UNIVERSITÉ DE STRASBOURG

ÉCOLE DOCTORALE AUGUSTIN COURNOT

Bureau d'Économie Théorique et Appliquée

THÈSE

présentée par :

Frédéric Olland

soutenue le : **03 Décembre 2014**

pour obtenir le grade de

Docteur de l'Université de Strasbourg

en Sciences Économiques

Essais sur les firmes hétérogènes et la productivité des exportateurs et des importateurs

THÈSE dirigée par :

Bertrand Koebel	Professeur, Université de Strasbourg

RAPPORTEURS :

Flora Bellone	Professeur, Université de Nice Sophia-Antipolis
François Fontaine	Professeur, Université Paris 1

EXAMINATEUR :

Phu Nguyen-Van	Chargé de recherche CNRS, Université de Strasbourg

UNIVERSITÉ DE STRASBOURG

Faculté des Sciences Économiques et de Gestion

ESSAIS SUR LES FIRMES HÉTÉROGÈNES ET LA PRODUCTIVITÉ DES IMPORTATEURS ET DES EXPORTATEURS

Un thèse présentée pour l'obtention du grade de

Docteur en Sciences Économiques

par

FRÉDÉRIC OLLAND

3 décembre 2014

JURY

Flora BELLONE	Rapportrice externe	Professeur, Université de Nice
François FONTAINE	Rapporteur externe	Professeur, Université de Paris 1
Bertrand KOEBEL	Directeur de thèse	Professeur, Université de Strasbourg
Phu NGUYEN-VAN	Examinateur	Chargé de recherche, BETA-CNRS

UNIVERSITÉ DE STRASBOURG

Faculté des Sciences Économiques et de Gestion

ESSAYS ON FIRMS' HETEROGENEITY AND THE PRODUCTIVITY OF EXPORTERS

A thesis presented for the degree of

Doctor of Philosophy in Economics

by

FRÉDÉRIC OLLAND

December 3rd, 2014

JURY

Flora BELLONE	External referee	Professor, University of Nice
François FONTAINE	External referee	Professor, University of Paris 1
Bertrand KOEBEL	Ph.D supervisor	Professor, University of Strasbourg
Phu NGUYEN-VAN	Examiner	Researcher, BETA-CNRS

Remerciements

Écrire une thèse est un processus long et fortement non-linéaire. Il y a ces périodes d'enseignement où le temps vous manque, ces organisations de colloques qui vous désorganisent, ou simplement ces périodes de doutes et de questionnements sur le bien fondé de la modélisation économique. Le monde de la recherche académique et la façon dont il fonctionne ne sont pas une évidence pour un néo-doctorant, et l'apprentissage se fait au fil du temps. Au bout du compte, on rend un travail dont on est fier, mais jamais complètement satisfait.

Heureusement, ce long chemin, on ne le parcourt pas tout seul. Au Bureau d'Économie Théorique et Appliquée, et à la Faculté des Sciences Économiques et de Gestion de Strasbourg, j'ai profité d'un environnement et d'une ambiance de travail exceptionnels. J'ai eu la chance de rencontrer des collègues qui sont devenus des amis et les fréquenter au quotidien durant ces quatre années a été un élément de motivation supplémentaire. J'ai particulièrement apprécié refaire le monde avec Benjamin, Bruno, Emre, Faustine, Guillaume, Nguyên (œil), Marlène, Mickael, Roberto, Sila ou encore Thomas. J'ai adoré former le *Cournot Band* le temps d'un concert de Noël avec Thierry et Jean-Philippe et Florence. J'ai passé de bons moments avec Camille, Christian, Cyrielle, Lesya, Lionel, Nùria, Nicolas, Qiao, Tim, Valérie, Vincent, Wallyia et Xi. Parmi ces collègues, je veux remercier Audrey-Rose Menard en particulier. J'ai partagé avec elle les bonnes et les moins bonnes périodes de la thèse, depuis nos débuts en octobre 2010. Audrey a été un soutien incomparable et permanent qui m'a permis d'arriver au bout.

L'écriture en elle-même de cette thèse a bénéficié du concours de beaucoup de personnes. En premier lieu mon directeur de thèse, Bertrand Koebel. Ses conseils ont été précieux et appréciés à leur juste valeur. Son travail rigoureux et son perfectionnisme ont rendu cette thèse bien meilleure. Avec ce Bertrand là, j'ai pu maximiser la qualité de mon travail, et si à long terme, cette thèse n'est pas pure et parfaite, la faute m'en incombe.

Je tiens aussi à remercier Xi Chen. Co-écrire avec Xi a été ma meilleure expérience de recherche. J'ai beaucoup appris sur l'économétrie à son contact et cette thèse lui doit beaucoup. Dans ce domaine qu'est l'économétrie, j'ai aussi pu profiter du savoir des meilleurs. Outre Bertrand et Xi, Frédo Jean-Baptiste, Roberto Martino, Phu Nguyen-Van m'ont apporté de précieux conseils. Bruno Rodrigues m'a aussi apporté ses connaissances sur les ordinateurs et la programmation, moi qui préfère habituellement démontrer des résultats avec une feuille de papier et un stylo. Je remercie également tout ceux qui ont participé à la relecture de cette thèse, et tout particulièrement Faustine Perrin et Nicolas Olland, qui ont dépensé un temps dont ils ne disposaient pas forcément. Les judicieux conseils de Faustine et sa disponibilité ont été importants en cette période de fin de thèse.

Le temps est un actif intangible précieux, et je remercie également Flora Bellone, François Fontaine et Phu Nguyen-Van d'avoir accepté de prendre du leur pour juger ce travail et venir le discuter à Strasbourg.

Je finirai, c'est une évidence, par remercier chaleureusement mes parents. Ils m'ont soutenu sans faillir depuis le premier jour de mes études et même bien avant déjà. Cette thèse est aussi un peu la leur.

Résumé

L'étude de l'économie internationale a une longue histoire en sciences économiques. On cite souvent David Hume comme ayant été le premier à utiliser la modélisation pour exposer sa théorie d'ajustement des stocks d'or, dans son essai *Of the balance of trade*, publié en 1758. D'autres auteurs tels que Adam Smith ou David Ricardo l'ont imité ensuite. Toutes leurs théories avaient pour but de comprendre les mécanismes liés à l'échange de marchandises, entre des États souverains. Dans la théorie de l'avantage comparatif de David Ricardo comme dans les modèles avec avantages relatifs *à la* Heckscher et Ohlin, tout repose sur l'idée d'un commerce entre pays. A aucun moment, on n'y voit apparaître l'entreprise comme un acteur de l'échange. Or ce sont bien les entreprises qui sont au cœur du marché international et qui sont les principaux échangeurs de marchandises. Les premiers modèles de commerce international à les intégrer sont relativement récents (Helpman and Krugman, 1985). On y réfère souvent comme étant la *nouvelle théorie du commerce international*. Ces modèles ont l'avantage de pouvoir expliquer pourquoi il existe du commerce à l'intérieur même de chaque industrie (commerce intra-branche), là où les modèles classiques *à la* Ricardo et Heckscher-Ohlin impliquaient une nécessaire spécialisation des économies. Les firmes sont considérées comme identiques ayant pour but de maximiser leurs profits. Finalement, chaque entreprise représentative exporte une part fixe de sa production, qui dépend des coûts et de la demande du marché. L'avancée est incontestable mais un regard sur la situation des entreprises soulève de nouvelles questions, plus microéconomiques. Pourquoi

existe-t-il des entreprises purement domestiques, pourquoi certaines exportent ? Melitz (2003), propose de répondre à ces questions en abolissant l'hypothèse d'existence d'une entreprise représentative au profit d'entreprises hétérogènes. Selon cette théorie, chaque firme est différente par sa productivité. Certaines – les plus productives – ont les capacités d'affronter le marché international. D'autres peuvent générer du profit, mais uniquement sur le marché domestique. Enfin, les moins productives ont des coûts trop importants et arrêtent immédiatement de produire. La recherche académique portant sur les firmes et leur place dans le commerce international a été abondante depuis le début des années 2000 et l'article fondateur de Melitz (2003).

Empiriquement, la recherche sur ce sujet est elle aussi foisonnante, facilitée par la disponibilité croissante des données d'entreprises. Ces études ont confirmé l'existence de différences de performance entre les entreprises. Plus précisément, elles ont prouvé que les entreprises exportatrices étaient en moyenne plus productives, plus grandes, plus intensives en capital, employaient plus de salariés et à des salaires plus élevés que les entreprises qui n'exportent pas (Bernard and Jensen, 1999). Il a aussi été montré que ces faits stylisés caractérisent également les entreprises importatrices. Le sens de la causalité entre statut international de l'entreprise et performance a été beaucoup discuté. Les entreprises sont-elles plus performantes parce qu'elles exportent ou importent ? Ou sont-ce les entreprises les plus performantes qui s'auto-sélectionnent sur le marché international ? Bien que les deux sens de causalité ne s'excluent pas mutuellement, il semblerait qu'il soit moins facile de démontrer le phénomène d'apprentissage que le phénomène de sélection.

Cette thèse s'inscrit dans cette littérature et tente d'apporter des contributions à la fois théoriques et empiriques.

Le premier chapitre comporte une revue de littérature ainsi qu'une description des données utilisées dans la thèse. La revue de littérature vise à présenter les principales contributions empiriques et théoriques qui vont être utilisées dans les trois chapitres suivants. La description des données donne un aperçu du panel utilisé, fourni par l'INSEE et les services des douanes. Empiriquement, ce premier chapitre revient sur les évidences qui ont été apportées de la supériorité des exportateurs sur les non exportateurs en terme de productivité, de ventes, d'emploi et de salaires (Bernard and Jensen, 1995, 1999), avant de s'intéresser au sens de causalité. Les exportateurs sont-ils plus productifs parce qu'ils exportent ? Ou exportent-ils parce qu'ils sont plus productifs ? La littérature semble pencher pour la deuxième hypothèse, celle de l'auto-sélection sur le marché international. Les entreprises les plus productives sont les seules en mesure de supporter les "coûts fixes irrécupérables" associés à l'exportation: adaptation des produits, recherches de réseaux de distribution, etc. Les Chapitres 4 et 5 de cette thèse s'inscrivent dans ce débat.

La partie théorique présente d'abord le modèle de Melitz (2003), qui sera repris dans les Chapitres 3 et 5 de la thèse. Elle revient ensuite sur les différents développements de ce modèle qui concernent la structure des coûts des entreprises (utilisés dans le Chapitre 5) ou encore les asymétries et la croissance (utilisés dans le Chapitre 3). Une présentation des données est faite en fin de chapitre. Elle montre l'activité de la France dans le commerce mondial avant de s'intéresser de plus près aux activités des entreprises elles-mêmes : combien exportent ? Quelle part de leurs ventes ? Vers quels pays ? Survivent-elles longtemps à l'activité internationale ? Une analyse du panel d'entreprises permet de répondre à ces questions. Ce panel est construit à partir de données d'entreprises de la base *Enquête annuelle d'entreprises* fournies par l'INSEE pour la période 1996-2007 ainsi que des données import/export du service des douanes françaises, disponibles pour les années 1994-2012.

Le deuxième chapitre a pour objectif de contribuer à la littérature théorique. En intégrant des asymétries dans un modèle de croissance avec hétérogénéité des entreprises (Gustafsson and Segerstrom, 2010), la lumière est mise sur les effets d'une libéralisation du commerce sur une économie technologiquement avancée et une économie technologiquement en retard. A court terme, le pays avancé profitera plus fortement de la libéralisation du commerce, parce qu'il sera plus facile pour ses entreprises d'exporter. A long terme en revanche, il pourrait y avoir un effet négatif sur l'incitation des entreprises à innover, sur l'investissement, et donc sur la croissance dans le pays le plus avancé. Un effet de rattrapage a lieu et le niveau de l'économie en retard se rapproche du niveau de l'économie avancée. Je démontre aussi que l'efficacité d'un pays dans le domaine de la recherche et développement joue un rôle important dans la détermination des effets précédemment cités.

Dans le troisième chapitre, le phénomène de *l'apprentissage par l'exportation* est étudié. Les entreprises qui interviennent sur le marché international (en important ou en exportant) deviennent-elles plus productives ? Cette étude empirique reprend le panel d'entreprises françaises cité plus haut, afin d'identifier un tel effet. La méthode économétrique utilisée est assez singulière. Elle reprend l'idée de De Loecker (2013) et estime l'apprentissage par l'exportation directement via une estimation de productivité *à la* Olley and Pakes (1996) et Levinsohn and Petrin (2003). Les résultats suggèrent non seulement qu'exporter permet de rendre les entreprises plus productives, mais aussi qu'importer peut avoir des effets encore plus bénéfiques.

Dans le quatrième et dernier chapitre, nous nous intéressons à la structure des coûts des entreprises et plus particulièrement aux coûts fixes liés à l'exportation. Ces coûts sont généralement considérés comme étant identiques pour toutes les entreprises dans la littérature théorique. Dans ce chapitre, nous relâchons cette hypothèse. Nous montrons dans un premier temps que les coûts fixes d'entrée sont bien existants pour les entreprises qui souhaitent exporter. Dans un deuxième temps, notre analyse empirique montre que ces coûts ont une dimension individuelle non négligeable. Précisément, la productivité individuelle des firmes affecte le coût fixe d'entrée sur le marché international. A partir de ce constat, nous développons un modèle *à la* Melitz (2003) dans lequel les coûts d'entrée sont hétérogènes. Nous démontrons que selon le degré d'ouverture de l'économie, cette hétérogénéité peut avoir des effets positifs ou négatifs sur le niveau agrégé de productivité.

Enfin, la conclusion de cette thèse aborde quelques thèmes qui sont l'objet de mes actuelles recherches.

Contents

List of Figures

List of Tables

1 General Introduction

1.1 Firm heterogeneity in international trade

Research in international trade has a rather long history. We often attribute the first economic model to David Hume in his essay, *Of the balance of trade*, published in 1758 (Krugman, 2012). After him, other authors like Adam Smith in *The Wealth of Nation* or David Ricardo in *On the Principles of Political Economy and Taxation* constructed economic models for investigating issues related to gains from trade. In Adam Smith's theory of *absolute advantage* – as in David Ricardo's *comparative advantage* one – the actors of international trade are countries and gains from trade are considered at the level of sovereign states. More recently, Ricardian models *à la* Heckcher, Ohlin and Samuelson rely on countries' endowments in labour and capital to explain the volume of trade. These models emphasise the inter-industry aspect of trade and imply a necessary specialisation of asymmetric economies in industries in which they have a relative advantage. A first drawback of these models is that they remain silent on the intra-industry aspect of trade. Looking at trade data, economists observed that most trade actually occurs between similar countries, with similar factor endowments. A second drawback is the absence of firms, while they appear to be – more than countries – the main players of international trade.

The first models of international trade integrating firms are relatively recent (Helpman and Krugman, 1985). One refer to this literature as the *New Trade Theory*. This theory is able to explain intra-industry trade by assuming that firms produce with increasing returns to scale in imperfect markets. However, firms are considered as identical, and modelled as a *representative firm* that maximises its profit. As a result, all firms are exporters and export a constant share of their production, according to the technology and the market demand. The step forward is substantial, but the theory still fails when it comes to explaining particular microeconomic facts relative to firms' behaviours. Why do some firms export? Why do some firms remain pure domestic producers? Data reveal that only a small share of firms actually engage in international markets, and when they do, they export a relative small share of their production (Bernard and Jensen, 1995).

Melitz (2003) proposes a model in which the representative firm is replaced by heterogeneous firms, each firm being characterised by a different productivity. The most productive ones self-select into the international market. Others generate profits, but only within the domestic market. Finally, the less productive firms directly stop producing. Since the pioneer paper of Melitz (2003), academic research on firms in international trade is abundant. Empirically, the growing availability of micro-level data allows to analyse differences in firms' performances, characteristics and market participation decisions. The findings are that exporting firms are bigger, more productive, more capital intensive than non exporting firms. They also employ more workers and pay higher wages (Bernard and Jensen, 1999). This result is also valid for importing firms. Nevertheless, the direction of causality between the decision to import or export and firms' performances have been widely discussed. Do more productive firms self-select into international markets? Or do firms become more productive because they enter international markets? Although both approaches are not mutually exclusives, it appears easier to bring evidence for the selection effect than for the learning effect.

This thesis fits into this literature and attempts to contribute both theoretically and empirically.

1.2 Contribution of the thesis

This thesis contains four chapters.

Chapter 2 introduces the literature that considers firms at the center of international trade. It includes both empirical and theoretical contributions to the literature. This chapter also provides a description of the data used in the thesis.

On the empirical side, this chapter examines the superiority of exporters over non-exporters, in terms of productivity, sales, employment and wages (Bernard and Jensen, 1995, 1999), before discussing the direction of causality. Most findings confirm the existence of a selection process: only the most productive firms are able to bear sunk entry costs associated with international trade. However, the results on learning-by-exporting are more controversial. Both learning and self-selection effects are studied in Chapters 3 and 4, respectively.

The theoretical part of the chapter aims at providing insights from the pioneer model of Melitz (2003). This model will serve as a basis for Chapters 3 and 5. Then, it presents different developments of this model. I notably focus on developments related to fixed cost structure (Chapter 5), or asymmetries and growth (Chapter 3).

The description of the data gives an overview of our firm-level panel, provided by the *Institut National de la Statistique et des Études Économiques* (INSEE) and the French Custom Services. The dataset comprises information on French manufacturing firms with at least 20 employees for the period 1996-2007. It presents French firms' activities in international trade. How many of them are traders? How much do they trade? To/from which countries? A panel data analysis allows to answer these questions.

Chapter 3 is a theoretical contribution to the literature on trade between asymmetric countries. Since the 1980's and the New Trade Theory, the models usually consider trade between two symmetric countries. The growth model of trade presented by Grossman and Helpman (1991) is an example. Melitz (2003) also considers two symmetric countries in his heterogeneous firm model. I this chapter, I use an endogenous Research and Development (R&D) driven growth model of trade with heterogeneous firms, as in Baldwin and Robert-Nicoud (2008) and Gustafsson and Segerstrom (2010). This allows to study both the short-run effect and the long-run effect of trade liberalisation. However, unlike the previous quoted authors, I investigate the different productivity growth path when countries are different in: (i) size, (ii) technology, and (iii) R&D capabilities.

