up to serve the home market and inefficient firms going out of business. With greater availability of cheap raw materials and imported technologies, liberalization also increased the opportunity of the home firms to become more productive. These might have pushed earlier non-exporting home firms to innovate, imitate and adapt to better technologies, increase productivity level and grow in the home market. Firms that substantially increased their productivity levels and grew sufficiently in the home market may have entered the export market.

The previous empirical studies on India addressed the issue of firm heterogeneity in export decision, and focused on the factors like technological effort, firm size, productivity, sunk cost, factor intensities, ownership status (Kumar and Siddharthan, 1994; Agarwal, 2002; Hasan and Raturi, 2003, Bhatt and Narayanan, 2009; Chadha, 2009; Bhavani and Tendulkar, 2010 and Srinivasan and Archana 2011, Haider, 2012, Padmaja & Sasidharan, 2016). However, none of the above studies has looked at the effect of home market on export decision of a firm. In this context,

The thesis empirically analyses the role of home market performance on the export entry decision of firms in Indian manufacturing sector during 1993-2016.

The first empirical analysis examines the effect of prior performance in the home market on the export entry decision of Indian manufacturing firms. It investigates whether firms that grew more in the home market and firms that were more productive than others prior to entry began to export. The theoretical model argues firms need to reach a threshold efficiency level to enter the export market and the threshold level can be reached through investment in technology. Combining both, the second empirical analysis of the thesis examines the impact of investment in in-house R&D and technology import on the productivity of Indian manufacturing firms in the pre-export-entry period. The analysis is conducted in the post-liberalization period.

Previous studies on India discussed the importance of technology investment in firm performances (Raut, 1995; Basant and Fikkert, 1996; Hasan, 2002; Parameswaran, 2009; Rijesh, 2015). Studies for the post-liberalization period by Hasan (2002), Paramewaran (2009) and Rijesh (2015) reported significant positive impact of embodied and dis-embodied technology purchases on the productivity for the manufacturing firms. Parameswaran (2009) also found investment in R&D increased productivity of Indian firms. While these studies have spoken about the importance of technology in raising firm productivity, they did not distinguish between the pre-entry and post-entry productivity growth. The impact of R&D and technology imports on firm productivity might differ between pre and post-entry period, as investment in technology is likely to be smaller in the pre-export-entry period compared to the post-export-entry period. Exporting firms in India have invested more in R&D than non-exporting firms (Kumar and Aggarwal, 2005; Parameswaran, 2010). However, firm export behaviour literature has shown that productivity of firms in India has increased more in the pre-entry period compared to the post-entry period (Haider, 2012; Thomas and Narayanan, 2016; Gupta et al., 2018). Did investment in technology increase the productivity of Indian manufacturing firms in the pre-entry period and induce firms to reach the threshold productivity level required to enter the export market? In this context,

The thesis empirically analyses the impact of investment in in-house R&D and technology imports on the productivity of Indian manufacturing firms in the pre-export-entry period.

1.4 Chapter Scheme

The rest of the thesis is organised under the following chapters. A brief discussion of each chapter is provided below.

Chapter 2: Review of Literature

This chapter reviews both theoretical and empirical literature related to firm-level export behaviour. The chapter starts with providing a background of theoretical research on firm export behaviour. Highlighting the role of home market in export entry decision, the first section of the chapter discusses the literature on home market role in international trade. It is then followed up by a review of literature on infant industry protection, which is used to develop the theoretical model of the thesis. The next section provides a review of empirical literature of firm heterogeneity and trade along with the literature discussing export performance of firms in the context of India. This sets the context of the first empirical analysis of this thesis. Then, the empirical literature on firm-level productivity and innovation has been discussed focusing on India, which set the context of the second empirical analysis.

Chapter 3: A theoretical analysis of role of home market in export entry

This chapter develops a model of a firm's life cycle where productivity is endogenous which evolves depending on investment in technologies in the past years. The structure of the model is designed as follows. There are two countries – Home and Foreign. Home country represents developing countries while foreign country represents developed countries. The model assumes that there is only one domestic/home firm and many foreign firms and explain the evolution of the domestic firm. In the beginning domestic firm is inefficient relative to the foreign firms and therefore protected by home government. Protection is temporary and given in the form of complete import ban. Under protection, the domestic firm earns supernormal profit, which it invests in R&D. Productivity/efficiency of the domestic firms increases with R&D investment. The model shows that in the process of its evolution, firm starts with selling only in the home market and then after reaching a threshold level of productivity and size, it enters the export market.

Chapter 4: The Role of Home Market on Export Participation Decision: Evidence from Indian Manufacturing

This chapter is the first empirical analysis of the thesis. The chapter analyses the impact of prior performance in the home market on the export entry decision of Indian manufacturing firms during the period 1993-2016. In order to examine the impact of prior home market performance, the chapter starts with observing the trajectory of home market sales for both export starters and non-exporters in the years prior to entering the export market when both operated solely in the home market. Then, the chapter compares export starters and non-exporters to examine whether the former has been bigger, more productive, more technology intensive than the latter. In proceeding towards a systematic examination of the association between home market performance and export participation, the chapter develops an empirical binary choice model following Robert and Tybout (1997). The analysis has been done on a sample that allows analysing the role of prior performance in the home market on export entry along with the role of sunk cost.

Chapter 5: Home Market Competition, Innovation and Productivity: Evidence from Indian Manufacturing

The chapter examines the impact of firms' investment in technology on the productivity of Indian manufacturing firms in the pre-export entry period. The chapter considers investment in three forms of technologies – in-house R&D, embodied technology obtained through import of capital goods, disembodied technology imported against royalty payments. In analysing the impact of technology on firm productivity, chapter uses two-stage growth accounting approach. In the first stage, chapter estimates firm-level total factor productivity from a Cobb-Douglas production function using Levinsohn and Petrin (2003) method. In the second stage it uses fixed effect method to analyse the impact of R&D and technology imports on the estimated firm level total factor productivity. Then, to understand the technology behaviour of non-exporters and future exporters prior to their entry, the chapter analyses the pre-entry differences in the impact of technology investment on firm productivity between future exporters and non-exporters. Lastly, the chapter finds out whether the investment in technology imports substitutes investment in R&D or it complements R&D investment.

Chapter 6: Conclusion

A summarization of each of the chapter along with the findings is briefly discussed in this chapter.

CHAPTER 2: Review of Literature

2.1. Background

The theoretical research on international trade has gone through various changes in its structural framework during the second half of the 19th century. In the decades of 1970s and 1980s, trade theories have shifted from the traditional perfectly competitive market structure (Hecksher-Ohlin theorem) to monpolistically competitive market structure with scale economies (Krugman, 1979). Krugman (1980) showed that trade can take place within industries even if countries have similar technologies, factor endowments and preferences. Economies of scale and love for varieties are argued as the cause of trade. Due to scale economies, it is cost effective to produce at a large scale. Therefore, a country would prefer to produce few varieties and export them instead of producing all the varieties while importing the rest. This shift in the understanding of the nature and causes of trade between countries, fathered a new strand of trade theory literature; popularly known as ‘new trade theory’.

Among the many simplified assumptions made by Krugman (1980) an important one was the assumption of homogeneity of firms within an industry. The fact that firms within an industry differ in characteristics was not unknown at that time, but the aim was to explain large volume of intra-industry trade between similar countries (mainly between industrial countries) for which symmetry assumption was sufficient. Subsequent models of new trade theories assumed firms are symmetric within an industry having identical production technologies/productivities. Therefore these models were worked out for a single representative firm in the industry.

However, with the advent of the firm level data, it was found that firms are heterogeneous in nature even within a narrowly defined industry and the differential characteristics of firms have important bearing on trade participation and performances. It has been empirically observed that all firms within the same industry may not export.

Typically, an exporting firm is found to be larger and more productive compared to a non-exporting firm (Bernard and Jensen, 1995, 1999; Clerides et al., 1998; Baldwin and Gu, 2003; Alvarez and Lopez, 2005). While analysing firm's behaviour of participating in the international markets, micro level empirical studies ascertained that larger and more productive firm enters the export market, previous years' experience of exporting also act as an impetus for export market participation. The earlier representative firm model could not explain these findings that led to the development trade models including firm heterogeneity

Melitz (2003) modified Krugman (1980) model by introducing firm heterogeneity within monopolistically competitive model of trade. The stylized model framed by Melitz (2003) first describes a closed economy (autarky situation) with heterogenous firms and then introduced trade into that model. It was assumed that, in autarky, while entering into the home market, firms are unaware about their productivity levels. Upon entry, productivities are drawn from an exogenously given productivity distribution curve. Firms drawing productivity from the lower tail of the distributions are forced out of the market leaving firms lying above a certain productivity threshold to operate in the (domestic) market in the closed economy. When the economy opens up home country firms are intended to extend their operation beyond the borders to realize scale economies and to appropriate the expected profit from exporting. However, they must incur large sunk cost to enter the export market. All firms operating in the home market are not capable of bearing the sunk cost. Those having productivity beyond a certain threshold level enter the export market. The productivity threshold for survival in the domestic market also increases with the opening up of the economy as number of firms competing in the home country increases with the entry of foreign firms. Two productivity thresholds – a) the threshold for survival and b) the threshold for entering the export market are endogenously determined in the model. The model explicitly showed that the presence of sunk export entry cost makes productivity threshold for entering the export market larger than the productivity threshold for survival. Since entering the export market is costly and risky all the survival firms in the domestic market cannot enter the foreign market, only the more productive firms enter as they are capable of making sufficient profits to cover the large fixed costs of operations in the foreign market.

In a contemporenous study Bernard et al. (2003) also introduced firm-level heterogeneity in trade model and showed only productive firms enter the export market. Instead of considering a monopolistically competitive market structure Bernard et al. (2003) assumed firms are engaged in Bertrand competition and produce homogenous product. While Melitz (2003) showed that the reason behind the self-selection of productive firms in export market is the presence of sunk export entry cost Bernard et al. (2003) showed it is due to iceberg type transport cost involved with export sales. The trade models including firm heterogeneity later become popular as 'new-new trade theory'. The predictions and the arguments made were important from the policy perspective as these theories distinguished between exporting and non-exporting firms which allow policymakers to identify potential winners and losers from trade liberalization policies (Melitz and Redding, 2015). The new new trade theories also enhance the predictive power of the trade models in explaining magnitude of total trade between countries as it include both extensive and intensive margin of trade.

However, trade models of firm heterogeneity typically assumed productivity as exogenous. For example, both the studies mentioned before, Melitz (2003) and Bernard et al. (2003), assumed firms draw productivities from an exogenously given productivity distribution curve and productivities remain constant thereafter. Their analyses were focused on why productive firms enter into to export market, however, there was no mention of the reasons why productivities differ between firms. Also, productivity levels of firms are not constant; rather it evolves over time depending on the action taken by the managers of the firm. Recent studies have extended the heterogeneous firm model by endogenizing firm productivity. Bernard et al. (2011) introduced multi product firms in the trade model and showed firms choose their productivity level by deciding on the product mix. Products are characterized by product attributes and firms are characterized by firm abilities. Production of low attribute products involves high fixed cost, therefore are less productive. In equilibrium each firm with a given ability decides an attribute threshold, and produce products lying above that threshold. As the economy opens up surviving firms chooses attribute thresholds higher than the autarky and this affects their productivity levels.

Atkeson and Burstein (2010) and Bustos (2011) argued that firms decide on production and export as well as choice of technology. Firms' choice of technology affects their level of productivity. There is a trade-off in choosing a better technology as it gives higher per unit profit/productivity but at the cost of higher fixed cost. While Bustos (2011) assumed there is no variable cost of innovation, Atkeson and Burstein (2010) assumed innovation involves variable cost. More a firm invest in innovation (i.e. greater the innovation intensity), more variable cost firm has to incur, however it increases the probability of a successful innovation. In the closed economy all the survival firms chooses the same level of innovation intensity. When the economy opens up, exporting firms chooses higher innovation intensity than the non-exporting firms since it increases the return from export sales. With the choice of the innovation intensity firm influence their productivity levels. Some studies such as Constantini and Melitz (2008); Atkeson and Burstein (2010) and Impullitti et al. (2013) derived trade models in dynamic framework where firm level productivity evolves through time. While Impullitti et al. (2013) assumed exogenous movement in productivity (that follows brownian motion stochastic process) the former two studies have considered productivity movement as endogenous and determined by endogenous innovation decision.

Most of the studies analyzing the endogeneity of the firm's productivity, focused on post-entry productivity evolution. There is no formalization of the pre-entry productivity movement. Therefore, there is still scope to develop models of trade where productivity levels of firms are evolving prior to entry and determined endogenously by the actions taken by firms, and its implication on trade participation, especially, export participation behaviour of firms. Given the interest to model productivity movement prior to export market entry, the present chapter discusses the literature on home market and trade, since prior to entry, firms operate in the home market.

The chapter reviews the related theoretical and empirical literature. Section 2.2 and Section 2.3 discuss the literature on the role of home market in international trade and the literature of infant industry protection respectively. This provides the theoretical background of Chapter 3 of the thesis. Section 2.4 provides a review of empirical literature of firm heterogeneity and trade, points out the gap in the literature and set out the context of the empirical analysis of Chapter 4 of this thesis. Section 2.5 and 2.6 discuss the empirical literature on firm level productivity and innovation with the objective of setting the context of the second empirical analysis, as elaborated in

Chapter 5 of the thesis. While analyzing the empirical literature, particular emphasis has been given to studies on India.

2.2. Literature of home market and trade

This section review the literature on home market and trade. Linder (1961) used evolutionary approach to discuss export participation behaviour of home entrepreneurs. Linder proposed that internal (home) demand is the necessary condition for a product to be a potential export product. Due to uncertainty of foreign market, introduction of a product always take place in a home country.[2] As the firm grows through operation in the local market it generates resources. The firm invests these resources to uncover information about the foreign market and when the local market become insufficient for its further expansion the firm starts to sell in the foreign market. Few years later, importance of home market sales on export came into forefront in reference to the product cycle model by Vernon (1966). It was argued that in the early stage of development of a product, production takes place aiming the home market[3]. However, after serving the home market for a considerable period of time, product gets standardized. Once the product gets standardized, then producer starts producing in large scale. With large scale of production, producers realize the economies of scale and this in turn helps them to export the product.

Hypotheses of Linder and Vernon are about new products, produced by developed countries where uncertainty about the foreign markets is considered to be the driving force for initial home market operation. Firms in developing countrties primarly produce homegenous products. Although demand for homogeneous products are not uncertain in the foreign market, firms in developing contries initially depend on home market, since in the beginning of their life cycle they don’t possess necessary scale and technology to survive in the foreign market. It is through their operation in the home market they generate resources such as capital and skill, and they learn to become

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[2] It was argued that a product gets introduced in a market only after its needs are felt by producers. A producer can aware of the needs that are sourced in home country. However, imperfect knowledge about the foreign market makes him unaware about the needs that arise in a foreign market.

[3] In the beginning of the product development stage an easy and efficient system of communication is necessary between the consumers and the producers of the product; efficient communication is a function of geographical proximity (Language, culture, customs, distance etc.), it is possible with a local market, however not with a foreign market.

productive, which in turn help them to enter the export market. Highlighiting the role of home market for developing countries, producing homogeneous products, Basevi (1970) and Frenkel (1971) have shown that inefficient entreprenuers of developing countries can export to developed countries if profits generated from home market offset the export market losses.[4] Porter (1990) talked about home market role while seeking answers to why a company began in a certain nation, how it grows, how it attains competitive advantage and whether it sustain or fail the competitive advantage. He argued that conditions in the home market play important roles in determining international competitiveness of a nation. Quality of the home market determines industrial competitiveness, more advanced and sophisticated the customers of the product are, more would be the pressure on the producers to innovate new techniques and greater is the chance to achieve competitive advantage in the future.

A formal tratement to the role of home market on trade pattern started with the seminal paper by Krugman (1980) which he termed as 'Home Market Effect' (henceforth HME). HME refers to the phenomenon of large country concentrating production and export in products having large home demand. He developed the concept of HME in a model of imperfect competition in presence of economies of scale and transportation cost. Increasing return industries producing differentiated goods tend to locate near the large market as doing so enable them to sell a large share of their output without incurring transport cost. Production tends to be more than proportional to the demand leading large countries to export more of differentiated products than small countries. Helpman and Krugman (1985) extend Krugman's model by introducing a homogeneous good sector along with the differentiated good sector to show that large country export more of differentiated products and small country export more of homogenous products. Goods exported by increasing return industries are those having large home demand and hence the name HME. It assumed that trade is free in homogeneous product and costly in differentiated product. Free trade in the homogeneous product led to factor price equalization. Since producers in both countries face same wages, with similar technology and cost of production, producers in differentiated good industry tend to concentrate near the large market to reduce transport cost. They do not operate in multiple markets to reap the benefits of scale

[4] Export generates scale economies that increases home market profits to an extent that make home profits net of losses from export higher than profit without export.

economies. Assuming each producer of the differentiated product produces a single variety this results in production of more varieties in the large country compared to the small country.

The theoretical prediction of home market effect is ambiguous and rest on many simplifying assumptions. Davis (1998) showed the theoretical validity of HME rest on the assumption of transport cost. If transport costs are identical for differentiated and homogeneous goods then HME disappears and both country (large and small) produce both types of goods exactly in proportion to their market size. Head et al. (2002) allowed consumers to differentiate goods based on country origin and showed it leads to reverse HME.[5] Yu (2005) showed that existence of HME depends on the assumption of constant consumers' expenditure share on manufacturing goods. Behrens et al. (2009) showed HME disappears in multiple country setting. In a recent theoretical study Erhardt (2017) incorporated firm heterogeneity within the model of differentiated product industries and showed that although HME exists, it is stronger in less differentiated industries.

The present study also relates to another strand of the literature that analyses the effect of shocks in the home market on firm's export sales. Ahn and McQuoid (2012) showed that export sales fall in response to a positive shock in the home market, as firms face constraints in physical and financial capacity. Similarly, Vannoorenberghe (2012) argued firms reduce export sales in response to a positive domestic demand shock unless the shock transmitted to the foreign market. However, Blum et al. (2013) showed export is unaffected by domestic demand shock for perennial export and responsive only for the occasional exporters.

2.3. Literature on infant industry protection

Review in the previous section underlined the importance of home market in export participation of domestic firms. We have seen that home market provides the space to the domestic firms to grow and eventually enter the export market. However, in the face

[5] Reverse home market effect refers to small countries having larger share of differentiated good producing and exporting firms than large countries.

of competition with the efficient foreign firms, domestic firms cannot even sell in their home market if they are not protected. This leads us back to the infant industry protection argument proposed originally by Hamilton and List.

The central argument of the infant industry protection is that protection provides opportunities to the newly established local firms to learn and develop which an otherwise free market mechanism jeopardise in the face of competition with the well-established foreign firms. In the early phase of production, unit production costs are higher for domestic firms compared to the foreign firms producing identical products. Free trade poses a risk to the domestic firms as it freely opens up the domestic market to the efficient foreign producers. A newly established firm over a period of time learns through adopting new technologies, training, structural re-organisation and eventually become as efficient as the foreign firms. Protection provides the time and resources to the local entrepreneurs to learn to improve productivity (Tornell, 1991).

Protection, although is necessary, should not be permanent. Under permanent protection, domestic firms lack the incentive to invest in cost-reducing technologies since they do not have to compete with foreign firms ever. However, temporary protection does not only increase the profit from innovation but also expose the domestic firms to the threat of future competition with efficient foreign firms (Miyagiwa and Ohno, 1999). Protection should be temporary because the domestic firms do not learn forever and there is no need for protection in the post-learning period. Renewal of protection is undesirable since it makes the policy ineffective.

The existence of a temporary disadvantage such as, having an inferior technology is not sufficient to justify infant industry protection. Kemp (1960) argued the case for infant industry is rest on the existence of dynamic learning effect. The dynamic learning effect is external to the firm and same as the dynamic economies of scale. There exist dynamic economies of scale if unit production cost of a firm reduces as a result of rise in the industry output and production cost of all firms in an industry reduces simultaneously. This happens when there is spillover in the economy. In the presence of spillover marginal private benefit falls short of marginal social benefit, firms do not invest in technologies as they cannot appropriate all the returns from technology investment. In such situation, protection can be provided as an incentive to domestic firms to invest in technology and early welfare losses from protection (due to reduction in consumer surplus) can be compensated with the future profits. However, in absence of spillover, firms can appropriate returns from technology investment, and hence invest in technology even without a protection. An infant firm will also invest in technology by taking loans from financial market against future profits (Meade, 1955). Hence there is no need of protection. Bardhan (1971) designed a dynamic oligopoly model incorporating dynamic learning to determine the optimal amount of protection.

During the early 1990s, there was a general acceptance of infant industry argument among economists and policy makers in developing countries. Most of the developing countries during 1950s and 1960s adopted import substitution policy to develop their industrial base. Financial market in the developing countries were not developed, loans were difficult to obtain, so protection was needed. Chang (2003) noted developed countries such as USA, UK undertook similar policies when they were in the earlier phase of their industrialization process. However, since 1960s scepticism started growing against infant industry argument.[6] During that time Baldwin (1969) attacked the tariff protection policy by arguing that the tariff although increases the profitability of the domestic firms it does not remove the core problem of externality that causes lack of incentive among domestic firms to invest in new technologies. The government may set a high tariff to cover up the cost of the technology adoption along with the cost of production. However that attracts more firms into the industry, a price war start which eventually forces out the firms investing in new technologies. Therefore a tariff protection policy is ineffective in stimulating domestic firms to invest in new technologies.

Time inconsistency of the protection policies is another often made criticism against infant industry argument (Staiger and Tabellini, 1987; Matsuyama, 1990; Tornell, 1991). It is about continuing protection beyond the announced date. Renewal of protection by government raises the question of the credibility of the government which is then exploited by the domestic firms. Miyagiwa and Ohno (1999) showed that credibility affects the speed of technology adoption. Miravete (2003) showed that only

[6] Since 1980s developing countries started shifting their policy stance towards more open market.

the presence of dynamic economies of scale can make protection policy time consistent. Melitz (2005) showed that existence of dynamic learning effect is not sufficient to justify protection; it should depend on the industry's learning potential, speed of learning and the degree of substitutability between domestic and foreign good.[7] Protection is often not an outcome of national welfare maximisation, but politically motivated outcome influenced by special interest group (Xu, 2006). Sauré (2007) criticised infant industry case by arguing that protection may end economic growth if a traditional technology of low growth potential exist with high instantaneous return which outcompete advanced technologies with low short run returns. In a strategic trade policy model Bhattacharjea (2002) showed that protection policy can affect the entry deterrent behaviour of foreign firms where government regularly updates its information about the foreign cost based on the foreign firm's response in the previous period.

In this context, the present study designs a dynamic model of infant industry protection where protection is temporary and provided in the form of a complete ban on import. The model assumes an economy where knowledge is specific to the firm, the government is credible, but the capital market is imperfect. In such situation protecting infant industries can lead to the optimal allocation of resources in the long run. Protection is needed as it cannot readily borrow from the capital market against the future profit in the presence of imperfect capital market. Since the knowledge is specific, a firm that invests in new technology does not fear losing future profits as a result of technology spill over. The credibility of the government forces domestic firms to invest within the announced period of protection.

2.4. Empirical literature on firm heterogeneity and trade

The first empirical analysis of the thesis examines the role of home market performance on the export participation of Indian manufacturing firms, after controlling for firm heterogeneity. This section reviews the literature on firm heterogeneity and export.

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[7] The author showed that in either of the following cases protection is not optimal – domestic firms are highly inefficient, slow speed of learning, high degree of substitutability between domestic and foreign good.

Bernard and Jensen (1995) pioneered the discussion on the role of firm characteristics in firm level export. Using data of manufacturing firms of United States during 1976 to 1987 the study found only a small percentage of firms tend to export, even within a narrowly defined industry. Bernard et al. (2007) found that only 18% of the total manufacturing firms in United States in the year 2002 were engaged in exporting business. Share of exporting firms varied considerably between industries ranging from 38% in Computer and Electronic industry to 8% in Apparel industry. Not only a small percentage of firm export, but also the bulk of export share were concentrated in the hand of very few exporters. Mayer and Ottavanio (2008) analyzed data across 7 countries (Germany, France, United Kingdom, Hungary, Italy, Norway and Belgium) for the year 2003 and found that top 1% and 5% exporters account for more than 45% and more than 70% of the total export respectively.

The micro level studies that examined the export behaviour of firms also found that exporting firms are different in characteristics from non-exporters. Bernard and Jensen (1995) found that a typical exporting plant in US is larger (both in terms of shipments and employment), more productive (in terms of both shipments and value added per employee), pays higher wages to both to labour, more capital intensive (in terms of capital-labor ratio as well as investment ratio) and employs higher proportion of non-production workers to production workers than a typical non-exporting firm. The degree of difference between exporters and non-exporters although reduces after controlling for industry differences, firm size and location, overall trends remained unchanged. U.S exporters were 97% larger (in terms of employment) and 11% more productive (in terms of value added per employee) during 1976-87. Similar were the findings of other studies for other countries. For instance, while analysing export participation of Chilean manufacturing firms, Alvarez and Lopez (2005) found (controlling for firm size and ownership) exporting firms are 19% more productive, sell 60% more, pays 20% more wages and were 60% more capital intensive than non-exporting firms.

Why exporting firms are more productive than non-exporters? Several empirical studies have analysed the causes of the productivity differences between the exporting and non-exporting firms starting with Bernard and Jensen (1999). In particular, the paper empirically tested two alternative hypotheses explaining productivity difference between exporting and non-exporting firms – self-selection hypothesis vs. learning by doing hypothesis. The former argues that firms are productive before they enter the export market and it is the productive firms that self-select the export market[8]. The later argues that act of exporting increases productivity, so productivity improvement is a post entry phenomenon.[9] In testing the validity of the two hypotheses performance of firms in the United States were examined before and after their entry (in the export market) during the period 1884 to 1992. Based on the regressions of pre-entry plant's characteristics and its growth rates on export status in the later years controlling for plant size, location of the industry, it was found that exporters are better than non-exporter in terms of most of the pre-entry plant characteristics and its growth rate (Shipments, employment, labour productivity, wages per worker, non-production to total employee). However, productivity growth was found to be lesser for exporting firms than non-exporting firms suggesting against the learning by doing hypothesis.[10] Clerides et al. (1998) found similar result using the data on manufacturing firms from developing countries. The current export entry decision of Columbian and Moroccan firms depends on past realization of the average variable cost (AVC) supporting self-selection hypothesis. However, current AVC was found to be unrelated to past participation controlling for the past AVCs and capital stock.

Using data of manufacturing firms from Taiwan (China) and Korea, Aw et al. (2000) found that in the former country export entrants were more productive than non-exporter prior to entry, however, in the latter country no such pattern was observed. In neither of the two countries productivity improvement of continuous exporters were higher than never exporters.[11] Similarly, Bernard and Wagner (1997) and Arnold and Hussinger (2005) found evidence consistent with only self-selection hypothesis for German Manufacturing firms. Wagner (2007) provides a nice review of 54 empirical studies that covered 34 countries including industrialized, Latin American, Asian

[8] Only productive firms are capable of bearing the risk and the cost associated with export market participation.
[9] With participation in the export market firm learns from international market and become large and productive.
[10] Although productivity did not increase more for exporting firms than non-exporting firms, employment growth and probability of survival of exporting firms were showed to be higher than the non-exporting firms.
[11] In Taiwan (China) although productivity gap between export entrants and non-exporters widens after entry they could not assign it to the export experience.

countries and noted that self-selection of productive firms into export market was more prominent as opposed to the learning by doing hypothesis as the evidences were mixed in case of the latter.

Studies found evidence in favour of learning by doing hypothesis includes Baldwin and Gu (2003) for Canada, Alvarez and Lopez (2005) for Chile, Blalock and Gartler (2004) for Indonesia, Van Biesebroeck (2005) for Sub Saharian African countries, Serti and Tomasi (2008) for Italy. Castellani (2002) argued that intensity of foreign participation determines whether the learning effect will exists or not. Author showed presence of learning effect when export performance is measured by export intensity and no learning effect with binary export variable for Italian firms.

Virtually all the previous studies have found exporters were productive prior to entry. The finding suggests the possible presence of sunk cost into export market which only productive firms can bear. Robert and Tybout (1997) is the first study that empirically tested the role of sunk cost in export entry. Authors developed an export supply function for Columbia including sunk cost. The findings of the study supported the existence of sunk export entry cost as it found previous year's exporting status has a positive effect on the probability of exporting in the current year.[12] Clerides et al. (1998) found that past participation into the export favourably affects the current participation decision. Bernard and Wagner (2001) studied the behavior of German firms to examine the role of sunk costs. The authors found that experience of export in the previous year have a positive and significant effect on the probability of export in the current year after controlling for other firm-level heterogeneity. Both Robert and Tybout (1997) and Bernard and Wagner (2001) found the effect of previous export status diminishes over time. This was captured by introducing the dummy variables indicating plant's past export experiences. It was found that firms that exported 2 or more years back are less likely to enter the export market than the firms that exported one year back. Robert and Tybout (1997) showed that if a firm do not export continuously for two years then it lose its entire previous export network, therefore pays the sunk cost upon entry. Similar

[12] Firm that exported in the previous years have already incurred the sunk cost of export. They would like to continue exporting since exiting would make them to repay the sunk cost in future re-entry. Robert and Tybout (1997) further found that both observed and unobserved (Managerial skill) firm level heterogeneity explain variation in the export status of plants.

to the above studies Bernard and Jensen (2004) found firms in US pay sunk entry cost and its effect on the probability to export depreciates over time. Later studies (Sinani and Hobdari, 2010; Alvarez et al., 2013) found the similar.

Going further from the relation between export and productivity several studies have examined the relation between firm heterogeneity and export destinations served (Wagner, 2012). Examining the export market transaction destination data of Belgium firms during 1996-2004, Muûls and Pisu (2009) found that most firms export in few countries, only few firms export in multiple countries and the number of export destination served by a firm increases with firm productivity. Castellani et al. (2010) found similar result for Italian exporting firms. Verardi and Wagner (2010) found that among the German exporters, those exporting outside the Eurozone are more productive than those exporting only to Eurozone. A number of studies from various countries (such as, De Loecker, 2007 for Slovenia; Pisu, 2008 for Belgium) showed that more productive firms enter into more developed markets while less productive firms enter in less developed markets. In other words, more productive firms self-select to more developed countries. The result indicates sunk cost of entering into developed countries is higher than less developed countries. There is no conclusive evidence of differential learning effect from exporting in different destination countries. For instance, Pisu (2008) found productivity gap between exporting and non-exporting firms of Belgium did not increase after entering the export market irrespective of the export destination (developed and developing). However, De Loecker (2007) for Italy found that exporting firms that export to high income countries observe post entry improvement in productivity that surpasses the productivity growth of non-exporters.