In the short run, I find that an advanced country in terms of technology and/or R&D capabilities benefits more from trade liberalisation because the market is less competitive in the foreign country. At the intensive margin, exporters from the advanced country can win market shares in the foreign country. At the extensive margin, it becomes easier for non-exporters to enter the foreign market. However, in the long run, trade liberalisation has a negative impact on innovation intensive of firms. As the markets are becoming more competitive, the expected profits of entry are reduced and potential entrants invest less in R&D. Here, the advanced country suffers more then the laggard one. The productivity level in the laggard economy catches the level of the advanced economy up.

In Chapter 4, I study the learning effects of trade. I explore the following question: Are firms becoming more productive because they start to trade? In that purpose, I rely on a methodology based on the production function estimation developed by De Loecker (2013). I consider an endogenous productivity process that allows the previous trade status of the firms to impact future productivity levels. Many empirical works on the learning effects of trade focus on learning-by-exporting. A particularity of this chapter is that it also provides results on learning-by-importing.

I find that French firms significantly experience both learning-by-exporting and learning-by-importing, in almost all manufacturing sectors. In addition, I show that the effects are stronger for firms that start to import. This finding supports the theoretical prediction that technology transfer is a strong channel of learning.

In the last chapter of this thesis, we focus on the fixed cost structure. More precisely, we examine the fixed costs associated with export market entry. In the existing literature, these costs are often considered to be symmetric across firms (as in Melitz, 2003). In this chapter, this hypothesis is relaxed and we allow for heterogeneous fixed costs. Using an empirical strategy based on the treatment evaluation techniques with matching, the estimations show that the fixed entry costs (that are usually sunk) are significant for newcomers in the export market. The results confirms the findings of Roberts and Tybout (1997). Second, we evidence that these sunk costs are firm-specific and depend significantly on firm's productivity (TFP).

With this working assumption, we develop a model *à la* Melitz (2003) in which the sunk entry costs in the export market are heterogeneous across firms. In particular, it becomes a function of firm productivity. With this framework, we show that the model of Melitz (2003) can yield biased predictions on the self-selection mechanism, and therefore the extensive margin of trade.

2 Firms in International Trade

2.1 Introduction

A large literature looking at firm-level performances emerged with the growing availability of micro data at firm and plant level during the past 20 years. Specifically, the relationship between firms' characteristics and export performances has been widely studied since the seminal paper of Bernard and Jensen (1995). Empirical results show that exporters are larger, more productive, more capital intensive and pay higher wages than non-exporters. Intuitively, the causality of the relationship between export activities and performance is unclear, and this issue is widely discussed in the literature. There are basically two hypotheses: (i) the *learning-by-exporting* hypothesis, i.e. a post-entry increase in firms' productivity due to firms' exporting experience, and (ii) the *self-selection* hypothesis, i.e. export market entry decisions are governed by pre-entry productivity differences between active firms. Of course, these two hypotheses are not mutually exclusive. However, if there is now a large consensus about self-selection, the empirical evidence on learning-by-exporting are restricted to some precise groups of firms, in specific industries or specific countries. Self-selection is more easily testable and has a more intuitive explanation: firms face an additional cost to enter the export market, so that only the more productive ones can bear this cost and start to export. The important paper of Roberts and Tybout (1997) shows the importance of fixed entry costs for the international markets.

The two evidences (i) that exporters are more productive than non-exporters, and (ii)

that there exist some entry costs to export, are the key elements of theoretical models with firm heterogeneity, the so-called "new new trade theory" that arose in the beginning of the years 2000. The pioneer paper from Melitz (2003), uses heterogeneity in labour productivity and sunk entry costs in order to reconcile international trade models with firms-level evidence. Bernard et al. (2003) model firms heterogeneity by introducing Bertrand competition in a Ricardian model of trade. In both models, all firms do not necessarily export (as it is the case with the representative firm in new trade theories) and the most productive ones self-select into the export market. These models have become workhorses, developed in many directions in order to give new insights on international trade, with the ability to catch micro-economic as well as macro-economic evidence.

This chapter provides an overview of the literature on firms in international trade that is necessary for a good comprehension of the remainder of this thesis, and that is consistent with the content of the next chapters. This chapter is organised as follows: Section 2.2 deals with the empirical research on export performances, fixed entry costs and productivity. First, I present the standard methods used to identify learning-by-exporting and self-selection. Second, I review evidence that have been found on learning-by-exporting before going through the self-selection hypothesis and the possible explanations of it. Third, I describe the link between imports and productivity. Section 2.3 deals with the theories of heterogeneous firms. After a review of the basic structure of the Melitz (2003) model (that is used in chapter 3 and chapter 5 of the thesis), I expose some developments that will be useful for the comprehension of this thesis. In particular, I focus on the extensions of the model that concern asymmetries, survival and exit, growth, and the costs structure. The last two sections describe the French data used in the thesis and provides some descriptive statistics about France in international trade, the French firms and their behaviour in the international market.

2.2 Trade and productivity

Since the seminal paper of Bernard and Jensen (1995), numerous papers use firm-level data to identify an *export premium*, mostly in terms of productivity, productivity growth, employment and wages (Aw and Hwang, 1995; Clerides et al., 1998; Bernard and Jensen, 1999). The *export premium* is simply the performance differences between the firms that export and the firms that do not export. The performance measures can be productivity, sales, wages or size. Formally, the export premium is the average percentage difference between exporters and non-exporters. It can be estimated by β in the following regression:

$$\log(Y_{it}) = \alpha + \beta \text{Export}_{it} + \gamma \text{Control}_{it} + e_{it} \tag{2.1}$$

where Y_{it} is a measure of performance (e.g. TFP, labour productivity, employment, wages paid, etc.), Export_{it} is a dummy variable for the export status of the firm i, and Control_{it} is a set of control variables that usually contains indicators about industry and size. From these studies, it is admitted as evidence that "exporters are larger, more productive, more capital-intensive, more technology-intensive, and pay higher wages". In short, "exporters are better" (Wagner, 2007).

However, the underlying issue of this result concerns the direction of causality between export decision and performances. Do exporting firms become more productive after entering the export market (learning-by-exporting) or is it only the most productive firms that become exporters (self-selection)? Although these two approaches are not mutually exclusive, recent developments of the empirical literature underline the importance of self-selection whereas the conclusion on learning-by-exporting are more controversial. We note that not only exports are important for explaining the productivity gains from trade. There is also an *import premium*, and this premium matters on the domestic market as well as the export market. This chapter focuses on the link between trade and productivity, and does not survey research on other aspect of international economics such as the *foreign direct investment*-productivity relationship.

2.2.1 Learning-by-exporting? Case-studies and micro-data studies

In the literature, studies on learning-by-exporting use two different approaches: the case-studies and the firm-level data analysis. On the one hand, researchers focused on case-studies to evaluate the impact of exporting on firm's productivity. In the mid-eighties, several papers used direct feedback from exporting firms (in developing countries, mainly) in order to identify any benefit of exporting on their productivity (see Westphal et al. (1979), Rhee et al. (1984) for Korean firms; and Silva et al. (2012a) for a review of case studies). The conclusion of these studies is that exporting firms can benefit and learn from their relation with foreign buyers, suppliers, or even competitors. They can have access to information, knowledge and technologies that help them to improve product quality and design, production process or market knowledge. It gives them an edge compared to the domestic producers when it comes to productivity.

Two main problems arise with this kind of studies. First, the sample is small and selection of firms is biased towards relatively big firms (compared to the countries average) that are more likely to benefit from strong partnership with foreign firms. Second, these studies focus on developing countries and could hardly be generalised to developed countries that are technologically advanced and may not benefit that much from foreign buyers and suppliers. However, these studies give good intuitions on the channel through which firms may learn from exporting.

On the other hand, a more recent approach appeared along with the availability of large micro dataset at the plant-level or at the firm-level. In practice, different ways have been used to identify learning-by-exporting with plant-level data. The standard one consists in evaluating the *export premium* for the new entered firms and is estimated by adding fixed effect to control for plant heterogeneity between different years. The estimated equation becomes:

$$\log(Y_{it}) - \log(Y_{i0}) = \alpha + \beta_1 \text{Start}_{it} + \beta_2 \text{Export}_{it} + \beta_3 \text{Stop}_{it} + \gamma \text{Control}_{it} + e_{it} \tag{2.2}$$

where Start_{it}, Export_{it} and Stop_{it} are dummy variables equal to one if the firm starts exporting between the two periods 0 and t, exports in the two periods or stop exporting between the two periods, respectively. From this equation, one can analyse separately the performances of the three types of firm. β_1 represents the contribution to the average growth of the performance variable Y_{it} of the new exporters relative to non-exporters between both years. Following Bernard and Jensen (1995), many papers use this technique with different estimation techniques: for example Clerides et al. (1998) use GMM estimator. Other more structural approaches have also been used in the literature. Delgado et al. (2002) look whether there is stochastic dominance of the productivity distribution of the exporters over non exporters.

De Loecker (2013) uses a non-parametric estimator and integrates directly exports in the estimation of productivity. In chapter 4, I use this estimation technique to evaluate a potential "learning-by-trading" for French firms.

Estimating learning-by-exporting implies to deal with the selection bias of new exporters. In addition, the pre-entry and post-entry effects are hardly identified with the standard approach described above. If better firms become exporters, it is not surprising that they remain better after entering the export market. An important approach to avoid sample selection problems is the matching method, largely used in the literature (Wagner, 2002; Girma et al., 2003, 2004; Arnold and Hussinger, 2005; Fernandes and Isgut, 2005; Alvarez and López, 2005; De Loecker, 2007).[1] The idea of such a method is to separate the data sample between firms starting to export (*treated* group) at a certain period of time and firms remaining purely domestic sellers (*control* group) at this period. Matching each treated firm with a non-treated one on a vector of observed characteristics X (usually productivity, size, sector) allows to obtain pairs of firms that are – except for the export market participation (which is the treatment variable), – as similar as possible. Finally, the Average effect of the Treatment on the Treated (ATT) – which is the effect of the decision to start to export on the newly exporter – can be estimated. Formally, the ATT can be written as:

$$\begin{aligned} ATT &= E\left[Y_{1it} - Y_{0it} \mid X_{it}, D_i = 1\right] \\ &= E\left[Y_{1it} \mid X_{it}, D_i = 1\right] - E\left[Y_{0it} \mid X_{it}, D_i = 1\right] \end{aligned} \tag{2.3}$$

where Y_{1it} is the performance of newly exporters i at period t, Y_{0it} is the performance of purely domestic producers i at period t, and D_i is the export status of firm i. The first term in the right-hand side of equation (2.3) is the average performance of the newly exporters that can directly be computed regressing Y on X for the treated group. The second term is the average performance of non-exporters, had they started exporting. The latter is a counter factual case and it cannot be observed. Using the matching techniques, one can select an appropriate control group (with same characteristics X_{it} as the treated group), that allows the substitution of the unobserved $E\left[Y_{0it} \mid X_{it}, D_i = 1\right]$ by the observed $E\left[Y_{0it} \mid X_{it}, D_i = 0\right]$, without creating a bias. If matching quality is sufficient, we obtain a consistent estimator of

[1]This method is commonly used in labour market research (see for example Heckman and Hotz (1989)).

ATT. This ATT, in turn, can be interpreted as learning-by-exporting.

Can we identify clear evidence from all these studies? Some studies report LBE, others do not. We can hardly draw a big picture about what we know (Wagner, 2007). Martins and Yang (2009) performed a meta-study on 30 published papers using various countries, various time periods and various methodologies. They found quite robust results: the impact of export on productivity is higher (*i*) in developing countries, (*ii*) in the first years of exporting, and (*iii*) in selected industries. LBE doesn't seem to be a generalised phenomenon but it can be specific to countries, industries, or groups of firms. A lot of research has still to be conducted in this area. Silva et al. (2012a) suggest that "future development and studies may focus on the analysis of particular learning channels instead of analysing learning-by-exporting in an abstract way".

2.2.2 The concept of self-selection and its causes

I turn now to the alternative hypothesis of why exporters are more productive than non-exporters, namely the self-selection. To empirically test the presumed superiority of exporters before they enter the foreign market, the standard method consists in comparing the productivity of non-exporters and exporters before they start exporting. The regression, used in Bernard and Jensen (1999), is a variant of (2.1):

$$\log(Y_{it-n}) = \alpha + \beta \text{Export}_{it} + \gamma \text{Control}_{it-n} + e_{it} \tag{2.4}$$

where Y_{it-n} is the measure of performance of firm i at period $t-n$. β measures how future exporters outperform non-exporters, n years before entering the foreign market.[2] Almost all studies on this issue have proven the existence of a self-selection process (for example Clerides et al. (1998); Bernard and Jensen (1999, 2004); Isgut (2001); Delgado et al. (2002); Girma et al. (2004); Alvarez and López (2005)). The intuition behind this evidence is straightforward: only more productive firms start to export because they are able to pay the extra costs associated with exporting. These costs might be of different nature. Transportation costs (sometimes called iceberg trade costs in the literature) are one of them. But we can also

[2] One can also compare the growth of productivity the years before the exporter starts exporting with the following specification: $\log(Y_{it-1}) - \log(Y_{i0}) = \alpha + \beta \text{Export}_{it} + \gamma \text{Control}_{i0} + e_{it}$. Here, β represents how future exporters grow compare to non-exporters the years before they starts exporting.

think of costs of establishing a distribution network or costs of adapting products to foreign tastes. These are called "sunk" costs and constitute a barrier to export market entry, that only more productive firms can bear. The idea of the sunk costs appeared in the literature with theoretical models of Baldwin (1988, 1989); Dixit (1989b) and Krugman (1989). Their hypothesis was that the sunk entry costs, once paid by the firm, create hysteresis on the market: it can be an optimal choice for a forward-looking firm with no positive operating profit in the export market yet, to continue exporting. Furthermore, previous export participation can reduce the sunk costs of re-entering a foreign market, suggesting that previous export experiences increase the probabilities to export again. These theories have led researchers to try to empirically test the existence of the sunk costs, to quantify the effects of previous export market participation and to evaluate the impact of different firms' characteristics on export decision. In an important paper, Roberts and Tybout (1997) define a standard approach using a dynamic discrete choice to model firms' export participation:

$$Y_{it} = \begin{cases} 1 & \text{if } \pi_{it} - F_i^0 + F_i^0 Y_{it-1} \geq 0 \\ 0 & \text{otherwise} \end{cases} \tag{2.5}$$

where Y_{it}, the export participation decision for the firm i at time t, depends on the profit of the firm, π_{it}, the sunk entry costs, F_i^0, and the past export participation decision, $F_i^0 Y_{it-1}$.[3] They found that sunk costs are significant as well as previous export experiences in explaining the export decision. Bernard and Jensen (2004) and Campa (2004) also validate the sunk cost hysteresis assumption for US and Spanish plants, respectively, and previous export experiences seem to dramatically increase the probability of being an exporter. Das et al. (2007) incorporate the two aspects of trade behaviour, namely the participation and the volume in order to quantify the sunk costs and to provide a series of policy recommendations. Their simulations point out that the policies targeting export revenues are much more effective than entry cost subsidies.

An other important and related explanation of the self-selection process is the "conscious self-selection". Forward-looking domestic firms having export activities in mind invest in technology to improve the quality of their products in order to fit the tastes and quality stan-

[3] Note that firms that export at the period $t-1$ earn π_{it}.

dards of the foreign consumers. In so doing, they improve their productivity to perform well enough to overcome sunk entry costs and to face fiercer competition in the international market. This hypothesis could explain the higher productivity growth of future exporters over the domestic producers (Alvarez and López, 2005; Eliasson et al., 2012). Bellone et al. (2008) show that the productivity dynamic of new French exporters is U-shaped. They suggest that firms first make investments to prepare themselves to become exporters. Iacovone and Javorcik (2012) find that future exporters prepare themselves to export by improving the quality of their product. This gives them a price premium on their domestic market. Lileeva and Trefler (2010) find a simultaneity between firms' export decisions and investment decisions. While starting exporting, firms tend to invest in product innovation, and adopt more advanced technologies. Decisions of exporting and investing seem to be correlated and it is difficult to identify the two effects separately. In chapter 3, I try to decompose these two effects by estimating learning-by-exporting together with the production function.

2.2.3 The importance of Imports

More recent developments focus on additional sources of productivity. International trade does not consider only export activities, but also import activities. At the macroeconomic level, economic theory states that developing countries benefit from the imports of goods from industrialised countries, through technology adoption and the diversification of variety (Grossman and Helpman, 1991). Is it the same dynamic at the firm level? Does a firm benefit from the supplier technology or from the increased number of intermediate input available? The lack of imported material inputs in the basic Melitz (2003) model is one of the reason why imports have been studied a lot less than exports at the firm level. However, some studies report that an import premium also exists, and that importers are more productive than non-importers (Kasahara and Rodrigue, 2008; Bernard et al., 2007; Muûls and Pisu, 2009; Castellani et al., 2010; Vogel and Wagner, 2010; Bekes et al., 2009; Amiti and Konings, 2007). Of course, the discussion on the direction of the causality also applies here. Does more productive firms import because of self-selection? Is there any learning-by-importing effect? Or both? As for export, econometricians have positive conclusions about self-selection. Finding foreign suppliers and establishing contracts with them is costly. Only firms that are efficient enough can bear the sunk costs associated with importing. As for exports, the learning-by-importing channels are still hard to prove properly. However, intuitively, engaging in import activities may help to improve productivity: firms that start to import do so because they benefit either from a drop of their costs or from a rise in the intermediate input quality. They can also expect positive spillovers from their new partnership through product innovations. Eaton and Kortum (1999) argue that three quarters of innovative ideas are taken from abroad. Increasing the number of varieties used in the process of production may also be an advantage (Halpern et al., 2005; Bas and Strauss-Kahn, 2010). It is, in fact, more intuitive to think of technology transfers (as discussed in Grossman and Helpman (1991) for example) as the result of imports of more technology-intensive goods. Learning-by-importing might be easier to extract from data analysis than learning-by-exporting.

Most of the studies on the imports-productivity relationship also look at the exports-productivity one. They find a hierarchy: two-way traders are the most productive firms; they outperform one-way traders (either only importing or only exporting firms); non-trading firms are the least productive (Muûls and Pisu, 2009; Castellani et al., 2010; Vogel and Wagner, 2010; Kasahara and Lapham, 2013). Interestingly, imports seems to have a positive effect on export sales. However, exporting does not raise the probability of starting to import (Aristei et al., 2013). Because of this relationship between the imports and exports, Kasahara and Lapham (2013) state that: "policies which inhibit the importation of foreign intermediates can have a large adverse effect on the exportation of final goods".

2.3 Theory of heterogeneous firms

Some features and stylised facts of international trade are not explained and are "missing" in the new trade theory model developed by Helpman and Krugman (1985), and Krugman (1989) in the eighties. Representative firms export a constant share of their production, equally distributed across all destinations. Obviously, this assumption constraints the analysis of international trade, the (potential) gains from trade and the analysis of the role played by firms. In particular, due to the use of a representative firm in previous trade models, it is impossible to explain: (*i*) the coexistence between exporters and purely domestic firms, (*ii*) the small fraction of exporters, (*iii*) the different productivity of firms, and (*iv*) the export productivity premium (or other measures of performances) of exporters.

Two approaches introducing firm heterogeneity appear at the beginning of the 2000's, with Bernard et al. (2003) and Melitz (2003). Bernard et al. (2003) use a multi-country Ricardian model of international trade with constant return to scale. They combine heterogeneity in firms' efficiency with Bertrand competition: for a particular variety, potential competitors have different productivities and only the lowest-cost supplier survive in a particular country, pricing the good at the second lowest-cost suppliers marginal cost.[4] Variable trade costs ensure the existance of a single supplier per country (and not necessarily a domestic one). As trade liberalisation takes place, the highest productive firms "win" markets, and drive out less productive firms. This, in turn, raises aggregate productivity. A similar reallocation of production mechanism occurs in Melitz (2003). He develops a model with increasing return to scale and Dixit and Stiglitz (1977) monopolistic competition as in Krugman (1989), that is able to account for different types of firms, i.e. exporters and non-exporters. It has become a benchmark framework for recent research in both theory and empirics of international trade. The premises of Melitz' paper can be found in the model of firm entry and exit developed by Hopenhayn (1992b,a). Using productivity shocks and sunk entry costs, Hopenhayn presents a model with a stable steady-state where firms entry in the market exactly compensates firms exit and where job creation compensates job destruction. Melitz (2003) considers a general equilibrium model of international trade that extends Krugman (1989), where imperfect competition takes the form of Dixit and Stiglitz's (1977) monopolistic competition. As in Hopenhayn (1992b), the key features of this model are the presence of entry sunk costs and the exogenous distribution of firms' productivity. There is a positive demand for each variety (because consumers have "love for variety"), each firm chooses to produce if its expected profit is greater than the sunk entry cost. The same mechanism applies for the export market. Each firm chooses to export if its potential export profit is greater than the sunk entry cost of export. Then, there are three types of firm: (i) highly productive firms that can export, (ii) firms that remain purely domestic producers, and (iii) the least productive firms that immediately exit production. With this setting, trade liberalisation leads to an intra-industry reallocation of production: more productive foreign firms are replacing least productive domestic firms, mechanically raising the average productivity. The model is built

[4] They use a probabilistic formulation of technology heterogeneity as in Eaton and Kortum (2002), but with Bertrand imperfect competition instead of perfect competition, so that firms charges different prices and have heterogeneous mark-ups.

on the assumption that firms face fixed production costs. The underlying explanation of export premium chosen by Melitz is clearly self-selection, and the model is completely silent on learning-by-exporting. As the marginal cost (productivity) of firms does not change during its lifetime, there is no possibility of any improvement of productivity due to firm export status.[5]

2.3.1 Presentation of the basic Melitz model

To provide the reader with an insight of the heterogeneous firms framework and to simplify the comprehension of the developments made in chapters 5 and 3, I derive a simple version of Melitz (2003) with two symmetric trading countries.

Demand for variety

The model is built on the model of international trade of Krugman (1989). Consumers have the constant elasticity of substitution (CES) preferences with *love for variety*. They maximise their utility function given by:

$$U = \left[\int_{\omega \in \Omega} q(\omega)^{\alpha} d\omega \right]^{\frac{1}{\alpha}} \tag{2.6}$$

subject to the budget constraint:

$$\int_{\omega \in \Omega} q(\omega) p(\omega) d\omega = E,$$

where $q(\omega)$ is the demand addressed to variety ω, $p(\omega)$ is the price of variety ω and E represents the aggregate expenditures. $\alpha \in [0, 1]$ represents the degree of product differentiation. The elasticity of substitution between products is characterised by $\sigma \equiv 1/(1-\alpha)$. Solving the maximisation problem, we can determine the Marshallian demand function for a variety ω:

$$q(\omega) = p(\omega)^{-\sigma} P^{\sigma-1} E, \tag{2.7}$$

[5]Clerides et al. (1998) were the first to take learning-by-exporting in consideration. In their model, firms productivity is modelled by a stochastic process which is changing if firms participate to the international market. Their empirical results, however, do not provide any evidence for this.

where the aggregate price, P, is defined as the price of the aggregate composite good defined as Q:[6]

$$P \equiv \left[\int_{\omega \in \Omega} p(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}}. \tag{2.8}$$

Producers behaviour

On the production side, there is a continuum of firms. Each firms produce a variety ω, with labour, l, as the only factor of production. As each consumer/worker is endowed with one unit of labour, the aggregate labour L is also a measure of the market size. The technology of the firm is determined by its cost function that depends on a marginal cost, denoted by a, and a fixed production cost f, that is paid every period.[7] To produce q_d units of a variety, the labour used is given by: $l_d(q_d, a) = f_d + q_d a$, where the subscript d refers to the domestic market.

Firms also have the opportunity to export. They face a variable trade cost that takes the classical "iceberg" form: $\tau > 1$ units of a variety has to be shipped for one unit to reach the destination and the fixed cost of production in the export market is f_x.[8] Therefore, $l_x(q_x, a) = f_x + q_x a$ are necessary to produce the q_x units that are sold abroad.

Taking the demands $q_d(\omega)$ and $q_x(\omega)$ for their variety as given, the profit maximisation program of firms consists of setting prices for both the domestic and the export markets:

$$\pi_d(\omega) = \max_{p_d(\omega)} \left[p_d(\omega) q_d(\omega) - w \left(f_d + q_d(\omega) a(\omega) \right) \right]$$
$$\pi_x(\omega) = \max_{p_x(\omega)} \left[p_x(\omega) q_x(\omega) - w \left(f_x + q_x(\omega) \tau a(\omega) \right) \right],$$

where the wage, w, is normalised to 1. The first order condition yields the pricing rules for both markets:

$$p_d(\omega) = \left(\frac{\sigma}{\sigma - 1} \right) a(\omega), \qquad p_x(\omega) = \left(\frac{\sigma}{\sigma - 1} \right) \tau a(\omega). \tag{2.9}$$

As in Krugman (1989), the country-symmetric CES preferences of consumers implies con-

[6]Making the same development, we obtain the demand in the foreign country: $q(\omega) = p(\omega)^{-\sigma} P^{*\sigma-1} E^*$. As we are in a model with symmetric countries, $P^* = P$, and $E^* = E$.

[7]In the paper of Melitz (2003), the productivity parameter φ is used instead of the marginal cost a. I will stick to the marginal cost in order to remain consistent with the notations in the rest of this thesis. The marginal cost is simply the inverse of productivity and to compare with Melitz notations, we have that $a = 1/\varphi$.

[8]All costs are in unit of labour. Subscript x refers to the export market.

stant mark-ups of $(\sigma/\sigma-1)$ for any producing firm.[9] However, the presence of the variable trade cost τ implies the domestic firm to charge a lower price than a foreign firm with equal productivity. With the pricing rules equations given by (2.9) and the demand given by equation (2.7), we can rewrite the domestic and export revenues and profits of firms as a function of their marginal cost:

$$\begin{aligned} r_d(a) &= \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} a^{1-\sigma} P^{\sigma-1} E; \quad \pi_d(a) = \frac{r_d(a)}{\sigma} - f_d; \\ r_x(a) &= \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} (\tau a)^{1-\sigma} P^{\sigma-1} E; \quad \pi_x(a) = \frac{r_x(a)}{\sigma} - f_x. \end{aligned} \tag{2.10}$$

Firm entry and exit

This model is dynamic, and there is market entry and exit at every period.[10] The timing of the model is really important and is summarised by Figure 2.1. At each period, there are potential entrants that have to decide whether or not they incur the fixed starting cost $f_e > 0$ to enter the market. Once they decide to support this cost, firms learn their marginal cost a associated with their variety ω. This marginal cost is exogenously drawn from a distribution $g(a)$ that has positive support over $[0;\infty)$ and a continuous cumulative distribution $G(a)$.[11] It is constant over firms' lifetime. The model is, in a way, solved backwards. We first determine whether or not a given firm makes profits on the different markets. Second, we determine whether or not a potential entrant decides to pay the fixed entry cost f_e.

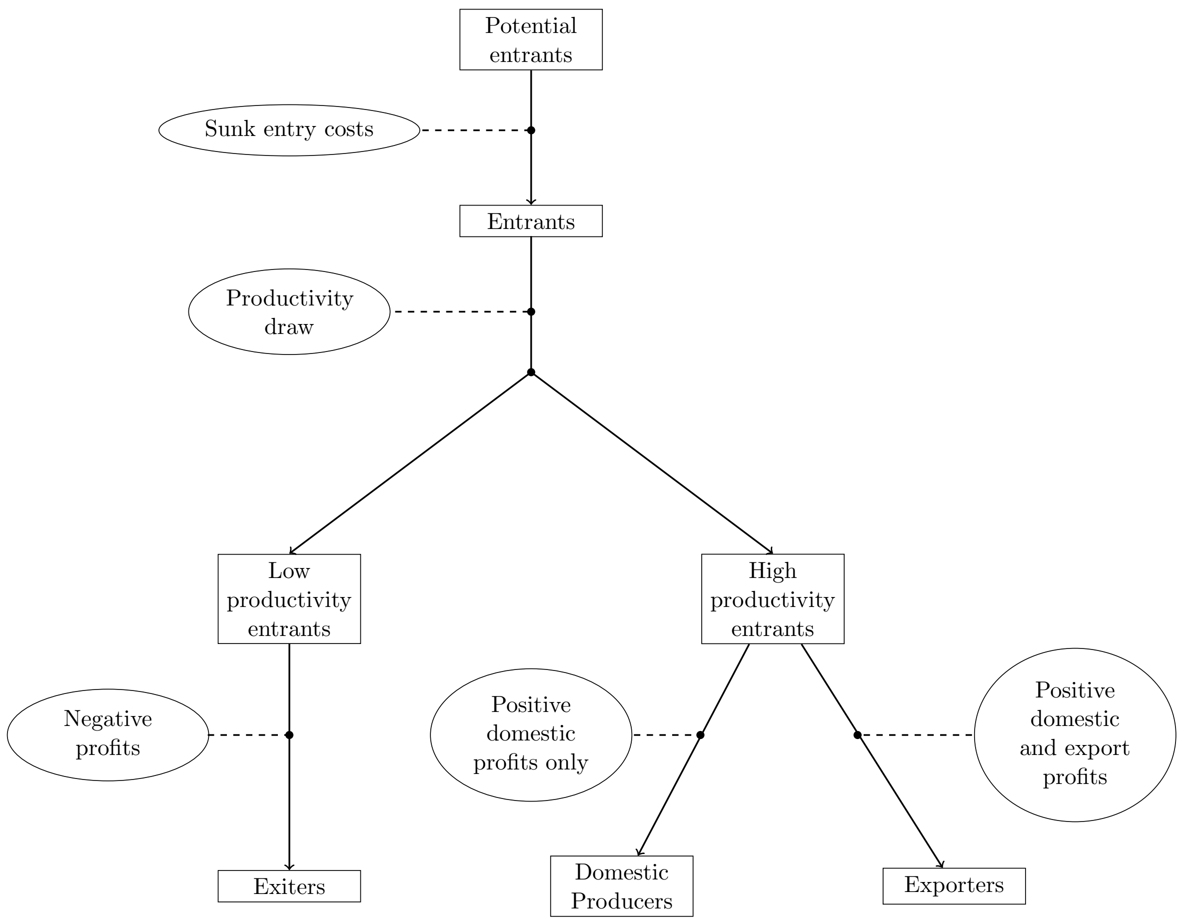
New entrants that draw a marginal cost above a cutoff value a_d, cannot make profit in any market. These firms immediately exit production. Firms that draw a marginal cost lower than a_d start to produce and serve the domestic market. Among the producing firms, those with a marginal cost lower than a cutoff value defined as a_x, are sufficiently productive to make profit in the export market and start to export. Therefore, firms with marginal cost equal to the cutoff values a_d and a_x are making zero profit in the domestic and export market,

[9] As the price is decreasing in σ, the more differentiated the products are, the more market power the firms have.

[10] Some versions of heterogeneous firm models get rid of the dynamic part mainly to simplify calculations. Although such a model would not have any prediction on entry and exit of firms, it would not change the predictions about self-selection and reallocation of production.

[11] Hereafter, we express variables as a function of a and we drop the ω to simplify notations.

Figure 2.1: Timing of the Melitz' model



respectively. This implies:

$$\begin{aligned} \pi_d(a_d) = 0 \Leftrightarrow r_d(a_d) = \sigma f_d; \\ \pi_x(a_x) = 0 \Leftrightarrow r_r(a_x) = \sigma f_x. \end{aligned} \tag{2.11}$$

Combining the Equations (2.11) in the expression of revenues given by (2.10) yields the first of our two zero cutoff profit conditions, expressing a_x in terms of a_d:[12]

$$a_x = \left(\frac{f_x}{f_d}\right)^{\frac{1}{1-\sigma}} \frac{a_d}{\tau} \tag{2.12}$$

Then, we need to write the expected profit of firms, which is the profit of the average productive firm. Having defined the cutoff values a_d and a_x, and the distribution $g(a)$, we can determine the expected productivity of domestic and exporting firms. We sum the productivity of producing and exporting firms with the following integrals:

$$\tilde{a}_d(a_d) = \int_0^{a_d} a^{1-\sigma} \frac{g(a)}{G(a_d)} da; \qquad \tilde{a}_x(a_x) = \int_0^{a_x} a^{1-\sigma} \frac{g(a)}{G(a_d)} da,$$

where $g(a)/G(a_d)$ represents the distribution of a conditional on entry. $\tilde{a}_d$ and $\tilde{a}_d$ are the average productivity in the domestic and export markets, respectively, and depend only on the cutoff values a_d and a_x. They allow to write the average revenue and profit of domestic firms $r_d(\tilde{a}_d)$ and $\pi_d(\tilde{a}_d)$, as well as the revenue and profit of the exporting firms, $r_x(\tilde{a}_x)$ and $\pi_x(\tilde{a}_x)$. Finally, the average revenue is the sum of the average revenue in the domestic market and the average revenue in the export market conditional on export market entry:

$$\bar{r} = r_d(\tilde{a}_d) + \frac{G(a_d)}{G(a_x)} r_x(\tilde{a}_x), \tag{2.13}$$

where $G(a_d)/G(a_x)$ is the probability of exporting conditional on surviving. We construct the average profit the same way to obtain the zero cutoff profit (ZCP) condition:

$$\bar{\pi} = \pi_d(\tilde{a}_d) + \frac{G(a_d)}{G(a_x)} \pi_x(\tilde{a}_x). \tag{2.14}$$

It is now time to go backwards, and determine whether firms decide to enter or not the

[12] To remain consistent with empirical evidence and ensure that not all firms export, Melitz makes the assumption that $\tau^{1-\sigma} f_x < f_d$.

market by paying the fixed cost f_e. Each potential entrant looks at its expected profit and compares it with the cost associated with entry. Remember that up to this point, firms have no information on their future productivity, so the expected profit is given by the average profit $\bar{\pi}$. This profit is realised at every period until the firm is hit by a bad shock that happens with probability δ. The expected profit of a potential entrant is then $\sum_{t=0}^{\infty}(1-\delta)^t\bar{\pi} = \bar{\pi}/\delta$. Therefore, the net value of entry in the market today is defined as the expected profit times the probability of entry minus the fixed cost: $G(a_d)\bar{\pi}/\delta - f_e$. Free entry ensures that firms enter the market until the net value of entry is driven to zero. The free entry condition is given by:

$$\bar{\pi} = \frac{\delta f_e}{G(a_d)}. \tag{2.15}$$

The equilibrium cutoff values a_d and a_x as well as the expected profit $\bar{\pi}$ can be derived from equations (2.12), (2.14) and (2.15). With these equilibrium values, one can recover all the equilibrium variables of the model.

Aggregation and stationary equilibrium

If we consider the mass M of variety available for consumption (this represents also the number of producing firms), which is defined as the sum of the varieties produced in the domestic country M_d and the varieties produced abroad M_x, we can write the weighted average productivity in the whole economy:

$$\tilde{a}(a_d^*, a_x^*) = \left(\frac{1}{M}\left[M_d\tilde{a}_d(a_d^*)^{1-\sigma} + M_x(\tau\tilde{a}_x(a_x^*))^{1-\sigma}\right]\right)^{\left(\frac{1}{\sigma-1}\right)}. \tag{2.16}$$

This weighted average productivity is a key variable of the model because it contains the information on the distribution of the marginal cost over firms. As it only depends on a_d and a_x, we use it to recover the equilibrium aggregate variables of the model:

$$\begin{aligned} P &= M^{\frac{1}{1-\sigma}}p_d(\tilde{a}); \quad & E &= Mp_d(\tilde{a})q_d(\tilde{a}) = Me(\tilde{a});\\ \Pi &= M\bar{\pi}; & W &= P^{-1}, \end{aligned} \tag{2.17}$$

where W is the social welfare and e is individual expenditures.

To fully determine the aggregate variables, we now turn to the labour market in order to derive M_t, M_d and M_x. As we are looking for a stationary equilibrium, all variables have to be constant over time. This requires the number of producing firms, M, to be constant so that the number of entrant M_e at each period is equal to the number of firms hit by the bad shock δ. This is accounted for by the equation: $1/G(a_d)M_e = \delta M$. The amount of labour used by the new entrant is then defined as $L_e = M_e f_e = 1/G(a_d)\delta M$ and can be rewritten $L_e = M\bar{\pi} = \Pi$ using the free entry condition. To produce, labour is the only available factor and its payment must match the difference between the aggregate revenues R, and the aggregate profit Π. This is: $L_p = R - \Pi$. On the labour market, the amount of workers available L, is shared between the producing firms (L_p) and the entrants (L_e). The clearing market satisfies $L = R$. The total revenue is therefore fully determined by the market size. From equation (2.17) we can derive the number of firms M:

$$M = \frac{R}{\bar{r}} = \frac{L}{\sigma(\bar{\pi} + f_d + G(a_x)/G(a_d)f_x)} \tag{2.18}$$

This completes the resolution of the model since we can use M and a_d to recover all aggregate variables.