Some recent studies have analysed the timing of entry into the export market and export duration at the firm level. Sheard (2014) showed that more productive firms take lesser time to enter export markets.[13] Discussing on the order of entry he showed that nearer markets are entered before the distant markets while larger (smaller) markets are entered sooner by more (less) productive firms.[14] Fabchamps et al. (2008) explained the

[13] In explaining this he argued delaying entry reduces entry cost but increases the revenue loss, the latter increases with the productivity of firms while the former is unrelated to productivity.
[14] Lawless (2009) argued productivity thresholds to enter various market differ and order of entry to these markets follows this order of the productivity thresholds.

duration until firms start to export in order to test two alternative mechanisms of learning to export - productivity learning and market learning and found evidence in favour of the latter.[15] Ilmakunnas and Nurmi (2010) analysed export exit dynamics along with the export entry dynamics. Using data on Finnish firms and employing discrete time duration analysis they showed that large, productive, capital intensive firms take lesser time to start export and continue to export for longer periods. Similar was found by Demirhan (2016) for Turkish manufacturing firms. While discussing about the survival in export markets, most studies found survival rates of exporting firms to a particular product-destination are small (Sabuhoro et al. 2006; Esteve-Perez et al. 2013; Gullstrand and Persson 2015).

In the literature of firm heterogeneity and firms export performance a new dimension, namely the financial dimension was introduced in Greenaway et al. (2007). The role of financial variables on export decision of firms in United Kingdom (UK) during the period of 1993-2003 was analyzed in this study. Two financial variables (current asset to current liability ratio and short term debt to total asset ratio) were considered and it was found that financial variables are significant determinants of export decision of a firm in UK and more importantly importance of financial variables on export decision is more for firms that face financial constraint. Nagraj 2014 also confirms the importance of financial stature of a firm in determining its export participation rate.

The research of firm level data opened new dimension to the analysis of the effect of trade liberalization on firm level productivity. Melitz (2003) showed that productivity threshold for survival is higher in an open economy than in a closed economy hence trade liberalization increases the productivity of the industry by driving out the least efficient firms from the market and reallocating resources from least to most efficient firms. This is a pro-competitive effect of liberalization of trade. Pavcnik (2002) found $2/3^{rd}$ of the growth in aggregate productivity following trade liberalization in Chile is due to exit of the low efficiency firms and growth of the more efficient firms. Trefler (2004) found similar result in the context of trade liberalization in Canada. Bernard et

[15] They found time taken to export a new product decreases with export experience but remains unaffected by total experience. The effect of the productivity learning is captured through experience in general since inexperienced firms learns and increase productivity through its experience and eventually export. Export experience captures the effect of market learning on export as with export experience firms get familiar to the foreign markets which further intensifies export.

al. (2006) found that productivity growth and probability of firm to exit the export market is higher in industries subject to large reduction in trade cost.

2.4.1. Empirical literature- *the role of home market in trade*

In this section we discuss about the empirical papers that tested the validity of Home Market Effect (HME). As mentioned in the section 2.2 home market effect refers to the firms in large countries having comparative advantage in production and export of products having large home demand.

The empirical evidence of HME has been mixed. Using the industry level data, Weder (2003) estimated the size of the home market in US and UK for each of the 26 four digit industries and in support of HME found that there exist a positive relationship between the relative size of home market and relative size of export, bigger is the size of the home market in one country relative to the other, greater is the relative size of export in that country. The author further found that the relationship is stronger in high economies of scale industries, compared to the low economies of scale industries. Similarly, Head and Ries (2001) found home market effect is stronger for the group of high economies of scale industries than the group of low economies of scale industries during the period of substantial trade liberalization between Canada and USA. Davis and Weinstein (2003) used industry data for a set of OECD countries and showed higher home demand translates into greater production and greater export. While analysing the cross-country empirical studies on HME, Head and Mayer (2004) noticed that the presence of HME is supported only in few industries whereas the presence of reverse home market effect were more frequent. Hanson and Xiang (2004) found strong evidence of home market effect in industries characterize by high transport cost and large degree of differentiation. Crozet and Trionfetti (2008) tested HME using the data of 25 industries from 25 countries for a period of 7 years and found that HME is non-linear with the size of the market, implying it is stronger (weaker) if the size difference between the two countries is large (small).

Most studies on home market effect did not differentiate between firms within an industry in a country. However, firms differ substantially within an industry, many such evidences have been found with the emergence of firm level data. In a recent theoretical study Erhardt (2017) incorporates firm heterogeneity within the model of differentiated product industries and showed that although HME exists, it is stronger in less differentiated industries, finding that contrasts with previous studies.[16] Using the firm level data from World Bank survey of enterprises of 121 countries Medin (2017) found evidence of reverse HME, where number of exporting firms was found to be smaller in high income countries relative to the rest of the world.

2.4.2. Indian Studies

A large body of literature discussed export performance of firms and its determinants in the context of India. While some studies have analysed only the export intensity of firms (Aggarwal, 2002; Agnihotri and Bhattacharya, 2015; Chadha, 2009; Kumar and Siddharthan, 1994), others examined both export intensity and export market participation decision of firms (Bhat and Narayanan, 2009; Bhavani and Tendulkar, 2001; Hasan and Raturi, 2003; Kemme et al., 2014; Srinivasan and Archana, 2011).

The technology factor in international trade has been one of the key questions analysed (Kumar and Siddharthan, 1994; Agarwal, 2002; Hasan and Raturi, 2003; Chadda, 2009). Variables such as R&D intensities, imports of raw materials and capital goods, technological fees and royalty payments have been used in the empirical studies to capture the role of technology. Bhatt and Narayanan (2009) showed that investment in technology motivate firms to enter as well as to expand in the foreign market. Srinivasan and Archana (2011) and Hasan and Raturi (2003) found investment in indigenous technologies motivates firms only to enter into the foreign market but does not encourage them to increase their export share.

Aggarwal (2002) emphasized on foreign direct investment as a determinant of export. He found that MNE affiliated perform somewhat better than the local firms, however, he did not find any positive influence of FDI on export intensity in high tech industries.[17] Nagaraj (2014) found more of financially healthy firms participate in export. The impact of characteristics of management team such as – education level,

[16] See Weder (2003) and Hanson and Xiang (2004).
[17] Kemme et al (2014) examined the role of FDI for service firms and found presence of FDI increases export market participation as well as export intensity in IT firms.

length of tenure, international exposure on export performance has been examined in Agnihotri and Bhattacharya (2015). Mishra & Jaiswal (2012) examined the impact of mergers and acquisitions on export penetration and found that the industries with more mergers and acquisitions are more likely to participate in export market. The impact of the size of the firm on export behaviour was discussed in almost every study. More or less it was found that large firms participate more and sell more into the export market. However, Patibandla (1995) found export intensity is inversely related to size for engineering firms.

Some recent studies have analysed the relation between export participation and productivity in Indian manufacturing (Ranjan and Raychaudhuri, 2011; Haider, 2012; Mallick and Yang, 2013; Pattnayak and Thangavelu, 2014; Thomas and Narayanan, 2016; Gupta et al., 2018). They found positive association between the two and subsequently tested the validity of self-selection and learning-by-doing hypotheses. Haider (2012), Thomas and Narayanan (2016) and Gupta et al. (2018) found that the former is valid although the latter is not while others including Ranjan and Raychaudhuri (2011), Mallick and Yang (2013) and Pattnayak and Thangavelu (2014) have found evidence in support of both the hypotheses. To establish self-selection of productive firms either a probit regression model of export status on prior productivity controlling other firm characteristics is used (Ranjan and Raychaudhuri, 2011; Thomas and Narayanan, 2016; Gupta et al., 2018) or a propensity score matching method is employed (Mallick and Yang, 2013), which compares the pre-entry productivity of each new exporter with the corresponding matched non-exporters. Learning by doing hypothesis has been tested using the matching method. Firms exiting from the export market were found to observe a declining productivity prior to exit (Sharma and Mishra, 2011; Mallick and Yang, 2013).

2.4.3. Gap in the literature

There are little empirical research analysing the role of home market on export. While some empirical studies tested the validity of 'home market effect' these studies are macro analysis of country's pattern of specialization in trade. There is no empirical analysis of home market role on export at the firm level. The previous studies on home market apart from being macro level analysis, discussed about the role of home market size. However, our focus in this thesis is to investigate the importance of firm's performance in the home market on its future export potential. The existing literature of export behaviour of India manufacturing firms although examined the effect of various firm characteristics such as size, productivity, technology, financial condition, past export experience. However, these studies did not analyse the role of firms' past performance in the home market on their export participation decision. This is where the first empirical analysis (Chapter 4) of the thesis contributes to the literature.

2.5. Firm innovation and productivity-*a review of the existing studies*

The first empirical analysis of the thesis examines the effect of prior performance in the home market on the export participation decision of Indian manufacturing firms. The second empirical analysis of the thesis focuses on analyzing whether rise in the home market competition led by (driven by) economic liberalization and [technology related activities] (technological innovation) undertaken by firms increases the productivity of Indian manufacturing firms during their period of operation in the home market or not. This section elaborates the literature on the technological innovation by firms and productivity. The section is divided in two subsections. The first subsection discusses the empirical literature on determinants of innovation, especially highlighting the studies related to India. The second subsections presents a brief review of literature on determinants of firm productivity, focusing on studies related to India.

2.5.1. Literature on the determinants of innovation

The earlier studies in the Indian context, primarily identified various firm-level characteristics, product and policy related factors as the determinants of innovation.

Development of technological capacity of firm depends on investment in in-house R&D and technology purchase. The relation between the R&D and technology purchase is a widely researched area in the technology literature. If there is a complementary relation between R&D spending and technology import then R&D activities are adaptive kind and expected to be small. On the other hand if they are substitute then R&D spending is expected to be large. Using the data of 100 engineering firms Lall (1983) found R&D

expenditure is adaptive kind, higher for firms having foreign licensing agreements and for firms that spend more on royalties. Similar was found by Katrak (1985), Deolalikar and Evenson (1989) and Katrak (1990). Siddharthan (1988) found a positive relationship between the two but only for private firms, whereas public sector firms are found to import little and spend more on own R&D spending. Kumar and Saqib (1996) and Basant (1997) found neither a complementary nor a substitution relation between technology import and R&D intensity. Some scholars have argued both are jointly determined (Deolalikar and Evenson 1989, Basant 1997).

Based on questionnaire based survey of 56 technology importing enterprises in electrical and industrial machinery industry Katrak (1990) showed that relationship between the R&D and technology import depends on the purpose of importing technology and the technology import agreements.[18] Aggarwal (2000) showed that relationship between the two interacted with government de-regulation policy of mid 1980s, with the removal of entry barrier industries that seen rise in technology import were high R&D intensive industries while prior to that technology import were substitute.

Discussing on the mode of technology transfer, Sidhharthan (1992) argued when technology is non-standardised, difficult to codify and involves large transaction cost, internal transfer of technology through foreign direct investment can be the preferred method of technology purchase than the market based method of technology purchase such as licensing. However, Kumar (1987) showed that large presence of foreign direct investment reduces industries' R&D efforts.[19] Using firm level data Kumar and Aggarwal (2005) showed that technology import is not an important determinant of firm R&D intensity for MNCs and in the post liberalization period there has not been any significant improvement in the R&D efforts of MNCs while local firms' R&D efforts have improved significantly. Sasidharan & Kathuria (2011) showed that among the foreign firms probability of investment in R&D is more for minority owned foreign

[18] When the objective of the technology import is development of technological capabilities then it increase own R&D spending, however, when the objective is product or process development then imported technology is adaptive kind. If technology seller provides exclusive right of sales of the product produced using the imported technology then importing substitute own R&D spending.
[19] Foreign subsidiaries have access to the R&D lab of the parent firm and therefore most R&Ds happen in the country where parent firm is located.

firms relative to the domestic firms while probability is less for majority owned foreign firms.[20] The paper also revealed that there is no FDI spillover effect in R&D efforts of domestic firms. Technology spillover took place only between the MNCs in the pharmaceutical industry, no domestic firm benefitted from the technology spillover (Feinberg and Majumdar, 2001). Kumar and Aggarwal (2005) examined the role of liberalization as a determinant of R&D activity; distinguishing between pre-reform and post-reform era. In the post reform era larger firms, firms investing more in technology import and more outward oriented firms invest more in R&D while in the pre-reform period era these factors had no influence on R&D.

The role of firm size and market structure on R&D is another largely debated issue which underwent substantial empirical verification in the Indian context. The findings are mixed. Kumar and Saqib (1996) found probability to invest in R&D increases with firm size, but only up to a threshold level, whereas R&D intensity increases steadily with firm size. Among other studies that found positive relation are Lall (1983), Katrak (1985), Basant (1997), Parameswaran (2010). Siddharthan and Agarwal (1992) found positive relation between firm size and probability to open R&D lab, however revealed smaller firms invest larger share of their sales on R&D expenditure than large firms. Ghosh (2009), Sashidharan & Kathuria (2011) are among some of the studies that found negative relationship between firm size and R&D intensity. Mishra (2007) found a non-linear inverted U-shaped relationship between firm size and incentive to invest in R&D. This result was further affirmed by other studies; Katrak (1990), Subodh (2002) and Pradhan (2003). In contrast to these studies, Kumar and Aggarwal (2005) found a cubic (horizontal S-shaped) relation between firm size and R&D intensity where very small firms have high R&D intensity, then it decreases with firm size, after reaching a threshold, R&D intensity increases with size and again reach a threshold and then start declining.

According to Schumpeter (1942), market competition reduces entrepreneurs' R&D activities while Arrow argued competitive firms are more likely to invest in R&D. Empirical studies in India found mixed result. Supporting Schumpeterian view

[20] Author agued this is because unlike majority owned foreign firms minority owned firms are less likely to receive technology from parent firm due to limited control of the parent firm and risk of technology (patent) protection in developing country like India.

Sashidharan and Kathuria (2011) found irrespective of technology classification (high, medium and low) of the sectors R&D intensity is more in firms belonging to concentrated industries. Kumar and Saqib (1996) found absence of competition reduces the incentive to invest in R&D, however, once the decision of investment is taken competition is unrelated to R&D spending. Parameswaran (2010) showed that there is negative relation between market concentration and R&D intensity in supplier dominated and science based sectors whereas in scale intensive sectors there is positive relation between the two. Negative relation between market concentration and R&D intensity was also found in Kumar (1987), Ambrammal and Sharma (2014). Aggarwal (2000), Subodh (2002), Mishra (2007) and Basant & Mishra (2013) did not find any significant impact of market concentration on R&D intensity. It is argued that outward orientation of firms is likely to push firms to invest in R&D as the competitive pressure is high in the global market. Empirical studies on India unanimously found this is indeed true (Siddharthan and Aggarwal, 1992; Kumar and Saqib, 1996; Aggarwal, 2000; Pradhan, 2003; Kumar and Aggarwal, 2005; Ghosh, 2009, Parameshwaran, 2010; Sasidharan and Kathuria, 2011).

Previous studies have spoken about the differences in technological opportunities across industries and its impact on R&D intensity. Kumar and Saqib (1996) showed machinery and chemical and drug industries invest more in R&D compared to the other industries. Kumar and Aggarwal (2005) showed Chemical and engineering industries are more R&D intensives that the rest. Identifying the heterogeneity in technology opportunity Parameswaran (2010), Sasidharan and Kathuria (2011) estimated R&D intensity function separately for high tech and low tech industries. Deolalikar and Evensohn (1989) made separate estimation for each industries. Others have considered industry dummies in their analysis.

While the above studies consider innovation input as the measures of innovation, some scholars have argued that innovation output is a better measure of innovation. Limited availability of data on innovation output in Indian context did not studies to analyze the innovation output as a measure of innovation. Exceptions are Ray and Bhaduri (2001) and Ambrammal and Sharma (2014). Both studies estimated the knowledge production function that relates innovation input with innovation output. Ray and Bhaduri (2001) used data on electronics and pharmaceutical firms and focused on the role of learning.

They found introduction of innovation (innovation output) depends on both learning though experience and learning from spillover[21], however, R&D efforts (innovation input) itself do not lead to innovations, it happens only with experience. Ambrammal and Sharma (2014) considered R&D efforts as innovation input and patenting as innovation output. They found that patenting did not increase as a result of increasing R&D intensity for domestic firms but for foreign firms R&D intensity contributed significantly to patenting.

2.5.2. Literature on the determinants of firm productivity

Numerous studies have examined the factors influencing productivity of firms in Indian industries. The policy related factors discussed in the literature analysed the effect of trade and foreign direct investment (FDI) liberalization on firm productivity and correspondingly discussed on the role of competitiveness. The major firm related factors appeared in the literature are R&D activities, technology import, firm size and age and firm ownership. The empirical studies on manufacturing firms in India almost unanimously found trade liberalization accelerate productivity of firms. Krishna and Mitra (1998) found weak evidence of productivity growth in the post liberalization era.[22] Using tariff line data Topalova and Khandelwal (2011) showed both input and output liberalization has increased firm level productivity. However, effect of input trade liberalization on firm-level productivity was found to be stronger. Nataraj (2011) examined the firms in the informal sector that constitutes more than 80% of the total manufacturing employment in India and showed that contrary to the firms in the formal sector productivity growth of firms in informal sector is due to reduction in the output tariff. While analysing the effect of input trade liberalization Goldberg et al. (2010) found there has been on average 31% increase in the number of products produced by Indian manufacturing firms following the input trade reform. Ahsan (2013) showed the interaction between the 'speed of contract enhancement' and the liberalization led productivity growth. It was shown that contract intensive firms located in states with a

[21] Spillover was measured by number of national and International training programmes and seminar attended by firm.
[22] Krishna and Mitra (1998) took four industries in their study and found growth rate in productivity increases only in three industries and the growth rate was 3-6%

very efficient judiciary system experienced higher productivity gain following input tariff liberalization than other firms and firms located in other states.

Some studies have used decomposition analysis to investigate the relative contribution of various components in the aggregate productivity growth of the industry in the post liberalization period. Decomposing aggregate total factor productivity growth in reallocation and intra-firm productivity growth, Sivadasan (2006) showed that the latter channel have the dominating effect in the aggregate productivity movement. On the contrary, Nataraj (2011) found the evidence of re-allocation effect among the firms in the informal sector. Kim and Saravanakumar (2012) decomposed productivity growth in all four components-technological progress, change in allocative efficiency, change in technical efficiency and change in scale efficiency and found that more or less in all the industries technological progress is the largest and technical efficiency change is lowest component of productivity growth. There are some industry specific studies as well. Parameswaran (2004) considered industries from capital goods producing sector and decomposed the total factor productivity growth in technical efficiency component and technological progress component. He showed that although industries experienced technological progress, technical efficiency has declined in the post reform era. While analyzing the Electronics Hardware Industry, Majumder (2010) found similar result, however, showed that industry could not sustain its' initial total factor productivity growth as reform policies have intensified in the later years.

To examine the impact of trade, Mitra et al. (2014) took export and import as two explanatory variables and showed both have positive and significant effect on productivity. While discussing about the two-way effects of the export-productivity linkage some studies (such as Haidar, 2012; Sharma and Mishra, 2011) have shown linkage run from productivity to export. They found exporting firms did not increase productivity after entering into the export market, however, exporting firms were more productive than non-exporting firms prior to entering the export market. On the contrary Mallick and Yang (2013) showed the increment in firm level productivity is both pre and post-entry phenomenon.

Kato (2009) argued that liberalization of trade increases firm productivity through various channels – one among which is competition. He then analysed the effect of product market competition on the productivity of Indian manufacturing firms during the decade following economic reform (1991-92 to 2001-02) and found productivity growth has been higher for firms with lower market share and more so in a less concentrated industries. The author argued managers of firms occupying low market share in less concentrated industries face high competition pressure that forces them to exert more efforts.

Some studies have examined the link between firm size and productivity in the context of Indian manufacturing firms. De and Nagaraj (2014) found firms belonging to the lowest quintile of asset distribution are more productive than the firms belonging to the higher quintiles of asset distribution. The authors further showed that small firms that invest in R&D and have better access to cash/credit are more productive than the small firms that do not invest in R&D or face credit constraint. Majumder (1997) showed that large firms are less productive but more profitable. Mitra et al. (2012) brought out the importance of core infrastructure including Air, Communication, Rail, Road on the productivity of Indian manufacturing firms.

Several studies have examined the effect of technology related variables on firm level productivity. There are three types of technology investment – investment in own in-house R&D, technology purchase through licensing (disembodied technology import), technology purchase through import of capital goods (embodied technology import). Productivity growth due to technical change can also come through technology spillover from other firms in the industry. Raut (1995) and Basant and Fikkert (1996) analysed the effect of inhouse R&D, disembodied technology import and spillover on productivity of Indian manufacturing firms. Basant and Fikkert (1996) found impact of disembodied technology import on productivity is higher than the impact of own R&D. Both Raut (1995) and Basant and Fikkert (1996) found R&D spillover raises productivity of firms in Indian manufacturing sector.[23] Parameswaran (2009) and Rijesh (2015) analysed the effect of both embodied and dis-embodied technology imports on the productivity of Indian manufacturing firms. They found that both form of technology imports positively influences the productivity of Indian firms, however the

[23] Basant and Fikkert (1996) further showed that knowledge spillover from other domestic firms can itself increase productivity, however unless a domestic firm undertake its own R&D activities knowledge spillover from foreign firms cannot be beneficial.

effect of the former is stronger than the latter. Classifying firms in high and low technology intensive industries Parameswaran (2009) showed that embodied (disembodied) technology import is important only in low (high) technology intensive industry. Sharma (2012) distinguished return from R&D between domestic and foreign firms and showed it is higher for the latter. Parameswaran (2009) further found trade related knowledge spillover increased the productivity of Indian manufacturing firms. Arguing that patent is a better indicator of innovation than R&D expenditure, Ambrammal and Sharma (2015) showed that investment in R&D increases productivity in Indian firms only when such investment generate patentable innovation output.

Some studies examined the role of FDI spillover in particular. Kathuria (2001) showed that technology spillover from foreign firms increases the productivity of domestic firms in non-scientific industries. However, in scientific industries domestic firms benefit from foreign technology spillover, only if it is supplemented by indigenous R&D efforts. Similarly, Pradhan (2002) found that there is spillover effect from the presence of foreign firms in pharmaceutical industry only if domestic firms increase their absorptive capacity through R&D investment. Comparing the FDI spillover effect between pre and post liberalization period Kathuria (2002) showed that FDI spillover effect gets magnified in the post liberalization period for scientific firms whereas it remain unaltered for non-scientific firms. Siddharthan and Lal (2004) found in the beginning of the liberalization period spillover effect was modest while in the later years it increased. Behera (2014) found that FDI spillover effect was stronger in industries where reform measures were more intense. Marin and Sasidharan (2010) identified the role of the type of subsidiaries in FDI spillover effect and showed that positive spillover effect emanating from subsidiaries that spend substantial amount in R&D and export substantially (termed as competence creating subsidiaries) while no or negative spillover effect from subsidiaries spend little and export little (termed as competence exploiting subsidiaries). Examining both horizontal and vertical FDI spillover effect Malik (2015) found presence of only vertical spillover effect where direction of the effect is from downstream industries to upstream industries in low technology industries. However, in high technology industries there is presence of both horizontal and vertical spillover effect while the latter is stronger.[24] Fujimori and Sato

[24] Discussing further on the forward and backward linkages on vertical spillover effect he showed that

(2015) showed that there is only vertical spillover effect from FDI and there is a long gestation period in realization of the FDI spillover effect.

While the above studies examined the spillover effect from the presence of MNCs to the domestic non-subsidiary firms some studies have analysed the impact of foreign equity participation in subsidiary firm. Sharma (2010) found presence of foreign equity increases the productivity of subsidiary firm and creates a gap in productivity between subsidiary and non-subsidiary firms in the machine industry during the period 1994-2006. Arguing that the source of foreign equity is important Banga (2004) compared between the two source countries –Japan and USA and showed that foreign equity coming only from the former has significant positive impact on productivity growth of firms in Automobile, Electrical and Chemical industries.

2.5.3. Gap in the literature

It can be seen from the review of the literature that previous studies have spoken at length about the importance of technology investment for growth of the firm (Raut, 1995; Basant and Fikkert, 1996; Hasan, 2002; Parameswaran, 2009; Rijesh, 2015). However, what has not been discussed is the differential impact of technology investment on the productivity growth between the pre-export-entry and post-export-entry period. The impact of R&D and technology imports on firm productivity might differ between pre and post entry period, as investment in technology is likely to be smaller in the pre-export-entry period compared to the post-export-entry period. In fact, exporting firms in India have invested more in R&D than non-exporting firms (Kumar and Aggarwal, 2005; Parameswaran, 2010) which seems to imply that the productivity accelerating effect of R&D investment is higher in the post entry period than the pre-entry period. However, it has been shown that firms improve their productivity more in the pre-entry period (Wagner, 2007; Haider, 2012; Thomas and Narayanan, 2016; Gupta et al., 2018). In this context, it may be interesting to understand the role of in-house R&D investment and technology import on the productivity of Indian firms in the pre-entry period.

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although there is negative spillover effect from the forward linkages, positive spillover from backward linkages was stronger.

CHAPTER 3: A theoretical analysis of role of home market in export entry

3.1. Introduction

The difference between the characteristics of exporters and non-exporters is well established in literature (Hirsch and Adar, 1974; Bernard and Jensen 1995, 1999). It has been shown that exporters are larger and more productive than non-exporters. Moreover, higher productivity of exporters vis-à-vis non-exporters has been shown to be a pre-entry phenomenon. Melitz (2003) dealt with the causes of productivity difference between the exporters and non-exporters and argued that as productive firms are able to cover sunk cost, they are able to enter the export market. Much of the theoretical literature on trade incorporating firm heteroegeneity assume productivity to be exogenous and constant; in reality, however, productivity is endogenously determined and evolves over time depending on the actions taken by the firms.

In the context of firm evolution, Linder (1961) and Vernon (1966) underscore home market's role in export of firms. They have argued that, due to uncertainty, foreign market is not accessible to the new firms. Therefore, new firms in the beginning start production in the home market. Home market, provides them opportunities to grow, realize scale economies and eventually to enter the export market. Their hypotheses were developed in the context of developed countries where firms produce differentiated products. Firms in developing countries, on the other hand, are different from firms in developed countries as they are majorly the producers and exporters of primary products. However, understanding the role of home market in export is no less important for firms in developing countries. The domestic firms in developing countries do not have access to the technologies necessary for entering the export market. The relevance of home market lies in providing ground for technology building. Technologies are not readily available as it cannot be easily purchased from the market since the technology market is imperfect. When it is purchased, it cannot be put to immediate use since it requires modifications and adaptation to meet the domestic needs. Domestic firms therefore need to develop their own technological capabilities. Technology development is a time consuming process and home market operations provide that time and opportunities to the domestic firms, particularly to the new firms who do not yet have the resources to invest in technology. New firms can invest the profits generated through their operations in the home market in technology adaptation or technology development.

The new firms cannot even operate in the home market if it is not protected (List, 1841). Protection from foreign competition provides opportunities to infant firms to learn and develop through operations in the home market.[25] Protection, although necessary, should be temporary as with permanent protection, there is no threat of future competition. Further, firms do not learn forever and therefore there is no need of protection once the learning period is over. Protection policy should be time consistent as renewal of protection raises questions on the credibility of government which affects speed of technology investment and lengthen the protection period (Matsuyama, 1990; Tornell, 1991; Miyagiwa and Ohno,1999). In an oligopolistic framework, Marjit and Ray (2017) discussed about the inter-relationship between technology, competition and export and showed that competition reduces export profitability of domestic firms in a protected domestic market if lower technology prevails.

The present chapter develops a dynamic model of firm evolution where productivity of a firm evolves depending on firm's action in the previous years. The model considers a representative domestic firm and discusses its evolution process. In the initial phase, domestic firms are inefficient while foreign firms are at the end of their life cycle and operates at the frontier level. An economy is assumed where knowledge is firm specific, capital market is imperfect and government is credible. In the beginning of its life cycle, representative domestic firm is provided with temporary protection in the form of

[25] A counter argument provided by the advocates of the FDI liberalization is that the presence of foreign firms can be helpful in domestic firms' technology building as foreign firms may share technologies to the domestic subsidiaries, and there can be spillover of technology from foreign to domestic firms. However, foreign firms hardly share their technologies with domestic subsidiaries and the technologies that spillover to domestic firms need adaptation which requires technological efforts from the part of domestic firms.

complete import ban. Protection is needed as domestic firms cannot readily borrow capital from the imperfect capital market. Since knowledge is specific, firm that invests in new technology does not have fear of losing future profits as a result of technology spill over. The credibility of the government forces domestic firms to invest within the announced period of protection.

In absence of a superior technology, the domestic firm, in the beginning, sell its product in the home market. Under protected home market, profits are generated from home market operation which provide resources to invest in technology investment. Investment in technology leads to productivity improvement, making it endogenously determined in the model. Productivity improvement further increases the firm size and profits which is again invested in technology spending under the threat of removal of protection. The process continues and the domestic firm keeps on increasing its size and efficiency level by serving more home customers. When it reaches a threshold size, productivity reaches the frontier level. Domestic firms now enter the export market. Protection is no longer needed. Government having perfect knowledge withdraws protection at this stage.

3.2. Background

There is perfect competition in world market and monopoly in domestic market. One domestic firm and *n* foreign firms are competing over the production of a homogeneous good. The domestic firm has just started producing the product and at its infant stage. Foreign firms are identical, mature, more efficient than the domestic firm and produce with the best available technology. In other words, foreign firms are operating at the frontier level of technology. The domestic firm can improve its technology level over time through investing in technology/innovation. The frontier level of technology is assumed to be fixed over time, implies there is no scope for technological progress for foreign firms.

The domestic firm wishes to catch up with the foreign firms and therefore seek temporary protection from home government. Under protection, it can sell in the domestic market and use its earnings to improve its production technology. The home government dislike giving protection as it distorts consumption, however, may provide temporary protection since it provides an opportunity for the infant domestic firm to survive without lengthening the distortionary effect of protection. Capital market is assumed to be imperfect, hence the domestic firm cannot take loans to invest in technology against future profits.

In protecting the domestic firm the home government has assumed to completely ban imports during the time interval [0, T). The domestic firm enjoys monopoly power in the domestic market under such protection.[26] The time is continuous. The protection policy is assumed to be credible, as there is neither non-removal credibility problem nor non-renewal credibility problem. This implies that the protection is going to end exactly at time point T, home government cannot be lobbied to extend the protection period beyond time point T. Therefore, the domestic firm must invest in technology and must reach the frontier level by the end of the protection period, failing to do so domestic firm cannot survive beyond the protection period.