Results

The question underlying trade models is the following: "Is there any gain to trade?" This model of heterogeneous firms has a clearcut answer to provide: trade liberalisation unambiguously raises productivity and improves welfare. In the original model, Melitz presents first a comparison between a closed economy and an opened economy to show the implication of trade liberalisation. However, it is more realistic, and therefore more informative, to assume a fall in trading costs between open countries. By either diminishing the fixed cost f_e or the variable trade cost τ, trade liberalisation induces an increase in aggregate productivity. To see that, we look at equations (2.12) and (2.14). The ZCP condition (Equation (2.14)) changes whereas the right-hand side of the free entry condition (equation (2.15)) remains unchanged, so that the new equilibrium cutoff value for domestic market entry is lower $a'_d < a_d$. This means that a firm needs a lower marginal cost to survive in the domestic market. On the contrary, if both trade costs (f_e or τ) and a_d decrease, equation (2.12) implies that the cutoff value for export market entry will increase such that $a'_x > a_x$. More firms are able to export in the new setting. A *reallocation of production* occurs. The least productive firms are driven out of the market, replaced by the more productive foreign domestic producers (that start to export). Looking more precisely at the revenues of firms in equation (2.10), it is easy to show that $r_d(a') < r_d(a)$ for $a' < a$. This means that the revenues on the domestic market are reduced and the domestic firms lose market shares to the benefit of the new foreign exporters. We now look at the combined profit of exporters: $r_d(a) + r_x(a) = r_d(a)[1 + \tau^{1-\sigma}]$. Of course if trade liberalisation consists of a fall in the fixed costs f_e, the sales of exporters will shrink as a_d decreases (f_e does not appear in this expression). However, Melitz shows that if the variable trade cost τ decreases, the combined sales of exporters actually increase.

To sum up, trade liberalisation is expected to (i) drive the least productive firms out of the market, (ii) shrink the market shares and profits of the least productive surviving firms, (iii) allow the more productive domestic producers to start to export, and (iv) increase the market shares and the profits of exporters. The aggregate productivity will unambiguously increase as well as the dispersion of profits, increasing inequality between firms' market shares and profits.

2.3.2 Developments of heterogeneous firms models

One of the reason why the Melitz's model became so successful and developed (theoretically as well as empirically) is that it is highly tractable. Moreover, combined with a suitable distribution of productivity, it allows to derive closed forms of equilibrium variables. Unsurprisingly, it has become a benchmark framework, extensively used in the trade theory literature to shed light on the importance of firms behaviours in trade patterns. Numerous extensions of this framework have been developed. Helpman et al. (2004) study the foreign direct investments and the decision to produce overseas. As in Melitz, only the highly productive firms engage in foreign activities. Among them, the most productive choose to make foreign direct investments and produce directly overseas. Antràs and Helpman (2004) investigate the organisational form of firms in a North-South model of trade. Again, productivity is the key determinant of firms' structure. The most productive firms outsource production in the South whereas the less productive ones outsource in the North. Mayer et al. (2014) develop a multi-product firms model and are interested in the product-mix of the firms. They find that tougher market competition forces firms to change their product mix and to focus on their best ones. This intra-firm reallocation is a vector of productivity gain. Kasahara and Lapham (2013) integrate the possibility of importing intermediate goods for production. They show that imports are complementary to exports and play a significant role in the productivity gains from trade. Yeaple (2005) and Bustos (2011) study the technology adoption. Firms can choose their technology of production. Only the most productive firms can bear the fixed production costs associated with the high technology. In this context, trade liberalisation leads some firms to upgrade technology. Labour market frictions and wage inequality are studied in Helpman and Itskhoki (2010) and Amiti and Davis (2012). Their models are in accordance with empirical results: the most productive firms pay higher wages (Bernard and Jensen, 1999). Interestingly, they find an inverted U-shape relationship between opening to trade and wage inequality. In this thesis, I am particularly interested in the developments related to the fixed cost structure (Chapter 5) and asymmetries and growth (Chapter 3).

Fixed cost structure

An important feature in the Melitz's model to produce the self-selection mechanism is the fixed cost (both fixed entry costs and fixed production costs). It is the key element separating firms able to earn revenue from export market, and those who cannot.[13] Studying these unrecoverable costs and their implications is therefore needed and can help designing export oriented reforms. Chaney (2008) and Helpman et al. (2008) point out that the presence of these costs helps to decompose growing trade flows into an extensive and an intensive margin. Trade liberalisation not only induces more exports for exporters (intensive margin), but also induces more exporters (extensive margin).[14] As both margins are actually important to explain the growing trade flows and gains from trade, the new new trade theory provides a more complete framework compared to the only "once-new" trade theory. However, the nature of these costs and its determinants are quite unclear. They are usually seen as costs of adapting products to foreign tastes and/or as costs of establishing a distribution network in a foreign country. These suppositions are in line with the model of Chaney (2008) that uses destination specific fixed export costs. However, the study of Lawless (2010) suggests that a

[13] Empirically, the existence and the importance of the sunk costs has been emphasised by the study of Roberts and Tybout (1997)

[14] Remember that all firms export in the model of Krugman, so that the impact of trade barriers changes on trade flows goes only through the intensive margin.

sunk cost is paid when a firm exports for the first time. After that, entry in other markets is much more dynamic, so that we can expect that the sunk costs are substantially reduced to enter a further market.

Arkolakis (2010) proposes a model where firms do not enter an entire market by paying a common fixed cost but rather try to reach directly consumers with marketing expenditures. Firms face an increasing marginal marketing cost to reach each additional consumer, and decide to export if and only if the profit from the first consumer is positive. This "market penetration approach" of fixed costs allows to explain the existence of many small exporters (because the cost of reaching the very first consumer might not be to large).[15] Arkolakis (2010) also shows that trade liberalisation profits more to the small exporters (because of increasing marginal marketing costs).

In Chapter 5, we use a fixed costs approach that is firm-specific. The firm efficiency can help reducing sunk costs because "good" firms are not only more efficient in producing but also more efficient in adapting products or negotiating contracts. We extend the basic Metliz (2003) model by endogenising sunk costs of entry into export market. Our model highlights the role of heterogeneity in the sunk costs structure and the links between productivity and sunk entry costs. Our empirical analysis confirms the existence of the sunk costs and the assumption that firms productivity affects the sunk entry costs.

Asymmetries

Country specific sunk costs can be seen as an asymmetry but it is not the only one that can differentiate countries in international trade market. Some papers developed heterogeneous firms model and explore the predictions when countries are not symmetric. In Melitz and Ottaviano (2008), countries are not endowed with the same number of consumers and therefore have different market sizes. Their model predicts that a country with a larger market (i) will exhibit a higher average productivity, (ii) have more available varieties, at lower prices, and (iii) have a higher consumers' welfare than a country with a smaller market. Because the average productivity is higher in this country, the competition is also tougher and entry is more difficult (the marginal cost cutoff value for market entry is lower). Regarding the trade pattern, having a bigger trading partner offers more opportunities to export to local

[15] Empirical support for this result is reported in Eaton et al. (2011).

firms (market size effect). However, the tougher competition prevents them to export and the overall effect is null according to Melitz and Ottaviano (2008).

Bernard et al. (2007) include a second factor of production and a second industry. They model asymmetries as in a comparative advantage Heckcsher-Olhin model: countries have different factor endowments and industries have different factor intensities. Resulting reallocation mechanisms induced by trade liberalisation are more complex than in the Melitz model. It occurs at the same time within industries and countries (the Melitz effect), and across industries and countries (the Heckscher-Ohlin effect). The gain from trade of the classical Heckcsher-Ohlin models are magnified by the intra-industry reallocation *à la* Melitz. Although the productivity growth is stronger in comparative advantage industries because the two effects are positive, Bernard et al. (2007) show that positive intra-industry effects can compensate the negative inter-industry effects in the comparative disadvantage industry.

In the paper of Falvey et al. (2011), the distribution of firms' productivity in the domestic country dominates that of the foreign country. It gives to the former a technological absolute advantage over the latter. This "technological gap" is at the origin of average productivity differences between countries (the margin cost market entry cutoff in the domestic market is lower in the leading country) and works as a magnifier of the reallocation effect. They find that opening to trade increases the average productivity gap.

Growth

The Melitz framework has the ability to explain productivity growth due to a trade liberalisation episode. However, there is no prediction on the long-run growth rate of the economy. A series of papers following Baldwin and Robert-Nicoud (2008), integrate the heterogeneous firm framework into a product-innovation endogenous growth model (Grossman and Helpman, 1991). The effects of trade liberalisation on growth are dual. On the one hand, the reallocation of production (from low productive domestic firms to high productive foreign firms) still have a positive impact on productivity growth. On the other hand, the increasing competition on markets decreases firms' innovation incentives, and slows the introduction of new variety. The overall impact on growth is ambiguous and depends on the specification of R&D. Gustafsson and Segerstrom (2010) use a specification with an inter-temporal knowledge spillovers parameter that is a key determinant of the overall effect of trade on growth. In short, if the R&D difficulty decreases (strong scale effect) too much with the stock of knowledge, the overall impact on growth can be negative.

In Chapter 3, I use a R&D-driven growth model that extends Gustafsson and Segerstrom (2010) to study the impact of trade liberalisation on the productivity growth of two countries that can be different in size, have different industry efficiency levels or different innovation efficiency levels. I find that trade liberalisation triggers asymmetric changes of endogenous variables in the short-run and asymmetric level effects in the long-run. On the one hand, the Melitz reallocation effect induces asymmetric productivity gains for both countries, where the technologically leading country gains more from trade. On the other hand, firms' innovation incentives are asymmetrically reduced, leading to an asymmetric slowdown in the productivity growth rate (the technologically leading country growth being more affected). Both effects are driven by a parameter of relative industry efficiency and a parameter of innovation efficiency.

2.4 Data used in the thesis

As this thesis studies firms behaviour in a context of trade, we need a rich database with information on production, exports/imports, employment, wages and so on. In order to build such a database, I use different sources. Chapter 2 and Chapter 4 use the EAE (*Enquète Annuelle d'Entreprise*), that provides detailed information for all French manufacturing firms with more than 20 employees (including energy and food industries) over the period 1996-2007. This database integrates about 25000 firms per year and comprise more than 300000 observations over the whole period. From EAE, we can exploit firm-level information on production (operating revenue), intermediates inputs, value added, capital stock (proxy by physical immobilisations), employment (number of employees), total wages paid, and investments. Table 2.1 presents an overview of the main variables in 2005.

All the information on labour, capital stock and materials are crucial to estimate firms' productivity (especially because it is estimated as the Total Factor Productivity (TFP) with the Olley and Pakes's (1996) or Levinsohn and Petrin's (2003) methods), that we want to link with the trading behaviours of firms.

We are able to classify them by sectoral activities at the 2-digit level using the NACE

Table 2.1: Summary of principal variables of the database in 2005

Variable	Mean	Min.	25%	Median	75%	Max.
Employment	130.4	1	27	42	87	98970
Capital	9881	1	680	1764	5423	134600000
Sales	36700	85	3278	6428	15910	40100000
Exports	8080	0	0	154.7	1939	4544000
Imports	6573	0	0	252.3	1694	16010000

Note: Employment is in number of employees. Other variables are in thousand of Euros.

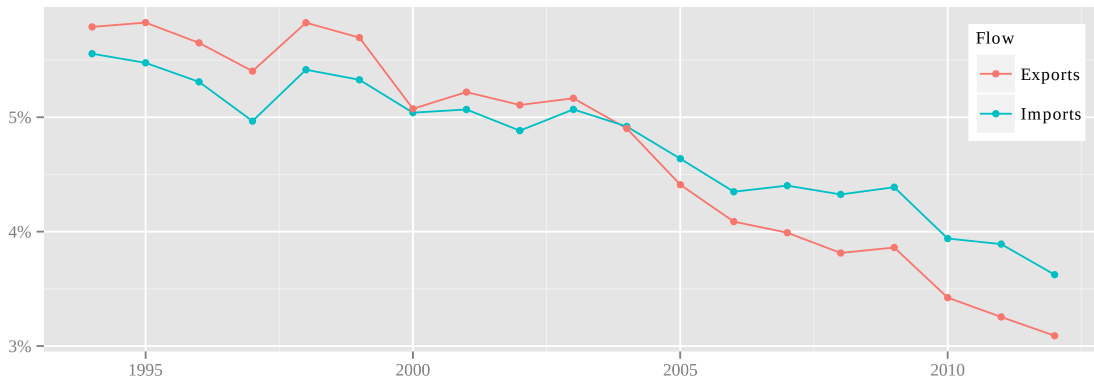
rev.1 code and by geographical positions (classified by regions).[16] This feature can be useful to focus the analysis on a particular sector, on a particular region, or both. Our trade data are provided by the French Custom Services and contains the French trade flows for the years 1994-2012. It provides firm-level data on the value and mass of all imported and exported goods, classified by products (it matches 6-digit Harmonised System (HS6) but can be extended to a 8-digit classification specific to France). The database also specifies the country of origin for imported goods and the country of destination for exported ones.

These two databases are merged using the "siren" code that identifies every single French firm. Finally, I obtain an unbalanced panel of about 22000 firms per year over the period 1996-2007. It combines all important information of firms on production, intermediate inputs, capital stock, employments, trade and investment and so on.[17]

In Chapter 5, we work with French firm-level data from the Amadeus database, provided by the Bureau van Dijk. As the EAE database, it combines production and financial key variables for more than 7000 "large" firms from 2003 to 2009. More details on Amadeus database are directly given in Chapter 5. The price index used for deflating values for the EAE and the Amadeus databases are constructed based on INSEE's sector-level series. Finally, Chapter 2 uses aggregate data from the World Trade Organisation.

[16]For a detailed description of sectors, see Table 2.8 in appendix.
[17]Table 2.7 reports all the variables I have at hands.

Figure 2.2: Share of French trade in total world trade



Source: WTO data.

2.5 What do French data say?

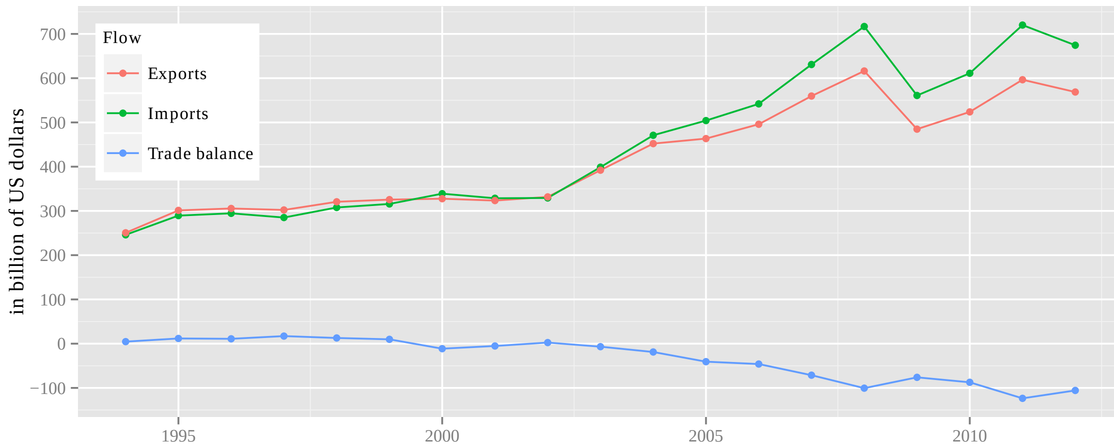
France in the World trade

According to the World Bank, France is the 5th economy in the world in terms of GDP in the year 2012, with a GDP of 2 612 878 US dollars. It is, then, not surprising to find France among the most trading countries. The World Trade Organisation reports that, in 2012, France trade flows of merchandises reached 1200 billions of US dollars, among which exported merchandises account for 568 billions of US dollars and imported merchandises account for 674 billions of US dollars. This represents about 3.09% of the world's total volume of exports and 3.69% of the world's total volume of imports. The net volume of French trade has been increasing between 1994 and 2012, but the share of French trade in the total world trade has been decreasing during the period (see Figure 2.2). However, this seems to be a general trend for developed countries, and France is no exception. For developed countries, the trend is clearly decreasing (Germany is quite stable but it is more the exception rather than the rule) and this decrease is associated to the rise of developing countries, especially the explosion of the share of China, which increased from 3,79% in 1994 to 11,13% in 2012. Other developing countries have an increasing trend, though less spectacular than for China.[18]

We notice from Figure 2.2 that the share of exports decreases faster than the the share of imports. This observation leads us to verify the evolution of French trade flows in terms of

[18] See Figure 2.10 in the appendix.

Figure 2.3: Export volume, import volume and the trade balance



Note: WTO data

volume. Figure 2.3 reports imports and exports volume as well as the commercial balance for France. It indicates that exports have grown more slowly than imports. As a consequence, we observe a decrease in the commercial balance over the period 1994-2012. The commercial balance (that only takes into account goods but not services here) starts to fall in deficit since the year 2000 and still continues to deteriorate. The deficit exceeded the 100 billion on US dollars in 2011. However, it is not easy to draw any conclusion on the reasons of the trade deficit, even less easy to give policies advices. To reverse this tendency, one could suggest the possibility of decreasing the imports. Kasahara and Lapham (2013) shows that imports have a positive impact on exports and such a policy could end up with unexpected effects. In order to investigate the determinant of trade, we focus our analysis on the behaviour of main traders, i.e. firms. We try to understand their characteristics, the driving forces of trade, and to figure out how to incite firms to export more (intensive margin) or to start to export (extensive margin). What can we learn from the study of French firms and French exporters? This section analyses the trade flows of the French firms, using the EAE-Custom database, and underlines some regularities in traders characteristics.

Share of traders and trade intensity

It is usually admitted in the literature that only a small part of firms are exporters and when they export, it is most of the time a small part of their production (Eaton et al., 2011). In our

Table 2.2: Share of exporters, importers and two ways traders (in %)

Year	Number of firms	Exporters	Importers	Two ways traders
1996	27343	64.50	63.81	53.85
1997	27523	65.36	64.85	54.77
1998	25416	69.04	69.23	59.41
1999	25393	69.37	69.67	59.91
2000	25232	69.63	70.99	60.78
2001	25690	68.22	67.43	58.01
2002	25412	68.13	66.80	57.57
2003	24953	67.79	67.08	57.67
2004	24214	67.69	68.63	58.39
2005	24715	67.32	68.32	57.86
2006	22862	67.82	69.30	58.41
2007	22309	67.80	69.34	58.45

database however, we report a share of exporters that is relatively high. It goes from 64% in 1996 to 70% in 2000. Of course, the reason of this bias is the limitation of the EAE database that contains informations only on firms that have at least 20 employees. Studying a more exhaustive database, Crozet et al. (2011) found that only 31% to 35 % of firms were exporters in France between 1995 and 2005. Big firms are more likely to export and their study reports that only 20.8 % of firms under 20 employees declare to be exporters. Probably, the same selection bias occurs for imports: 64% to 71% of firms have an import activity between 1996 and 2007 in our database.

Having this limitation in mind, we can still compare the share of exporters (importers) per year or in the different sector of the manufactured products. Table 2.2 presents the number and the share of exporters, importers and two-ways traders per year.[19] From Table 2.2, we can notice that all three shares are slightly increasing between 1996 and 2000 and decreasing after that. We observe that the share of importers and the share of exporters are similar. Of course, the share of two-ways traders is lower because some firms only import or only export.

To study the intensive margin of trade, it is useful to look at the share of export revenue in the total revenue of firms. This export intensity is reported per year in Table 2.3.[20] I also

[19]Table 2.9 presents the same variable per sector in 2005.
[20]Table 2.10 gives this information for the year 2005 at the sector level.

Table 2.3: Export and import intensities per year

Year	Number of firms	Export intensity	Import intensity
1996	27343	19.09	21.63
1997	27523	19.88	21.80
1998	25416	19.96	21.23
1999	25393	19.74	22.12
2000	25232	20.46	21.87
2001	25690	21.39	25.61
2002	25412	21.09	22.96
2003	24953	21.04	22.16
2004	24214	21.73	23.54
2005	24715	22.16	25.92
2006	22862	22.89	25.46
2007	22309	24.36	27.14

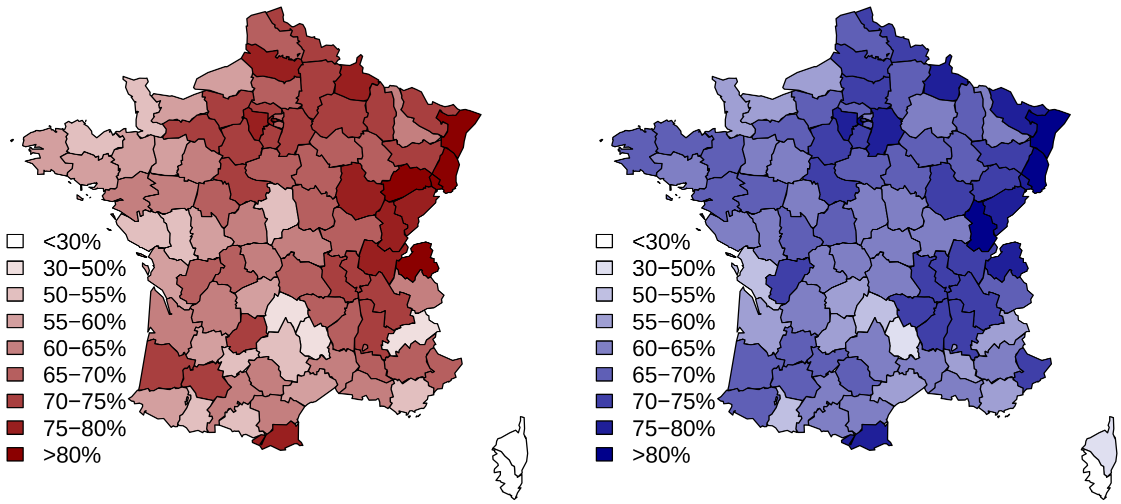
report in this table the import intensity, that is the imported part of the intermediate inputs used by firms.[21] Between 1996 and 2007, the export intensity has grown, but the import intensity has grown even more. This is not surprising, and the conclusion corroborate the conclusion made when studying Figure 2.3.

Another interesting feature of the EAE database is that it allows to identify the locations of firms. Therefore, we can compare the share of exporters and importers, and the average export and import intensities of French regions. Figure 2.4 presents the share of exporters and the share of importers. Not surprisingly, regions in the borders seem to have a higher share of exporters (except near Pyrénées). It is especially true for Alsace (where more than 80% of firms are importers or exporters), which has borders with Germany. The map of export and import intensity (Figure 2.5) is not really different. Again, border regions have a higher export revenue relative to total revenue. They also import more intermediates inputs.

Geographical position seems to be an important characteristic to explain firms' trading decisions. Proximity to borders might reduce both the variable and the entry costs, allowing more firms to make profits abroad.

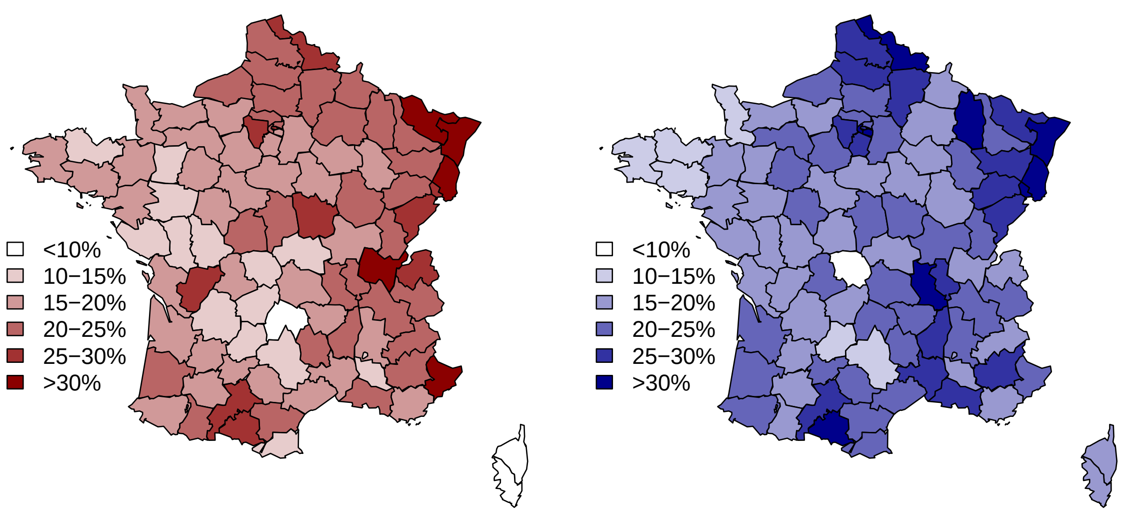
I also look at the number of partners of firms. Figure 2.6 plots the distribution of the number of export destinations of firms as well as the number of countries they import from. First, we observe that a lot of firms only trade with one foreign country. In this context, it is

[21] The export intensity and import intensity are computed on, respectively, exporters only and importers only.



(a) Share of exporters (in %) (b) Share of importers (in %)

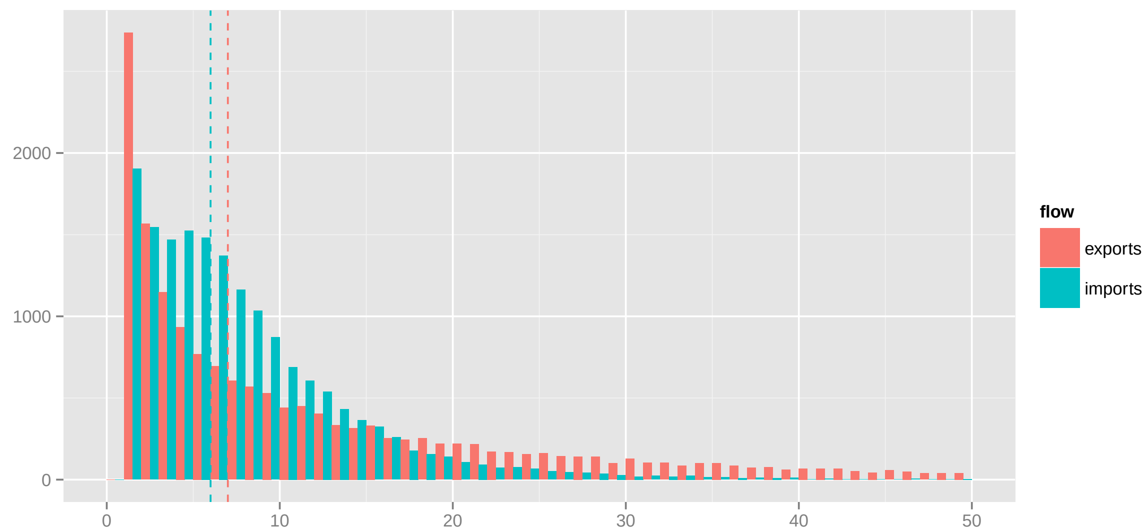
Figure 2.4: Shares of traders per regions in %



(a) Export intensity in % of total revenue (b) Import intensity in % of intermediate inputs

Figure 2.5: Trade intensity of traders in %

Figure 2.6: Distribution of the number of export destination and origin of import



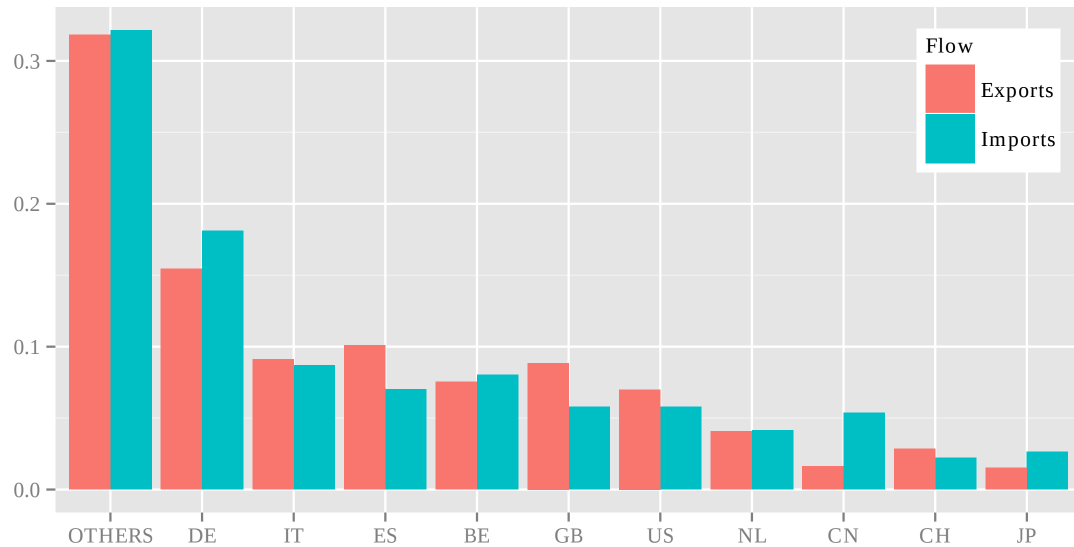
Note: Number of destination and origin is on the x-axis, it's frequency on the y-axis.
The two dashed lines represent the medians.

obvious that firms in the border have an advantage and it might not reflect a pure productivity advantage. Second, Figure 2.6 also reveals a difference of distribution in the number of export destination and the number of origin of imports. It seems easier to import from several countries than to export in several countries. This could indicate high country specific fixed entry costs. The costs structure might be different when it comes to imports. More firms are importing from several origins. It suggests that country's specific fixed costs related to imports are lower and that there might be an important cost to start exporting the first time.

Partners of French firms

Economic gravity models predict that the trade volume between two countries increases with the size of these countries and decreases with the distance between them. Keeping this in mind, we would expect Western European countries to be the best trading partners of France. From Figure 2.7, we identify the 10 best partners in terms of percent of total export and import volumes in 2005. As expected, the large and close countries arrive first. Germany accounts for about 16% of total exports and 18% of total imports in 2005. Italy, Spain, Bel-

Figure 2.7: Bilateral trade in 2005 (in %)



Bilateral imports and exports in percentage of total imports and exports.
Own calculations based on French Custom Data.
DE = Germany, IT= Italy, ES=Spain, BE = Belgium, GB=Great-Britain, US= United States, NL= Netherlands, CN=China, CH=Switzerland, JP=Japan, OTHERS = rest of the world.

gian and United Kingdom follow. Note that these five first partners are Europeans. Among France's 10 best trading partners, only USA, China and Japan are not in the European region. We can again rely on the gravity equation to explain the presence of these countries. USA, China and Japan are the three biggest countries in the world in terms of GDP.[22] Interestingly, among the 238 destinations of exports in 2005, these 10 countries represent about 68% of the total volume of exports and imports of French firms, 32% only is left for to 237 remaining countries.

Entry and exit

Since the paper of Chaney (2008), we know that the extensive margin is crucial to analyse trade flows. I look here at the entry and exit of French firms in the international market. Table 2.4 and Table 2.5 give the number of firms per year, and the entry and exit in absolute value.

[22]In Table 2.11 in the appendix, I also report the percentage of exporters exporting in a particular country. The same is done for imports.

Table 2.4: Entry and exit in the export market

Year	Number of exporters	Continuous	Entry	Exit
1996	17635	15070	2565	2201
1997	17989	15434	2555	2950
1998	17547	15039	2508	2113
1999	17614	15434	2180	2136
2000	17569	15478	2091	2187
2001	17526	15382	2144	2272
2002	17312	15254	2058	2282
2003	16915	15030	1885	2141
2004	16391	14774	1617	1681
2005	16637	14710	1927	2711
2006	15505	13926	1579	1986
2007	15125	13519	1606	–

Read the table as follows: in year 1996, there is 17635 exporters, 2565 are entering and were not exporters in 1995, 2201 are exiting and will not be exporters any more in 1997.

Table 2.5: Entry and exit in the import market

Year	Number of importers	Continuous	Entry	Exit
1996	17448	15009	2439	2009
1997	17848	15439	2409	2567
1998	17595	15281	2314	1913
1999	17692	15682	2010	1947
2000	17912	15745	2167	2552
2001	17323	15360	1963	2210
2002	16976	15113	1863	1998
2003	16738	14978	1760	1820
2004	16618	14918	1700	1528
2005	16886	15090	1796	2481
2006	15844	14405	1439	1806
2007	15468	14038	1430	–

Note: Table 2.4 reads as Table 2.5.

Table 2.6: Characteristics of firms in 2005

Characteristics	Two ways	Exporters only	Importers only	Non-trading
Number of observations	14041	2242	2443	5097
Employment	174.2	41.7	63.6	68.6
Sales	49,630,000	7,156,000	13,030,000	20,930,000
Wages per worker	28,420	27,150	25,710	25,790
Sales per worker	285,200	180,300	219,400	165,900
Value added per worker	64,460	53,150	57,770	50,440
Capital per worker	106,500	73,740	104,600	70,650
Investment per worker	8,796	6,807	9,042	7,373

Note: Values represent the mean of firms. Employment is in number of employees. Other variables are in Euros.

We observe that the dynamics of entry and exit are similar. Clearly, entries are decreasing with time in our panel (for both the export and the import market) whereas the number of exiting firms fluctuates from year to year but have a relatively flat trend over the period. Questions about the extensive margin often concern the role of new exporters and how to encourage firms to export. Looking at the dynamics of entry and exit, one would suggest to study the other part of extensive margin. Why firms exit the market, and how to help them to make profit and to survive in the export market.

Export and import premium of French firms

We can also identify some regularities concerning the characteristics of French trading firms. First, I split firms in different groups: (i) two ways traders, (ii) exporters only, (iii) importers only, and (iv) non traders. Second, I report the mean performances of firms for the different groups in Table 2.6. In the database, two ways traders perform better than other categories, as expected. Importers only seems to perform better than exporters only (except for the wages paid). On average, non traders are bigger than exporters only and importers only, but they do not perform as good. I also divide firms in exporters and non exporter groups and importers and non importers groups. In each case, the trading first group performs better than the second one.[23]

After estimating the productivity of firms using the control function approach, I report

[23] In the Appendix, I present the same table for exporters/non-exporters in Table 2.12 and importers/non-importers in Table 2.13.

in Table 2.8 the average productivity for (*i*) two-ways traders, (*ii*) one way traders and (*iii*) non traders. From this table, we can see that the two ways traders are the most productive and non traders are the less productive, on average. The one-way traders lie in the middle of the two other groups. In Figure 2.9, I plot the distribution of estimated productivity for the three groups. The productivity premium of the two-ways traders appears also here.