Under free trade, foreign firms can sell in both domestic and world market. However, when the home government completely bans imports, foreign firms sell only in the world market. Domestic firm being inefficient in the beginning can neither sell in the domestic market nor in the world market under free trade, but under protection, it can sell in the domestic market. It also sells in the world market when it reaches a certain efficiency level, and domestic market become insufficient for its further expansion.

3.3. Demand System

There are two markets-domestic market and world market. Suppose, the inverse demand function in the domestic market is

$$p^d = g(Q^d) \qquad where\ g'(Q^d)<0 \qquad (1)$$

[26]There are other protection policy instruments such as tariff, quota, production subsidies etc. To avoid complexity, import banning is considered as the protection policy. It avoids modeling the effect of market sharing on production decision in a dynamic setting.

Where, p^d is the domestic price and Q^d is the domestic demand of the product. The function g is the negative sloped domestic demand function. Domestic demand function assumed to be time invariant.

While the domestic demand function is downward sloping, the world demand function is assumed to be perfectly elastic at price $\bar{p}$. This is a standard assumption taken in most neo-classical trade models implying the domestic country is small relative to the rest of the world. Hence, if p^w is the world price, then

$$p^w = \bar{p} \tag{2}$$

3.4. Production System

This section describes the production system. The technology of production is represented by cost function. The cost function of the domestic firm at time point t is given by

$$\left.\begin{aligned} C_t(q_t) &= \int_0^{q_t} c_t(q_t)dq_t + \bar{F} \\ &\text{And} \\ c_t(q_t) &= A_t + h(q_t) \end{aligned}\right\} \tag{3}$$

Where $C_t(q_t)$ and $c_t(q_t)$ are the total and the marginal cost of producing q unit of output by domestic firm at time t. $\bar{F}$ is the fixed cost of production.

The marginal cost $c_t(q_t)$ consists of two components – A_t, representing technology, and $h(q_t)$, representing the scale. The technology, A_t, often refer as shift parameter since any change in the value of A_t shifts the marginal cost curve. Lower value of A_t corresponds to better technology while higher value of A_t corresponds to a poorer technology: as A_t falls the domestic firm moves from higher marginal cost to a lower marginal cost. The other component of the marginal cost, $h(q_t)$, indicates the change in the marginal cost of production due to the change of the scale of production, which captures along the curve movement. Marginal cost function is assumed to be an increasing function of sales, i.e. $h'(q_t)$.

Foreign firms are homogeneous having identical cost functions.The cost function of the each of the foreign firm is given by

$$\left.\begin{aligned} \tilde{C}(\tilde{q}_t) &= \int_0^{\tilde{q}_t} \tilde{c}(\tilde{q}_t)d\tilde{q}_t + \bar{F} \\ &\text{And} \\ \tilde{c}(\tilde{q}_t) &= \bar{A} + h(\tilde{q}_t) \end{aligned}\right\} \qquad (4)$$

Where $\tilde{C}(\tilde{q_t})$ and $\tilde{c}(\tilde{q_t})$ are the total and the marginal cost of producing $\tilde{q}_t$ unit of output by each foreign firm at time t. $\bar{F}$ is the fixed cost of production.

It is assumed that foreing firms are well established and each of them produces with the frontier level of technology. The frontier level of technology $\bar{A}$ is assumed to be fixed over time and therefore marginal cost function of the foreign firm is independent of time. While marginal cost curves of foreign firms do not shift unlike marginal cost curve of the domestic firm, foreign firms can move along their marginal cost curve by changing the scale of production which is represented by $h(\tilde{q_t})$.

The domestic and foreign firms can sell in either of the two markets - Domestic and World. However, since domestic market is assumed to be temporarily protected (by complete import ban) foreign firms cannot sell in the domestic market during the protection period. But the domestic firm does not face any import barrier in the world market, therefore can sell in either or both domestic and world market.

Let q_t^d and q_t^f are the output sold by the domestic firm in the domestic and world market respectively. Then total output sold by the domestic firm q_t is given by

$$q_t = q_t^d + q_t^f \qquad (5)$$

Let A_0 is the initial level of technology of the domestic firm. Marginal cost of the domestic firm reduces over time. More it invests in R&D, marginal cost of the domestic firm reduces more and the firm moves up in the technology ladder, the technology parameter of the firm A_t falls and as a result marginal cost curve of the domestic firm shifts downward. The motion of the technology parameter is represented by

$$\left.\begin{array}{c} \dot{A}_t = -k_t A_t \\ \\ \text{And} \\ \\ k_t = \alpha\varphi(r_t) \quad \text{where } \alpha>0,\ \varphi(r_t) > 0,\ \varphi'(r_t)>0 \text{ and } \varphi''(r_t) < 0 \end{array}\right\} \quad (6)$$

Here r_t is the level of R&D investment at time t or R&D input, k_t is the resultant change in the technology parameter or R&D output. The R&D production function is considered as an increasing and a concave function. In other words, knowledge increases with investment in R&D, but at a decreasing rate.

3.5. The Monopolist Problem

The monopolist maximises the present value of its life time profit subject to the conditions that its marginal cost evolve over time through investment in R&D, output sold in the world market is either zero or positive, and boundary conditions are satisfied. The monopolist problem can therefore be stated as

$$Max \int_0^T e^{-\rho t}\, \pi[q_t^d, q_t^f, r_t]\, dt \qquad (7)$$

$$\left.\begin{array}{c} \dot{A}_t = -k_t A_t; \\ \\ q_t^f \geq 0; \\ \\ A_t|_{t=0} = A_0 \ and\ A_t \leq \bar{A} \end{array}\right\} \qquad (8)$$

This is a fixed time horizon and fixed endpoint optimisation problem with inequality constraint where $\pi[q_t^d, q_t^f, r_t]$ is the instantaneous profit function of the domestic monopolist, the control variables are q_t^d, q_t^f and r_t, the state variable is A_t, and $\rho > 0$ is the discount factor.

From (1) – (5), the instantaneous profit function of the monopolist is given by[27]

$$\pi\left[q_t^d, q_t^f, r_t\right] = g\left(q_t^d\right)q_t^d + \bar{p}q_t^f - \bar{F} - \int_0^{q_t}[A_t + h(q_t)]dq_t - r_t \qquad (9)$$

Let $\mathcal{H}[q_t^d, q_t^f, r_t, A_t]$ is the current value Hamiltonian of the above problem.

$$\mathcal{H}\left[q_t^d, q_t^f, r_t, A_t\right] = \pi\left[q_t^d, q_t^f, r_t\right] - \mu_t k_t A_t$$

Where μ_t is the current value shadow price of the technology parameter and $\mu_t \geq 0$

Since, here the current value Hamiltonian ($\mathcal{H}$) is maximised subject to the inequality constraint imposed on q_t^f, following Lagrange function is formed before optimization.

$$\mathcal{L}\left[q_t^d, q_t^f, r_t, A_t\right] = \mathcal{H}\left[q_t^d, q_t^f, r_t, A_t\right] + \delta_t q_t^f$$

Where δ_t is the Lagrange multiplier and $\delta_t \geq 0$. Using (6) and (9) Lagrange function $\mathcal{L}$ can be expressed as

$$\mathcal{L}\left[q_t^d, q_t^f, r_t, A_t\right] = g\left(q_t^d\right)q_t^d + \bar{p}q_t^f - \bar{F} - \int_0^{q_t}[A_t + h(q_t)]dq_t - r_t - \alpha\mu_t\varphi(r_t)A_t + \delta_t q_t^f \qquad (10)$$

The first order necessary conditions for optimization are given by

$$\frac{\delta\mathcal{L}}{\delta q_t^d} = g\left(q_t^d\right)\left(1 - \frac{1}{\varepsilon}\right) - A_t - h(q_t) = 0 \qquad (11)$$

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[27]Since import is banned domestic demand is entirely served by the domestic firm i.e. $Q_t^d = q_t^d$

$$\frac{\delta \mathcal{L}}{\delta q_t^f} = \bar{p} - A_t - h(q_t) + \delta_t = 0 \qquad (12)$$

$$\frac{\delta \mathcal{L}}{\delta r_t} = 1 + \alpha \mu_t \varphi'(r_t) A_t = 0 \qquad (13)$$

$$\dot{\mu}_t = q_t + \alpha \mu_t \varphi(r_t) + \rho \mu_t \qquad (14)$$

And

$$\dot{A}_t = -\alpha \varphi(r_t) A_t \qquad (15)$$

Where $\mathcal{E}$ is the elasticity of domestic demand function.

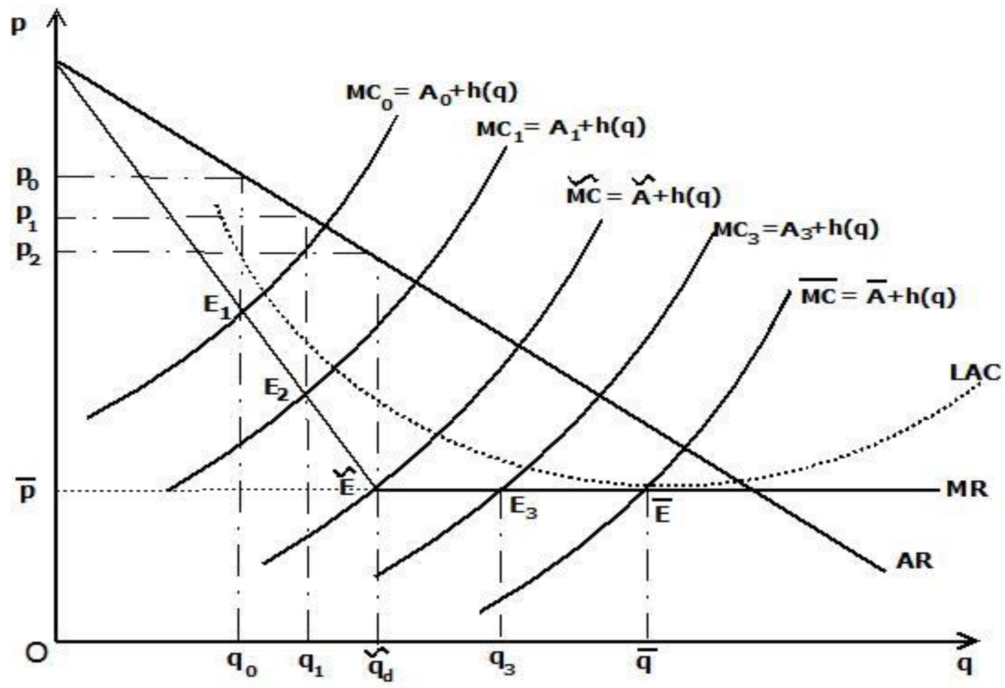
The complementary slackness conditions are

$$\left.\begin{array}{c} \delta_t = 0, \quad q_t^f > 0 \\ \text{Or} \\ \delta_t > 0, \quad q_t^f = 0 \end{array}\right\} \qquad (16)$$

3.6. Graphical Exposition

Motivating from Aggarwal and Barua (2004), figure 3.1 graphically depicts the movement of the marginal cost curve and the corresponding change in the output sold in domestic and world market. The initial technology of the domestic firm is A_0. The initial marginal cost curve is MC_0. Since import is banned the domestic firm behaves like a monopolist, charges p_0 price and produces q_0 output and sells all of it in the domestic market. Since protection is temporary, under the threat of future competition from foreign firms it invest its rent in R&D activities, as a result it improves it production technology. The newly acquired technology level is A_1 which shifts the marginal cost curve downward from MC_0 to MC_1. It now produces more output q_1, but still it sells only in the domestic market. Therefore, domestic sales increases from $q_0$to q_1. More the firm invest in R&D further down the marginal cost shifts. Firm's R&D investment continues until the frontier technology level $\bar{A}$ is reached. Correspondingly marginal cost kept on shifting from MC_0 to $\overline{MC}$.

Figure 3.1: A graphical exposition of the evolution of the domestic firm



Entry into the world market occurs when the firm improves its technology beyond $\tilde{A}$. In other words, when marginal cost curve shifts below $\widetilde{MC}$ export starts. When the marginal cost is given by $\widetilde{MC}$, firm produces $\widetilde{q_d}$ level of output and sells it entirely in the domestic market. $\widetilde{q_d}$ is the minimum level of output that the domestic firm must sell in the domestic market before it enter the world market. It is therefore the threshold level of home market sales. When the technology level improves beyond $\tilde{A}$ to A_3, firm produces q_3 level of output among which it sells $\widetilde{q_d}$ in the domestic market and export the rest which is $(q_3 - \widetilde{q_d})$. Notice that once the firm crosses the threshold level of technology $\tilde{A}$ it does not increase its domestic sales, but it increases its production which it accommodates by increasing export. Finally, when the firm reaches the frontier level of technology, $\bar{A}$, marginal cost shift to $\overline{MC}$ and it now passes through the minimum point of the long run average cost curve, LAC. At $\overline{MC}$, firm produces $\bar{q}$, sell $\widetilde{q_d}$ in the domestic market and export $(\bar{q} - \widetilde{q_d})$. After the firm reaches the frontier technology level it stays there and continues, to sell $\widetilde{q_d}$ in the domestic market and $(\bar{q} - \widetilde{q_d})$ in the world market until the protection period ends.

3.7. The Optimum Sales and Export Market Entry

This section solves the equation (11)-(16) and find out the optimum total sales, optimum domestic and foreign sales.

3.7.1. Case 1 ($\boldsymbol{\delta_t > 0}$)

When $\delta_t > 0$, then from the complementary slackness condition export, $q_t^f = 0$.

The optimum level of output sold in the domestic market is obtained from (11). In the absence of an exact functional form of $h(.)$ and $g(.)$, optimum domestic sales, q_t^d, cannot be explicitly determined. However, the trajectory of output sold in the domestic market q_t^d can be determined by time differencing equation (11), and it is given by

$$\dot{q}_t^d = \frac{-\alpha\varphi(r_t)A_t}{g'(q_t^d)\left(1-\frac{1}{\varepsilon}\right)-h'(q_t)} \tag{17}$$

Where $\dot{q}_t^d$ is the change in output sold in domestic market. If second order condition for monopoly profit maximization holds, at equilibrium slope of the marginal cost curve is higher than the slope of the marginal revenue curve. The slope of the marginal revenue curve of the domestic market as obtained from equation (1) is $g'(q_t^d)\left(1-\frac{1}{\varepsilon}\right)$. The slope of the marginal cost curve is $h'(q_t)$. Hence, assuming second order condition holds $g'(q_t^d)\left(1-\frac{1}{\varepsilon}\right) - h'(q_t) < 0$. Also since $\alpha > 0, \varphi(r_t) > 0$ *and* $A_t > 0$; $\dot{q}_t^d > 0$.Since monopolist does not export when $\delta_t > 0$,then $\dot{q}_t^f = 0$. From (11), (12) and (17), the movement in δ_t is given by:$\dot{\delta}_t = g'(q_t^d)\left(1-\frac{1}{\varepsilon}\right)\dot{q}_t^d$. Since $g'(q_t^d) < 0$, assuming $\mathcal{E} > 1$ (elastic demand curve), $\dot{\delta}_t < 0$.

Hence, when $\delta_t > 0$, then $q_t^f = 0$, $\dot{q}_t^d > 0$ and $\dot{\delta}_t < 0$; from (16) when $\delta_t = 0$, then $q_t^f > 0$. This implies if δ_t is a continuous function of time in the beginning of its life cycle domestic firm sells only in the domestic market while sells nothing to the world market. It keeps on increasing its domestic sales as long as $\delta_t > 0$.

3.7.2. Case 2 ($\boldsymbol{\delta_t = 0}$)

When $\delta_t = 0$, then from complementary slackness condition $q_f(t) > 0$, which implies domestic firm sells in the world market when $\delta_t = 0$

Since $\delta_t = 0$, from (11) and (12):

$$\bar{p} = g\left(q_t^d\right)\left(1 - \frac{1}{\varepsilon}\right) \tag{18}$$

Since $g(.)$ is a continuous decreasing function, there exist a unique value of q_t^d, say $\tilde{q}_d$, at which equation (18) holds. Therefore, $\bar{p} \equiv g(\tilde{q}_d)\left(1 - \frac{1}{\varepsilon}\right)$. Hence, $q_t^d = \tilde{q}_d$ and $\dot{q}_t^d = 0$ when $\delta_t = 0$.

Optimum level of export/foreign sales can be determined by plugging $q_t^d = \tilde{q}_d$ in equation (12). Hence when $\delta_t = 0, \bar{p} = A_t - h\left(\tilde{q}_d + q_t^f\right)$. Again in the absence of the functional form of $h(.)$, optimum level of export, q_t^f, cannot be determined. However, the trajectory of q_t^f, can be traced by differentiating equation $\bar{p} = A_t - h\left(\tilde{q}_d + q_t^f\right)$ with respect to time and is given as

$$\dot{q}_t^f = -\frac{\dot{A}_t}{h'(q_t)} = \frac{\alpha\varphi(r_t)A_t}{h'(q_t)} \tag{19}$$

Where $\dot{q}_t^f$ is the trajectory of export. Since marginal cost is assumed to be an increasing function of sales, i.e. $h'(q_t) > 0$, and $\alpha > 0, \varphi(r_t) > 0 \; and \; A_t > 0$; $\dot{q}_t^f > 0$. Hence, domestic firm increases its export sales as it continues to invest in R&D when $\delta_t = 0$.

Notice, when $\delta_t > 0$ then, $(q_t^d)\left(1-\frac{1}{\varepsilon}\right) = \bar{p} + \delta_t$, and when $\delta_t = 0$ then, $g(q_t^d)\left(1-\frac{1}{\varepsilon}\right) = \bar{p}$ with $q_t^d = \tilde{q}_d$. Since $g(.)$ is a decreasing function of q_t^d, $q_t^d|_{\delta_t>0} < \tilde{q}_d$. Therefore, $\tilde{q}_d$ is the maximum level of output domestic firm sells in the domestic market during its life cycle.

Previously, it has been seen that as δ_t decreases from positive value to zero value, trajectory of output sold in the world market transit from zero to positive value. Transition takes place at a point where δ_t transit from positive to zero value. Therefore, if $\tilde{A}$ is the level of technology at which transition takes place then at $\tilde{A}$, $\bar{p} = \tilde{A} - h(\tilde{q}_d)$. Hence, the level of technology at which transition takes place is $\tilde{A} = \bar{p} - h(\tilde{q}_d)$.

Proposition 1: when $A_t > \tilde{A}$, then $q_t^d > 0$, $q_t^f = 0$, $\dot{q}_t^d > 0$ and $\dot{q}_t^f = 0$, when $A_t \leq \tilde{A}$, then $q_t^d = \tilde{q}_d$, $q_t^f > 0$, $\dot{q}_t^d = 0$ and $\dot{q}_t^f > 0$.

Therefore, in the beginning domestic firm sells only in the domestic market. As it continues to invest in technology, it grows by selling more in the domestic market, when the technology of the firm crosses the threshold level ($\tilde{A}$,) then firm sells a constant amount, $\tilde{q}_d$ in the domestic market. It is the threshold level of home market sales that determine entry into the world market for the domestic firm. In other words, the domestic firm must sell $\tilde{q}_d$ amount in the domestic market to enter the world market. This indicates a certain level of home market sales is a prerequisite to enter export market. When the domestic firm improves its technology beyond the threshold level, it produces more output, increases its export, but does not increase its domestic sale.

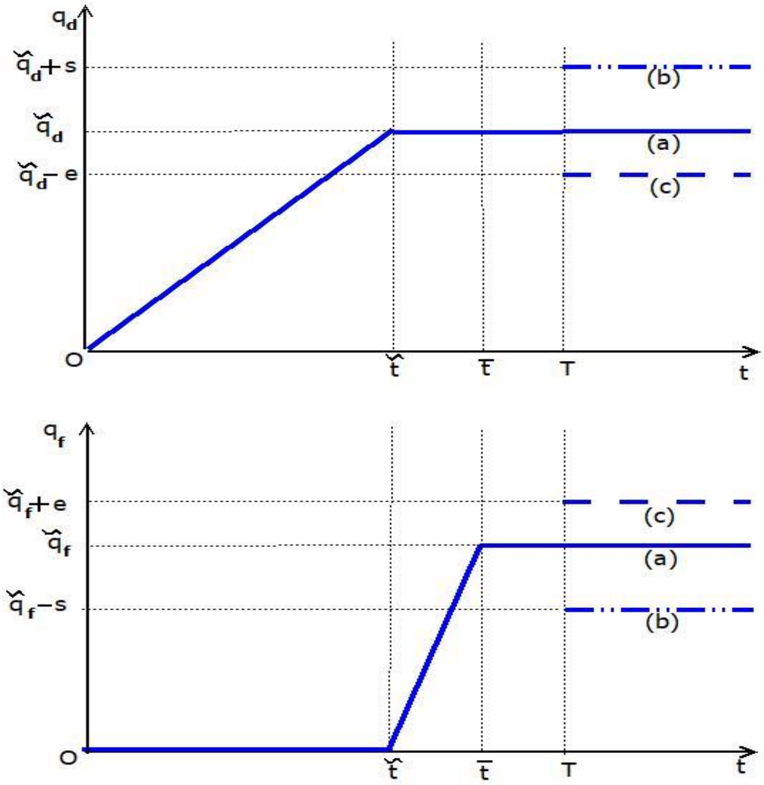
3.7.3. when $A_t = \bar{A}$

The domestic firm began export after reaching the threshold level of technology, $\tilde{A}$. However, it would survive, in the post protection period only if the firm reaches the frontier level of technology $\bar{A}$, by the end of the protection period. Therefore, the firm needs to invest further in technology development. Assuming that firm reaches the frontier level of technology A after it reaches the threshold level of technology $\tilde{A}$ as in Figure 3.1, at the frontier level of technology $\bar{p} = \bar{A} + h(\tilde{q}_d + q_t^f)$. Since $h(.)$ is a continuous and monotonic function of output, there is a unique value of q_t^f, say $\bar{q}_f$, at which the above equality holds. Hence, when the domestic firm operates at the frontier level of technology, then it produces $\bar{q} = \tilde{q}_d + \bar{q}_f$ level of output, sell $\tilde{q}_d$ in the domestic market and $\bar{q}_f$ in the world market. Since $\bar{A}$ is the frontier level of technology and $h(.)$ is a monotonically increasing function, $\bar{q}_f$ is the maximum export level of the domestic firm.

After the domestic firm reaches the frontier level, it cannot anymore increase its technology level. If it reaches the threshold level within the protection period [0, T], say at $\bar{t}$, then during $[\bar{t}, T]$ it will keep on producing $\bar{q}$, export $\bar{q}_f$ and sell $\tilde{q}_d$ in the domestic market. When protection is lifted after T, both the domestic and foreign firms operate at the minimum point of the long run average cost curve, each of them produces $\bar{q}$ level of output at the world price $\bar{p}$. Since including n foreign firms there are (n+1) firms producing the same product, total output produced by all firms is $(n+1)\bar{q}$. At the world price, $\bar{p}$, both the domestic and world market are perfectly elastic, hence, both the markets are treated together as one common market. Since all firms are equally efficient, entire market (domestic and foreign together) is shared equally among all the firms, however, it cannot be said how much each firm sells in the domestic and the world market.

The transition paths of domestic and export sales for the domestic firm are depicted in Figure 3.2. In the beginning domestic firm sells only in the domestic market. More it invests in technology, more productive it become, more it produces and sells in the domestic market. At time point $\tilde{t}$, the domestic firm reaches the threshold level of technology $\tilde{A}$, after which it enters the world market. Total and domestic sales increases continuously from 0 to $\tilde{q}_d$ during the period $[0, \tilde{t}]$. Foreign sales/export is zero during the same period. After time point $\tilde{t}$, as domestic firm continues to invest in R&D, it continues to increase its size by producing more. However, it does not sell beyond $\tilde{q}_d$ in the domestic market, the firm become larger by selling in the export market. When the technology reaches the frontier level $\bar{A}$ at time point $\bar{t}$, the domestic firm become as efficient as foreign firms. Frontier level of productivity is also reached, productivity cannot be increased any further by investing in R&D. During the period $[\tilde{t}, \bar{t}]$ domestic firm sells a fixed amount $\tilde{q}_d$ in the domestic market and increases export sales from 0 to $\bar{q}_f$. Time path of domestic sale before time $\tilde{t}$, and the time path of foreign sales during the period [$\tilde{t}, \bar{t}$] can either be linear, convex or concave depending on the functional form of the domestic demand function and marginal cost function of the domestic firm. For expositional ease a linear path is shown in Figure 3.2.

Figure 3.2: Transition path of domestic and export sales



After the domestic firm reaches the frontier level of technology it does not increase its production any further. Until the protection period ends at time point T, during $[\bar{t}, T]$ firm sells fixed amounts $\tilde{q}_d$ in the domestic market and $\bar{q}_f$ in the world market. In the post protection period, the domestic firm continues to produce a constant amount $\bar{q}$=$\tilde{q}_d + \bar{q}_f$. It sells either lesser than $\tilde{q}_d$ in the domestic market and more than $\bar{q}_f$ in the world market (case (c)), or same as $\tilde{q}_d$ in the domestic market and same as $\bar{q}_f$ in the export market (case (a)), or more than $\tilde{q}_d$ in the domestic market and lesser than $\bar{q}_f$ in the world market (case (b)). In either of three cases (case (a), (b) and (c)) total sales is fixed at $\bar{q}$.

3.8. Speed of Export Market Entry

This section examines the time of entry of the domestic firm in the export market. It has been seen that the domestic firm enter the world market before it reaches the frontier level. The technology threshold for entry is inferior to the frontier technology level. Since the firm must reach the frontier level within the protection period it then surely enters the world market before the protection end. But within the protection period when does the firm enter the world market? Does it enter at the beginning of the protection period or at the end? This depends on how quickly the domestic firm move down along the long run average cost curve. The amount the firm invest in R&D in each period determines the speed at which downward movement takes place. If the domestic firm invests more R&D at the beginning of the protection period, it enters the world market quickly, but if it invests less at the beginning and more at the end then entry would be delayed.

From equation (13), (14) and (15), the transition path or R&D investment is obtained as

$$\dot{r}_t = \frac{-\varphi'(r_t)[q_t + \rho\mu_t]}{\mu_t\varphi''(r_t)} \qquad (20)$$

Since $\mu_t > 0,\ \varphi'(r_t) > 0\ and\ \ \varphi''(r_t) < 0,\ \dot{r}_t > 0$

Therefore, the domestic firm tends to invest less in the beginning of the protection period. The closer it gets to the terminal date, the more it invests in R&D. Hence, entry to the export market happens at a later date during the protection period.

3.9. Conclusion

This chapter examines the role of home market in firm's decision to enter the export market. The vast trade literature on firm heterogeneity have both empirically and theoretically showed that productivity of a firm is one crucial factor that determines its export participation behaviour. These studies have assumed productivity to be exogenous and showed that the firms that happen to be more productive than others end up being exporters. This chapter designs a model of a firm's life cycle, where productivity is endogenous that evolves as a result of firm's investment in R&D. In the beginning firm is inefficient relative to the foreign firms and therefore protected by home government. Protection is temporary and given in the form of complete import ban. Under protection domestic firm earns supernormal profit which is invested in R&D. It has been shown that in the process of its evolution firm start with selling only in the home market, as it moves forward it keeps on increasing its size through selling more in the home market. After reaching a threshold level of technology and size it then enters the export market.

CHAPTER 4: The Role of Home Market on Export Entry Decision: Evidence from Indian Manufacturing

4.1. Introduction

Firm heterogeneity and its impact on export performance is a relatively recent phenomenon in the international trade literature. The micro-level studies documenting firm heterogeneity have found that only a small share of firms even within a narrowly defined industry export (Bernard and Jensen, 1995; Bernard et al. 2007) and exporting firms has superior characteristics compared to the non-exporting firms. It has been shown that productivity is the main determinant of firm participation in the foreign market (Clerides et al., 1998; Bernard and Jensen, 1999; Bernard and Wagner, 2001; Melitz, 2003; Aw et al., 2007; Wagner, 2012; Vu et al. 2016). In a seminal paper, Melitz (2003) showed that productive firms self-select in the export market since they are capable of incurring the sunk costs of entry in the export market.

Productivity of a firm does not remain constant throughout its operation; rather it evolves. Position of a firm in the productivity trajectory depends on its past behaviour. Past performance may bring important changes in the firm characteristics, such as up gradation of technology, improvement of productivity etc. These, in turn, may help a previously non-exporting firm to begin exporting. Previous research have shown that past experience of export positively influence the present choice of export since firms that export in the previous period already incurred the sunk cost of entering the export market (Robert and Tybout, 1997; Silvente, 2005; Sinani and Hobdari, 2010; Alvarez et al., 2013; Padmaja and Sashidharan, 2016). However, no attention is paid in the literature on the role of past behaviour in the home market in the firm's export entry decision.

In the existing trade theories, there are references of the home market playing an important role on the firm's decision to export. Linder (1961) postulated that due to the uncertainty of foreign needs, a firm, in the beginning, sells in the home market, and later when home market saturates, it extends its operation in the foreign market, Similarly, product life cycle hypothesis outlined various stages of product development where the first stage is development of the product in the home market that precedes the next stage of exporting which comes with the standardizaion of the product (Vernon 1966). The subsequent significance of 'home market effect' in international trade literature has focused on the role of home market size on trade pattern (Krugman 1980; Helpman and Krugman 1985; Davis 1998). They argued that in an imperfectly competitive market set up and in presence of transation cost, competitiveness of a country in the international market lies in the production of commodities that have a large home demand. The empirical analysis related to home market role on export tested the validity of the 'home market effect'. These studies are macro-level analysis and examined the effect of home market size. This chapter attempts to analyse the role of domestic firms' prior performance in the home market on their decision to enter the export market.

To examine the role of home market performance on the export entry, the case of Indian manufacturing firms is considered. The following reasons make Indian case interesting. Economic policies in India have seen a structural shift since the mid-1980s. The Indian government had taken steps to move the economy towards an open market from a protected self-oriented closed market. Two major policy shifts took place – deregulation of industries and liberalisation of trade. Prior to liberalisation, majority of Indian manufacturing firms operated in the home market. Only some firms were exporting. In the post-liberalisation period, conditions in the home market changed. Level of competition increased with more foreign firms coming and inefficient firms going out of business (Krishna and Mitra, 1998; Goldar and Aggarwal, 2005). Liberalisation also increased the opportunity of the domestic firms to become more productive and competitive by enabling greater access to cheap raw materials, essential capital goods and technologies through the import channel (Topalova and Khandelwal, 2011). Did increased competition led by economic liberalisation induce many non-exporters to grow in the home market, raise firm productivity level and eventually become exporters? Liberalisation process in India has been gradual and over the years more and more export promotion policies have emerged. Level of competition in the domestic market is likely to be more in the later phase of liberalization relative to the earlier phase. The analysis examines whether the role of domestic firms' prior performance in the home market on their export entry decision differs between the earlier and later phases of liberalisation.

In the post-liberalization period, manufacturing export increased in India (Veeramani, 2007). However, export concentration has been high, the top one per cent exporting firms in India account for 38% of the total exports (Economic Survey, 2018). Nagaraj (2014) showed that it is the big and the already established exporting firms that have expanded their export sales. There has been no or very little extensive export growth in the post-liberalisation period.[28] In such a context, it is important to understand how an Indian manufacturing firm takes the decision of export and what the various determinants of entry are.

In the Indian context, several empirical studies have analysed the determinants of firm export participation (Kumar and Siddharthan, 1994; Agarwal, 2002; Hasan and Raturi, 2003; Bhatt and Narayanan, 2009; Chadda, 2009). Bhatt and Narayanan (2009) showed that the probability of exporting increases with technology investment. Most of the studies have found that large firms participate in the export market. Highlighting the role of sunk cost in export participation, Padmaja and Sashidharan (2016) showed that past export experience increases the likelihood of exporting. Studies examining the relationship between firm productivity and export for Indian manufacturing firms found a positive association between the two and subsequently tested the validity of self-selection and learning-by-doing hypotheses. Haider (2012), Thomas and Narayanan (2016) and Gupta et al. (2018) found that the former hypothesis is valid while the latter is not. On the other hand, Ranjan and Raychaudhuri (2011), Mallick and Yang (2013) and Pattnayak and Thangavelu (2014) have found evidence in support of both the hypotheses.

[28] When rise in export by existing exporters increases the total export it is called intensive margin of trade and when total export increases due to the entry of the new exporters, it is called extensive margin of trade.

To the best of my knowledge, no study yet explored the role of past performance in the home market on export entry decision. The contributions of this analysis are the following. 1) This is the first study that investigates the role of prior home market performance on export entry. The chapter examines this in the context of an emerging economy – India with the use of longitudinal micro-level data of Indian manufacturing firms during the period of 1993 to 2016. Considering a sample of domestic Indian firms, the analysis tracks the home market sales and its growth in the pre-entry years and examines the difference in the growth pattern between future exporters and non-exporters. 2) While most of the previous studies on India have used either a linear probability model or a standard probit model to explain the export entry decision, a dynamic probit model is used in this analysis. Since export entry decision of a firm in a year is influenced by previous export experiences, a dynamic probit model is more suitable than other models.

This chapter is organised as follows. Section 4.2 describes the data used and sample construction. Section 4.3 provides descriptive statistics and preliminary evidence of the role of home market performance. Section 4.4 describes the model and the econometric methodology. Section 4.5 summarises the empirical results and section 4.6 concludes.

4.2. Data

The basic source of data for this research is the PROWESS database created by the Centre for Monitoring Indian Economy (CMIE). The database provides data on the financial performance of around 40,000 Indian companies belonging to the Manufacturing, Mining, Construction and Service sectors.[29] The analysis includes only manufacturing firms.[30] Prowess is preferred over the manufacturing census of India, Annual Survey of Industries (ASI), since the latter considers factory as a unit as opposed to the firm. The decisions, including exporting, are usually taken at the firm level, although the firm might operate in multiple factories. Another interesting feature of the Prowess database is that data are available since 1989, which permits us to

[29] Inclusion of a company in Prowess is based on the availability of its complete and audited annual report. Large as well as small firms are covered. Information on the large firms are collected from annual reports whereas CMIE's own periodic survey collects data on small firms.
[30] More than 50 percent of the companies included in PROWESS are manufacturing firms (Kite, 2013).

investigate the presence of home market performance in post-liberalised India. As per the CMIE report published in 2009 Prowess accounts for 79 per cent of the value of the output of organised manufacturing sector in India. Export coverage of the database improved significantly from 25% of the total manufacturing export in 1990; to 50% in 2010 and further to 56% in 2015.

From PROWESS, data for the 17826 listed manufacturing firms for the period 1989-2016 are extracted[31]. The data contains missing, negative and zero values of many variables. Only those firms are selected that report data on key variables such as sales, wages and salaries and fixed assets. Observations with negative and zero values are removed. Since the intent is to analyse home market performance of Indian manufacturing firms, a sample of 13181 domestic firms are selected after dropping the foreign firms. A firm is considered to be an exporter in a particular year if it reported positive export in that year. To see the export dynamics of Indian domestic firms, based on the export status firms are classified in four categories – non-exporters, persistent exporters, export quitters and intermittent exporters. Firms that did not export in any of the sample years are defined as non-exporters, whereas firms that exported in all the sample years and the firms that continue to export after entering the foreign market till the end of the sample period are defined as persistent exporters. Intermittent exporters are firms that enter and exit multiple times. Table 4.1 reports the distribution of various types of exporters. Majority of the firms are observed to be non-exporters constituting 44.98% of the domestic firms. There is a fairly large representation of persistent exporters and intermittent firms. Before entering the export market, persistent exporters, as well as intermittent exporters, operated in the home market.

Table 4.1: Type of Exporters

Type of exporter	**No. of firms**	**Percentages**
Non-exporter	5929	44.98
Persistent Exporter	3705	28.11
Intermittent	3547	26.91

Source: Author's calculation

[31] During the time of extraction of the data it was available till the year 2018, however, last two years are not considered since beyond 2016 data have not been updated for all firms.

Before analysing the role of pre-entry home market performance on entry, it is interesting to see whether Indian domestic firms operated in the home market before entering the export market or they were born global firms. In doing so, export histories of all firms are tracked since their birth. Tracking export history of firms that incorporated on or after 1989[32], it is observed that around 65-70% of the domestic firms operated in the home market before their entry to the export market.

In the presence of intermittent exporters (Table 4.1), the firm's behavior in the home market prior to entry is not solely attributable to the home market since it is likely to be influenced by the previous export spell. To ensure that pre-entry home market performance is independent of the previous export spell, only those firms are considered in the final sample that remains inactive in the export market for three consecutive years before entering the export market. The rationale behind choosing three consecutive years of inactivity is based on the finding of Roberts and Tybout (1997) that showed after two years of inactivity informational advantages of exporting wipe out, firms lose most of their previous export networks and behave like new exporters.[33] Finally, a sample of 4269 firms is selected that reports export data for five consecutive years, among which first three years are non-exporting years when firms operate solely in the home market and the following two years are either exporting or non-exporting years. The sample allows analysing the effect of prior home market performanec along with the role of sunk cost. While average growth in home market sales during the pre-entry years is considered to gauge the effect of prior performance in the home market on export entry, the effect of past export choice on the present export choice captures the role of sunk cost. Firms in our sample are distributed in 24 aggregated two-digit industries and 64 disaggregated three-digit industries at NIC-2008 classification.[34] The Appendix table A4.2 list the industries (at 2-digit level) included in our sample.

[32] Since the sample covers the period 1989-2016, the entire export history cannot be observed for firms born prior to 1989. About 40% Indian firms in the data are born prior to 1989.

[33] Similar result was found in some other studies (Bernard and Wagner, 2001; Bernard and Jensen, 2004; Sinani and Hobdari, 2010).

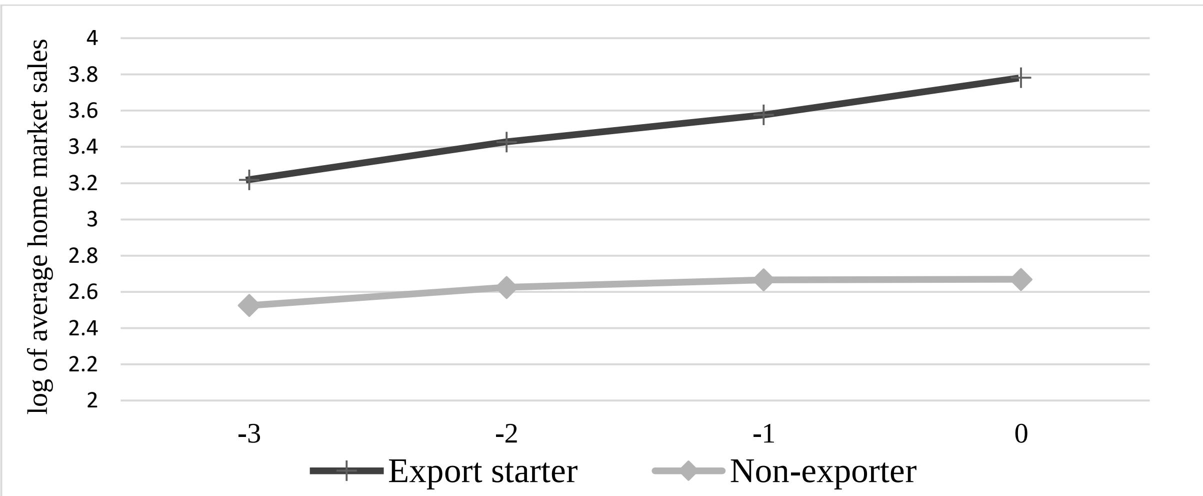
[34] Most firms in our sample belong to the following industries - Manufacture of Basic Metal (14%), Manufacture of food products (11%), Manufacture of chemical and chemical products (10%) and Manufacture of textile (10%).

The variables for which data are extracted from PROWESS are incorporation year, sales, wages and salaries, gross fixed asset, expenditure on raw materials, water and power, export status, R&D expenditure, import of capital goods, ownership categories. They are converted to constant price wherever necessary by deflating them with appropriate price index numbers. The data on the capital stock is created using the data of gross fixed asset by applying the perpetual inventory method based on Balakrishnan et al. (2000). See appendix table A4.1 for the measurement of the variables used in this paper.

4.3. Descriptive Statistics

In the final sample, firms are classified in two categories – export starter and non-exporter. Export starters are defined as firms that did not export in the previous three years but enter the export market in the current year, whereas non-exporters are the firms that neither export in the previous years nor in the current year. To have a preliminary idea of the role of prior home market performance on export entry the trajectory of home market sales for both export starters and non-exporters in the periods leading to entry are observed.

Figure 4.1: Trajectory of home market sales during 1993 – 2016



Source: Author's calculation

The evolution of home market sales for export starters and non-exporters are shown in figure 4.1 where 0 on the horizontal axis represents the entry year and -1, -2 and -3 represent pre-entry years when both export starters and non-exporters operated only in the home market. The figure clearly shows a differential path of growth of home market sales for export starters vis-à-vis non-exporters. It can be seen that the export starters were not only bigger but also grew more than non-exporters in the pre-entry years. Growth in home market sales for export starters was higher than non-exporters in each of the pre-entry years. The descriptive evidence suggests home market performance was higher for export starters.

Before proceeding to the econometric analysis of causal relation between home market participation and export status, it is interesting to see if the characteristics of the export entrants (or, export starters) differ from the characteristics of non-exporters in the sample. In this regard, mean values of firm characteristics are calculated for export starters and non-exporters and reported in table 4.2. The last column in the table provides a statistical test for the difference in the mean characteristics of export starters vis-à-vis non-exporters. It has been observed that before entry into the export market, export starters grew more in the home market than the non-exporters. The average growth rate in the home market sales in the pre-entry years for export starters was not only higher than that of non-exporters, the difference in the growth rates was statistically significant as shown by the t statistics.

Table 4.2: Mean characteristics of export starters and non-exporters

	Export entrants			Non-exporters			
	Obs.	Mean	S.D	Obs.	Mean	S.D	Mean Difference
Home Market Performance	2303	0.19	0.46	17621	0.10	0.44	0.085***
Log (Sales)	2303	3.89	1.49	17621	2.84	1.84	1.048***
Log (Capital stock)	2303	3.53	1.56	17621	2.79	1.59	0.737***
Log (Age)	2303	2.93	0.66	17621	3.03	0.67	-0.096***
Labour intensity	2303	0.10	0.15	17621	0.11	0.20	-0.014***
R&D intensity	2303	0.00	0.00	17621	0.00	0.00	0.0004***
Capital Import intensity	2303	0.01	0.06	17621	0.00	0.04	0.007***
Log (Total factor productivity)	2303	-0.10	1.29	17621	-0.20	1.36	0.108***
State Owned firms	2303	3.17	17.52	17621	4.99	21.77	-1.819***
Private Firms	2303	64.18	47.96	17621	70.55	45.58	-6.375***
Business group affiliated firms	2303	32.65	46.90	17621	24.46	42.99	8.194***

Note: *** refers to 1% level of significance.
Source: Author's calculation

Since the mean values only show an average picture, to have a better descriptive understanding of home market role, the distribution of home market sales in the pre-entry years for export starters against non-exporters are plotted for comparison in terms of level and growth rate. Figures 4.2 and 4.3 show that the distribution for export starters dominates the distribution for non-exporters both for level of home market sales and growth in home market sales, suggesting prior to entry export starters were not only bigger than the non-exporters, they even grew more than non-exporters in the pre-entry years, when both operated solely in the home market.

Looking at the other characteristics of export starters and non-exporters, it can be seen that former group of firms are bigger both in terms of sales and capital stock, and relatively younger than the latter group of firms. Although India is a labour abundant country non-exporters are found to be more labour intensive than exporters. Moreover, export starters invest more in new technologies than non-exporters. The amount invested in R&D activities per unit of output is higher for export starters than non-exporters. Embodied technology import is a common form of technology purchase by Indian manufacturing firms where technology is purchased through import of capital goods. Investment in embodied technology is higher for export starters relative to non-exporters.

Figure 4.2: Distribution of prior home market sales for export starters and non-exporters

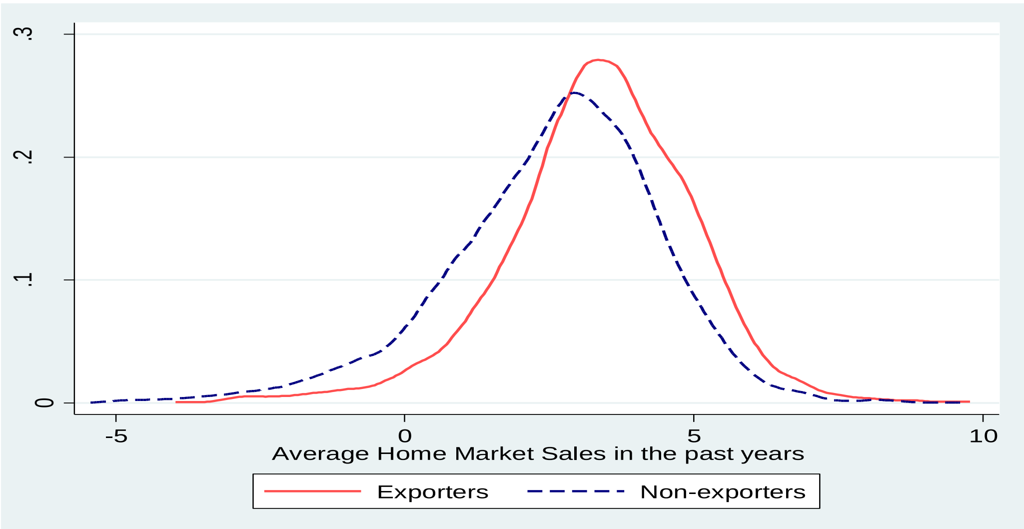
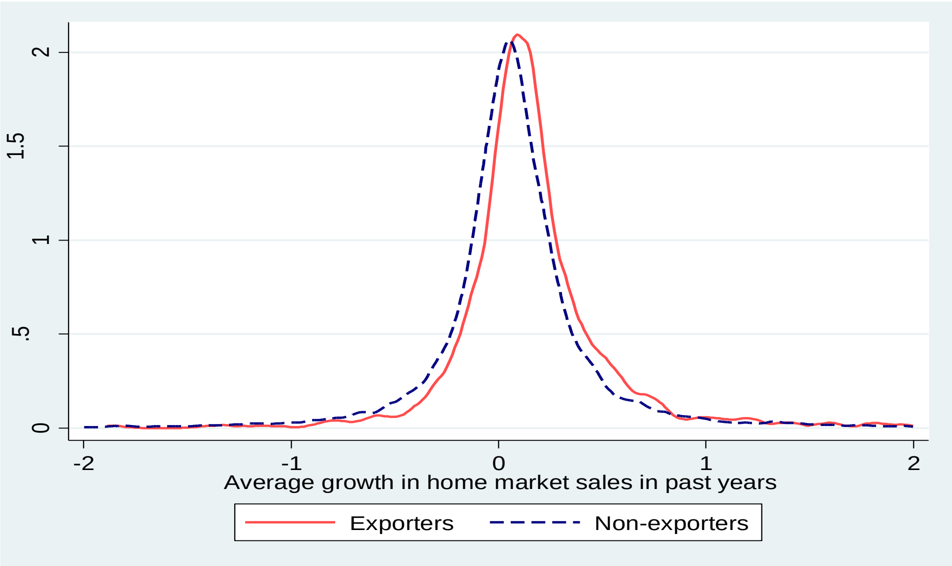


Figure 4.3: Distribution of prior growth in home market sales for export starters and non-exporters



Source: Author's calculation

Productivity is an important indicator of firm characteristics and the previous studies almost unanimously found exporters are more productive than non-exporters. In this analysis, Levinsohn and Petrin (2003) method is used to estimate productivity at firm level, as it is the most widely used and accepted technique to calculate productivity with unit level data. In line with the previous studies, export starters are found to be more productive compared to non-exporters. The percentage of business group affiliated private firms are more among exporters than non-exporters which indicates that group affiliation are conducive to export entry.

4.4. Methodology

4.4.1. Export decision model

To assess the role of prior home market performance along with other factors on export entry decision of a firm, the analytical framework proposed by Robert and Tybout (1997) is employed here.[35] Entering the export market involves incurring various costs

[35] Several subsequent studies including Bernard and Jensen (2004) and Arnold and Hussinger (2005)

such as collecting information about foreign market, creating business networks, procuring certification and clearances etc. These costs are non-recoverable and therefore sunk in nature.

Let S denotes the sunk cost of entry into the export market.[36] Then instantaneous profit from exporting (π_{it}) net of sunk cost is given by

$$\pi_{it} = r_{it}(\boldsymbol{Z}_{it}, \boldsymbol{W}_t) - S(1 - Exp_{it-1}) \qquad (4.1)$$

Where r_{it} is the incremental profit (beyond domestic market profit) from exporting of i^{th} firm in t^{th} time period, $\boldsymbol{Z}_{it}$ is the vector of (observed) characteristics of i^{th} firm in t^{th} time period, $\boldsymbol{W}_t$ is the vector of time specific exogenous factors, such as exchange rate shock, affecting exports of all firms equally. Export status of the i^{th} firm in $t\text{-}1^{th}$ period is denoted by Exp_{it-1}, equation (4.1) indicates that firm pays entry cost S in t^{th} period if it does not export in $t\text{-}1^{th}$ period (i.e. $Exp_{it-1} = 0$), otherwise it does not pay any entry cost (when $Exp_{it-1} = 1$) .

In a multi period model, a firm's decision on the choice to export in the current period depends not only on the current period profit from exporting but also on the expected profits in the future periods. Let V_{it} denotes the expected present (discounted) value of current and future periods' profits or the value function of the firm, then V_{it} can be expressed as

$$V_{it} = \pi_{it}(\boldsymbol{Z}_{it}, \boldsymbol{W}_t, Exp_{it-1}) + E_t(V_{it+1}|Exp_{it}) \qquad (4.2)$$

Equation (4.2) implies expected present value of current and future periods' profits is the sum of the current profit and the expected value of the future profits.

A firm will decide to enter the export market in t^{th} year if V_{it} from exporting is higher than V_{it} from non-exporting. In other words, if the incremental profit from exporting,

used the framework.

[36] Sunk cost is assumed to be constant across firms and time period.

r_{it}, and the changes in the expected future value of the firm due to exporting exceeds the sunk entry cost then a firm will choose to export. Therefore,

$$Exp_{it} = \begin{Bmatrix} 1 & if\ r_{it}(\boldsymbol{Z}_{it}, \boldsymbol{W}_t) + [E_t(V_{it+1}|Exp_{it} = 1) - E_t(V_{it+1}|Exp_{it} = 0)] \geq S(1 - Exp_{it-1}) \\ 0 & otherwise \end{Bmatrix} \quad (4.3)$$

The presence of sunk cost makes the export entry decision dynamic, since today's export generates an option value of easing tomorrow's export by making it free from entry cost. In equation (4.3), the term $[E_t(V_{it+1}|Exp_{it} = 1) - E_t(V_{it+1}|Exp_{it} = 0)]$ represents the option value.

To identify factors that determine the export entry decision of firms, non-structural approach is used which translates the model expressed in equation (4.3) into the following empirical binary choice model

$$Exp_{it} = \begin{Bmatrix} 1 & if \quad \gamma_0 + SExp_{it-1} + \gamma_1 HM_{it_0} + \gamma_2 \boldsymbol{Z}_{it-1} + \boldsymbol{\eta}_j + \boldsymbol{W}_t + \mu_i + \omega_{it} \geq 0 \\ 0 & Otherwise \end{Bmatrix} \quad (4.4)$$

Where the dependent variable (Exp_{it}) is export entry status of i[th] firm in the t[th] time period. Among the independent variables, primary variable of interest is home market performance(HM_{it_0}). It captures the effect of the firm's past performance in the home market on its decision to enter the export market. It corresponds to the experience in home market in pre-sample periods, and the suffix t_0 denotes pre-sample realizations. It is measured by the average growth rate in home market sales in the past three years when firm does not export. Other factors affecting export participation are contemporaneous variable. The second important independent variable considered in equation (4.4) is past export status (Exp_{it-1}). It captures the role of sunk cost in entry decision. The vector of observed firm characteristics is represented by$\boldsymbol{Z}_{it-1}$, industry and time dummies are included in the vector $\boldsymbol{\eta}_j$ and $\boldsymbol{W}_t$ respectively. Unobserved time invariant firm characteristics or unobserved firm heterogeneity such as, ability of the firm is represented by $\mu_i$and ω_{it} is the iid error term.

Based on the economic theory and the previous studies size, age, labour intensity, technology intensity, prior productivity and ownership dummies are considered as control variables in the export entry equation (equation 4.4). A positive relation between firm size and export entry is expected since large firms have scale advantage, better access to resources, and greater risk absorbing capacities. The capabilities older firms earn through their experience can keep them ahead of the younger firms to participate and prosper in international market. However, in a liberalized economy younger firms can find it easier to sell more in foreign market as they use modern technologies acquired through import (Aggarwal, 2002). Hence age can have either positive or negative effect on exports. Since India is a labour abundant country comparative advantage in production in India lies in using labour intensive production techniques. Therefore labour intensity is expected to have a positive effect on export entry decision.

Efforts made in acquiring new technologies and technological knowledge make a firm competitive to enter in the international market since better technology results in introduction of new products, quality improvements, reduction in the cost of production etc. A firm can acquire technology by investing in in-house R&D activities, correspondingly the variable R&D intensity (R&D expenditure per unit of sales) is included in the model. Technology can also be acquired through import, and large part of India's technology investment is in embodied form through import of capital goods such as imported machines (Rijesh, 2015). The variable, import of capital good intensity is used to capture the role of embodied technology.The coefficient of the variable is expected to have a positive sign. Prior productivity is expected to positively affect export entry since productive firms are relatively less risk-averse and capable of bearing the sunk cost of foreign market participation.

Based on ownership, domestic firms are divided in three categories- Business group affiliated private firms, unaffiliated private firms and state owned firms. Two dummy variables, namely business group and private are included in the regression equation 4.4. The former compares the probability of entry of business group affiliated private firms with the probability of entry of the omitted category, state owned firms. Similarly, the latter compares probability to entry between unaffiliated private firms and state owned firms. If a domestic firm is associated with a business group it is more likely to enter and expand in the foreign market. Firms associated with big businesses have an edge over other domestic firms since they have access to the superior technologies and region specific knowledge and distribution channel of the parent firm. Private firms are expected to be more efficient than state owned firms. Therefore positive coefficients of both the dummy variables are expected.

Apart from the above mentioned control variables, industry dummies at NIC - 3 digit level are included to control heterogeneity in export performance across industries. Time dummies (W_t) are also taken to control for any macroeconomic shocks such as changes in the exchange rate, credit market situation etc.

4.4.2. Econometric Method

The export decision model formulated above shows that firms' decision to enter in the export market depends on the past history of export. In other words, export decision is state dependent which implies dynamic panel data models are more suitable. The dependent variable, export status is also a binary variable. Taking into account both the dynamic and binary nature of the dependent variable dynamic random effect probit model, proposed by Wooldridge (2005) is used with some modification based on Chamberlin (1980) and Mundlak (1978).

The consistency of the estimators in a random effect model depends on the assumption of zero correlation between unobserved firm heterogeneity (μ_i) and the regressors of the model. In the export decision model formulated above (equation 4.4), explanatory variables representing firm size and productivity are correlated with the unobserved firm effects (μ_i) such as, managerial ability, product attributes. This makes these explanatory variable endogenous in the model. To consistently estimate the parameters of the model unobserved firm effects need to be controlled.

Two more serious problems that dynamic export decision models such as, model given by equation (4.4), must deal with are – the possibility of spurious estimation of the state dependence parameter and the initial condition problem. The coefficient of the variable lagged export status (Exp_{it-1}) gives the estimate of state dependence. There is true state dependence when the previous experience of export changes the preferences and the constraints faced by a firm in exporting at present. True state dependence makes the future choice of export dependent on past choice of exports. However, observed correlation between the past and future choice of export might not truly reflect the state dependence if the correlation is due to the presence of time persistent unobserved effects (Heckman 1981). Therefore, unaccounted unobserved firm effects (μ_i) resulted in spurious estimation of state dependence parameter.[37]

Initial condition problem is about the treatment of the initial value of the dependent variable (i.e. the value of the dependent variable at t=1 where $t \in 1(1)T$) for each cross sectional unit. Traditional random effect probit model assumes initial values as exogenous. However, initial conditions/values are unlikely to be exogenous in model of export entry because one can observe the export choice of the firms only in the initial year of the sample, which in all likelihood dependent on the export choices in the pre-sample years.[38]

Wooldridge (2005) devised a method that solves the initial condition problem as well as provides the true estimate of state dependence. Wooldridge (2005) proposed a conditional maximum likelihood estimator that specifies an auxiliary distribution of the unobserved individual effect (μ_i) conditional on the initial value of the dependent variable and exogenous variables. Using Wooldridge method on the export decision model given by equation (4.4) the unobserved heterogeneity can be expressed as

$$\mu_i = \varphi_0 + \varphi_1 Exp_{i0} + \varphi_2 Z_i + a_i \quad (4.5)$$

where $a_i \sim Normal\ (0, {\sigma_a}^2)$, Exp_{i0} is the initial value of the export of the ith firm in the initial period. And, Z_i is the vector of other explanatory variables for the ith firm in all the time periods.

In the spirit of Chamberlin (1980) and Mundlak (1978) eqution (4.5) is modified into the following expression of the unobserved effect.

$$\mu_i = \varphi_0 + \varphi_1 Exp_{i0} + \varphi_3 \overline{Z_\iota} + a_i \quad (4.6)$$

[37] When state dependence is spurious OLS estimates creates upward bias in estimation of the coefficient of the lagged dependent variable.

[38] The choice of export in the initial period of the sample is an outcome of the firm evolutionary process that had started much before the initial year of the sample for many firms and hence it can’t be exogenous.

Where $\overline{Z_i}$ is the vector representing the within means of the explanatory variables. Here Z_i is replaced by $\overline{Z_i}$. This is a standard practice used by the applied econometricians in implementing Wooldridge method when the sample size is large (Arulampalam and Stewart, 2009). Noticeably, the possible correlation between unobserved effect and explanatory variables is taken into account in equation (4.6) by explicitly considering μ_i as a function of within means of the explanatory variables.

Apart from Wooldridge (2005) method, there are some alternative methods of estimating dynamic random effect probit model such as, Heckman (1981) that also solves the initial condition problem. Papers that made a comparative analysis between various methods showed that for a moderately long panel (i.e. the panel longer than 5-8 periods) Wooldridge's method produces similar estimates as other methods (Arulampalam and Stewart, 2009; Rabe-Hesketh and Skrondol, 2013). However, Wooldridge's method is preferred since 1) it is relatively simpler and time inexpensive method; 2) it can be implemented with standard econometric packages such as STATA; 3) it allows estimating the average marginal effects and 4) The sample period in this analysis is more than 20 years.

Few other points are worth mentioning. Firstly, maximum likelihood estimators of a probit model are inconsistent in the presence of heteroskedasticity of the error term.[39] We have employed heteroskedastic probit model as an alternative specification to correct heteroskedasticity on the pooled data.[40] Secondly, often it is argued that the act of exporting changes the characteristics of a firm. For example, if a firm exports more it is going to invest more on technology. This brings in the simultaneity problem. To address the issue of simultaneity, we use one-year lag values of all the explanatory variables.

[39] Heteroskedasticity is a more serious problem in non-linear estimation since in linier model OLS estimates are only inefficient but not inconsistent in presence of heteroskedasticity.

[40] Heteroskedastic probit model corrects heteroskedasticity in a probit model by assuming variance of the error term as some function of the explanatory variables. We could implement it for pooled data specification of the probit model. However, for panel data probit model there is no specific command in the standard softwares to correct heteroskedasticity.

4.5. Result and Discussion

Analysis of role of home market in the post liberalization period (1993-2016)

In examining the role of home market performance on export entry, equation (4.4) is estimated for the entire post liberalization period (1993-2016), and then separately for the two sub periods – (1993-2003) and (2004-16). The results for the entire post liberalization period are reported in Table 4.3. Four alternative specifications of the model are worked out, each using separate estimation method. Column (1) reports estimates from a pooled probit regression. Estimates obtained from heteroskedastic probit regression are reported in column (2). Taking into account the panel nature of the data, column (3) reports estimates from random effect probit model. The estimates of our preferred method, Wooldridge dynamic probit, are reported in column (4) of the table. Estimates are found to be jointly significant in each of the specification as shown by the joint significance test. The wald test for heteroscedasticity supported the presence of heteroscedasticity. However, presence of it is does not create a problem since the significance level, direction of causality and numerical estimates of the coefficients remain more or less unchanged in the heteroskedaticity corrected model. The result of the likelihood ratio test in the last two columns indicate there is a significant random effect component.