Figure 2.8: Mean productivity of two ways traders, one way traders and non traders per year

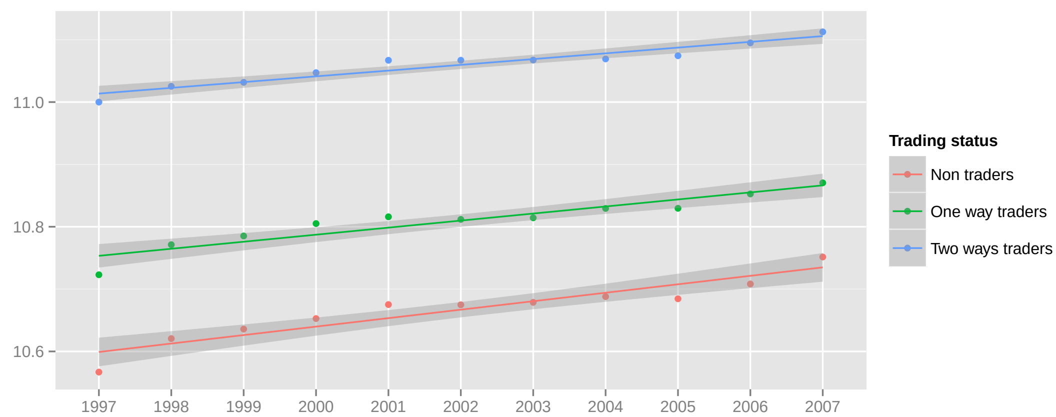
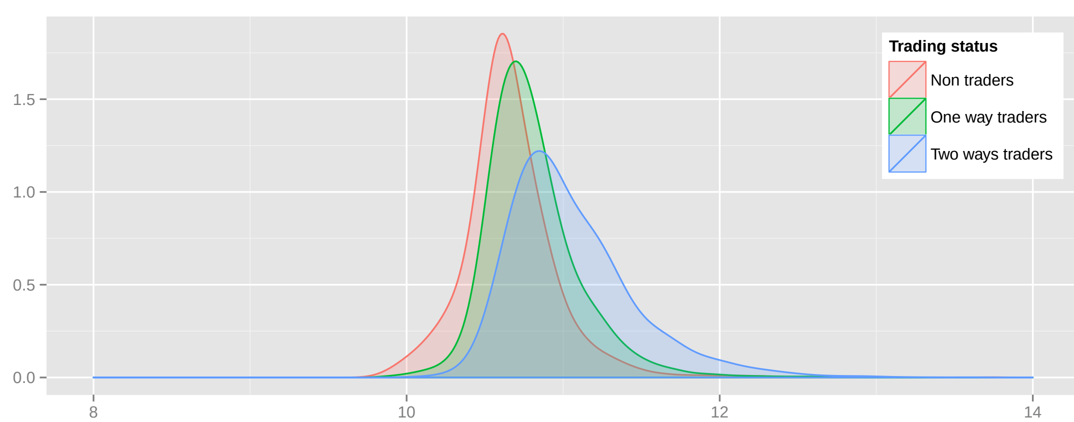


Figure 2.9: Distribution of productivity of two ways traders, one way traders and non traders over the period 1996-2007



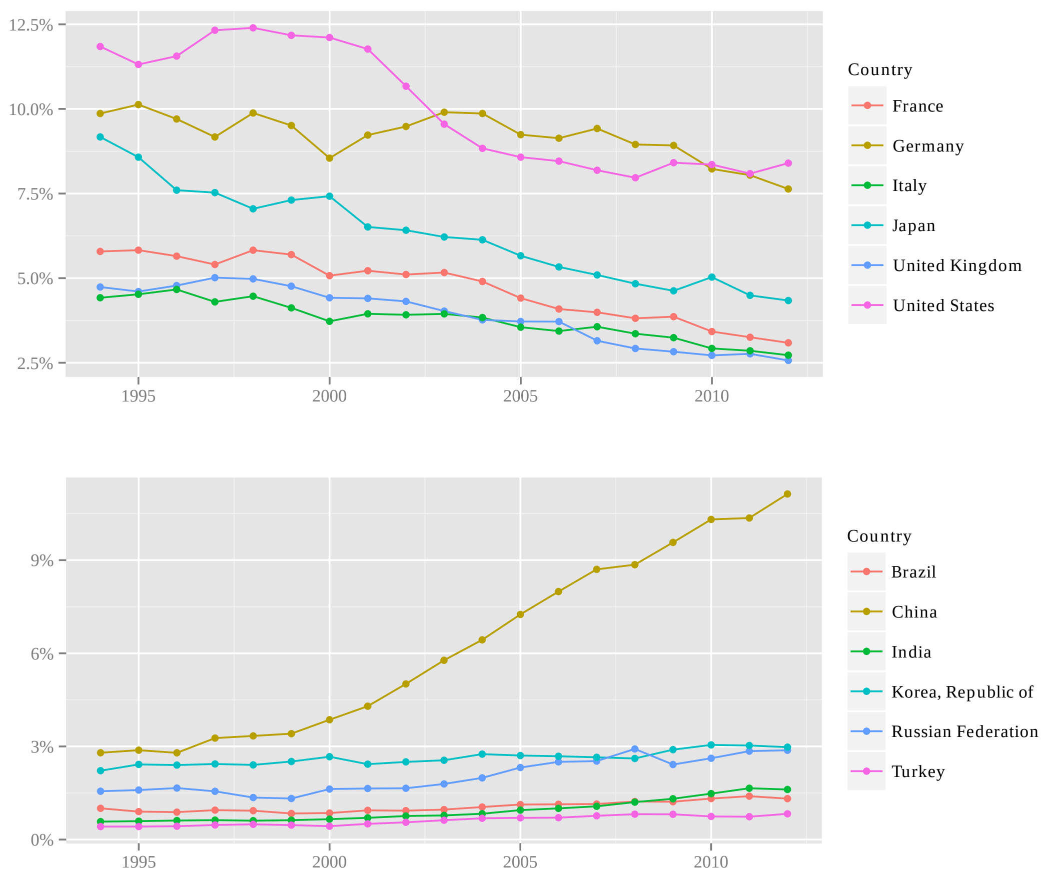
2.6 Appendix

Table 2.7: Available variables and their sources

Variable	Description	Sources
siren	ID of the firm	EAE & Custom
year	Year of exercise	EAE & Custom
RG	Regional code	EAE
CODEP	regions code	EAE
L	Average number of employees	EAE
W	Wages paid	EAE
t	Social welfare taxes	EAE
Y	Gross sales value	EAE
M	Intermediate inputs =	EAE
	Expenditures in merchandises	
	+Stock variation of merchandises	
	+Expenditures in raw material	
	+Stock variation of raw material	
	+Others expenditures	
VA	Value added =	EAE
	Gross sales value	
	+Stocked production	
	+Immobilised production	
	-Intermediate inputs (M)	
Π	Profits	EAE
T	Taxes on profits	EAE
K	Physical immobilisations	EAE
Inv	Investment in physical immobilisation	EAE
Imp	Imports value	Custom Services
Exp	Exports value	Custom Services
ExpD	Number of export destinations	Custom Services
ImpO	Number of import origins	Custom Services
ExpM	Mass of exports	Custom services
ImpM	Mass of imports	Custom services
NC8	Product code of exports/imports	Custom Services

Note: EAE database is available for the years 1996-2007. Custom services database is available for the years 1994-2012.

Figure 2.10: Export shares of developed and developing countries



Note: WTO data

Table 2.8: Sector denominations

Sector code	Denomination
A	Agriculture, hunting and forestry
C	Mining and quarrying
DA	Manufacture of food products, beverages and tobacco
DB	Manufacture of textiles and textile products
DC	Manufacture of leather and leather products
DD	Manufacture of wood and wood products
DE	Manufacture of pulp, paper and paper products; publishing and printing
DF	Manufacture of coke, refined petroleum products and nuclear fuel
DG	Manufacture of chemicals, chemical products and man-made fibres
DH	Manufacture of rubber and plastic products
DI	Manufacture of other non-metallic mineral products
DJ	Manufacture of basic metals and fabricated metal products
DK	Manufacture of machinery and equipment
DL	Manufacture of electrical and electronics equipment
DM	Manufacture of transport equipment
DN	Other manufacturing industries
E	Electricity, gas and water supply

Note: EAE database contains the code NACE rev.1.

Table 2.9: Shares of exporters, importers and two ways traders per sector in 2005 (in %)

Sector	Number of firms	Exporters	Importers	Two ways traders
A	36	88.89	19.44	19.44
C	390	41.03	28.72	20.51
DA	3408	60.48	65.35	49.68
DB	1847	75.91	77.91	71.85
DC	301	73.75	80.07	70.10
DD	934	60.17	64.78	46.68
DE	2306	62.01	59.63	48.79
DF	55	65.45	78.18	60.00
DG	961	89.91	93.03	87.10
DH	1631	80.07	83.69	73.51
DI	912	55.37	65.13	47.81
DJ	5015	58.27	57.51	46.76
DK	2274	80.08	76.08	70.58
DL	2161	75.75	77.05	70.06
DM	878	76.65	79.61	70.62
DN	1352	72.41	70.86	60.28
E	254	9.84	18.90	6.30

Table 2.10: Export and import intensities per sector in 2005

Sector	Number of firms	Export intensity	Import intensity
A	36	23.61	8.82
C	390	14.07	9.76
DA	3408	15.85	16.59
DB	1847	30.13	46.27
DC	301	24.33	37.31
DD	934	17.58	21.28
DE	2306	9.71	38.09
DF	55	22.48	43.84
DG	961	34.47	26.03
DH	1631	25.24	22.45
DI	912	19.34	18.22
DJ	5015	18.41	23.51
DK	2274	25.72	18.57
DL	2161	30.15	29.65
DM	878	26.83	28.48
DN	1352	19.93	23.22
E	254	12.54	6.52

Table 2.11: Part of firms that trade with a particular country (in %)

Country	Firms that import from	Firms that export in
DE	36.95	24.72
IT	37.28	20.83
ES	28.24	21.99
BE	32.17	29.73
GB	20.95	19.62
US	19.30	19.73
NL	21.82	16.81
CN	18.95	5.65
CH	13.69	29.81
JP	6.42	9.55

Note: Computed from the Custom database in 2005. Read as follows: 24.72% of french exporters export a least once in Germany.

Table 2.12: Characteristics of firms in 2005

Characteristic	Importers	Non importers
Number of observations	14041	2242
Employment	174.2	41.7
Sales	49,630,000	7,156,000
Wages per worker	28,420	27,150
Sales per worker	285,200	180,300
Value added per worker	64,460	53,150
Capital per worker	106,500	73,740
Investment per worker	8,796	6,807

Note: Values represent the mean of firms. Employment is in number of employees. Other variables are in Euros.

Table 2.13: Characteristics of firms in 2005

Characteristic	Exporters	Non exporters
Number of observations	16,484	7,540
Employment	155.9	67.0
Sales	43,780,000	18,370,000
Wages per worker	28,250	25,760
Sales per worker	270,800	183,200
Value added per worker	62,910	52,810
Capital per worker	102,000	81,640
Investment per worker	8,522	7,914

Note: Values represent the mean of firms. Employment is in number of employees. Other variables are in Euros.

3 Trade Pattern and Growth with Asymmetries

3.1 Introduction

Firm heterogeneity in trade models allows to explain the coexistence of exporters and non exporters, giving rise to a literature that studies the effect of trade liberalisation on firms export decisions and on aggregate productivity. Melitz (2003) finds that liberalisation produces an intra-industry reallocation of production: when trade costs decrease, the less productive domestic firms are replaced by the more productive foreign firms. This reallocation effect leads to a direct and unambiguous positive effect on aggregate productivity. Gustafsson and Segerstrom (2010) integrate an innovation sector in a Melitz-type model in order to obtain a positive productivity growth rate in the long-run.[1] In their model, trade liberalisation still produces the direct reallocation effect of the Melitz (2003) model, and there is now an indirect channel that retards productivity growth (G&S effect, hereafter). The growing competition in local markets increases the costs of developing a profitable variety of product and decreases firms innovation incentives in the R&D sector. As a consequence, economic growth slows down.

However, these papers only offer a framework to understand the trade situation between two countries that are symmetric. From a policy point of view, it is important to determine

[1] Baldwin and Robert-Nicoud (2008) and Unel (2010) use similar models

whether different countries benefit or suffer in the same way from trade liberalisation. In this paper, we relax the symmetry assumption. Countries can be different in many aspects. In our growth model, there is several possibilities to model these differences. We can consider different country size and/or population growth, different technology in the production sector, different efficiency in the innovation sector, or different fixed and variable trade costs. In order to analyse the impact of trade liberalisation on asymmetric countries and to determine the strength and the direction of both the reallocation (Melitz) effect and the growth (G&S) effect, we choose to focus on (i) technological differences (ii) innovation sector efficiency and (iii) for market size differences. As Falvey et al. (2011) state: "substantial productivity gaps still exist even among the worlds most advanced industrial countries" and we follow them modelling a technological gap in term of productivity distribution across both countries. In the innovation sector as well, efficiency gaps in R&D and innovation. Countries also differ in size and the potential demand for a good depends on the the market size. Through the demand channel, firms mark-up, profits and innovation incentives would be asymmetric in the two countries, and their response to trade liberalisation might be asymmetric as well.

First, we find that the direct Melitz reallocation effect has a positive effect on productivity in both countries but the strength of this effect depends on productivity differences. The technologically leading country benefits more than the laggard one because its threshold value for local market entry decreases more. Second, the indirect effect of trade liberalisation on productivity growth is asymmetric and depends on productivity differences. In general, a more productive country suffers a higher slowdown of its productivity growth rate in the short-run, and its share of produced variety has decreased at the new equilibrium. The rest of the paper is organised as follows. Section 3.2 presents the framework of our model. Section 3.3 analyses the steady state equilibrium. Section 3.4 highlights the effects of trade liberalisation and section 3.5 concludes.

3.2 R&D-driven growth model

The model extends Gustafsson and Segerstrom (2010). It is a R&D driven growth model where firms are heterogeneous as in the Melitz (2003) pioneer paper. There are two countries: a domestic country and a foreign one (subscripted by $i = D, F$). Firms produce using a single factor of production, labour (L_{it}), which is inelastically supplied. In order to identify a potential market size effect on productivity level and productivity growth, we allow L_{it} to differ across the two countries. As each individual is endowed by one unit of labour, L_{it}, also refers to the population size which grows in both countries at the exogenous rate n.

3.2.1 Consumer behaviour

In both countries, the representative consumer maximises the same discounted utility function given by:

$$U_i = \int_0^{\infty} e^{-(\rho-n)t} \ln(u_{it})dt, \tag{3.1}$$

where ρ is the consumer discount rate. The representative consumers share the same form of utility function in both countries but its utility, u_{it}, differs as the number of variety available at time t in each country, m_{it}^c, differs. We have:

$$u_{it} = \left[\int_0^{m_{it}^c} q_{it}(\omega)^{\alpha} d\omega\right]^{\frac{1}{\alpha}}, \tag{3.2}$$

where $q_{it}(\omega)$ is the quantity of variety ω consumed at time t and α represents the degree of product differentiation.[2] Maximising (3.1) using (3.2) yields the demand function:

$$q_{it}(\omega) = p_{it}(\omega)^{-\sigma} P_{it}^{\sigma-1} e_{it}, \tag{3.3}$$

where $\sigma \equiv 1/(1-\alpha)$ is the elasticity of substitution, e_{it} are the individual expenditures and $p_{it}(\omega)$ is the price of the variety ω. In the previous equation, P_{it} denotes the aggregate price level defined as:

$$P_{it} \equiv \left[\int_0^{m_{it}^c} p_{it}(\omega)^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}}. \tag{3.4}$$

The dynamic resolution yields the Euler equation which requires that e_{it} grows according to:

$$\frac{\dot{e}_{it}}{e_{it}} = r_{it} - \rho, \tag{3.5}$$

[2]Here, m_{it}^c refers to varieties produced in the domestic country and varieties exported by the foreign one. Later in the paper, we use $m_{it} \neq m_{it}^c$ which is the number of varieties produced in country i.

where r_{it} is the nominal interest rate.[3,4]

3.2.2 Producer behaviour

The model considers two sectors: the production sector works under Dixit-Stiglitz monopolistic competition whereas the innovation sector is perfectly competitive. First, firms decide whether they invest or not in the creation of a new variety of product. When a firm innovates, the new variety is developed and the firm learns the marginal cost, denoted by a, associated to this particular variety which is drawn from a probability density function $g_i(a)$.[5] Following Falvey et al. (2011), the productivity asymmetry appears in the country specific distribution function of firm's marginal cost. We assume asymmetric Pareto cumulative distribution functions across countries that are given by:

$$G_D(a) = \left(\frac{a}{\bar{a}_D}\right)^k, \quad G_F(a) = \left(\frac{a}{\bar{a}_F}\right)^k \tag{3.6}$$

where k is a shape parameter. Productivity asymmetries take the form of two different values for the maximal marginal costs $\bar{a}_D$ and $\bar{a}_F$ that a firm can draw from its respective distribution. Assuming $\bar{a}_D < \bar{a}_F$ ensures that the marginal costs distribution of the domestic country always dominates the foreign one, so that the domestic country has a technological advantage. In practice, the worst firm in the domestic country is always better than the worst firm in the foreign country. Second, taking their productivity a as a fix parameter, firms decide whether they exit production, produce for local market only or produce for both the local and the export market. The model is solved backward and we have to define the market entry condition before the free entry condition.

Profit of the firms

Firms can make profit on the local market and on the export market. They face an iceberg trade cost in the export market ($\tau > 1$) meaning that they have to send τ units of product for one unit that reaches destination. This can be seen as transport costs. A firm that produces

[3] Equation (3.5) ensures that the equilibrium interest rate is constant over time and equal to ρ in both countries so that $r_{it} = r_t = \rho$.

[4] The dotted variable are differentiated with respect to time.

[5] As there is a single factor of production, labour, $a(\omega)$ can be seen as the inverse of the productivity.

in the local market gets a profit $\pi_{it}(\omega)$. By exporting, this firm can make an additional profit $\pi^*_{it}(\omega)$ where an $(^*)$ denotes values for the export market. Firms maximise profit by setting their pricing rule in both local and export market. As in Gustafsson and Segerstrom (2010), we set the wages as the *numéraire*, so the profit equations can be written as follows:

$$\pi_{it}(\omega) = \max_{p_{it}(\omega)} \left(p_{it}(\omega) - a(\omega)\right) q_{it}(\omega)$$

$$\pi^*_{it}(\omega) = \max_{p^*_{it}(\omega)} \left(p^*_{it}(\omega) - \tau a(\omega)\right) q^*_{it}(\omega).$$

Using equations (3.3) and (3.4) and taking first order conditions of profits, the prices of a variety ω in both the local and the export market are:[6]

$$p_{it}(\omega) = \left(\frac{\sigma}{\sigma - 1}\right) a(\omega) \;\; ; \;\; p^*_{it}(\omega) = \left(\frac{\sigma}{\sigma - 1}\right) \tau a(\omega).$$

Using these pricing rules, we obtain the following profit equations of domestic and foreign firms in the local and the export market:

$$\pi_{Dt}(\omega) = \chi_D a(\omega)^{1-\sigma}; \quad \pi_{Ft}(\omega) = \chi_F a(\omega)^{1-\sigma} \tag{3.7}$$

$$\pi^*_{Dt}(\omega) = \theta \chi_F a(\omega)^{1-\sigma}; \quad \pi^*_{Ft}(\omega) = \theta \chi_D a(\omega)^{1-\sigma}, \tag{3.8}$$

where $\chi_i \equiv \sigma^{-\sigma}(\sigma - 1)^{\sigma-1}\left(E_{it}/P^{1-\sigma}_{it}\right)$ represents the demand, E_{it} the aggregate expenditures in both countries, and $\theta \equiv \tau^{1-\sigma}$.