The coefficients of the variable past export are positive and significant at 1% level across all the specifications. It captures the role of sunk cost in export participation decision. Since in the sample firms do not export in t-4th, t-3th and t-2th years but export in t-1th and tth years, only one year of lag export is considered to see the relevance of sunk cost on export entry status. Entry to the export market involves various costs such as cost for knowing the preferences of the foreign customers, adapting the product to the foreign needs, cost on establishing a business network etc. These costs are sunk in nature. In presence of sunk cost firms that exported in the past years are likely to export today to avoid the re-payment of the sunk cost.[41] The result indicates that Indian manufacturing firms bear sunk cost in entering the export market and that makes previous exporters less likely to exit the export market. The numerical estimates reveal

[41] Following Baldwin (1988) an increase in the sunk entry costs increases the time span between entry to and exit from the export market.

exporting in the previous year increases today's probability of exporting by 25 to 26%. Persistency in the export market was shown in several previous studies for developed as well as developing countries (such as, Robert & Tybout, 1997; Bernard & Jensen, 2004;; Kemne et. al, 2014, Padmaja & Sashidharan, 2016).

Table 4.3: Estimation for the entire post liberalization period (1993-2016)

Period of Analysis = 1993-2016				
Dependent Variable: Export status				
Independent Variables	**Pooled Probit**	**Heteroskedastic probit**	**RE probit**	**Wooldridge Dynamic probit**
	(1)	(2)	(3)	(4)
Past export status	0.266***	0.267***	0.251***	0.256***
	(0.005)	(0.005)	(0.006)	(0.007)
Home market Performance	0.016***	0.016***	0.015***	0.017***
	(0.004)	(0.004)	(0.004)	(0.005)
Log (Size)	0.026***	0.025***	0.029***	0.031***
	(0.002)	(0.002)	(0.002)	(0.002)
Log (Age)	-0.002	-0.0003	-0.001	0.008
	(0.003)	(0.003)	(0.003)	(0.013)
Labour intensity	0.034***	0.036***	0.038***	0.047***
	(0.010)	(0.010)	(0.012)	(0.029)
R&D intensity	0.623	1.220	0.608	-0.983
	(0.530)	(0.699)	(0.508)	(0.719)
Capital Import intensity	0.070**	0.076**	0.068**	0.072**
	(0.032)	(0.032)	(0.032)	(0.034)
Log (Prior Productivity)	0.014***	0.013***	0.015***	0.009***
	(0.002)	(0.002)	(0.002)	(0.003)
Business group	0.064***	0.062***	0.072***	0.076***
	(0.011)	(0.011)	(0.012)	(0.013)
Private firm	0.071***	0.069***	0.079***	0.082***
	(0.011)	(0.011)	(0.013)	(0.014)
initial				0.021**
				(0.009)
Constant	-0.425***	-0.490***	-0.442***	-0.469***
	(0.057)	(0.077)	(0.081)	(0.088)
Mean of time-variant firm characteristics	No	No	No	Yes
Industry Dummy	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes
Likelihood Value	-4802.495	-4794.857	-4790.770	-4776.836
Joint significance of all explanatory variables (χ^2)	3529.57***	330.55***	3318.44***	3261.51***
Heteroskedasticity test		14.17**		
LR test (rho=0)			23.44***	27.63***
Observations	19,885	19,885	19,924	19,924
Number of firms			4,269	4,269

Notes: The values in the parentheses are the standard errors. Standard errors in column (1) and (2) correspond to the robust standard errors. ***Statistically significant at 1% level, ** 5% level. Average partial effects are reported. State owned firms form the reference category.

The coefficient of variable capturing the role of home market performance prior to entry is positive and significant across the regression methods. This implies firms that grew more in the home market during the non-export years are more likely to enter the export market. It can be argued that with the growth in the home market sales, firms gather resources (physical, human and informational) that enable them to bear the fixed cost of entry into the export market. Moreover, stronghold in the home market allows offsetting any plausible future losses from exporting. The magnitude of the coefficient in column (4) indicates probability of export to increase by 1.7% following a 1% increase in the growth of home market sales. The changing nature of the home market caused by economic liberalization of the 1990s may have made firms more export oriented. The removal of import protection increased home market competiveness as difficulties in surviving pushed many earlier non-exporting firms to invest in efficiency enhancing activities. The greater availability of cheap materials, imported machines helped these domestic firms to increase their productivity levels. In the process, firms those are more dynamic, have better managers grow more than the others, move up to higher and more efficient production frontiers and eventually enter the export market.

There is evidence for self-selection of productive firms to the export market as coefficients of prior productivity are found positive and significant in all the regressions. Participation in the world market is a risky venture where a firm can suffer big losses. More productive firms have better chances of succeeding in the export market, as they can diversify risk across markets and product lines. Since world market is more competitive than the domestic market, more productive firms are also better placed to serve the former compared to the less productive firms. Moreover, productive firms are more likely to bear the sunk cost of exporting. Probability of exporting is estimated to increase by 1% following 1% increase in the productivity level of firms. This is in line with previous studies (Ranjan and Raychaudhuri, 2011; Haider, 2012; Mallick and Yang, 2013; Pattnayak and Thangavelu, 2014; Thomas and Narayanan, 2016), which found that self-selection hypothesis holds for Indian firms.

The coefficients of firm size are positive and significant in all the specification indicating large firms have scale advantage in entering the export market. Large firms possess oligopoly control of the domestic market that provides the scope for scale advantages in production, innovation as well as in export marketing (Hirsch and Adar

1974; Glesjer et al. 1980). The result corroborates with most of the previous studies on India (Kumar and Siddharthan 1994; Aggarwal 2002; Chadha 2009). Experience of production, as it appears, is not a significant determinant of export entry. Since age may positively or negatively affect export, as discussed previously, it seems there are both experienced and young exporters in the sample offsetting the effect of each other. Previous studies (Bhatt and Narayanan, 2009 and Padmaja and Sasidharan, 2016) found negative association between age and export entry. The coefficient of the variable labour intensity indicates labour intensive firms are more likely to enter the export market which corroborates with the prediction of the standard trade theories[42] and previous studies (Kumar and Siddharthan, 1994; Hasan and Raturi, 2003; Bhatt and Narayanan, 2009).

To capture the effect of technology two technology variables – R&D intensity and import of capital goods intensity are used. The former represents in-house research & innovation activities whereas the latter represents foreign technologies embodied within the imported capital goods. The coefficient of R&D intensity came out to be insignificant. This is not surprising since Indian firms invest very little in in-house innovation activities.[43] Import of capital goods intensity, however, found to have a significant positive impact on the probability of export entry. Imported machines embody modern technologies and when adapted to the local condition save time and improve production efficiency. Previous studies found similar result.

The positive and significant coefficient of the two ownership dummies show ownership difference matters in export participation of Indian Manufacturing firms. The probability of exporting is more for business group affiliated firms relative to the base category-state owned firms. This is because firms belonging to some big business group can make use of the technology and distribution channel of the parent firms. Private firms are more export oriented than the state owned firms which supports the common

[42] According to standard trade theories comparative advantage in developing countries lies in the production of labour intensive product.

[43] Moreover, innovative activities in India are concentrated only in few sectors such as, Pharmaceuticals, Chemicals. Importance of R&D will be reflected in sector specific analysis that focuses on specific sectors, however, importance of in-house R&D activities on export may not found in aggregate analysis which covers entire manufacturing sector.

perception that the public companies are inefficient. The result conforms to most of the previous studies such as Aggarwal (2002).

The variable initial captures the role of initial condition or the initial year of export on export participation. The significance of the variable indicates the endogeneity of the initial value of export. Since entire export history was not observed for all firms[44] it was important to control the endogeneity of the initial value of export status in the sample. This is because as oppose to the later values of export status, the initial value cannot be explained by the previous realization of the variable. Hence, the positive and significant coefficient of the initial value rationalizes the preference for using Wooldridge's model over other standard binary choice models.

Analysis for the changing role of home market over the liberalization period

Liberalization process in India has been gradual. During the initial years of liberalization only the tariff barriers were removed. Later non-tariff barriers were also removed. Although level of competition increased in India in the post-liberalized period due to openness, but in the initial phase of liberalization the increase in the domestic market competitiveness was moderate. Later, with deeper reforms degree of competition increased further. Therefore, impact of home market performance on export entry is likely to vary over the post liberalization period. The analysis for the two sub periods, 1993-2003 and 2004-16, are conducted to separate the impact of home market performance between the initial and later phase of liberalization. Here, the year 2004 is considered as the dividing year since the intension was to see the impact of home market performance in first ten years of liberalization vis-à-vis the later periods. Estimation results are reported in table 4.4.

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[44] Since PROWESS reports data since 1989, export status of the firms incorporated before 1989 could not be tracked from their birth.

Table 4.4: Estimation for initial (1993-2003) and later (2004-16) phase of liberalization

Dependent Variable: Export status		
Independent Variables	**Initial phase (1993-2003)**	**Later phase (2004-2016)**
	(1)	(2)
Past export status	0.305***	0.237***
	(0.014)	(0.010)
Home market Performance	0.018	0.013***
	(0.011)	(0.005)
Log (Size)	0.038***	0.026***
	(0.005)	(0.002)
Log (Age)	0.030	-0.001
	(0.037)	(0.014)
Labour intensity	0.062	0.031
	(0.079)	(0.029)
R&D intensity	0.211	-0.201
	(1.524)	(0.744)
Capital Import intensity	0.035	0.085**
	(0.071)	(0.037)
Log (Prior Productivity)	0.003	0.011***
	(0.006)	(0.004)
Business group	0.069***	0.072***
	(0.025)	(0.015)
Private firm	0.070***	0.080***
	(0.026)	(0.015)
initial	-0.008	0.032***
	(0.020)	(0.009)
Constant	-1.176	-0.419***
	(503.134)	(0.084)
Mean of time-variant firm characteristics	Yes	Yes
Industry Dummy	Yes	Yes
Year Dummy	Yes	Yes
Likelihood Value	-1582.142	-3154.354
Joint significance of all explanatory variables (χ^2)	1047.08***	2178.94***
LR test (rho=0)	0.51	14.05***
Observations	5,099	14,825
Number of firms	1,603	3,571

Notes: The values in the parentheses are the standard errors. ***Statistically significant at 1% level and ** 5% level. Average partial effects are reported. State owned firms form the reference category.

Home market performance is not significant in the initial phase of liberalization, while it is positive and significant in the later phase. The result can be interpreted as the difference in the level of competitiveness between the two sub periods. In the initial phase, reform measures were weaker while in the later phase as a result of deeper reform policies competition level in the home market increased which resulted in capacity building, more investment in technology and productivity improvement. The fact that the variables import of capital goods and prior productivity are positive and significant only in the second phase of the liberalization further establishes the argument made. Sunk cost and firm size were important determinants of export participation during the both the phases of liberalization. Notice that the variable initial is not significant in the initial phase of liberalization indicating exogeneity of the initial value of the export status.

Table 4.5: Estimation for firms incorporated in pre and post 1989 period

Dependent Variable: Export status		
Independent Variables	**Incorporation year<1989**	**Incorporation year≥1989**
	(1)	(2)
Past export status	0.261***	0.240***
	(0.008)	(0.011)
Home market Performance	0.021***	0.012**
	(0.007)	(0.005)
Log (Size)	0.031***	0.021***
	(0.003)	(0.003)
Log (Age)	0.014	-0.001
	(0.023)	(0.008)
Labour intensity	0.076*	0.050***
	(0.042)	(0.015)
R&D intensity	-0.320	-0.025
	(1.009)	(0.618)
Capital Import intensity	0.075	0.071*
	(0.050)	(0.039)
Log (Prior Productivity)	0.011***	0.014***
	(0.004)	(0.003)
Business group	0.070***	0.076**
	(0.015)	(0.032)
Private firm	0.073***	0.083***
	(0.015)	(0.031)
initial	0.016	
	(0.011)	
Constant	-1.115	-0.854
	(224.326)	(403.624)
Mean of time-variant firm characteristics	Yes	
Industry Dummy	Yes	Yes
Year Dummy	Yes	Yes
Likelihood Value	-2827.936	-1916.9226
Joint significance of all explanatory variables (χ^2)	2036.75***	1281.36***
LR test (rho=0)	6.05***	11.93***
Observations	11,398	8,526
Number of firms	2,145	2,124

Notes: The values in the parentheses are the standard errors***Statistically significant at 1% level, ** 5% level and * 10% level. Average partial effects are reported. State owned firms form the reference category.

Since the entire export history can be tracked only for firms that are incorporated post 1989, the role of home market performance is evaluated separately for the sample of firms that are incorporated prior to 1989 and the sample of firm that are incorporated post 1989. The result appears in table 4.5. Since initial year of export status is observed for the latter, Wooldridge method is applied only for the former. Home market performance prior to entry is found to be important determinant of export entry for both the group of firms.

4.6. Conclusion

The chapter analysed the impact of home market performance on export entry decision of Indian manufacturing firms during the period 1993-2016. To evaluate home market performance, sample has been created with firms reporting export data for five consecutive years, among which first three years are non-exporting years when firm operates solely in the home market and the next two years are either exporting or non-exporting years. Comparing export starters and non-exporters it has been found that export starters are bigger, younger, more productive and more technology intensive than non-exporters. Looking at the trend in the home market sales of export starters vis-à-vis non-exporters it has been found that export starters grew more than the non-exporters in the home market in the pre-entry years. Home market performance has been measured by the growth in the home market sales in the past years when firm operated solely in the home market.

For econometric analysis an empirical binary choice model has been developed to examine the impact of pre-entry growth in home market sales on the probability to export. The model has been estimated with Wooldridge (2005) method, as well as with the other econometric methods for robustness. Importance of prior performance in the home market in determining the probability of entry came unequivocally across the estimation methods. In the separate analysis for the two sub-periods (1993-2003 and 2004-2016) it has been found that home market performance is a positive and significant determinant of entry only in the later phase of liberalization. Greater competitiveness of the home market in later phase is argued as the reason for such finding. Lastly, home market performance has been found to be important for both the group of firms that are incorporated prior to 1989 and post 1989.

Chapter 4 - Appendix

Table A4.1: Measurement of variables

Variable	Definition/ Measurement
Export Status	Dummy variable that takes value 1 if the firm has exported during the year, otherwise it takes value 0.
Home market growth	Average growth rate in home market sales in the past 3 years when firm does not export. Deflated value of the home market sales is used where whole sales price index (WPI) at 5 digit level is used as deflator.
Size	Log of real capital stock. Capital stock is calculated at replacement cost using perpetual inventory method followed by Balakrishnan (2000). For detail see appendix A5.1 of chapter 5.
Age	Log of firm age. Age is the difference between current year and incorporation year.
Labour Intensity	Ratio of real expenditure on wage and salaries and real capital stock. Consumer price index (CPI) for industrial worker is used as deflator in the numerator.
Research and development Intensity	Ratio of R&D expenditure sales both expressed in constant price. The nominal R&D expenditure is deflated by R&D deflator to obtain the numerator where R&D deflator is the average of capital goods and wage deflator. WPI is used as deflator in denominator.
Capital import intensity	Ratio of deflated import of capital goods and deflated sales. Unit value index for imported machinery and transport equipment is used as deflator in the numerator. WPI is used as deflator in denominator.
Productivity	Total factor productivity of firms calculated after estimating value added production function using the Levinsohn and Petrin (2003) method. For detail see chapter 5.
Business groups	Dummy variable takes value 1 if firm belong to some business group.
Private firms	Dummy variables takes value 1 if firm is an Indian private firms.

Table A4.2: List of Industries

NIC code	Industry description
10	Manufacture of food products
11	Manufacture of beverages
12	Manufacture of tobacco products
13	Manufacture of textiles
14	Manufacture of wearing apparel
15	Manufacture of leather and related products
16	Manufacture of wood and products of wood and cork, except furniture
17	Manufacture of paper and paper products
18	Printing and reproduction of recorded media
19	Manufacture of coke and refined petroleum products
20	Manufacture of chemicals and chemical products
21	Manufacture of pharmaceuticals, medicinal chemical and botanical products
22	Manufacture of rubber and plastics products
23	Manufacture of other non-metallic mineral products
24	Manufacture of basic metals
25	Manufacture of fabricated metal products, except machinery and equipment
26	Manufacture of computer, electronic and optical products
27	Manufacture of electrical equipment
28	Manufacture of machinery and equipment n.e.c.
29	Manufacture of motor vehicles, trailers and semi-trailers
30	Manufacture of other transport equipment
31	Manufacture of furniture
32	Other manufacturing

CHAPTER 5: The Impact of R&D and Technology Import on the Productivity of Indian Manufacturing firms Prior to Entry

5.1. Introduction

The previous chapter found prior productivity is an important factor affecting decision to enter the export market for Indian manufacturing firms in the post liberalized era. It has been shown that firms which are more productive than others began exporting. This chapter examines how Indian firms grew productive in the home market prior to entering the foreign market. The theoretical model in Chapter 3 showed that threshold efficiency level to enter the export market can be reached through investment in technology. In a seminal study, Solow (1957) recognized that technological progress as a key determinant of productivity growth. While Solow considered technological progress as exogenous, the endogenous growth theories developed later argued that technological progress occurs through the deliberate actions taken by firms in the form of investment in R&D activities (Grossman and Helpman, 1990, 1991). A number of empirical studies have examined the relationship between R&D investment and firm productivity (Griliches, 1986; Hall and Mairesee, 1995; Griffith et al., 2006). Generally, they have found a positive and significant effect of R&D investment on firm productivity growth although the impact of R&D found to across these studies differ.

Knowledge creation through in-house R&D investment is a costly phenomenon, which firms in developing countries find particularly difficult to carry out. Moreover, it requires availability of necessary inputs such as, risk bearing capital, skilled and trained workers which are scarce in developing countries (Sharma, 2014). International trade, provides an important channel of technology transmission for developing countries (Grossman and Helpman, 1991; Feenstra et al., 1992; Keller, 2004). Grossman and

Helpman (1991) argued that growth of firms in developing countries depends substantially on the imported inputs, which has contributed significantly in the development of the industrial base in these countries. Empirical studies for developing countries have also found positive and significant effect of imported inputs on the firm level productivity. For example, Halpern et al. (2015) found contribution of imported inputs in the productivity growth of Hungarian manufacturing firms has been 22% during 1993-2002. Productivity accelerating effect of imported inputs was also found by Amiti and Konings (2007) in the context of Indonesian firms.

A few studies in the Indian context have also examined the role of in-house R&D investment and technology import on firm productivity. Raut (1995) found that firms' investment in own R&D did not contribute to the productivity growth of the manufacturing firms, however industry-wide R&D spillover increased firm productivity. Arguing that import of disembodied technology is an important source of technology acquisition in developing countries, Basant and Fikkert (1996) examined the impact of firms' investment in in-house R&D and disembodied technology import on the productivity of Indian firms. They found imported disembodied technologies contributed significantly to the growth of Indian firms while investment in R&D did not influence firms' productivity. Highlighting the importance of imported inputs, Hasan (2002) analysed its impact on firm productivity and found technology embodied within the imported inputs is a significant contributor of firm productivity growth. Parameswaran (2009) and Rijesh (2015) found both embodied and disembodied technology import positively affect productivity of Indian manufacturing firms.

The impact of R&D and technology imports on firm productivity might differ between pre and post entry period, as investment in technology is likely to be smaller in the pre-export-entry period compared to the post-export-entry period. Exporting firms of India have been shown to have invested more in R&D than non-exporting firms (Kumar and Aggarwal, 2005; Parameswaran, 2010). However, firm export behaviour literature has shown that firm-level productivity improvement is predominantly a pre-entry phenomenon. (Haider, 2012; Thomas and Narayanan, 2016; Gupta et al., 2018). In this context, it may be interesting to understand the role of in-house R&D investment and technology import on the productivity of Indian firms in the pre-entry period.

Focusing on the pre-export entry period, this chapter examines the role of own R&D, embodied and disembodied technology imports on total factor productivity of domestic Indian manufacturing firms. Impact of technology on productivity is likely to differ across industries. In accounting for this, previous studies (Basant and Fikkert, 1997; Hasan, 2002) conducted separate analysis for various industry types arguing technological opportunities differ between scientific and non-scientific industries. Industry competitiveness is another factor that may affect the relationship between technology investment and productivity as competitive industries find greater need for technology investment compared to the oligopolistic industries. Usually, industry dummies are included in the regression estimation to control for industry differences. However, it may not entirely control the competition effect since competitiveness does not only differ across industries but also differ within industry over time. Kato (2009) analysed the effect of competition on the productivity growth of Indian firms in the post liberalization period and found that productivity growth has been higher for firms belonging to competitive industries. So the effect of competition is controlled in this chapter while analysing the impact of firm investment in R&D and technology imports on the productivity of domestic manufacturing firms (prior to entry) in India during the period 1994-2016.

In view of the importance of R&D and technology import in firm productivity, considerable attention has been given in understanding the determinants of R&D intensity, where the focus has been particularly on the relationship between R&D and technology imports. Cohen and Levinthal (1989) argued that firms in the developing countries cannot readily use imported technologies in the production process. Imported technologies need to be adapted to local conditions, which requires some amount of investment in building own technological capacity, implying a complementary relationship between own R&D and technology imports. However, Lall (1987) argued that (some) firms may prefer investing in technology creation over technology import if they intend to produce substitutes of the imported products. Empirical evidence on the relationship between the two is inconclusive in India. While Siddharthan (1992), and Sasidharan and Katuria (2011) found complementary relationship between the two, Basant and Fikkert (1996) and Parameswaran (2009) found that they are substitutes (in terms of their joint effect on productivity), while Kumar and Saqib (1996) found they are unrelated. Mitra et al. (2016) argued absorptive capacity of the new technologies depends on the availability of and the quality of physical infrastructure. Kumar and Aggarwal (2005) showed that in the pre liberalization period, although imported technology did not increase firm-level R&D efforts, in the post liberalization period, firm level R&D intensity increased with the investment in technology imports. The result seems to suggest that among many reasons, rise in the export participation following liberalization increased import of technologies, which in turn increased firms' investment in own R&D. Unlike exporting firms, non-exporting firms cannot use export networks to access newly developed foreign technologies which implies that prior to export entry imported technologies may not increase firm own R&D activities. In this context, the chapter examines the relationship between own R&D and technology imports in the pre-entry period for Indian manufacturing firms.

The chapter is organised as follows. Section 5.2 describes the model and the methodology used in the analysis and the estimation issues. Section 5.3 describes the data and provides descriptive statistics. Section 5.4 presents the findings of the study and section 5.6 concludes.

5.2. Methodology

To estimate the impact of knowledge capital on productivity, previous studies have generally used the 'production function approach'. Under this approach, knowledge inputs (or knowledge capital) (such as, stock of own R&D, stock of imported technologies) are included in the production function along with conventional inputs-labour, capital and materials. Most studies have estimated a Cobb-Douglas form of the extended production function in estimating the output elasticities of various types of knowledge inputs (Hall and Mairesee, 1992; Raut, 1995, Basant and Fikkert, 1997). However, some studies such as Hasan (2002) estimated production function in Translog form as well as in Cobb-Douglas form.

Another approach often used by researcher in estimating the impact of technology on firm productivity is called the 'growth accounting approach' (Coe and Helpman, 1995; Amiti and Konings, 2007; Sharma, 2012). This is a two stage approach, where in the first stage total factor productivity is estimated at the firm level and in the second stage the effect of technology on the estimated total factor productivity is analysed.

Production function approach does not directly estimate the effect of technology on productivity since it estimates an output or value added production function. On the contrary, growth accounting approach directly estimates the effect of technology on firm productivity. Moreover, if a variable cannot be expressed as an input in the production function then the productivity impact of that variable cannot be estimated using production function approach. Since the present chapter intends to analyse the effect of technology as well as competition on firm productivity, the 'growth accounting approach' is used following Sharma (2012) and Kumar and Sharma (2015).

Estimation of total factor productivity

The micro-level productivity estimation method involves first estimating a production function, and second estimating the residual as a measure of total factor productivity (TFP). Assuming Cobb-Douglas production technology, a value added production function is specified as:

$$y_{ijt} = \beta_0 + \beta_k k_{ijt} + \beta_l l_{ijt} + \omega_{ijt} + u_{ijt} \qquad (5.1)$$

Where y_{ijt} represents the value added (output net of material inputs) of firm i, in industry j, in period t, k_{ijt} and l_{ijt} are capital and labour inputs respectively, ω_{ijt} represents the unobserved transmitted productivity component and u_{ijt} is *i.i.d* error term. Each of these variables are expressed in natural logarithm. The productivity component captures the growth in the value added which is not attributed to the variation in inputs[45]. The ordinary least square (OLS) estimation of the production function leads to inconsistent estimates as it fails to address the issue of simultaneity bias, arises due to the correlation between choice of inputs and the unobserved productivity shock (ω_{ijt}) (Van Beveren, 2010)[46].

[45] Therefore ω_{it} indicates growth in the output due to technological progress, managerial abilities, input qualities.

[46] There are other issues such as selection bias, omitted output and input price bias. Selection bias arises due to non-random selection of firms as productivity analyses usually use balanced panel which exclude firms that enter and exit over a period. The present study, however, uses unbalanced panel including all firm-year observations and therefore free from this bias. The omitted output and input price biases arise due to the use of industry price deflators instead of firm level price deflators. For a detail discussion of these biases see Ackerberg et al. (2007).

To obtain consistent estimates of TFP a semi parametric estimation method developed by Levinsohn and Petrin (2003) is used.[47] Levinsohn and Petrin method (LP method) generates a proxy for the productivity shock, ω_{ijt}. Intermediate inputs (materials or energy) is proposed as the proxy variable since it responds quickly to the productivity shocks.[48] The proxy variable is assumed to be a monotonically increasing function of the productivity shock given the semi fixed input capital, such as $m_{ijt} = m_{ijt}(\omega_{ijt}, k_{ijt})$, where m_{ijt} denotes the intermediate input. Monotonicity assumption allows inverting the above function to obtain productivity as a function of intermediate input and capital stock. Hence the production function can be written as

$$y_{ijt} = \beta_l l_{ijt} + \phi_{ijt}(m_{ijt}, k_{ijt}) + u_{ijt} \tag{5.2}$$

Where $\phi_{ijt}(m_{ijt}, k_{ijt}) = \beta_0 + \beta_k k_{ijt} + \omega_{ijt}(m_{ijt}, k_{ijt})$

Error term in equation (5.2) is not correlated with the inputs. The input coefficients are estimated in two stages using semi parametric method, where coefficient of the freely variable input-labour is estimated in the first stage followed by second stage estimation of the capital coefficient. The full estimation involves a series of steps (for details, see Levinsohn and Petrin, 2003). After estimation of the coefficients of the production function, TFP in level is calculated as follows.

$$\widehat{\Omega}_{ijt} = e^{\widehat{\omega}_{ijt}} \text{ where } \widehat{\omega}_{ijt} = \hat{y}_{ijt} - (\hat{\beta}_0 + \hat{\beta}_k k_{ijt} + \hat{\beta}_l l_{ijt}) \tag{5.3}$$

The value added production function is estimated separately for each 2-digit industries. To avoid selection bias, data for all firms are used in estimating TFP. The semi-parametric method used in this study inverts the proxy variable, and therefore truncates the observation with zero values of the proxy variable. Hence, following Levinsohn and Petrin (2003) the proxy variable is chosen based on the number of non-zero observation of each of the two potential candidates - material and energy. Separate

[47] Parametric methods such as fixed effect, instrumental variable (IV) and general methods of moments (GMM) can partially solve the simultaneity bias, however, semi-parametric estimation methods are better (See Van, 2010 for a discussion).

[48] Another commonly used semi-parametric estimation algorithms is that of Ollay and Pakes (1996). It consider investment as the proxy variable. However, investment is costly to adjust as it does not respond quickly to changes in productivity (Levinsohn and Petrin, 2003), therefore intermediate input is a better proxy than investment.

proxy variable is used for each two digit industry since number of non-zero observation for each of the two variables may differ across industries. Material came out to be the suitable candidate for most industries. See appendix table A5.1 for the choice of the proxy variable in each industry.

5.2.1. Econometric models

After estimating firm level total factor productivity (TFP) using LP method, effects of various forms of technology investments and competition on the estimated TFP are examined. Drawing from Kumar and Sharma (2015), the productivity model is specified as:

$$PROD_{ijt} = \gamma_0 + \gamma_1 \boldsymbol{STECH}_{ijt-1} + \gamma_2 COM_{jt-1} + OWN_{ij} + \eta_j + w_t + \mu_i + \varepsilon_{ijt} \quad (5.4)$$

Where $PROD_{ijt}$ denotes productivity of i^{th} firm in j^{th} industry in t^{th} time period. It is assumed to be a function of industry competitiveness, denoted by COM_{jt-1}, stock of various types of technologies, denoted by the vector $\boldsymbol{STECH}_{ijt-1}$, firm ownership ($OWN$), other industry characteristics (η_j), time variant exogenous shocks (w_t) and unobserved firm characteristics (μ_i). ε_{ijt} is the iid disturbance term in productivity equation. Notice, one year lag values of industry competitiveness and technology vectors are taken.

Firms in developing countries mainly acquire technology through three channels, represented by three technology variables – stock of R&D capital (SRD), stock of embodied technology import (SET/K), stock of disembodied technology import (SDET). The measure for SRD is obtained from the expenditure on firm own R&D activities while the measure for SDET is obtained from expenditure for royalty payments and technological licensing. Both are estimated using perpetual inventory method. Expenditure on imported capital goods is used to measure stock of embodied technology. However, technology embodied in the imported capital goods is unknown. Following some of the previous studies (Hasan, 2002, Parameswaran, 2009), it has been assumed that recently imported capital goods contain newly developed technologies. Subsequently, share of recently imported capital goods in total capital stock is used as a measure of stock of disembodied technology import. See appendix 5.1 for the detail discussion on the measurement of these variables.

Another channel through which technologies is acquired by developing countries firms is foreign direct investment spillover, denoted as FDISPIL (Kathuria, 2000). The first three channels, SRD, SET/K and SDET, requires direct spending on technology investment, whereas in the last channel (FDISPIL) technologies spillover from foreign firms to domestic firm. These four components together, form the technology stock vector (**STECH**) in equation (5.4). The proponents of foreign direct investment (FDI) argue that the host country can benefit from FDI as foreign firms possess modern and superior technologies and if FDI is allowed these technologies can transmit to vertically and horizontally related domestic firms. MNCs and the foreign subsidiaries cannot appropriate all the quasi rents associated with their production activities since knowledge is partially a public good (Kathuria, 2001). Only the horizontal spillover is considered in this study. The acquired technological knowledge form each of the four technology variables are expected to increase firm level total factor productivity since they increase the efficiency of production inputs, improves the quality of output, change the organisation of production.

Competition level has increased in the post liberalization period with some industries observing greater rise in the competitiveness than others (Goldar and Aggarwal, 2005). Firms belonging to more competitive industries are likely to see a larger rise in the productivity level compared to the firms belonging to less competitive industries. The theoretical literature argues competition can increase within-firm productivity by reducing X-inefficiency (Leibenstein, 1966). The rise in the competition level reduces managerial slackness and motivate a firm to put more effort which increases the productivity of the firm. Therefore the coefficient of competition variable (COM) in equation (5.4) is expected to be positive.

The control variables used in this study are firm size (SIZE) and ownership dummies (OWN). Large firms have more resources, exploit scale economies, diversify risks and can be more productive than small firms. This study uses the data of only domestic firms. Therefore, based on ownership firms are categorised as private firms and state owned firms. The dummy variable private (PVT) is included to see whether private firms are more productive than state owned firms where latter is the omitted category in the regression. A section of the private firms are affiliated to business groups. Business group affiliated firms (BG) are likely to be more productive than others since business group affiliation provides the institutional framework, increases the lender confidence, allows accessing the networks of the business groups. Industry dummies (η_j) capture the variation in total factor productivity across industries, year dummies (w_t) control business cycle effects.

To examine whether the relationship between own R&D and technology imports is complementary or substitute, a second econometric model of the determinants of R&D intensity is developed this study based on Kumar and Aggarwal (2005). R&D intensity equation is expressed as.

$$RDI_{ijt} = \beta_0 + \beta_1 ETI_{ijt-1} + \beta_1 DTI_{ijt-1} + \beta_1 \boldsymbol{X}_{ijt-1} + \eta_j + w_t + \mu_i + e_{ijt} \quad (5.5)$$

Where RDI_{ijt} is the research and development (R&D) intensity of i^{th} firm in j^{th} industry in t^{th} time period. The primary variables of interest are ETI_{ijt-1} and DTI_{ijt-1} representing the embodied and disembodied technology import intensity. The former is imported through purchase of capital goods while the latter involves technology purchases against royalty payments and technological licensing. The control vector denoted by, $\boldsymbol{X}_{ijt-1}$ includes variables representing observed firm characteristics. Based on the economic theory and the previous studies (such as, Kumar and Saqib, 1996; Kumar and Aggarwal, 2005; Sashidharan, 2011) the variables – SIZE, AGE, industry competitiveness (COM), vertical integration (VI), productivity gap (GAP), private dummy (PVT), business group dummy (BG) are considered as the control variables. One year lag values of all the above variables are taken. Industry characteristics affecting firm-level R&D intensity are subsumed in η_j, while w_t represents the vector of time varying exogenous variables and μ_i represents the unobserved firm characteristics. The disturbance term in R&D expenditure equation is denoted by e_{ijt}.

The relationship between the both form of technology imports and R&D can either be complementary and substitutes. Therefore the coefficients of ETI and DTI can either be positive or negative. A positive relation is expected between size and R&D intensity.

Following the Schumpeterian hypothesis large firms are likely to invest more in R&D since they can spread the risk associated with R&D across product lines and volume of sales (Cohen and Levinthal, 1989). Learning is one important feature of innovation in less developed countries (Nelson, 1987), therefore older firms may invest more in R&D than younger firms. A positive relationship is expected between competition and firm level R&D intensity as incremental gain from R&D is higher for competitive firms than oligopoly firms (Arrow, 1962). Vertically integrated firms are likely to invest more in R&D, since they internally organize majority of their activities and therefore have greater chances of appropriating the benefits of in-house R&D. A positive relationship is expected between productivity gap (GAP) and R&D intensity since firms lying below the frontier face greater competitive pressure. Industry dummies ($\boldsymbol{\eta}_j$) are included since technological opportunities as well as condition of appropriation differ across industries (Nelson and Wolff, 1997).[49] Year dummies ($\boldsymbol{w}_t$) are included to capture the business cycle effects.

5.2.2. Estimation Issues

Endogenity problem is one of the key econometric issues in panel data regression analysis. Endogenity problem may arise due to the presence of unobserved firm heterogeneity leading to omitted variable bias. It may also be caused by the presence of two way relationship (i.e. simultaneity bias). Since unobserved firm heteroegeneity is likely to be present in this analysis[50], panel data fixed effect (FE) estimation method is used. For instance, managerial quality is unobserved and can affect both the dependent (firm productivity) and independent variables (firm own R&D stock, technology imports) which make error terms correlated with the regressors. Fixed effect model eliminates the firm specific time invariant variables by transforming the model in mean deviation. However, by transforming the model FE method reduces the degrees of variation in the regressors, omits time invariant variables. Mairesse and Sassenou (1991) argued FE method may aggravate the multicollinearity problem, if it exists, by reducing the variation in the data and also increases the problem of measurement errors by reducing the signal to noise ratio. Parameters estimated using FE model are also less efficient than the parameter estimated using the random effect (RE) model, given

[49] Research opportunities are greater especially in chemical and machinery sectors.
[50] For instance, managerial quality is unobserved and can affect both the dependent (firm productivity) and independent variables (competition, firm innovation) bringing the endogeneity problem.

that the latter is consistent. Therefore, the study also reports the estimates of RE estimation method. To choose between FE and RE, Hausman test is used.

Fixed effect model solves the endogeneity problem that arises from the exclusion of the time invariant regressors. However, the error term may include business cycle component common to all firms which might affects the level of input choices by firms to the extent business cycles are serially correlated (Basant and Fikkert, 1996). Year dummies are included to account for the business cycle effect. Moreover, business cycle or any other shock to the productivity is likely to affect the flexible inputs of the production process which is labor. Use of LP method in calculating TFP corrects labour adjustment due to the productivity shock. Productivity shocks may also influence the firm's decision to invest in technologies. However, it only affects the technology investment in the current year, the fact that stock of technology variables are used in this analysis makes technology variables less likely to be correlated to productivity shocks. Error term might be heteroskedastic or serially correlated. Raut (1995) and Hasan(2002) used Cochrane-Orcutt transformation to remove error correlation. However, robust standard errors are reported in this study to correct heteroskedasticity and within panel serial correlation.

When endogeneity problem arises due to the presence of two way relationship, it leads to simultaneity bias. Several scholars have argued that productivity and innovation are simultaneously determined, and correspondingly used simultaneous equation model in estimating the parameters of both the equations (Crepon et al., 1998; Loof and Hesmati, 2006; Hall et al., 2009; Castellacci, 2011). They have used a two-step procedure where in the first step, reduced form parameters are obtained by estimating the reduced form equations and in the second step structural parameters are estimated from the estimated reduced form parameters. Identification of the structural equation is a crucial issue in simultaneous equation model which require specification of the exclusion restriction. Exclusion restriction is about exclusion of a certain number of explanatory variables from each of the structural equations of the model. For example, in a simultaneous equation system that determine innovation and productivity of firms, productivity (innovation) equation is identified if it excludes some of explanatory variables included in the innovation (productivity) equation.

Specification of the exclusion of the restriction may impose an a-priori structure to the model, Chudnovosky et al. (2006) argued that if theoretically solid arguments cannot be given behind the exclusion of some variables it is better to use a fixed effect method than using a simultaneous equation system. Moreover, simultaneous equation system become very complex, if the model needs to account the possibility of having two-way relationships among many variables. For example, variables- total factor productivity, stock of R&D, stock of embodied and disembodied technology import all are simultaneously related, leading to a simultaneous equation system with many structural equations. Following Kumar and Aggarwal (2005), lag values of the technology variables are used to correct the endogenity due to both way relationship between the technology variables and firm productivity. Fixed effect estimation method is used in this study along with lag values of (all) the explanatory variables, since use of lag values is a simple but effective way of solving simultaneity bias without assuming any a-priori structure to the model.

Other than the issue of endogeneity, one need to address sample selection issue. In this analysis selection bias may arise from two sources. First source of selection bias arises due to exclusion of post (export) entry period from the analysis. In the post-entry period, firms are likely to invest more in the innovation activities relative to the pre-entry period, exporting firms are likely to be more productive than non-exporting firms. Therefore, exclusion of post entry period may select out a segment of the population which is highly innovative and productive causing selection bias. However, since the analysis pertains only to the pre-entry period, the sample used in this study is representative and is not subject to selection bias, as long as no conclusion is made on the R&D and productivity behaviour of firms in the post entry periods.

The second source of selection bias is related to the choice of the sample for estimating the R&D intensity equation. If the sample includes only the firms that report positive R&D spending and exclude all the R&D non-reporting firms then such sample may cause selection bias since R&D non-reporting firms might also be spending on R&D. Following the disclosure norms of Indian Companies Act (1956), companies are required to report expenditure only for the heads for which spending is more than 1% of their total sales. Since most Indian companies invest limited amount in R&D, they often do not report their spending on R&D activities, hence inclusion of only R&D

reporting firms in the sample may exclude the group of small R&D spending firms.[51] Correcting the selection bias some previous studies (Sasidharan and Kathuria, 2011; Ambrammal and Sharma, 2014) have adopted Heckman sample selection model. The method includes inverse mills ratio as the correction term in the R&D intensity equation.

Heckman sample selection model considers non-reporting firms as omitted category and includes them within the selection equation assuming that they performed R&D but did not report. However, when firms do not report R&D spending it is not clear whether firms do not spend on R&D (R&D non-performers) or they do spend (R&D performers) but do not report. Since non-reporting firms could be non-performers their inclusion in the selection equation may generate inconsistent estimates. Moreover, if the non-reporting firms have been R&D performers, but similar in characteristics to the R&D reporting firms, then there is no selection bias (Jefferson et al., 2006). Although it is likely that R&D non-reporting firms spend less than 1% of their sales on R&D and are different from R&D reporting firms that spend more than 1% of their sales, it should be noted that several firms that spend less than 1% of their sales on R&D are found to have reported their R&D expenditure data. Therefore, no correction formula is used in this study. Instead, a sample of firms that report positive expenditure in any one of the technology related activities namely, in-house R&D or import of embodied technology or import of disembodied technology, is taken in estimation of the R&D intensity equation. The sample is referred as the 'technology sample' in this study. Here, following Jefferson et al. (2006), it is assumed that if a firm does not report R&D spending (or, report zero R&D spending), but reports positive spending on other technology heads, then the firm is a truly R&D non-performing firm.

5.3. Data and descriptive statistics

Firm level information is extracted from Prowess database created by Centre for Monitoring Indian Economy (CMIE), as in Chapter 4. The basic information about the Prowess database are already discussed in chapter 4. From Prowess database

[51] Moreover, the evolutionary models of technological progress have argued that firms in less developed countries such as India, are engaged in 'minor' innovations those are informal or tacit in nature (Nelson and Winter, 1982), which do not get reflected under the entries of formal R&D expenditure.

information has been extracted for 17,826 listed manufacturing firms for the period 1989-2016.[52] Similar to the previous chapter, a sample of 13181 domestic firms, which reported data on key variables such as, sales, wages and salaries and capital stock is selected.[53] Data on various firm characteristics including year of incorporation, sales, wages and salaries, gross fixed assets, expenditure on R&D, import of capital goods, royalty payments, and ownership are extracted from PROWESS.

Since the study intends to analyse the role of technology investment on productivity in the pre-entry period, years prior to the entry year are selected for each firm. Born global firms are excluded since they do not operate in the home market prior to entry. Moreover, firms that operate in the home market only for a small duration are also excluded. Only those firms are included that operated in the home market for at-least 3 consecutive years prior to entering the export market, and there are 6023 such firms. The choice of 3 years of home market operation takes into account the fact that productivity of intermittent exporters during the period of operation in the home market is not influenced by the previous export spell, which allow attributing pre-entry productivity growth with the technology decision taken in the home market. Robert and Tybout (1997) showed that if firms remain inactive for 2 or more consecutive years in the export market prior to the re-entry then the influence of the previous export spell completely goes away. For each of the 6023 domestic firms the sample period covers only the pre-entry years, obtained by dropping the entry and the post entry years.

Finally, to estimate the productivity equation (equation 5.4) a sample of 3014 domestic firms are selected which report data on firm sales for at least 5 consecutive years. This has been done to obtain the non-missing data on the estimated technology stock variables. Each of the technology stock variables, say stock of R&D has been estimated by taking the sum of the R&D expenditure in the past 5 years. Since there are large number of missing observations on these variables, before taking the sum, following Raut (1995), 1 is added to the reported data for all firms in all time periods corresponding to then non-missing sales. Firms that do not report sales data for at least

[52] During the extraction of data from Prowess it was available till the year 2018, however in the last two years data for all firms are not uploaded in the database.
[53] Since the study intend to analyze the impact of investment in technology on the productivity of Indian manufacturing firms, only domestic firms are included in the sample.

5 consecutive years are dropped from the sample, as technology stock variables cannot be estimated for them.

Table 5.1: Summary statistics: sample for estimating productivity equation

	Obs.	Mean	Std.	Min	Max
Size	15266	3.00	1.64	-5.04	8.97
Total Factor Productivity (PROD)	15266	-1.37	1.49	-6.66	6.53
Stock of R&D (SRD)	15266	1.18	0.15	1.16	4.71
Share of recent import capital good (SET/K)	15266	-3.43	1.50	-9.45	-0.25
Stock of imported disembodied technology (SDET)	15266	-2.73	0.86	-4.43	-0.16
FDI spillover (FDISPIL)	15266	-3.01	1.06	-5.22	-0.16
HHI	15266	-0.20	1.34	-17.63	7.60
Ownership: % State Owned firms	15266	5.04	21.89	0.00	100.0
Ownership: % Private Firms	15266	94.96	21.89	0.00	100.0
Ownership: % business group affiliated private firms	15266	28.91	45.33	0.00	100.0

Note: except ownership all variables are expressed in logs.

Summary statistics of the variables is reported in Table 5.1. It is observed that there are considerable inter-firm variation in all the variables. Appendix A5.1 provides a brief discussion of the variables used in this analysis including their measurement. To examine the difference in the pattern of investment in technologies between the firms that later emerge as exporters (or, future exporters) and non-exporters in the pre-entry period, mean values of the technology stock variables are reported separately for the group of future exporters and the group of non-exporters in Table 5.2. It is observed that prior to entry future exporters invested more in in-house R&D and disembodied technology import but invested less on embodied technology import compared to non-exporters.

Table 5.2: Stock of investment in technologies for future exporters and non-exporters prior to entry

	Future exporters		Non-exporters		
	Mean	S.D	Mean	S.D	Mean Difference
Stock of R&D (SRD)	1.38	0.23	1.33	0.15	0.04***
Share of recent import capital good (SET/K)	-1.77	1.35	-1.26	1.50	-0.51***
Stock of imported disembodied technology (SDET)	1.20	0.18	1.18	0.14	0.03***

Note: variables are expressed in logs.

5.4. Result and Discussion

5.4.1. The impact of own-R&D and technology imports on firm TFP

The estimates of total factor productivity equation 5.4 for the period 1994-2016[54] are reported in Table 5.3. The first 5 columns report the FE estimates, which is the preferred method as suggested by the Hausman test. The last column reports the RE estimates which is used to examine the effect of time invariant ownership variables on TFP. Estimation in each of the 6 specifications are overall significant, as F test (for fixed effect) and wald Chi-square test (for random effect) reject the null hypothesis that all the coefficients are jointly zero. Since panel data estimations are likely to suffer from heteroskedasticity, robust standard errors are reported in all the specifications. The control variable, firm size (SIZE), is included only in first two specifications of the model and dropped from the subsequent specifications since it is highly collinear with stock of embodied technology import variable (SET/K) (see appendix table A5.2). It can be seen from column 1 that when both the variables are included together in the regression both are insignificant. When stock of embodied technology import (SET/K) is dropped in column 2, then firm size (SIZE) become a significant determinant of firm productivity, and when firm size is dropped in column 3, stock of embodied technology import become a significant variable.

The competition variable (HHI) is negative and statistically significant (Column 5 and 6, Table 5.3) indicating that rise in the competition level in the post liberalized India (see, Figure A5.1 in appendix) increased the total factor productivity of Indian manufacturing firms. Rise in the competitiveness of the market is expected to push the managers of domestic firms to exert greater efforts in the management of the production activities, rationalization of the organisation structure, and adopt better management practises.

The positive coefficient of the FDI spillover variable (Column 4 to 6, Table 5.3) indicates higher is share of output produced by foreign firms in an industry greater is

[54] Although the data is available since 1989, first 5 years are not included as productivity equation includes technology stock variables calculation of which require data for at least 5 years.

the productivity of domestic firms in that industry. This finding can be considered as the evidence for presence of FDI spillover effect. The presence of foreign firms in the industry influences the performance of domestic firms by competition effect, demonstration effect, labour migration and better management practices. Our result is consistent with the findings of the previous studies (Kathuria, 2000; 2001). Private firms are found to be more productive than the state owned firms. Among the private firms, business group affiliated firms are found to be less productive. Efficient business group affiliated firms operates in both export and home market. Those operating only in the home market are less efficient.

Table 5.3: Regression result for estimating total factor productivity equation

	Period of Analysis: 1994-2016					
Independent Variables	**Dependent Variable**: Total factor productivity					
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(SIZE)	-0.067	-0.107**				
	(0.063)	(0.046)				
Ln(SRD)	0.351**	0.372**	0.315*	0.318**	0.311*	0.285**
	(0.162)	(0.161)	(0.162)	(0.162)	(0.161)	(0.129)
Ln(SET/K)	0.046		0.090**	0.089**	0.091**	0.190***
	(0.049)		(0.037)	(0.036)	(0.037)	(0.020)
Ln(SDET)	-0.061	-0.027	-0.099	-0.085	-0.102	-0.117
	(0.181)	(0.187)	(0.179)	(0.179)	(0.175)	(0.140)
Ln(FDISPILL)				0.075***	0.073***	0.046**
				(0.026)	(0.026)	(0.019)
Ln(HHI)					-0.086*	-0.093***
					(0.047)	(0.031)
Private						0.480***
						(0.110)
Private*Business group						-0.180***
						(0.050)
Constant	-0.909**	-0.923**	-0.950***	-0.718*	-0.898**	-1.602***
	(0.363)	(0.366)	(0.355)	(0.392)	(0.422)	(0.335)
Industry dummy	NO	NO	NO	NO	NO	YES
Year dummy	YES	YES	YES	YES	YES	YES
R-square	0.033	0.033	0.033	0.035	0.036	
F test	9.00***	9.36***	9.31***	9.28***	9.26***	
Wald chi2 test						1330.19***
Hausman test	114.86***	159.71***	216.40***	186.37***	255.53***	
Number of firms	3,014	3,014	3,014	3,014	3,014	3,014
Observations	15,266	15,266	15,266	15,266	15,266	15,266
Estimation method	FE	FE	FE	FE	FE	RE

Note: The values in the parentheses are the robust standard errors. The '***' , '**' "*" refer to 1%, 5% and 10% level of significance. FE-Fixed effect, RE-Random effect. State owned firms are the reference group in the last column.

Turing to the variables of interest, the coefficient of stock of R&D capital (SRD) is found to be positive and significant across all specifications (Column 1-6, Table 5.3), although at 10% level, indicating productivity accelerating effect of in-house R&D activities in the pre-entry period. Since investment in in-house R&D activities reduces cost of production, introduces new products and organisation of production, greater is the stock of R&D higher is the firm productivity. The coefficient of stock of embodied technology import (SET/K) is found to be positive and significant (Column 3-6, Table 5.3). This indicate that greater the share of newly imported capital goods in total capital stock, higher is the productivity of the domestic firms. Removal of import restriction following liberalization in India substantially increased imports of capital goods, which has contributed to the productivity growth of domestic manufacturing firms. The impact of disembodied technology import (SDET) on productivity of firms is insignificant in all specifications (Column 1-6, Table 5.3). The finding seems counterintuitive and the reason could be the choice of sample that focuses only to the pre-entry years. These results in table 5.3 suggest that in the pre-entry period, stock of R&D and embodied technology import increased the productivity of domestic Indian manufacturing firms, however, import of disembodied technology did not contribute to firm productivity growth.

Comparison with previous studies

The impact of investment in technology on firm total factor productivity has been analysed in six previous studies (Raut, 1995; Basant and Fikkert, 1996; Hasan, 2002; Parameswaran, 2009; Rijesh, 2015). Each of these studies, except Sharma (2014), have estimated an extended Cobb-Douglas production function to estimate the elasticities of various forms of technology. The analysis here used a two-step growth accounting approach such that the effect of competition on productivity could be controlled. This analysis is closest to Parameswaran (2009) and Rijesh (2015) both in terms of the period covered and the variables included. While the studies by Raut (1995), Basant and Fikkert (1996) and Hasan (2002) were in the context of pre-liberalization period, the present study pertains to post-liberalization period. Basant and Fikkert (1996) did not examine the effect of imported embodied technology. Raut (1995) uses a combined measure for disembodied technology by taking the sum of own R&D investment and royalty payments, whereas here investment in in-house R&D and disembodied technology import are distingushed.

In conformity with result of Parameswaran (2009) and Rijesh (2015) the analysis finds positive and significant impact of stock of embodied technology import. Both studies considered the entire manufacturing sector in their analysis, the study period in Paramesawaran is 1989-2000 and in Rijesh it is 1995-2000. The estimated elasticity of embodied technology import is 0.28 in Parameswaran (2009) while here lower elasticity of 0.14 in the fixed effect regression is found, however, it is higher than what Rijesh found, which is 0.01. Similar to Parameswaran (2009) the study finds positive and significant impact of own R&D stock. However, estimated elasticity in the present study is much higher than what Parameswaran found, 0.42 as against 0.002. One striking difference of this estimation here is the insignificant effect of disembodied technology import, while all the previous studies found positive and significant effect. This suggests that prior to entering the export market, firms do not rely on imported disembodied technology for productivity improvement. However, result reported in table 5.3 suggests that those who invested in import of disembodied technology later become exporter.

5.4.2 Comparison between emerging exporters and non-exporters

In order to see whether productivity impacts of the technology variables differ between firms that later emerge as exporters and those remain non-exporters, interaction variables are introduced in the regression equation 5.4. Here technology variables SRD, SET/K and SDET are interacted with a dummy of firm’s future export status. The dummy variable takes value 1 if the firm is a future exporter and 0 if the firm remained a non-exporter during the entire sample period. The interactions of future export status with R&D sock (SRD) and embodied technology import stock (SET/K) are insignificant (Column 1 and 2, Table 5.4) indicating that there is no difference in the impact of in-house R&D investment and embodied technology import between the future exporters and the non-exporters.

Table 5.4: Role of technology on TFP: Comparison between future exporter and non-exporters

Dependent Variable: Total factor productivity

Period of Analysis: 1994-2016		
Independent Variables	(1)	(2)
Ln(SRD)	0.409**	0.422**
	(0.174)	(0.175)
Ln(SET/K)	0.085**	0.084**
	(0.040)	(0.040)
Ln(SDET)	-0.218	-0.208
	(0.167)	(0.170)
Ln(FDISPILL)	0.072***	0.078***
	(0.026)	(0.027)
Ln(HHI)	-0.084*	-0.084*
	(0.047)	(0.047)
Ln(SRD)*Future exporter	-0.189	-0.220
	(0.155)	(0.162)
Ln(SET/K)*Future exporter	-0.012	-0.011
	(0.045)	(0.045)
Ln(SDET)*Future exporter	0.355**	0.323*
	(0.166)	(0.170)
Ln(FDISPILL)*Future exporter		-0.027
		(0.033)
Constant	-1.001**	-1.008**
	(0.407)	(0.407)
Year dummy	YES	YES
R-square	0.038	0.038
F test	9.05***	8.76***
Hausman test	230.97***	234.43***
Number of firms	3,014	3,014
Observations	15,266	15,266
Estimation method	FE	FE

Note: The values in the parentheses are the robust standard errors. The '***' , '**' "*" refer to 1%, 5% and 10% level of significance. FE-Fixed effect.

5.4.3. Relationship between firm R&D and technology import

For estimating R&D intensity equation (equation 5.5) 'technology sample' is created, which consists of 1586 firms that invested under any one of the following three technology heads – in-house R&D, import of embodied technology through purchase of capital goods, import of disembodied technology against licensing or royalty payments. As argued in the methodology section, the sample has been chosen to avoid wrongly treating the unreported observation of the technology variables as either a positive or zero values. In the 'technology sample' the firms spend on at least one technology head. Since log-log model is used here, to prevent loss of observations, log of the technology variables are taken after adding 1 to the reported values. Additionally, following Jefferson et al. (2006), three dummy variables, identifying firms with zero observations (of the technology variables) are included, each for three technology variables. For instance, R&D dummy variable is included that takes value 1 for observation with zero R&D expenditure in the sample, and value 0 for observation with positive R&D expenditure. The inclusion of these dummy variables for the zero observations allows regression procedure to generate a coefficient corresponding to the dummy variable that re-centres the zero observations around the regression line formed by non-zero observations (Jefferson et al., 2006).

Table 5.5 presents the estimation results of R&D intensity equation. Notice, that the technology import variables - embodied (ETI) and disembodied technology import (DTI) are included alternatively in the regression since they are highly collinear (see appendix table A5.3). The model is estimated with fixed effect (FE) method as suggested by the Hausman test. Also notice that a dummy variable is included for each of the technology variables in the regression equations due the reason mentioned before.[55]

Coefficients of both embodied (ETI) and disembodied technology import (DTI) are positive and significant indicating a complementary relationship between technology purchase and in-house R&D spending (Column 1 and 2, Table 5.5). This implies R&D spending by Indian manufacturing firms is adaptive type, at least in the pre-entry period. It may be argued that technological capacity of firms in the pre-entry period are poorer than what is required to use these imported technologies in the domestic condition. Therefore, they invest simultaneously on technology import and in-house R&D activities. Notice that, the coefficient of disembodied technology import is higher than the coefficient of embodied technology import, which seems to indicate that imported disembodied technologies need more adaptation than imported embodied technology import. The finding on the relationship between disembodied technology import and

[55] For example, column 1 includes R&D dummy (RD dummy) and embodied technology import dummy (ET dummy) since the regression involves R&D intensity and embodied technology import intensity as the technology variables.

R&D does not conform to the previous studies that consider post liberalization era as the sample period (Kumar and Kumar, 2005; Sasidaran and Kathuria, 2011). However, the complementary relationship is consonant with studies that considered pre-liberalization era as the study period (Lall, 1983; Katrak, 1989; Siddharthan, 1992). Similar to previous studies, a complementary relationship between R&D and imported capital goods (i.e. embodied technology import) has been found in this analysis.

Table 5.5: Regression result for estimating R&D intensity equation

Period of Analysis 1994-2016		
Independent Variables	**Dependent Variable**: R&D intensity	
	(1)	(2)
Ln(SIZE)	-0.463***	-0.336***
	(0.069)	(0.071)
Ln(AGE)	-0.261***	-0.157*
	(0.087)	(0.084)
Ln(ETI)	0.110***	
	(0.015)	
Ln(DTI)		0.264***
		(0.040)
Ln(VI)	0.028	-0.020
	(0.036)	(0.039)
Ln(GAP)	0.116***	0.073***
	(0.015)	(0.017)
Ln(HHI)	0.138***	0.117**
	(0.051)	(0.047)
RD dummy	-0.217***	-0.235***
	(0.058)	(0.057)
ET dummy	0.136***	
	(0.027)	
DET dummy		0.059
		(0.043)
Constant	-0.472	-0.793***
	(0.312)	(0.306)
Industry dummy	NO	NO
Year dummy	YES	YES
R square	0.352	0.388
F test	17.06***	18.30***
Hausman test	1533.79***	977.42***
Number of firms	1,486	1,486
Observations	5,300	5,300
Estimation method	FE	FE

Note: The values in the parentheses are the robust standard errors. The '***' and '**' refer to 1% and 5% level of significance. One year lagged value all explanatory variables are taken. FE-Fixed effect

The analysis here find that the competition variable (HHI) is a positive and significant determinant of firm level R&D intensity implying firms belonging to competitive industries invest less in R&D relative to firms belonging to concentrated industries. The result conforms to the Schumpeterian view, firms in the concentrated market invest more in R&D since they can appropriate more return from R&D investment. Size is negatively associated with R&D spending implying smaller firms spends more on R&D. This captures the scale efficiency of the large firms. The coefficient of the AGE variable indicates younger firms invest more in R&D. The coefficient of the variable productivity gap (GAP) is found to be positive and significant indicating that higher is the productivity gap (from the best performing firm in the industry) greater is firms' investment in R&D. The result indicates a tendency towards catching up.

5.5. Conclusion

This chapter examined the contribution of firm investment in in-house R&D and technology imports, in combination with industry competitiveness and FDI spillover to the productivity growth of Indian manufacturing firms in the pre-export entry period. Using growth accounting approach the analysis has been done in the two stages. In the first stage, using the Levinsohn and Petrin (2003) method, firm level total factor productivity has been estimated over the period 1994-2016. In the second stage, the impact of firms' investment in R&D and technology import has been tested on the estimated total factor productivity after controlling for industry competitiveness. To examine the growth in firm productivity in the pre-entry period, second stage analysis has been done on a sample of firms that operated for at least 3 consecutive years in the home market prior to entering the export market. Since firm specific unobserved factors, such as managerial ability are likely to affect firm productivity, fixed effect method is used in this analysis. The potential endogeneity problem has been tackled by taking one year lag values of the independent variables.

The results obtained in this analysis suggest that in the pre-entry period, investment in R&D and embodied technology import have increased the productivity of Indian manufacturing firms. The recent studies on India, by Parameswaran (2009) and Rijesh (2015) found similar result, although they did not distinguish between pre-entry and post entry productivity growth. Opposite to the findings of these studies our analysis found that investment in import of disembodied technology did not contribute to the productivity growth. Since this analysis is for the pre-entry period, it seems plausible that technological capacities of Indian firms were poorer prior to the entry, and hence they could not use the imported disembodied technologies to their benefit. Another finding support this argument as it has been found that imported technologies are adaptive kind, and it is the imported disembodied technologies that need more adaptation compared to the imported embodied technologies.

The analysis next examined whether the patterns of investment in various form of technologies and their impacts on productivity have been different between future exporters and non-exporters. It has been found that prior to entering the export market future exporters invested more in R&D and disembodied technology import compared to the non-exporters, but invested less in embodied technology import. Productivity accelerating effects of R&D and disembodied technology import have been found to be similar between future exporters and non-exporters. While disembodied technology imports found not to contribute to the productivity growth of non-exporters, it is found to increase the productivity of future exporters. Therefore, it can be said that firms those looking to enter the export market must invest in import of disembodied technologies.

Chapter 5 Appendix

A5.1. Measurement of Variables

This section discusses the definitions and the measurements of the variables used in this chapter.