Stock market value of the firm

Following R&D growth models, we assume all profits to be continuously paid to shareholders as dividends. Shareholders also expect capital gain (losses) on their ownership. During a brief time interval dt, *arbitrage* in the capital market ensures that these benefits equal the risk free return:

$$\pi_{it}(a_i)dt + \dot{v}_{it}(a_i)dt = r_{it}v_{it}(a_i)dt$$

[6] Here, if $i = D$, p^*_{Dt} is the pricing rule of a domestic firm for the export market.

where v_{it} denotes the discounted value of a firm at time t. This yields:

$$v_{it}(a_i) = \frac{\pi_{it}(a_i)}{r_{it} - (\dot{v}_{it}(a_i)/v_{it}(a_i))}$$

Furthermore, given a specific marginal cost a, the *arbitrage* in the product market implies that the discounted value of a firm must exceed the sunk cost of domestic and export market entry. Usually, they are viewed as the costs of adapting the technological innovation to the specific market standards, regulations and norms. To enter the local (export) market, a firm needs to create f (f^*) units of knowledge. The price of a unit of knowledge is denoted by b_{it}. As in Jones (1995), we use the R&D specification proposed by Grossman and Helpman (1991) and add an inter-temporal knowledge spillover parameter ϕ. This parameter allows for both strong scale effects ($\phi > 0$) and weak scale effects ($\phi < 0$). It generalises the Grossman and Helpman (1991) specification which is $\phi = 1$. Segerstrom (1998) argues that strong scale effects ($\phi = 1$) are not relevant because "steadily increasing R&D effort has not lead to any upward trend in economic growth rates". Therefore, we define:

$$b_t \equiv \frac{1}{(m_{Dt} + m_{Ft})^{\phi}} = \frac{1}{m_t^{\phi}} \tag{3.9}$$

where $m_t = m_{Dt} + m_{Ft}$ is the worldwide number of produced varieties. Unlike Gustafsson and Segerstrom (2010), we assume perfect international spillovers, so that both countries have access to the same capital of knowledge in the innovation sector. To introduce an asymmetry in the innovation sector, we add a parameter λ_i, capturing the efficiency of the R&D in the country i. A higher λ_i implies that the costs of one unit of knowledge is higher in country i. At time t, a firm bears the sunk cost $\lambda_i b_t f$ for local market entry and $\lambda_i b_t f^*$ for export market entry. Hence, the *arbitrage* equation in the product markets implies:

$$v_{it}(a_i) = \lambda_i b_t f; \qquad v_{it}(a_i^*) = \lambda_i b_t f^*,$$

for firms that are indifferent to produce locally or to exit production and for firms that are indifferent to produce locally only or to produce in both local and export market, respectively. Here, the parameter λ_i also imply that the markets entry costs implicitly become heterogeneous across countries.

Market entry condition

As in Melitz (2003) three types of firms appear: (i) the firms who immediately exit the market with a too high marginal cost $a > a_i$, (ii) the firms who produce only in the domestic market with marginal cost included between a_i and a_i^*, and (iii) the firms with a marginal cost lower than a_i^* who can also make profit in the export market. Here, a_i $(i = D, F)$ are the threshold values at which firms are indifferent between being local producer or immediately shutting down the production, and a_i^* are the threshold value at which firms are indifferent between producing in both local and foreign market or remaining only a domestic producer. Substituting profit using equations (3.7) and (3.8) into the two previous equations yields the entry condition for domestic and export markets:

$$\lambda_D b_t f = \frac{\chi_D a_D^{1-\sigma}}{\psi_t}; \quad \lambda_F b_t f = \frac{\chi_F a_F^{1-\sigma}}{\psi_t} \tag{3.10}$$

$$\lambda_D b_t f^* = \frac{\theta \chi_F a_D^{*1-\sigma}}{\psi_t}; \quad \lambda_F b_t f^* = \frac{\theta \chi_D a_F^{*1-\sigma}}{\psi_t} \tag{3.11}$$

where $\psi_t \equiv \rho - \dot{b}_t / b_t$ is the discount factor.[7] The left-hand side of equation (3.10) (of (3.11)) represents the costs associated to local (export) market entry and the right-hand side is the discounted benefits from producing locally (from exporting) of a firm that has drawn the exact marginal cost a_i (a_i^*).

Innovation behaviour and free entry condition

Innovators decide whether they invest or not in the creation of a new variety. Making an *arbitrage* between expected returns and costs, they choose to incur (or not) the innovation sunk cost. In order to produce a new variety, innovators must pay f_I unit of knowledge as variety-development costs at price $\lambda_i b_t$. When a firm pays these costs, the new variety is developed and the firm learns the productivity a associated to this particular variety. Keeping in mind that the innovation sector is perfectly competitive, the arbitrage equation in this

[7] Note that $\dot{v}_{it}(a_i)/v_{it}(a_i) = \dot{b}_t / b_t$ as f and f^* are constant, and $r_{it} = \rho$ is fixed by equation (3.5) in both countries.

market can be written as:

$$\lambda_i b_t f_I = \int_0^{a_i} \left[\frac{\pi_{it}}{\psi_t} - \lambda_i b_t f \right] dG(a) + \int_0^{a_i^*} \left[\frac{\pi_{it}^*}{\psi_t} - \lambda_i b_t f^* \right] dG(a),$$

where $G(a)$ is the cumulative function of $g(a)$ defined by equation (3.6). In this expression, the left hand side refers to the costs of developing a new variety. The first term on the right hand side is the expected benefits of producing and selling in the local market and the second term refers to the expected benefits of producing and selling in the export market. Hence, we have the costs that exactly balance the expected benefits. Introducing equations (3.7) and (3.8) in the previous equation, the free entry conditions can be written as:

$$\begin{aligned} \lambda_D b_t \bar{f}_D &= \frac{1}{\psi_t} \left[\chi_D \int_0^{a_D} a^{1-\sigma} \frac{g(a)}{G(a_D)} da + \theta \chi_F \int_0^{a_D^*} a^{1-\sigma} \frac{g(a)}{G(a_D)} da \right] \\ \lambda_F b_t \bar{f}_F &= \frac{1}{\psi_t} \left[\chi_F \int_0^{a_F} a^{1-\sigma} \frac{g(a)}{G(a_F)} da + \theta \chi_D \int_0^{a_F^*} a^{1-\sigma} \frac{g(a)}{G(a_F)} da \right] \end{aligned} \quad (3.12)$$

where

$$\bar{f}_i \equiv f \frac{1}{G(a_i)} + f + f^* \frac{G(a_i^*)}{G(a_i)} \quad (3.13)$$

represents the *ex ante* expected unit of knowledge needed to create a profitable variety.

We follow Gustafsson and Segerstrom (2010) and define the flow of new variety, $\dot{m}_{it}$, produced in country i. This flow depends on the resources attributed to R&D, namely L_{iIt} (because the innovation sector uses only labour), divided by the cost of developing profitable variety.

$$\dot{m}_{it} = \frac{L_{iIt}}{\lambda_i b_t \bar{f}_i} \quad i = D, F \quad (3.14)$$

where L_{iIt} is the part of total labour L_{it} devoted to the innovation sector in the country i. Therefore, the flow of new variety increases as the labour used in the innovation sector increases and decreases as the costs of innovation increases.

3.3 Steady-state equilibrium

3.3.1 Growth rate

In this model, R&D drives economic growth. Then, we have to determine the growth rate of varieties in both economies $g_D \equiv \dot{m}_{Dt}/m_{Dt}$ and $g_F \equiv \dot{m}_{Ft}/m_{Ft}$. From $m_t = m_{Dt} + m_{Ft}$, m_{Dt} and m_{Ft} must grow at the same rate g at steady-state. We can solve for g differentiating the flow of new varieties, (3.14):

$$g_D = g_F = g = \frac{n}{1-\phi} \tag{3.15}$$

where g is the worldwide growth rate of variety. As in Jones (1995) and Segerstrom (1998), we have a semi-endogenous growth model. The steady-state growth rate is constant and depends only on the population growth and the inter-temporal knowledge spillover parameter ϕ. To ensure a positive growth rate, we assume that $\phi < 1$. Note that even with productivity asymmetries and different market size, the steady-state growth rates of both economies are constant and equal. Therefore, any shock like trade liberalisation can only affect the short-run growth rate and ends up with level effect on the endogenous variables.

3.3.2 Threshold values

We can now determine the productivity threshold values of entry in the local and export markets in both countries. Following Falvey et al. (2011), we can write the productivity gap as function of $\bar{a}_D$ and $\bar{a}_F$:

$$\mu \equiv \left(\frac{\bar{a}_F}{\bar{a}_D}\right)^k > 1.$$

As well as for the productivity gap in the production sector, we define an efficiency gap in the innovation sector:

$$\kappa \equiv \left(\frac{\lambda_F}{\lambda_D}\right)^\beta > 1,$$

where $\beta \equiv k/(\sigma-1) > 1$. Here, $\kappa > 1$ means that $\lambda_D < \lambda_F$, so that the costs for market entry is lower and the domestic country has a higher efficiency in the innovation sector. Threshold values are derived from a system of equations given by the market entry conditions (3.10), (3.11) and the free entry conditions (3.12):[8]

$$a_D = \bar{a}_D \left[\frac{f_I}{f}(\beta-1)\right]^{\frac{1}{k}} \left(\frac{1-\mu\kappa\Omega}{1-\Omega^2}\right)^{\frac{1}{k}}, \quad a_F = \bar{a}_F \left[\frac{f_I}{f}(\beta-1)\right]^{\frac{1}{k}} \left(\frac{1-(\mu\kappa)^{-1}\Omega}{1-\Omega^2}\right)^{\frac{1}{k}} \tag{3.16}$$

$$a_D^* = \bar{a_D} \left[\frac{f_I}{f^*}(\beta-1)\right]^{\frac{1}{k}} \left(\frac{\mu\kappa\Omega-\Omega^2}{1-\Omega^2}\right)^{\frac{1}{k}}, \quad a_F^* = \bar{a_F} \left[\frac{f_I}{f^*}(\beta-1)\right]^{\frac{1}{k}} \left(\frac{(\mu\kappa)^{-1}\Omega-\Omega^2}{1-\Omega^2}\right)^{\frac{1}{k}}. \tag{3.17}$$

We define $\Omega \equiv \theta^{\beta}(f^*/f)^{1-\beta}$ that represents the degree of openness: if trade costs (sunk costs and/or transport costs) go to infinity, Ω goes to 0, and if trade is costless ($\theta = 1$ and $f^* = f$), Ω goes to 1. As a result, an increase in Ω can be seen as trade liberalisation. The threshold values depend on the productivity differences, innovation efficiency, but not on markets sizes. Unlike Gustafsson and Segerstrom (2010) results, these values are asymmetric for the two countries, for both local and export markets, and we need to impose $\mu = \kappa = 1$ to obtain their results. In this paper, we focus on the asymmetric cases. In order to get relevant positive threshold values we need the restrictions $\Omega < (\kappa\mu)^{-1}$ and $\Omega < \kappa\mu$. These restrictions mean that the asymmetries between the two countries must not be too large. With this assumption, we can study the relative threshold values:

$$\frac{a_D}{a_F} = \frac{a_F^*}{a_D^*} = \mu^{-\frac{1}{k}} \left(\frac{1-\mu\kappa\Omega}{1-(\mu\kappa)^{-1}\Omega}\right)^{\frac{1}{k}} < 1. \tag{3.18}$$

We can also determine the cost of a profitable variety for an innovator:

$$\bar{f_D} = f\left(\frac{\beta}{\beta-1}\right)\left[\frac{1-\Omega^2}{1-\mu\kappa\Omega}\right], \quad \bar{f_F} = f\left(\frac{\beta}{\beta-1}\right)\left[\frac{1-\Omega^2}{1-(\mu\kappa)^{-1}\Omega}\right]. \tag{3.19}$$

3.3.3 Labour market

We now solve for the labour market equilibrium in both countries. As labour is not mobile internationally, all the labour in one country is either employed in the production sector or in the innovation sector. The full employment equilibrium condition in the labour market requires the labour force to be employed in the production sector (L_{iPt}) or in the innovation sector (L_{iIt}) so that $L_{it} = L_{iPt} + L_{iIt}$. First, we write the labour used in the production sector

[8] See appendix for detail of calculations

as the sum of the labour used for local consumption and for the export market:

$$L_{DPt} = \left[\int_0^{a_D} a q_D m_D \frac{g(a)}{G(a_D)} da + \int_0^{a_D^*} \tau a q_F m_D \frac{g(a)}{G(a_D)} da \right]$$

$$L_{FPt} = \left[\int_0^{a_F} a q_F m_F \frac{g(a)}{G(a_F)} da + \int_0^{a_F^*} \tau a q_D m_F \frac{g(a)}{G(a_F)} da \right].$$

Rearranging these equations using the demand given by (3.3) and the free entry conditions given by (3.12) yields:

$$L_{DPt} = (\sigma - 1)\psi \lambda_D \gamma_D \bar{f}_D m_t^{1-\phi}$$

$$L_{FPt} = (\sigma - 1)\psi \lambda_F \gamma_F \bar{f}_F m_t^{1-\phi},$$

where $\gamma_{Dt} \equiv m_{Dt}/m_t$ and $\gamma_{Ft} \equiv m_{Ft}/m_t$ are the share of worldwide varieties produced by each country.[9] Second, rearranging the flow of new variety given by equation (3.14), we can determine the amount of labour used in the innovation sector:

$$L_{DIt} = g \lambda_D \gamma_D \bar{f}_D m_t^{1-\phi}$$

$$L_{FIt} = g \lambda_F \gamma_F \bar{f}_F m_t^{1-\phi}$$

After these calculations, the full employment equilibrium conditions $L_{it} = L_{iPt} + L_{iIt}$ in both countries require:

$$L_{Dt} = \lambda_D \gamma_D \bar{f}_D m_t^{1-\phi} (g + (\sigma - 1)\psi), \tag{3.20}$$

$$L_{Ft} = \lambda_F \gamma_F \bar{f}_F m_t^{1-\phi} (g + (\sigma - 1)\psi), \tag{3.21}$$

As $\bar{f}_D$ is fixed by (3.19) and g is fixed by (3.15), from (3.20), we can state that any increase in γ_D must be balanced by a permanent decrease in m_t, in order to maintain equality in the labour market. The inverse is true from (3.21). Then, in the $(\gamma_D; m_t)$ space, the domestic steady state function is upward-sloping whereas the foreign steady state function is downward-sloping. The intersection of the two curves gives a unique steady-state m_t corresponding to a specific share $(\gamma_D; \gamma_F)$ of produced variety. Using (3.19), (3.20) and (3.21) ,

[9] See Appendix for detailed calculations

we have:

$$\frac{\gamma_D}{\gamma_F} = \kappa^{\frac{1}{\beta}} \frac{L_{Dt}}{L_{Ft}} \left(\frac{\bar{f}_F}{\bar{f}_D} \right) = \kappa^{\frac{1}{\beta}} \frac{L_{Dt}}{L_{Ft}} \left(\frac{1 - \mu\kappa\Omega}{1 - (\mu\kappa)^{-1}\Omega} \right). \tag{3.22}$$

Note that both the relative market size, the innovation efficiency and the productivity gap appear in this expression. Thus, they all play a role in the determination of γ_D and γ_F. If $\mu = \kappa = 1$, and $L_{Dt} = L_{Ft}$, each country produces exactly the same number of varieties and we come back to the results of Gustafsson and Segerstrom (2010). Now we focus on different asymmetric cases.

3.3.4 Analysis

Market size effect

First looking at the threshold values equations (3.16) and (3.17), we can observe that market sizes do not appear. Hence, market sizes do not play a role in the determination of the average productivity. Second, we can see from (3.16) and (3.17), if $\mu = \kappa = 1$, the threshold values of local and export markets entry are equal in both countries, meaning that the cost of developing a profitable variety is also equalised ($\bar{f}_D = \bar{f}_F$). Then, from (3.22) a larger country has a higher share of produced varieties. In fact, market size differences allow the larger country to invest more labour in R&D than the smaller country. As the costs of developing a profitable variety are equalised, the larger country produces a larger share varieties. This result corresponds to a pure market size effect. We have:

Proposition 1 *If $\mu = \kappa = 1$, $L_{Ft} > L_{Dt}$ implies i) $a_D = a_F$ and ii) $\gamma_F > \gamma_D$.*

Technological gap

If we let $\kappa = 1$, from (3.18), the threshold value for local market entry is lower in the domestic market. Unambiguously, we have here a productivity gap effect. To enter the local market, firms in the domestic (foreign) country must have a higher (lower) productivity level because their market is more (less) competitive. In the export market, the threshold value for market entry is higher in the domestic country meaning that firms need lower productivity to enter the export market. Finally, for a domestic firm that produces a new variety, it is harder (on average) to enter the local market, but it is easier to export (compared to a foreign firm). Coming to the innovation analysis, if there is no market size differences ($L_{Dt} = L_{Ft}$), no innovation efficiency differences ($\kappa = 1$) and the domestic country has a productivity advantage ($\mu > 1$), the foreign country produces a higher share of varieties at equilibrium. This result can be surprising and counter-intuitive but it can be explained by a lower innovation incentives for a potential entrant in the domestic country. As $\mu > 1$, from (3.19), it is harder to develop a profitable variety $(\bar{f}_F / \bar{f}_D < 1)$ so firms invest less in the R&D sector. We have:

Proposition 2 *If $L_{Dt} = L_{Ft}$, $\kappa = 1$ and $\mu > 1$, then i) $a_D < a_F$, ii) $a_D^* > a_F^*$, and iii) $\gamma_F > \gamma_D$.*

Innovation efficiency gap

If we let $L_{Dt} = L_{Ft}$, $\mu = 1$ and $\kappa > 1$, from (3.18), the threshold value for local market entry is lower in the domestic market. This result seems surprising. However, being more efficient in the innovation sector implies that more firms are willing to enter the market, rising competition and driving prices and firms' mark-up down. Then, a firms needs a higher productivity to make enough profit to enter the market, and the marginal cost threshold value a_D is driven down. Also the fiercer competition makes it more difficult for foreign firms to export. Coming to the innovation analysis, the domestic country that has the highest innovation efficiency uses less labour resources in the innovation sector for two reasons: their efficiency advantage allow them to be as efficient as the foreign country using less resources, and the fiercer competition drives the innovation incentives of firms down. As with the technological gap, we have:

Proposition 3 *If $L_{Dt} = L_{Ft}$, $\mu = 1$ and $\kappa > 1$, then i) $a_D < a_F$, ii) $a_D^* > a_F^*$, and iii) $\gamma_F > \gamma_D$.*

3.4 Trade liberalisation

We identify two different effects of trade liberalisation on productivity. In the short-run, the threshold values for market entry are modified and the average productivity in a specific country change. The reduction of trade costs also has an impact on the costs of developing a new variety, so the innovation incentives are affected and finally growth can temporary slow down or accelerate. In this section, we assume that trade liberalisation takes place, meaning that transport costs or sunk costs for the export market are reduced (τ or f^* are reduced so that Ω increases), and analyse how different countries respond to this shock.