Value Added: Value added at constant price is obtained by subtracting input at constant price from output at constant price. Input at constant price is the deflated value of the nominal expenditure on materials. Price index for intermediate goods is used as the deflator. Output at constant price is obtained in two steps. In the first step, nominal value of output is estimated by adding change in stocks to sales, and then subtracting purchase of finished product from the added figure. In the second step, nominal value of output of each firm is deflated by whole sale price index (WPI) number, where WPI figures disaggregated at NIC- five digit level is used. The data on WPI is collected from the official website of Office of Economic Advisor, Department of Industrial Policy and Promotion, Ministry of Commerce and Industry, Government of India. Finally, log transformation of the variable is considered. The variable is used in estimating production function while calculating firm level total factor productivity.

Material: The nominal expenditure on materials is deflated by price index for intermediate goods to obtain the expenditure on material at constant price. Price index for intermediate goods is obtained from used based classification of index number for industrial production published by Reserve Bank of India (RBI).

Energy: The expenditure in power and fuel reported in the annual reports of firms is used as a measure of energy input. The data is reported in current price. To convert it to constant price, whole sales price index (WPI) for the commodity group fuel and power is used as the deflator.

***Labour*:** The PROWESS does not provide information on the number of labour employed in each firm. However, it provides data on wages and salaries paid to the employees for each firm at each time point. Deflated value of wages and salaries is used as labour input. Consumer price index for industrial worker is considered as the deflator. The estimated measure of labour input can be interpreted as the effective labour employment where labour employed within the firm are weighted by the respective skill of the labour, wage rate captures the skill. Alternative method of measuring labour input used in previous studies is to divide expenditure on wages and salaries by an estimated industry specific wage rate of labour obtained from data published by Annual Survey of Industries (ASI). The problem with this method apart from being data intensive and complex is that it assumes all firms within the industry have same wage rate. Finally, log transformation of the variable is considered.

Capital: PROWESS reports data on book value of gross fixed asset. Some studies have deflated it by price index for machinery to obtain an estimate of capital stock series for every firm. However, the reported values of gross fixed assets are expressed in historical cost (${GFA_t}^h$) which do not take present value of capital into account. Thus, use of deflated values do not provide an appropriate estimate of capital stock series. To estimate capital stock, method proposed by Srivastava (1996) and Balakrishnan et al. (2000) is followed. Recognising the problem in using the reported values of GFA at historical cost they have estimated gross fixed asset/capital stock at replacement cost (${GFA_t}^r$). They have followed perpetual inventory method which estimates GFA at replacement cost in t+1th year as follows

$$P_{t+1}K_{t+1} = (P_{t+1}/P_t)P_tK_t + P_{t+1}I_{t+1} \qquad \text{(A5.1)}$$

Where P, K and I represent price of capital, gross physical capital stock and investment respectively. The nominal value of investment at period t+1 is obtained by subtracting book value of gross fixed asset at period t+1 from period t, i.e. $P_{t+1}I_{t+1} = {GFA_{t+1}}^h - {GFA_t}^h$. Obtaining capital stock series using perpetual inventory method requires estimating base year capital stock at replacement cost. In this study 2010 is considered as the base year since it is the year in which maximum number of firms have reported the data on gross fixed asset. To obtain the estimate of gross fixed asset/capital stock at replacement cost in 2010, GFA at historical cost in 2010 is revalued using a revaluation factor. The revaluation factor is calculated based on the following assumptions.

1) Based on ‘report of the census of the machine tools, 1986’ life of the machines (or capital goods) are assumed to be 20 years. Therefore, in the mix of capital stock available with the firms in the base year 2010 there is no capital that was purchased earlier than1990. This is off course true for firms incorporated prior to 1990. However, for firms that incorporated in the post 1990 period, the earliest vintage capital contained in the capital stock of 2010 are capital purchased in the incorporation year. Therefore the initial year of the oldest capital contained in the base year capital stock is either 1990 or the incorporation year whichever is later.

2) Price of capital changes at a constant rate between the initial year (1990 or the year of incorporation) and the base year 2010. The data on gross fixed capital formation at current and constant price are used to obtain the price index of capital during the period between the initial year and the base year and then the

growth rate in the price of capital is estimated as the average annual growth rate in the capital price indices during the period. The rates vary across firms depending on the incorporation year while the rate is same for all firms incorporated in the pre-1990 period. The data on gross fixed capital formation are obtained from national account statistics (NAS) of CSO.

3) Similar to the price of capital, firm's investment in capital goods is assumed to grow at a constant rate during the period between the initial year and the base year. The average annual growth rate in gross fixed capital formation during the initial year to the base year is considered as the rate at which investment grows. It is same for all firms incorporated prior to 1990. However, the rates vary across firms incorporated in the post 1990 period since the initial year varies.

Suppose π and g are the constant rates at which price of capital and investment grow. Assuming τ is the life of capital gross fixed asset at historical cost in base year is given by

$$GFA_0^h = P_0 I_0 + P_{-1} I_{-1} + P_{-2} I_{-2} + \cdots + P_{-\tau+1} I_{-\tau+1}$$

$$= \; P_0 I_0 \left(1 + \left[\frac{1}{(1+\pi)(1+g)}\right] + \left[\frac{1}{(1+\pi)(1+g)}\right]^2 + \cdots + \left[\frac{1}{(1+\pi)(1+g)}\right]^{\tau-1}\right)$$

$$= P_0 I_0 \left(\frac{[(1+\pi)(1+g)]^{\tau} - 1}{[(1+\pi)(1+g)]^{\tau-1}[(1+\pi)(1+g) - 1]}\right)$$

Gross fixed asset at replacement cost in base year is given by

$$GFA_0^r = P_0 I_0 + P_0 I_{-1} + P_0 I_{-2} + \cdots + P_0 I_{-\tau+1}$$

$$= \; P_0 I_0 \left(1 + \left[\frac{1}{1+g}\right] + \left[\frac{1}{1+g}\right]^2 + \cdots + \left[\frac{1}{1+g}\right]^{\tau-1}\right)$$

$$= P_0 I_0 \left(\frac{[1+g]^{\tau} - 1}{g[1+g]^{\tau-1}}\right)$$

Therefore, the revaluation factor (R_τ) used to obtain gross fixed asset at replacement cost from historical cost is given by

$$R_\tau = \frac{[(1+g)^\tau - 1](1+\pi)^{\tau-1}[(1+\pi)(1+g)-1]}{g([(1+\pi)(1+g)]^\tau - 1)} \qquad \text{(A5.2)}$$

And

$$GFA_0^r = R_\tau \, GFA_0^h$$

After calculating the revaluation factor using equation (A5.2), gross fixed asset at replacement cost in the base year is estimated. Base year GFA at replacement cost thus obtained is expressed in current price. It is then converted to base year GFA at replacement cost in 2000 constant price. Price index for machinery and machine tools is used as deflator as it consist of around 70% of the total capital goods as per the RBI bulletin, 1990. GFA at replacement cost at constant price in the preceding and the subsequent years are obtained by adding and subtracting investment at constant price to the corresponding years. For instance, GFA at replacement cost at constant price in 1999 is GFA at replacement at constant price in 2000 minus investment at constant price in 2000. Similarly GFA at replacement cost at constant price in all year years prior to 2000 are obtained. GFA at replacement cost at constant price in 2001 is obtained by adding investment at constant price in 2001 with the GFA at replacement cost at constant price in 2000. Similarly, GFA at replacement cost at constant price is obtained in all the subsequent years. Finally, natural log transformation of the variable is considered.

Stock of R&D capital (SRD): The study applies perpetual inventory method on firms' annual real investment in R&D to obtain stock of R&D capital. Stock of R&D capital of i^{th} firm in the t^{th} time period is given by

$$SRD_{it} = (1-\delta)SRD_{it-1} + RD_{it} \qquad \text{(A5.3)}$$

Where SRD_{it-1} and RD_{it} are stock of R&D capital and annual real R&D expenditure of i^{th} firm in $t\text{-}1^{th}$ and t^{th} time period respectively. Drawing from previous literature decay rate is assumed to be 15% (i.e.$\delta = 0.15$) per annum (Raut, 1995; Hasan, 2002). To obtain annual real R&D expenditure, annual nominal expenditures on R&D is deflated by the average of capital good and wage deflator. This is because expenditure on R&D consists of salaries of R&D personnel and purchase of R&D equipments. Capital good deflator is obtained by taking the ratio of gross fixed capital formation at current and constant price. Consumer price index for industrial worker is used as wage deflator. While some studies took weighted average of wage and capital deflator, the present study uses simple average in absence of relevant information on the composition of R&D expenditure. To cross check, the estimated R&D deflator is compared with an alternative measure of R&D deflator, which is the ratio of national R&D expenditure in current and constant price. Both the deflators are found similar. Following Raut (1995), 1 is added to the reported R&D expenditure for all firms in all the time periods, corresponding to non-zero sales. This ensures that firms with no R&D spending have non-zero stock of R&D. In construction of the stock measure, following Basant and Fikkert (1996), it is assumed that the effect of R&D investment persist for 5 years. Since the data is available from 1989, the initial year for which R&D stock is calculated is 1993. Therefor initial year R&D stock can be expressed as:

$$SRD_{i93} = RD_{i93} + 0.85 * RD_{i92} + (0.85)^2 * RD_{i91} + (0.85)^3 * RD_{i90} + (0.85)^4 * RD_{i89} \quad \text{(A5.4)}$$

In the following years, SRD is estimated using perpetual inventory method, as equation (A5.3). Finally, natural log transformation of the variable is considered.

Stock of embodied technology import (SET/K): Annual reports contain information on import of capital goods which is used in estimation of stock of embodied technology import. Firstly, the nominal expenditure is deflated to arrive at the real expenditure on import of capital goods, using the unit value index for imported machinery and transport equipment. The unit value index is obtained from RBI website. Secondly, the stock of recent investment in import of capital goods (SET) is calculated as follows:

$$SET_{it} = \sum_{\tau=0}^{T}(1-\delta)^{\tau} IC_{it-\tau} \quad \text{(A5.5)}$$

Where IC_{it} and SET_{it} are deflated value of import of capital goods and stock of embodied technology import of i^{th} firm in t^{th} time period respectively. Following Hasan (2002), the study consider 6% (i.e.$\delta = 0.06$) depreciation rate of imported capital goods. T=4 is chosen assuming recently imported capital goods contain embodied newly imported technologies. Finally, the share of newly imported capital goods is calculated by taking the ratio of SET and capital stock (K). The variable is express in natural logs.

Stock of disembodied technology import (SDET): The data on foreign currency spending on royalties and technical know-how and perpetual inventory method is used to calculate the stock of disembodied technology import (SDET). It is calculated as

$$SDET_{it} = (1-\delta)SDET_{it-1} + DT_{it} \quad \text{(A5.6)}$$

Where DT_{it} is the deflated value of the foreign exchange spending on royalties and technical know-how or the disembodied technology import of the i^{th} firm in the t^{th} time period. Again a depreciation rate of 15% is assumed i.e. $\delta = 0.15$. The United States R&D deflator is used as the deflator since United States is largest source country for India’s imported technologies. The exchange rate adjusted US GDP implicit price deflator is used as the US R&D deflator. Following Basant and Fikkert (1996), it is assumed that foreign technology contracts are for 4 years implying payment of technical fees or royalty payments last for 4 years. Therefore, 1992 is the initial year for which stock of disembodied technology import (SDET) could be calculated in the present study. SDET in 1992 is calculated as follows

$$SDET_{i92} = DT_{i92} + 0.85 * DT_{i91} + (0.85)^2 * DT_{i90} + (0.85)^3 * DT_{i89} \quad \text{(A5.7)}$$

The perpetual inventory method given by equation (A5.6) is followed to estimate the SDET in the following years. Finally, natural log transformation of the variable is considered.

FDI spillover (FDISPIL): The share of output produced by foreign firms in each industry in total industry output is considered as the measure of FDI spillover. Therefore,

$$FDISPILL_{jt} = \sum_{i'=1}^{m} Y_{i'jt} / \sum_{i=1}^{n} Y_{ijt} \quad \text{(A5.8)}$$

Where i' denote the foreign firm and i denote any firm in the j^{th} industry. Assuming there are m foreign firms and n firms ($m \leq n$) in the j^{th} industry, $Y_{i'jt}$ denotes the deflated value of sales of the i'^{th} foreign firm in the j^{th} industry, Y_{ijt} is the deflated value of sales of the i^{th} firm in the j^{th} industry and $FDISPILL_{jt}$ is the estimated FDI spillover in the j^{th} industry. The variable is calculated at NIC 4 digit classification level. Finally, natural log transformation of the variable is considered.

Competition: Previous empirical literature have used various competition measures namely, market concentration, rent surplus, price cost margin, and questionnaire based surveys to analyse the effect of competition on productivity. This study consider market concentration ratio as the competition measure. In particular, Hefindahl-Hirschmann index (HHI) is used as the competition measure. It is an industry level index, estimated as the sum of market share of all firms in the industry. However, another concentration index, namely 4-firm concentration ratio is also often used as competition variable. It is the sum of market share of 4 largest firms in the industry. Chakravarty (1995) argued that HHI follows the properties of a well behaved concentration index and directly related with the theory of oligopoly, when mark-up is high (low) then HHI is also high (low) for a given demand elasticity.

SIZE and AGE: Log of capital stock is used as measure of capital stock. Age is the log of difference between current year and incorporation year.

Research and development intensity (RDI): This variable is measured by taking the ratio of research and development (R&D) expenditure and sales. Double deflation method is used where R&D expenditure is deflated by R&D deflator (which is the average of wage and the capital good deflator), and sales is deflated by WPI at 5 digit level. Before deflation, 1 is added to the reported R&D expenditure for all firms in all the time periods to obtain a reasonable size of the sample. Finally, natural log transformation of this variable is used.

Embodied technology import intensity (ETI): The data on import of capital goods is considered as the measure of embodied technology import. The variable embodied technology import intensity is estimated as the ratio of deflated value of the expenditure on import of capital goods and deflated sales. Unit value index for imported machinery and transport equipment is used as deflator for import of capital goods, WPI at 5 digit level is used as deflator for sales. Before deflation, 1 is added to the reported value of the expenditure on import of capital goods for all firms in all the time periods to obtain a reasonable size of the sample. Finally, natural log transformation of this variable is used.

Disembodied technology import intensity (DTI): This variable is measured by taking the ratio of deflated value of foreign exchange spending on royalties and technical know-how and deflated sales. Exchange rate adjusted US GDP implicit price deflator is used as deflator in the numerator. Before deflation, 1 is added to the reported value of foreign exchange spending on royalties and technical know-how for all firms in all the time periods to obtain a reasonable size of the sample. Natural log transformation of this variable is used.

Productivity gap (GAP): To measure this variable firstly, the most productive firm in each of NIC-4 digit level industry is identified. The distance in the productivity level from the most productive firm gives the estimates of productivity gap for each firm in each industry. Natural log transformation of this variable is used in the regression

Vertical Integration (VI): The ratio of value added and sales is used as a measure of vertical integration for each firm. Natural log transformation of this variable is used.

Figure A5.1: Trends in competition variables

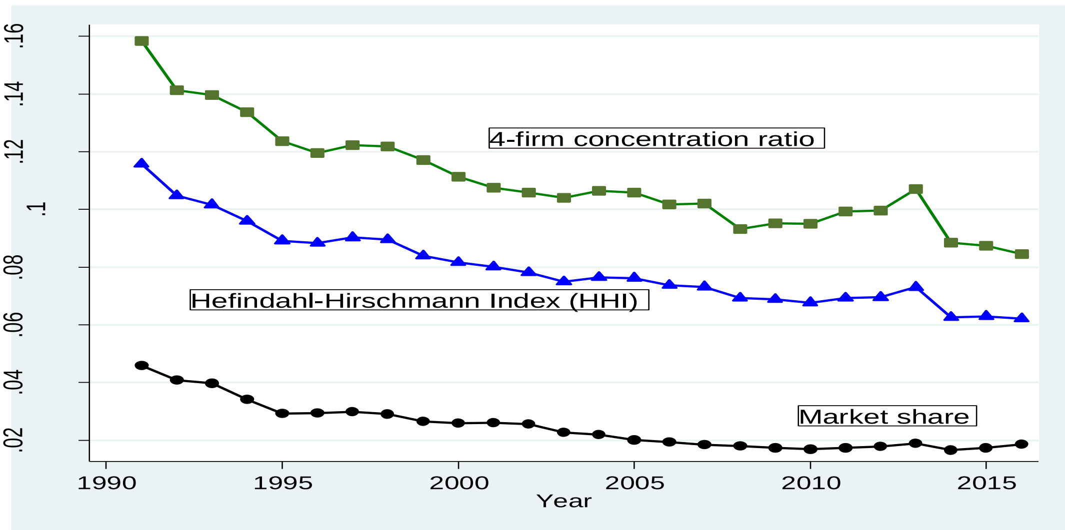

Table A5.1: Proxy used in LP estimation for different industries

Name of the Industry	**Proxy**
Manufacture of food products	Energy
Manufacture of Beverages	Material
Manufacture of Tobacco	Energy
Manufacture of Textile	Material
Manufacture of Wearing Apparel except manufacture of article of fur	Material
Manufacture of Leather and related products	Material
Manufacture of Wood and Wood Products including furniture	Material
Manufacture of Paper and Paper products	Material
Manufacture of Printing and reproduction of recorded media	Energy
Manufacture of Coke and Refined Petroleum Products	Material
Manufacture of Chemicals and Chemical Products	Material
Manufacture of Pharmaceuticals products	Material
Manufacture of Rubber and Plastic products	Material
Manufacture of other non-metallic mineral products	Material
Manufacture of Basic Metals	Material
Manufacture of Fabricated Metal Products	Material
Manufacture of Computer, Electronic and Optical products	Material
Manufacture of Electrical Equipment	Material
Manufacture of Machinery and Equipment n.e.c.	Material
Manufacture of Motor Vehicles, Trailers and Semi-trailers	Material
Manufacture of Other Transport Equipment	Material
Other Manufacturing	Material
Diversified	Energy

Table A5.2: Correlation matrix for productivity equation

	Ln(SIZE)	Ln(SRD)	Ln(SET)	Ln(SDET)	Ln(HHI)	Ln(FDISPILL)
Ln(SIZE)	1					
Ln(SRD)	0.2633	1				
Ln(SET)	**-0.9637**	-0.2148	1			
Ln(SDET)	0.2321	0.1233	-0.1324	1		
Ln(HHI)	-0.0529	0.0669	0.0528	0.0187	1	
Ln(FDISPILL)	-0.0289	0.0062	0.0371	0.0334	0.1663	1

Table A5.3: Correlation matrix for R&D intensity equation

	Ln(SIZE)	Ln(AGE)	Ln(ETI)	Ln(DTI)	Ln(VI)	Ln(GAP)	Ln(HHI)
Ln(SIZE)	1						
Ln(AGE)	0.1513	1					
Ln(ETI)	-0.5803	-0.3006	1				
Ln(DTI)	-0.7259	-0.2465	**0.8706**	1			
Ln(VI)	-0.0181	0.0667	0.0618	0.0686	1		
Ln(GAP)	0.125	0.0346	0.1477	0.123	-0.0781	1	
Ln(HHI)	0.0134	0.0152	-0.0548	-0.0407	-0.0699	-0.1887	1

CHAPTER 6: Conclusion

The literature on firm heterogeneity and export revealed that exporters are more productive than non-exporters, and it is the productive firms that enter the world market. The thesis started interrogating the causes of productivity differential between firms prior to entering the export market. At a point in time some firms may be less productive than others and may not export; however, they might become productive later, hence may enter the export market later. Therefore, the thesis argues that export participation of a firm needs to be discussed in a dynamic framework in the context of evolution of a firm. In the context of firm evolution 'Home Market Hypothesis' was proposed by Linder (1961) in which he argued that in the beginning, a firm sells in the home market and later it enters the export market as its efficiency level improves. Linder's home market hypothesis was in the context of developed countries, where home market operation in the early stage is due to uncertainty of the foreign market. Unlike developed countries, firms in developing countries do not have the necessary technology to export. Home market operation provides the opportunities to an infant developing country firm to develop its technological base. In the context of a developing country, the thesis developed a dynamic model of firm evolution that captures the role of home market on a firm's decision to enter into the foreign market.

The model is developed in a closed economy framework where there are a representative domestic firm and many foreign firms. The domestic firm is assumed to be at its infant stage and faces competition from the potential entry of the foreign firms. Foreign firms are more efficient than the domestic firm. Home government provides temporary protection to the domestic firm in the form of complete import ban to protect it against efficient foreign firms. In presence of protection, domestic firm enjoys monopoly power in the domestic market, incurs super normal profit which is invested in R&D activities. The temporary nature of protection forces the domestic firm to invest. Investment in R&D improves its efficiency as firm gradually moves down from a higher average cost curve to a lower average cost curve. As the firm keeps shifting down to lower and lower average cost curves, it keeps increasing its sale in the home market. It has been shown that once the firm reaches a certain threshold level of home market sales, it enters the export market. In the process, when the firm touches the frontier level technology, it becomes equally efficient as foreign firms and no longer needs protection. Thus, the theoretical analysis showed the importance of home market in entering the export market in a dynamic framework (Chapter 3).

In the empirical analysis, discussed in Chapter 4, the role of the home market on export entry is examined in the context of Indian manufacturing firms for the post liberalization period (1993-2016). To test home market role, it has been examined whether firms that grew more in the home market before entry are the ones that enter the export market. Using econometric analysis, following Robert and Tybout (1997), it has been found that probability of exporting is more for firms that grew more in the home market prior to entry. In other words, firms that performed well in the home market are found to have higher probability of entering the world market. It has also been found that productive firms began to export. In interpreting the result, it is argued that rise in the competition level following liberalization has pushed the domestic Indian firms to increase their productivity level. In the process, firms which increased their productivity level more than others grew more and eventually entered the world market.

Liberalization process in India has been gradual and protection has not been eliminated at one go. Therefore, home market conditions have also changed gradually. Although competitiveness in the home market increased in the post-liberalization period, it has increased more in the later phase of liberalization than the earlier phase. This might explain why the role of home market on export entry is more prominent in the later phase of liberalization. To examine this, separate analysis of the home market role on export entry has been conducted for the first (1993-2003) and the second (2004-16) phase of liberalization. In confirmation to the anticipation, it has been found that home market performance played a significant role in firms' export entry only in the later phase of liberalization (2004-2016), while it did not play any role in export entry during the initial phase (1993-2003) of the liberalization.

In the theoretical model, it has been shown that non-exporting firms need to reach a threshold technology level to enter the export market and it can be reached through investment in innovation activities. To empirically test it, the thesis examined the impact of firm investment in in-house R&D and technology imports on the productivity growth of Indian manufacturing firms in the pre-export entry period. Two types of technology imports – technologies purchased in embodied form through import of capital goods and the technologies imported in embodied form against royalty payment and technical fees have been considered. The result obtained in this analysis suggests that in the pre-entry period, investment in R&D and embodied technology import have increased the productivity of Indian manufacturing firms, however, investment in import of disembodied technologies did not contribute to the productivity growth.

While examining the difference in the pattern of investment in technologies between future exporters and non-exporters, it has been found that prior to entry future exporters invested more in in-house R&D and disembodied technology import but invested less on embodied technology import compared to non-exporters. Productivity accelerating effects of R&D and embodied technology imports have been found similar between future exporters and non-exporters; however, the impact of disembodied technology import has been found higher for future exporters. Therefore, it can be said that firms that are presently operating in home market but looking to enter the export market may focus on investing more in disembodied technologies relative to embodied technologies. Imported technologies, however, need to be adapted through investment in R&D since technology imports and R&D have been found to have a complementary relationship, in India, in the pre-entry period.

References

Ackerberg, D., Benkard, C. L., Berry, S., & Pakes, A. (2007). Econometric tools for analyzing market outcomes. *Handbook of Econometrics*, *6*, 4171-4276.

Agarwal, M., & Barua, A. (1993). Trade policy and welfare in a segmented market. *Keio Economic Studies, 30*(2), 31–44.

Agarwal, M., & Barua, A. (1994). Effects of entry in a model of oligopoly with international trade. *Journal of International Trade & Economic Development*, *3*(1), 1-13.

Agarwal, M., & Barua, A. (2004). Entry liberalization and export performance: a theoretical analysis in a multi-market oligopoly model. *The Journal of International Trade & Economic Development, 13*(3), 287-303.

Aggarwal, A. (2000). Deregulation, technology imports and in-house R&D efforts: an analysis of the Indian experience. *Research Policy*, *29*(9), 1081-1093.

Aggarwal, A. (2002). Liberalisation, multinational enterprises and export performance: evidence from Indian manufacturing. *Journal of Development Studies, 38*(3), 119-137.

Agnihotri, A., & Bhattacharya, S. (2015). Determinants of export intensity in emerging markets: An upper echelon perspective. *Journal of World Business*, *50*(4), 687-695.

Ahn, J., & McQuoid, A. F. (2012). Capacity constrained exporters: micro evidence and macro implications. https://digitalcommons.fiu.edu/economics_wps/2.

Ahsan, R. N. (2013). Input tariffs, speed of contract enforcement, and the productivity of firms in India. *Journal of International Economics, 90*(1), 181-192.

Alvarez, R., & Lopez, R. A. (2005). Exporting and performance: evidence from Chilean plants. *Canadian Journal of Economics, 38*(4), 1384-1400.

Alvarez, R., Faruq, H., & López, R. A. (2013). Is previous export experience important for new exports?. *The Journal of Development Studies*, *49*(3), 426-441.

Ambrammal, S. K., & Sharma, R. (2014). R&D and patenting by firms in India in high- and medium-high-technology industries. *Journal of Chinese Economic and Business Studies*, *12*(2), 181-207.

Amiti, M., & Konings, J. (2007). Trade liberalization, intermediate inputs, and productivity: Evidence from Indonesia. *American Economic Review*, *97*(5), 1611-1638.

Arnold, J. M., & Hussinger, K. (2005). Export behavior and firm productivity in German manufacturing: A firm-level analysis. *Review of World Economics, 141*(2), 219-243.

Arrow, K. J. (1962). Economic Welfare and the Allocation of Resources for Inventions. in R. R. Nelson (Ed.), *The Rate and Direction of Inventive Activity: Economic and Social Factors* (pp. 609-626), Princeton University Press, Princeton.

Arulampalam, W. & Stewart, M.B. (2009). Simplified estimation of Heckman Estimator of the Dynamic Panel Model and a Compariosn with Alternative Estimators. *Oxford Bulletin of Economics and Statistics, 71(5)*, 659-681

Atkeson, A., & Burstein, A. T. (2010). Innovation, firm dynamics, and international trade. *Journal of Political Economy*, *118*(3), 433-484.

Aw, B. Y., & Batra, G. (1998). Technological capability and firm efficiency in Taiwan (China). *The World Bank Economic Review*, *12*(1), 59-79.

Aw, B. Y., Chung, S., & Roberts, M. J. (2000). Productivity and turnover in the export market: micro-level evidence from the Republic of Korea and Taiwan (China). *The World Bank Economic Review*, *14*(1), 65-90.

Aw, B. Y., Roberts, M. J., & Winston, T. (2007). Export market participation, investments in R&D and worker training , and the evolution of firm productivity. *The World Economy*, *30*(1), 83–104.

Balakrishnan, P., Pushpangadan, K., & Babu, M. S. (2000). Trade liberalisation and productivity growth in manufacturing: Evidence from firm-level panel data. *Economic and Political Weekly*, 3679-3682.

Baldwin, R.E. (1988). Hysteresis in Import Prices: The Beachhead Effects. *American Economic Review, 78(4),* 773-785.

Baldwin, J. R., & Gu, W. (2003). Export-market participation and productivity performance in Canadian manufacturing. *Canadian Journal of Economics*, *36*(3), 634-657.

Baldwin, R. E. (1969). The case against infant-industry tariff protection. *Journal of Political Economy*, *77*(3), 295-305.

Banga, R. (2004). Impact of Japanese and US FDI on productivity growth: A firm-level analysis. *Economic and Political Weekly*, 453-460.

Bardhan, P. (1971). On optimum subsidy to a learning industry: An aspect of the theory of infant-industry protection. *International Economic Review*, *12*(1), 54-70.

Basant, R. (1997). Technology strategies of large enterprises in Indian industry: some explorations. *World Development*, *25*(10), 1683-1700.

Basant, R., & Fikkert, B. (1996). The effects of R&D, foreign technology purchase, and domestic and international spillovers on productivity in Indian firms. *The Review of Economics and Statistics*, 187-199.

Basant, R., & Mishra, P. (2013). Concentration and other determinants of innovative efforts in Indian manufacturing sector: A dynamic panel data analysis. *Working Paper No. 2013-02-01. Indian Institute of Management, Ahmedabad*.

Basevi, G. (1970). Domestic demand and ability to export. *Journal of Political Economy*, *78*(2), 330-337.

Behera, S. R. (2014). Local firms productivity spillover from foreign direct investment: a study of Indian manufacturing industries. *International Journal of Technological Learning, Innovation and Development*, *7*(2), 167-190.

Behrens, K., Lamorgese, A. R., Ottaviano, G. I., & Tabuchi, T. (2009). Beyond the home market effect: Market size and specialization in a multi-country world. *Journal of International Economics*, *79*(2), 259-265.

Benavente, M. J. (2006). The role of research and innovation in promoting productivity in Chile. *Economics of Innovation and New Technology*, *15*(4-5), 301-315.

Bernard, A. B., & Jensen, J. B. (1999). Exceptional exporter performance: cause, effect, or both?. *Journal of International Economics*, *47*(1), 1-25.

Bernard, A. B., & Jensen, J. B. (2004). Why some firms export. *Review of Economics and Statistics*, *86*(2), 561-569.

Bernard, A. B., & Wagner, J. (2001). Export entry and exit by German firms. *Weltwirtschaftliches Archiv*, *137*(1), 105-123.

Bernard, A. B., Eaton, J., Jensen, J. B., & Kortum, S. (2003). Plants and productivity in international trade. *American Economic Review*, *93*(4), 1268-1290.

Bernard, A. B., Jensen, J. B., & Lawrence, R. Z. (1995). Exporters, jobs, and wages in US manufacturing: 1976-1987. *Brookings Papers on Economic Activity. Microeconomics*, *1995*, 67-119.

Bernard, A. B., Jensen, J. B., & Schott, P. K. (2006). Trade costs, firms and productivity. *Journal of Monetary Economics*, *53*(5), 917-937.

Bernard, A. B., Jensen, J. B., Redding, S. J., & Schott, P. K. (2007). Firms in international trade. *Journal of Economic Perspectives*, *21*(3), 105-130.

Bernard, A. B., Redding, S. J., & Schott, P. K. (2011). Multiproduct firms and trade liberalization. *The Quarterly Journal of Economics*, *126*(3), 1271-1318.

Bhatt, S., & Narayanan, K. (2009). Technological efforts, firm size and exports in the basic chemical industry in India. *Oxford Development Studies*, *37*(2), 145-169.

Bhattacharjea, A. (2002). Infant industry protection revisited. *International Economic Journal*, *16*(3), 115-133.

Bhavani, T. A., & Tendulkar, S. D. (2001). Determinants of firm-level export performance: a case study of Indian textile garments and apparel industry. *Journal of International Trade & Economic Development*, *10*(1), 65-92.

Bigsten, A., & Gebreeyesus, M. (2009). Firm productivity and exports: Evidence from Ethiopian manufacturing. *The Journal of Development Studies*, *45*(10), 1594-1614.

Blalock, G., & Gertler, P. J. (2004). Learning from exporting revisited in a less developed setting. *Journal of Development Economics*, *75*(2), 397-416.

Blum, B. S., Claro, S., & Horstmann, I. J. (2013). Occasional and perennial exporters. *Journal of International Economics*, *90*(1), 65-74.

Blundell, R., Griffith, R., & Reenen, J. V. (1995). Dynamic count data models of technological innovation. *The Economic Journal*, *105*(429), 333-344.

Bosco Sabuhoro, J., Larue, B., & Gervais, Y. (2006). Factors determining the success or failure of Canadian establishments on foreign markets: A survival analysis approach. *The International Trade Journal*, *20*(1), 33-73.

Braga, H., & Willmore, L. (1991). Technological imports and technological effort: an analysis of their determinants in Brazilian firms. *The Journal of Industrial Economics*, *39*(4), 421-432.

Bustos, P. (2011). Trade liberalization, exports, and technology upgrading: Evidence on the impact of MERCOSUR on Argentinian firms. *American Economic Review*, *101*(1), 304-40.

Castellacci, F. (2011). How does competition affect the relationship between innovation and productivity? Estimation of a CDM model for Norway. *Economics of Innovation and New Technology*, *20*(7), 637-658.

Castellani, D. (2002). Export behavior and productivity growth: Evidence from Italian manufacturing firms. *Weltwirtschaftliches Archiv*, *138*(4), 605-628.

Castellani, D., Serti, F., & Tomasi, C. (2010). Firms in international trade: Importers' and exporters' heterogeneity in Italian manufacturing industry. *The World Economy*, *33*(3), 424-457.

Chadha, A. (2009). Product cycles, innovation, and exports: A study of Indian pharmaceuticals. *World Development*, *37*(9), 1478-1483.

Chakravarty, S.R. (1995). *Issues in Industrial Economics*, Avebury, Brookfield, USA.

Chamberlin, G. (1980). Analysis of Covariance with Qualitative Data. *The Review of Economic Studies, 47(1),* 225-238.

Chang, H. J. (2003). Kicking away the ladder: Infant industry promotion in historical perspective. *Oxford Development Studies, 31*(1), 21-32.

Chudnovsky, D., López, A., & Pupato, G. (2006). Innovation and productivity in developing countries: A study of Argentine manufacturing firms' behavior (1992–2001). *Research Policy*, *35*(2), 266-288.

Clerides, S. K., Lach, S., & Tybout, J. R. (1998). Is learning by exporting important? Micro-dynamic evidence from Colombia, Mexico, and Morocco. *The Quarterly Journal of Economics*, *113*(3), 903-947.

Coe, D.T. and Helpman, E. (1995). International R&D spillovers. *European Economic Review, 39(5),* 859–887.

Cohen, W. M., & Levinthal, D. A. (1989). Innovation and learning: the two faces of R & D. *The Economic Journal*, *99*(397), 569-596.

Cohen, W. M., Levin, R. C., & Mowery, D. C. (1987). Firm Size and R & D Intensity: A Re-Examination. *The Journal of Industrial Economics*, 543-565.

Cohen, W., (1995). Empirical Studies of Innovative Activity. In P. Stoneman (Ed.), *Handbook of the Economics of Innovation and Technological Change*, Oxford: Oxford University Press.

Costantini, J., & Melitz, M. (2008). The dynamics of firm-level adjustment to trade liberalization. In Helpman, E., Martin, D, and Verdier, T. (Eds.) *The Organization of Firms in a Global Economy*, *Vol 4* (pp. 107-141). Harvard University Press: Cambridge MA.

Crépon, B., Duguet, E., & Mairessec, J. (1998). Research, Innovation And Productivi [Ty: An Econometric Analysis At The Firm Level. *Economics of Innovation and New Technology*, *7*(2), 115-158.

Crespi, G., & Zuniga, P. (2012). Innovation and productivity: evidence from six Latin American countries. *World Development*, *40*(2), 273-290.

Crozet, M., & Trionfetti, F. (2008). Trade costs and the home market effect. *Journal of International Economics*, *76*(2), 309-321.

Dasgupta, P., & Stiglitz, J. (1980). Industrial structure and the nature of innovative activity. *The Economic Journal*, *90*(358), 266-293.

Davis, D. R. (1998). The Home Market, Trade, and Industrial Structure. *American Economic Review*, 88(5), 1264-1276.

Davis, D. R., & Weinstein, D. E. (2003). Market access, economic geography and comparative advantage: an empirical test. *Journal of International Economics*, *59*(1), 1-23.

De Loecker, J. (2007). Do exports generate higher productivity? Evidence from Slovenia. *Journal of International Economics*, *73*(1), 69-98.

De, P. K., & Nagaraj, P. (2014). Productivity and firm size in India. *Small Business Economics*, *42*(4), 891-907.

Demirhan, A. A. (2016). To be exporter or not to be exporter? Entry–exit dynamics of Turkish manufacturing firms. *Empirical Economics*, *51*(1), 181-200.

Deolalikar, A. B., & Evenson, R. E. (1989). Technology production and technology purchase in Indian industry: An econometric analysis. *The Review of Economics and Statistics*, 687-692.

Deolalikar, A. B., & Röller, L. H. (1989). Patenting by manufacturing firms in India: its production and impact. *The Journal of Industrial Economics*, 303-314.

Dixit, A. (1992). Investment and hysteresis. *Journal of Economic Perspectives*, *6*(1), 107-132.

Eaton, J., Kortum, S., & Kramarz, F. (2004). Dissecting trade: Firms, industries, and export destinations. *American Economic Review*, *94*(2), 150-154.

Erhardt, K. (2017). On Home Market Effects and Firm Heterogeneity. *European Economic Review, 98,* 316-340.

Esteve-Pérez, S., Requena-Silvente, F., & Pallardó-Lopez, V. (2013). The Duration of Firm-Destination Export Relationships: Evidence from Spain, 1997–2006. *Economic Inquiry*, *51*(1), 159-180.

Fafchamps, M., El Hamine, S., & Zeufack, A. (2007). Learning to export: Evidence from Moroccan manufacturing. *Journal of African Economies, 17*(2), 305-355.

Feenstra, R. C., Markusen, J. R., & Zeile, W. Accounting for Growth with New Inputs: Theory and Evidence. *The American Economic Review*, *82*(2).

Feinberg, S. E., & Majumdar, S. K. (2001). Technology spillovers from foreign direct investment in the Indian pharmaceutical industry. *Journal of International Business Studies*, *32*(3), 421-437.

Frenkel, J. A. (1971). On domestic demand and ability to export. *Journal of Political Economy*, *79*(3), 668-672.

Freund, C., & Pierola, M. D. (2015). Export Superstars. *Review of Economics and Statistics*, *97*(5), 1023-1032.

Fujimori, A., & Sato, T. (2015). Productivity and technology diffusion in India: The spillover effects from foreign direct investment. *Journal of Policy Modeling*, *37*(4), 630-651.

Geroski, P. A. (1990). Innovation, technological opportunity, and market structure. *Oxford economic Papers*, *42*(3), 586-602.

Ghosh, S. (2009). R&D in Indian manufacturing enterprises: what shapes it?. *Economics of Innovation and New Technology*, *18*(4), 337-352.

Glesjer, H., Jacquemin, A., & Petit, J. (1980). Exports in Imperfect Competition Framework: An Analysis of 1446 Exporters. *Quarterly Journal of Economics, 94*, 507-524.

GoI (2018). Economic Survey 2017-18. New Delhi, Delhi: Ministry of Finance, Department of Economic Affairs, Economic Division

Goldar, B. (2004) Productivity trends in Indian manufacturing in the pre- and post-reform periods. Economic and Political Weekly, 20 November, pp. 5033–5043.

Goldar, B., & Aggarwal, S. C. (2005). Trade liberalization and price-cost margin in Indian Industries. *The Developing Economies*, *43*(3), 346-373.

Goldberg, P. K., Khandelwal, A. K., Pavcnik, N., & Topalova, P. (2010). Imported intermediate inputs and domestic product growth: Evidence from India. *The Quarterly Journal of Economics*, *125*(4), 1727-1767.

Greenaway, D., Guariglia, A., & Kneller, R. (2007). Financial factors and exporting decisions. *Journal of International Economics*, *73*(2), 377-395.

Griffith, R., Huergo, E., Mairesse, J., & Peters, B. (2006). Innovation and productivity across four European countries. *Oxford Review of Economic Policy*, *22*(4), 483-498.

Griliches, Z. (1986). Productivity, R and D, and Basic Research at the Firm Level in the 1970's. *The American Economic Review*, *76*(1), 141-154.

Grossman, G. M., & Helpman, E. (1990). Trade, Innovation, and Growth. *American Economic Review, 80*(2), 86-91.

Grossman, G. M., & Helpman, E. (1991). *Innovation and growth in the global economy*. Cambridge, MA: MIT press.

Gullstrand, J., & Persson, M. (2015). How to combine high sunk costs of exporting and low export survival. *Review of World Economics, 151*(1), 23-51.

Gupta, A., Patnaik, I., & Shah, A. (2018). Exporting and firm performance: Evidence from India. *Indian Growth and Development Review*, *12*(1), 83-104.

Haidar, J. I. (2012). Trade and productivity: Self-selection or learning-by-exporting in India. *Economic Modelling*, *29*(5), 1766-1773.

Haider, J. I. (2012). Trade and productivity: Self-selection or learning-by-exporting in India. *Economic Modelling*, *29*(5), 1766-1773.

Hall, B. H., Lotti, F., & Mairesse, J. (2009). Innovation and productivity in SMEs: empirical evidence for Italy. *Small Business Economics*, *33*(1), 13-33.

Hall, B. H., & Mairesse, J. (1995). Exploring the relationship between R&D and productivity in French manufacturing firms. *Journal of Econometrics, 65*(1), 263-293.

Halpern, L., Koren, M., & Szeidl, A. (2015). Imported inputs and productivity. *American Economic Review*, *105*(12), 3660-3703.

Hanson, G. H., & Xiang, C. (2004). The home-market effect and bilateral trade patterns. *American Economic Review*, *94*(4), 1108-1129.

Hasan, R. (2002). The impact of imported and domestic technologies on the productivity of firms: panel data evidence from Indian manufacturing firms. *Journal of Development Economics*, *69*(1), 23-49.

Hasan, R., & Raturi, M. (2003). Does investing in technology affect exports? Evidence from Indian firms. *Review of Development Economics, 7*(2), 279-293.

Head, K., & Mayer, T. (2004). The empirics of agglomeration and trade. In In J. V. Henderson & J. F. Thisse (Eds.), *Handbook of Regional and Urban Economics* (Vol. 4, pp. 2609-2669). Amsterdam: Elsevier.

Head, K., & Ries, J. (2001). Increasing returns versus national product differentiation as an explanation for the pattern of US-Canada trade. *American Economic Review*, *91*(4), 858-876.

Head, K., Mayer, T., & Ries, J. (2002). On the pervasiveness of home market effects. *Economica*, *69*(275), 371-390.

Heckman, J.J. (1981). The Incidental Parameters Problem and the Problem of Initial Conditions in Estimating a Discrete Time-Discrete Data Stochastic Process. *In*

Structural Analysis of Discrete Data with Econometric Aplications. Manski C.F. & McFadden, D. (eds). MIT Press: Cambridge, MA, 179-195.

Helpman, E., & Krugman, P. R. (1985). *Market structure and foreign trade: Increasing returns, imperfect competition, and the international economy*. Cambridge, MA: MIT Press.

Hirsch, S., & Adar, Z. (1974). Firm Size and Export Performance. *World Development, 2(7)*, 41-46.

Horowitz, I. (1962). Firm size and research activity. *Southern Economic Journal*, *28*(3), 298-301

Ilmakunnas, P., & Nurmi, S. (2010). Dynamics of export market entry and exit. *Scandinavian Journal of Economics*, *112*(1), 101-126.

Impullitti, G., Irarrazabal, A. A., & Opromolla, L. D. (2013). A theory of entry into and exit from export markets. *Journal of International Economics*, *90*(1), 75-90.

Jefferson, G. H., Huamao, B., Xiaojing, G., & Xiaoyun, Y. (2006). R&D performance in Chinese industry. *Economics of Innovation and New technology*, *15*(4-5), 345-366.

Kathuria, V. (2000). Productivity spillovers from technology transfer to Indian manufacturing firms. *Journal of International Development*, *12*(3), 343-369.

Kathuria, V. (2001). Foreign firms, technology transfer and knowledge spillovers to Indian manufacturing firms: a stochastic frontier analysis. *Applied Economics*, *33*(5), 625-642.

Kathuria, V. (2002). Liberalisation, FDI, and productivity spillovers—an analysis of Indian manufacturing firms. *Oxford Economic Papers*, *54*(4), 688-718.

Kato, A. (2009). Product market competition and productivity in the Indian manufacturing industry. *The Journal of Development Studies*, *45*(10), 1579-1593.

Katrak, H. (1985). Imported Technology, Enterprise Size and R & D in a Newly Industrializing Country: The Indian Experience. *Oxford Bulletin of Economics and Statistics*, *47*(3), 213-229.

Katrak, H. (1990). Imports of technology and the technological effort of Indian enterprises. *World Development*, *18*(3), 371-381.

Keller, W. (2002). Trade and the Transmission of Technology. *Journal of Economic Growth*, *7*(1), 5-24.

Keller, W. (2004). International technology diffusion. *Journal of Economic Literature*, *42*(3), 752-782.

Kemme, D. M., Nikolsko-Rzhevskyy, A., & Mukherjee, D. (2014). Foreign Capital, Spillovers and Export Performance in Emerging Economies: Evidence from I ndian IT Firms. *Review of Development Economics*, *18*(4), 681-692.

Kemp, M. C. (1960). The Mill-Bastable infant-industry dogma. *Journal of Political Economy*, *68*(1), 65-67.

Kim, S., & Saravanakumar, M. (2012). Economic reform and total factor productivity growth in Indian manufacturing industries. *Review of Development Economics*, *16*(1), 152-166.

Kite, G. (2013). The Role of Information Technology Outsourcing on Output, Productivity and Technical Efficiency: Evidence from Indian Firms. *Journal of European Economy*, *12(3)*, 260-285.

Krishna, P., & Mitra, D. (1998). Trade liberalization, market discipline and productivity growth: new evidence from India. *Journal of Development Economics*, *56*(2), 447-462.

Krugman, P. (1980). Scale economies, product differentiation, and the pattern of trade. *The American Economic Review*, *70*(5), 950-959.

Krugman, P. R. (1979). Increasing returns, monopolistic competition, and international trade. *Journal of international Economics*, *9*(4), 469-479.

Kumar, N. (1987). Technology imports and local research and development in Indian manufacturing. *The Developing Economies*, *25*(3), 220-233.

Kumar, N., & Aggarwal, A. (2005). Liberalization, outward orientation and in-house R&D activity of multinational and local firms: A quantitative exploration for Indian manufacturing. *Research Policy*, *34*(4), 441-460.

Kumar, N., & Saqib, M. (1996). Firm size, opportunities for adaptation and in-house R & D activity in developing countries: the case of Indian manufacturing. *Research Policy*, *25*(5), 713-722.

Kumar, N., & Siddharthan, N. S. (1994). Technology, firm size and export behaviour in developing countries: the case of Indian enterprises. *The Journal of Development Studies*, *31*(2), 289-309.

Lall, S. (1983). Determinants of R&D in an LDC: The Indian engineering industry. *Economics Letters*, *13*(4), 379-383.

Lall, S. (1987). *Learning to industrialize: the acquisition of technological capability by India*. Springer.

Lawless, M. (2009). Firm export dynamics and the geography of trade. *Journal of International Economics*, *77*(2), 245-254.

Leibenstein, H. (1966). Allocative efficiency vs." X-efficiency". *The American Economic Review*, *56*(3), 392-415.

Levinsohn, J., & Petrin, A. (2003). Estimating production functions using inputs to control for unobservables. *The Review of Economic Studies*, *70*(2), 317-341.

Linder, S. B. (1961). The effect of trade on composition of production. In An essay on trade and transformation (pp. 82-109). Stockholm: Almqvist & Wiksell.

List, F., (1841). Das Nationale System der Politischen Ökonomie. 1st edition; in English: *The National System of Political Economy*, London: Longmans, Green and Co., 1885.

Lööf, H., & Heshmati, A. (2006). On the relationship between innovation and performance: A sensitivity analysis. *Economics of Innovation and New Technology*, *15*(4-5), 317-344

Mairesse, J., & Sassenou, M. (1991). R&D and productivity: a survey of econometric studies at the firm level. In *STI Review, OECD*.

Majumdar, R. (2010). Did liberalization impact productivity of the Indian electronics hardware industry? *International Journal of the Economics of Business*, *17*(2), 253-273.

Majumdar, S. K. (1997). The impact of size and age on firm-level performance: some evidence from India. *Review of Industrial Organization*, *12*(2), 231-241.

Malik, S. K. (2015). Conditional technology spillovers from foreign direct investment: evidence from Indian manufacturing industries. *Journal of Productivity Analysis*, *43*(2), 183-198.

Mallick, S., & Yang, Y. (2013). Productivity Performance of Export Market Entry and Exit: Evidence from I ndian Firms. *Review of International Economics*, *21*(4), 809-824.

Marin, A., & Sasidharan, S. (2010). Heterogeneous MNC subsidiaries and technological spillovers: Explaining positive and negative effects in India. *Research Policy, 39*(9), 1227-1241.

Marjit, S., & Ray, M. (2017). Export profitability, competition and technology. *International Review of Economics & Finance*, *47*, 35-45.

Matsuyama, K. (1990). Perfect Equilibria in a Trade Liberalization Game. *American Economic Review*, *80*(3), 480-92.

Mayer, T., & Ottaviano, G. I. (2008). The happy few: The internationalisation of European firms. *Intereconomics, 43*(3), 135-148.

Meade, J. E (1955). *Trade and welfare*. New York: Oxford University Press.

Medin, H. (2017). The reverse home-market effect in exports: a cross-country study of the extensive margin of exports. *Review of World Economics*, *153*(2), 301-325.

Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, *71*(6), 1695-1725.

Melitz, M. J. (2005). When and how should infant industries be protected?. *Journal of International Economics*, *66*(1), 177-196.

Melitz, M. J., & Redding, S. J. (2014). Heterogeneous firms and trade. In *Handbook of International Economics* (Vol. 4, pp. 1-54). Elsevier.

Miravete, E. J. (2003). Time-consistent protection with learning by doing. *European Economic Review*, *47*(5), 761-790.

Mishra, P., & Jaiswal, N. (2012). Mergers, acquisitions and export competitiveness: Experience of Indian manufacturing sector. *Journal of Competitiveness*, *4*(1).

Mishra, V. (2007). The determinants of R&D expenditure of firms: evidence from a cross-section of Indian firms. *Economic Papers: A Journal of Applied Economics and Policy*, *26*(3), 237-248.

Mitra, A., Sharma, C., & Véganzonès-Varoudakis, M. A. (2012). Estimating impact of infrastructure on productivity and efficiency of Indian manufacturing. *Applied Economics Letters*, *19*(8), 779-783.

Mitra, A., Sharma, C., & Véganzonès-Varoudakis, M. A. (2014). Trade liberalization, technology transfer, and firms' productive performance: The case of Indian manufacturing. *Journal of Asian Economics*, *33*, 1-15.

Mitra, A., Sharma, C., & Véganzonès-Varoudakis, M. A. (2016). Infrastructure, information & communication technology and firms' productive performance of the Indian manufacturing. *Journal of Policy Modeling*, *38*(2), 353-371.

Miyagiwa, K., & Ohno, Y. (1999). Credibility of protection and incentives to innovate. *International Economic Review*, *40*(1), 143-163.

Mukhopadhyay, A. K. (1985). Technological progress and change in market concentration in the US, 1963-77. *Southern Economic Journal*, 141-149.

Muldlak, Y. (1978). On Pooling of Time Series and Cross Section Data, *Econometrica*, *46(1)*, 69-85.

Muûls, M., & Pisu, M. (2009). Imports and Exports at the Level of the Firm: Evidence from Belgium. *The World Economy*, *32*(5), 692-734.

Nagaraj, P. (2014). Financial constraints and export participation. *International Economics*, *140*, 19–35.

Nataraj, S. (2011). The impact of trade liberalization on productivity: Evidence from India's formal and informal manufacturing sectors. *Journal of International Economics*, *85*(2), 292-301.

Nelson, R. R. (1987). Innovation and Economic Development Theoretical Reprospect and Prospect. In *Technology generation in Latin American manufacturing industries* (pp. 78-93). Palgrave Macmillan, London.

Nelson, R. R., & Wolff, E. N. (1997). Factors behind cross-industry differences in technical progress. *Structural Change and Economic Dynamics*, *8*(2), 205-220.

Nelson, R. R., and Winter, S.G. (1982). *An Evolutionary Theory of Economic Change*. Cambridge, MA and London: Harvard University Press.

Padmaja, M. & Sashidharan, S. (2016). Sunk Costs, Firm Heterogeneity, Export Market Entry and Exit: Evidence from India. *Journal of Quantitative Economics, 15(2)*, 367-393.

Parameswaran, M. (2004). Economic reforms, technical change and efficiency change: firm level evidence from capital goods industries in India. *Indian Economic Review*, 239-260.

Parameswaran, M. (2009). International trade, R&D spillovers and productivity: evidence from Indian manufacturing industry. *Journal of Development Studies*, *45*(8), 1249-1266.

Parameswaran, M. (2010). International trade and R&D investment: evidence from manufacturing firms in India. *International Journal of Technology and Globalisation*, *5*(1-2), 43-60.

Patibandla, M. (1995). Firm size and export behaviour: An Indian case study. *The Journal of Development Studies*, *31*(6), 868-882.

Pattnayak, S. S., & Thangavelu, S. M. (2014). Productivity and Learning-by-exporting: A Firm-level Analysis of Indian Manufacturing. *The World Economy*, *37*(7), 1016-1026.

Pavcnik, N. (2002). Trade liberalization, exit, and productivity improvements: Evidence from Chilean plants. *The Review of Economic Studies*, *69*(1), 245-276.

Pisu, M. (2008*). Export destinations and learning-by-exporting: Evidence from Belgium*. Working paper 140, National Bank of Belgium.

Porter, M. E. (1990). *The comparative advantage of nations*. New York: Free Press.

Pradhan, J. P. (2002). FDI spillovers and local productivity growth: evidence from Indian pharmaceutical industry. *Artha Vijnana*, *44*(3-4), 317-332.

Pradhan, J. P. (2003). Liberalization, firm size and R&D performance: A firm level study of Indian pharmaceutical industry. *Journal of Indian school of political economy*, *14*(4), 647-666.

Rabe-Hesketh, S. & Skrondal, A. (2013). Avoiding Biased Versions of Wooldridge's simple Solution to the Initial Conditions Problem. *Economics Letters, 120(2),* 346-349.

Ranjan, P., & Raychaudhuri, J. (2011). Self-selection vs learning: Evidence from Indian exporting firms. *Indian Growth and Development Review, 4*(1), 22-37.

Raut, L. K. (1995). R & D spillover and productivity growth: Evidence from Indian private firms. *Journal of Development Economics, 48*(1), 1-23.

Ray, A. S., & Bhaduri, S. (2001). R&D and technological learning in Indian industry: econometric estimation of the research production function. *Oxford Development Studies*, *29*(2), 155-171.

Rijesh, R. (2015). Technology import and manufacturing productivity in India: Firm level analysis. *Journal of Industry, Competition and Trade, 15*(4), 411-434.

Roberts, M. J., & Tybout, J. R. (1997). The decision to export in Colombia: An empirical model of entry with sunk costs. *The American Economic Review*, 545-564.

Sasidharan, S., & Kathuria, V. (2011). Foreign direct investment and R&D: Substitutes or complements—A case of Indian manufacturing after 1991 reforms. *World Development*, *39*(7), 1226-1239.

Saure, P. (2007). Revisiting the infant industry argument. *Journal of Development Economics*, *84*(1), 104-117.

Scherer, F. M. (1965). Firm size, market structure, opportunity, and the output of patented inventions. *The American Economic Review*, *55*(5), 1097-1125.

Scherer, F. M. (1967). Market structure and the employment of scientists and engineers. *The American Economic Review*, *57*(3), 524-531.

Schumpeter, J.A., 1942. *Capitalism, Socialism and Democracy*. Harper, New York.

Serti, F., & Tomasi, C. (2008). Self-selection and post-entry effects of exports: Evidence from Italian manufacturing firms. *Review of World Economics*, *144*(4), 660-694.

Sharma, C. (2010). Does productivity differ in domestic and foreign firms? Evidence from the Indian machinery industry. *Indian Economic Review*, 87-110.

Sharma, C. (2012). R&D and firm performance: evidence from the Indian pharmaceutical industry. *Journal of the Asia Pacific Economy*, *17*(2), 332-342.

Sharma, C., & Mishra, R. K. (2011). Does export and productivity growth linkage exist? Evidence from the Indian manufacturing industry. *International Review of Applied Economics*, *25*(6), 633-652.

Sharma, C. (2014). Imported intermediate inputs, R&D, and productivity at firm level: Evidence from Indian manufacturing industries. *The International Trade Journal*, *28*(3), 246-263.

Sheard, N. (2014). Learning to export and the timing of entry to export markets. *Review of International Economics*, *22*(3), 536-560.

Siddharthan, N. S. (1988). In-house R&D, imported technology, and firm size: lessons from Indian experience. *The Developing Economies*, *26*(3), 212-221.

Siddharthan, N. S. (1992). Transaction costs, technology transfer, and in-house R&D: a study of the Indian private corporate sector. *Journal of Economic Behavior & Organization*, *18*(2), 265-271.

Siddharthan, N. S., & Agarwal, R. N. (1992). Determinants of R&D decisions: a cross-section study of Indian private corporate firms. *Economics of Innovation and New Technology*, *2*(2), 103-110.

Siddharthan, N. S., & Lal, K. (2004). Liberalisation, MNE and productivity of Indian enterprises. *Economic and Political Weekly*, 448-452.

Silvente, F.R. (2005). The Decision to Enter & Exit Foreign Markets: Evidence from UK SMEs. *Small Business Economies*, 25(3), 237-253.

Sinani, E., & Hobdari, B. (2010). Export market participation with sunk costs and firm heterogeneity. *Applied Economics*, *42*(25), 3195-3207.

Sivadasan, J. (2006). Productivity Consequences of Product Market Liberalization: Micro-evidence from Indian Manufacturing Sector Reforms. *Working Paper No. 1062. Ross School of Business*, University of Michigan.

Solow, R. M. (1957). Technical change and the aggregate production function. *The Review of Economics and Statistics*, 312-320.

Srinivasan, T. N., & Archana, V. (2011). Determinants of export decision of firms. *Economic and Political Weekly*, 49-58.

Srivastava, V. (2000) *The Impact of India's Economic Reforms on Industrial Productivity, Efficiency and Competitiveness: A Panel Study of Indian Companies 1980–1997*, (New Delhi: National Council of Applied Economic Research).

Staiger, R. W., & Tabellini, G. (1987). Discretionary trade policy and excessive protection. *The American Economic Review*, 823-837.

Subodh, K. (2002). *Market concentration, firm size and innovative activity: a firm-level economic analysis of selected Indian industries under economic liberalization* (No. 2002/108). WIDER Discussion Papers//World Institute for Development Economics (UNU-WIDER).

Sutton, J. (1991). *Sunk costs and market structure: Price competition, advertising, and the evolution of concentration*. MIT press.

Thomas, R., & Narayanan, K. (2016). Productivity heterogeneity and export market participation: A study of Indian manufacturing firms. In F. De Beule & K. Narayanan (Eds.) *Globalization of Indian Industries* (pp. 97-120). Springer, Singapore

Topalova, P., & Khandelwal, A. (2011). Trade liberalization and firm productivity: The case of India. *Review of Economics and Statistics*, *93*(3), 995-1009.

Tornell, A. (1991). Time inconsistency of protectionist programs. *The Quarterly Journal of Economics*, *106*(3), 963-974.

Trefler, D. (2004). The long and short of the Canada-US free trade agreement. *American Economic Review*, *94*(4), 870-895.

Van Beveren, I. (2012). Total factor productivity estimation: A practical review. *Journal of Economic Surveys*, *26*(1), 98-128.

Van Biesebroeck, J. (2005). Exporting raises productivity in sub-Saharan African manufacturing firms. *Journal of International Economics*, *67*(2), 373-391.

Vannoorenberghe, G. (2012). Firm-level volatility and exports. *Journal of International Economics*, *86*(1), 57-67.

Veeramani, C. (2007). Sources of India's Export Growth in Pre-and Post-Reform Periods. *Economic and Political Weekly*, 2419-2427.

Verardi, V., & Wagner, J. (2011). Robust estimation of linear fixed effects panel data models with an application to the exporter productivity premium. *Jahrbücher für Nationalökonomie und Statistik*, *231*(4), 546-557.

Vernon, R. (1966). International investment and international trade in the product cycle. *The Quarterly Journal of Economics*, *80*(2), 190-207.

Vu, H.V., Holmes, M., Tran, T.Q., & Lim, S. (2016). Firm exporting and productivity: What if productvity is no longer a black box. *Baltic Journal of Economics*, *16(2)*, 95-113.

Wagner, J. (2007). Exports and productivity: A survey of the evidence from firm-level data. *World Economy*, *30*(1), 60-82.

Wagner, J. (2012). International trade and firm performance: a survey of empirical studies since 2006. *Review of World Economics*, *148*(2), 235-267.

Weder, R. (2003). Comparative home-market advantage: an empirical analysis of British and American exports. *Review of World Economics*, *139*(2), 220-247.

Wooldridge, J.M. (2005). Simple Solutions to the Initial Conditions Problem in Dynamic, Non-Linier Panel Data Models with Unobserved Heterogeneity. *Journal of Applied Econometrics*, 20(1), 39-54.

Xu, B. (2006). Infant industry and political economy of trade protection. *Pacific Economic Review*, *11*(3), 363-378.

Yu, Z. (2005). Trade, market size, and industrial structure: revisiting the home-market effect. *Canadian Journal of Economics*, *38*(1), 255-272.