3.4.1 Impact on threshold values

As Ω appears in the expressions of the threshold values, its increase will have an impact on them. From (3.16) and (3.17), we see that both a_D and a_F are decreasing in Ω. Trade liberalisation induces a reallocation of production (the Melitz effect) which unambiguously raises productivity in both countries. The new opportunities on the export markets due to trade liberalisation induce a competitive pressure on the local market. Firms with the lowest productivity level are pushed out and the average productivity raises. However, the magnitude of this reallocation and the impact on productivity in the two countries are not symmetric. From (3.18), it clearly depends on μ and κ. With $\mu > 1$ and/or $\kappa > 1$, any increase in Ω leads to lower a_D/a_F and a_F^*/a_D^* ratios. First, the threshold value of local market entry decreases more in the domestic country than in the foreign one. Second, the threshold value of export market entry increases more in the domestic country than in the foreign one. This is consistent with the long-run implication of the reallocation effect found by Falvey et al. (2011), in a static Melitz-type model. Trade liberalisation $(\Omega \uparrow)$ induces a reallocation of production that benefit to both countries $(a_D$ and $a_F \downarrow)$. However, this benefit is not symmetric. It does not depend on market size differences but on productivity differences and innovation efficiency differences between countries. From (3.18), when the domestic country has a productivity or innovative advantage $(\mu > 1$ or $\kappa > 1)$, its average productivity benefits more than the foreign country from the decreasing trade costs $(\frac{a_D}{a_F} \downarrow)$. The benefits for exporting are also higher in the domestic market $(\frac{a_F^*}{a_D^*} \downarrow)$.

3.4.2 Impact on growth

Trade liberalisation does not have any effect on the long-run growth rate of variety as Ω does not appear in (3.15). But in the short-run, there is a temporary effect on growth that goes through the labour market. First, if $\mu = \kappa = 1$, (3.19) implies that a higher Ω increases the costs of developing a profitable variety in both countries ($\bar{f}_D$ and $\bar{f}_F$ increase). Therefore, the equilibrium equations in labour market are modified. From (3.22), the shares of produced varieties are not affected for $\mu = \kappa = 1$. Therefore, equations (3.20) and (3.21) imply that for any permanent increase in $\bar{f}_i$, m_t must permanently decrease to maintain equality. A permanent decrease in m_t means that the long-run level of produced variety permanently decreases so that the world growth rate of innovation temporarily drops under the long-run value g.

Market size effect

This drop is symmetric in both countries if there are no productivity and innovation efficiency differences ($\mu = \kappa = 1$) and the shares of produced variety are proportional to market size.

Proposition 4 *If* $\mu = 1$, *then* $\frac{\partial \gamma_D/\gamma_F}{\partial \Omega} = 0$ *and* $\frac{\partial m_t}{\partial \Omega} = \frac{\partial m_{Dt}}{\partial \Omega} + \frac{\partial m_{Ft}}{\partial \Omega} < 0 \Rightarrow \frac{\partial m_{Dt}}{\partial \Omega} = \frac{\partial m_{Ft}}{\partial \Omega} < 0$

Proposition 3 states that if there is no productivity or innovation efficiency differences ($\mu = \kappa = 1$), trade liberalisation implies a permanent decrease in m_t but there is no modification of the shares of produced varieties as we can see from (3.22), meaning that both growth rates are retarded in the short-run and the number of variety produced is lowered in each country identically. This result is similar to the second theorem of Gustafsson and Segerstrom (2010), but in their case, the shares of produced varieties are equal because the market sizes are the same. Here, the shares of produced varieties in both countries depend on the relative market size and only on them. If the domestic country is larger, then more resources are employed in the innovation sector and more varieties are produced in the domestic country.

Technological and innovation efficiency gap

In the technological asymmetric case, however, the result is different:

Proposition 5 *If* $\kappa > 1$ *and/or* $\mu > 1$, *then* $\frac{\partial \gamma_D/\gamma_F}{\partial \Omega} < 0$ *and* $\frac{\partial \gamma_D}{\partial \Omega} < 0 < \frac{\partial \gamma_F}{\partial \Omega}$

From (3.22), any increase in Ω leads to a lower γ_D/γ_F ratio for constant market sizes. As $\gamma_D \equiv 1 - \gamma_F$, the share of foreign produced varieties is higher while the share of domestic produced varieties is lower at the new equilibrium. The effect of trade liberalisation on productivity growth is therefore clearly asymmetric. The competitive pressure on the local market induced by the reallocation effect reduces the expected profit of an innovation in both local and export markets. Moreover, the cost of a profitable variety increases because it becomes harder to enter the local market. The level of these variables are directly connected to the threshold values and therefore to the productivity gap μ and the innovation efficiency gap κ. As the local market entry threshold decreases more in the domestic country, proposition 4 can be interpreted as follows: innovation incentives are decreasing in both countries but the domestic one is more affected than the foreign one because the reallocation effect is stronger there. Therefore, in the short-run, productivity growth decreases more in the domestic country than in the foreign one. In the long-run, the growth rates reach their equilibrium values $g = g_D = g_F$ given by (3.15), and there are only level effects on the number of varieties m_{Dt} and m_{Ft} produced in each country and on the total number of produced varieties m_t. In the new equilibrium, we have a higher share γ_F of foreign produced varieties and a lower share γ_D of domestic produced varieties.

3.5 Conclusion

This chapter shows that asymmetric results occur on the two channels through which trade liberalisation affects productivity. First, the reallocation effect found by Melitz (2003) is asymmetric across the two countries and the productivity gains are larger in the more productive and innovative country. Market size differences play no role in determining the threshold values of market entry and therefore have no influence on the reallocation effect. Second, we find that trade liberalisation temporarily affects the productivity growth rate in an asymmetric way, leading to a change in the share of variety produced by each country at the new equilibrium. The more productive or the more innovative country suffers a decrease in its share of produced varieties and its productivity decreases relatively to the less productive country at the new equilibrium. There is a catching-up effect in the long term.

Appendix:

Appendix A: Threshold values

We use the same framework as in Gustafsson and Segerstrom (2010) in order to derive the threshold values given by (3.16) and (3.17). The asymmetry across countries yields different *arbitrage* equations for market entry in the domestic and the foreign country. These equations for both local and foreign markets are given by:

$$\lambda_D b_t f = \frac{\chi_D a_D^{1-\sigma}}{\psi}, \quad \lambda_F b_t f = \frac{\chi_F a_F^{1-\sigma}}{\psi}, \tag{3.10}$$

$$\lambda_D b_t f^* = \theta \frac{\chi_F a_D^{*1-\sigma}}{\psi}, \quad \lambda_F b_t f^* = \theta \frac{\chi_D a_F^{*1-\sigma}}{\psi}, \tag{3.11}$$

where $\chi_D \equiv \sigma^{-\sigma}(\sigma-1)^{\sigma-1}(E_{Dt}/P_{Dt}^{1-\sigma})$, $\chi_F \equiv \sigma^{-\sigma}(\sigma-1)^{\sigma-1}(E_{Ft}/P_{Ft}^{1-\sigma})$, and $\theta \equiv \tau^{1-\sigma}$. E_{it} represents the aggregate expenditures in both countries, P_{it} is the aggregate price index in country i and ψ is a discount rate.

Also, the arbitrage equations for entry in the innovation process for firms of both countries are given by:

$$\begin{aligned} \lambda_D b_t \bar{f}_D &= \frac{1}{\psi}\left[\chi_D \int_0^{a_D} a^{1-\sigma}\frac{g(a)}{G(a_D)}da + \theta\chi_F \int_0^{a_D^*} a^{1-\sigma}\frac{g(a)}{G(a_D)}da\right], \\ \lambda_F b_t \bar{f}_F &= \frac{1}{\psi}\left[\chi_F \int_0^{a_F} a^{1-\sigma}\frac{g(a)}{G(a_F)}da + \theta\chi_D \int_0^{a_F^*} a^{1-\sigma}\frac{g(a)}{G(a_F)}da\right], \end{aligned} \tag{3.12}$$

where $\bar{f}_i$ represents the *ex ante* expected cost of creating a profitable variety. From (3.11), we can write:

$$\chi_D = \lambda_D \psi_t b_t f a_D^{\sigma-1}; \quad \chi_F = \lambda_F \psi_t b_t f a_F^{\sigma-1} \tag{3.23}$$

Introducing (3.23) in (3.12) we can find:

$$\left(\frac{a_D^*}{a_F}\right) = \left(\frac{a_F^*}{a_D}\right) = \left(\frac{f^*}{\theta f}\frac{\lambda_D}{\lambda_F}\right)^{\frac{1}{1-\sigma}}. \tag{3.24}$$

Then, we use (3.23) into equation (3.12) in the following way:[10]

$$\lambda_D b_t \bar{f}_D = \frac{1}{\psi}\left[\chi_D \int_0^{a_D} a^{1-\sigma}\frac{g(a)}{G(a_D)}da + \theta\chi_F \int_0^{a_D^*} a^{1-\sigma}\frac{g(a)}{G(a_D)}da\right],$$

$$\lambda_D b_t \left[f_I + fG(a_D) + f^*G(a_D^*)\right] = \left[\lambda_D b_t f a_D^{\sigma-1}\int_0^{a_D} a^{1-\sigma}g(a)da + \theta\lambda_F b_t f a_F^{\sigma-1}\int_0^{a_D^*} a^{1-\sigma}g(a)da\right],$$

$$\lambda_D\left[\frac{f_I}{f} + G(a_D) + \frac{f^*}{f}G(a_D^*)\right] = \left[\lambda_D a_D^{\sigma-1}\int_0^{a_D} a^{1-\sigma}g(a)da + \theta\lambda_F a_F^{\sigma-1}\int_0^{a_D^*} a^{1-\sigma}g(a)da\right],$$

$$\left[\frac{f_I}{f} + G(a_D) + \frac{f^*}{f}G(a_D^*)\right] = \left(\frac{\beta}{\beta-1}\right)\left[a_D^k\bar{a}_D^{-k} + \theta\frac{\lambda_F}{\lambda_D}a_F^{\sigma-1}a_D^{*1-\sigma+k}\bar{a}_D^{-k}\right],$$

$$\left[\frac{f_I}{f} + G(a_D) + \frac{f^*}{f}G(a_D^*)\right] = \left(\frac{\beta}{\beta-1}\right)\left[a_D^k\bar{a}_D^{-k} + \theta\frac{\lambda_F}{\lambda_D}\left(\frac{a_D^*}{a_F}\right)^{1-\sigma+k}a_F^k\bar{a}_D^{-k}\right],$$

Using (3.24) and the definition of $\Omega \equiv \sigma^\beta\left(\frac{f^*}{f}\right)^{\beta-1}$, we have:

$$\left[\frac{f_I}{f} + \left(\frac{a_D}{\bar{a}_D}\right)^k + \left(\frac{\lambda_F}{\lambda_D}\right)^\beta\Omega\left(\frac{a_F}{\bar{a}_D}\right)^k\right] = \left(\frac{\beta}{\beta-1}\right)\left[a_D^k\bar{a}_D^{-k} + \left(\frac{\lambda_F}{\lambda_D}\right)^\beta\Omega a_F^k\bar{a}_D^{-k}\right],$$

$$\left(\frac{a_D}{\bar{a}_D}\right)^k\left[\frac{\beta}{\beta-1} - 1\right] = \frac{f_I}{f} + \kappa\Omega\left(\frac{a_F}{\bar{a}_D}\right)^k\left[1 - \frac{\beta}{\beta-1}\right]$$

$$\left(\frac{a_D}{\bar{a}_D}\right)^k = \frac{f_I}{f}(\beta-1) + \kappa\Omega\left(\frac{a_F}{\bar{a}_D}\right)^k$$

$$a_D^k = \bar{a}_D^k\left[\frac{f_I}{f}(\beta-1)\right] - \kappa\Omega a_F^k$$

Following the same steps, we can find the similar equation for the foreign country:

$$a_F^k = \bar{a}_F^k\left[\frac{f_I}{f}(\beta-1)\right] - \kappa^{-1}\Omega a_D^k$$

[10] Note here that $\int_0^{a_D} a^{1-\sigma}g(a)da = \left(\frac{\beta}{\beta-1}\right)a_D^{1-\sigma+k}\bar{a}_D^{-k}$ and $\int_0^{a_D^*} a^{1-\sigma}g(a)da = \left(\frac{\beta}{\beta-1}\right)a_D^{*1-\sigma+k}\bar{a}_D^{-k}$

Finally, we have two equations and we can solve for a_D and a_F. We find:

$$a_D^k = \bar{a}_D^k \left[\frac{f_I}{f}(\beta - 1)\right] - \kappa\Omega \left(\bar{a}_F^k \left[\frac{f_I}{f}(\beta - 1)\right] - \kappa^{-1}\Omega a_D^k\right)$$

$$a_D^k = \bar{a}_D^k \left[\frac{f_I}{f}(\beta - 1)\right] - \kappa\Omega\bar{a}_F^k \left[\frac{f_I}{f}(\beta - 1)\right] - \Omega^2 a_D^k$$

$$a_D^k(1 - \Omega^2) = \left[\frac{f_I}{f}(\beta - 1)\right] \left(\bar{a}_D^k - \kappa\Omega\bar{a}_F^k\right)$$

$$a_D^k = \bar{a}_D^k \left[\frac{f_I}{f}(\beta - 1)\right] \left(\frac{1 - \mu\kappa\Omega}{1 - \Omega^2}\right) \tag{3.25}$$

The same development is done for:

$$a_F^k = \bar{a}_F^k \left[\frac{f_I}{f}(\beta - 1)\right] \left(\frac{1 - (\mu\kappa)^{-1}\Omega}{1 - \Omega^2}\right) \tag{3.26}$$

Then, we look for the threshold values for the export market. Using (3.24), we have that:

$$a_D^* = \left(\frac{f^*}{\theta f}\frac{\lambda_D}{\lambda_F}\right)^{\frac{1}{1-\sigma}} a_F.$$

$$a_D^{*k} = \left(\frac{f^*}{\theta f}\frac{\lambda_D}{\lambda_F}\right)^{\frac{k}{1-\sigma}} \bar{a}_F^k \left[\frac{f_I}{f}(\beta - 1)\right] \left(\frac{1 - (\mu\kappa)^{-1}\Omega}{1 - \Omega^2}\right).$$

$$a_D^{*k} = \Omega\kappa\bar{a}_F^k \left[\frac{f_I}{f^*}(\beta - 1)\right] \left(\frac{1 - (\mu\kappa)^{-1}\Omega}{1 - \Omega^2}\right).$$

$$a_D^{*k} = \Omega\mu\kappa\bar{a}_D^k \left[\frac{f_I}{f^*}(\beta - 1)\right] \left(\frac{1 - (\mu\kappa)^{-1}\Omega}{1 - \Omega^2}\right).$$

$$a_D^{*k} = \bar{a}_D^k \left[\frac{f_I}{f^*}(\beta - 1)\right] \left(\frac{\mu\kappa\Omega - \Omega^2}{1 - \Omega^2}\right).$$

With the same development, we obtain:

$$a_F^{*k} = \bar{a}_F^k \left[\frac{f_I}{f^*}(\beta - 1)\right] \left(\frac{(\mu\kappa)^{-1}\Omega - \Omega^2}{1 - \Omega^2}\right).$$

Finally, we can recover the threshold values given by equations (3.16) and (3.17).

Appendix B: Labour market

In the labour market, we have to calculate the amount of labour used in the production sector and in the innovation sector.

$$L_{DPt} = \left[\int_0^{a_D} a q_D m_D \frac{g(a)}{G(a_D)} da + \int_0^{a_D^*} \tau a q_F m_D \frac{g(a)}{G(a_D)} da \right]$$

Substituting q_D and q_F using (3.3) yields:

$$\begin{aligned} L_{DPt} = & \int_0^{a_D} \sigma^{-\sigma} (\sigma-1)^{\sigma-1} \frac{E_{Dt}}{P_{Dt}^{1-\sigma}} a^{1-\sigma} (\sigma-1) m_D \frac{g(a)}{G(a_D)} da \\ & + \int_0^{a_D^*} \theta \sigma^{-\sigma} (\sigma-1)^{\sigma-1} \frac{E_{Ft}}{P_{Ft}^{1-\sigma}} a^{1-\sigma} (\sigma-1) m_D \frac{g(a)}{G(a_D)} da \end{aligned}$$

As $\chi_D \equiv \sigma^{-\sigma}(\sigma-1)^{\sigma-1}\frac{E_{Dt}}{P_{Dt}^{1-\sigma}}$ and $\chi_F \equiv \sigma^{-\sigma}(\sigma-1)^{\sigma-1}\frac{E_{Ft}}{P_{Ft}^{1-\sigma}}$, we can simplify to:

$$L_{DPt} = (\sigma-1) m_D \left[\chi_D \int_0^{a_D} a^{1-\sigma} \frac{g(a)}{G(a_D)} da + \theta \chi_F \int_0^{a_D^*} a^{1-\sigma} \frac{g(a)}{G(a_D)} da \right]$$

Then we use equation (3.12) to substitute the term in brackets to obtain:

$$L_{DPt} = (\sigma-1) \psi m_D \lambda_D b_t \bar{f}_D$$

$$L_{DPt} = (\sigma-1) \psi \lambda_D \gamma_D \bar{f}_D m_t^{1-\phi}$$

Using the same demonstration, we obtain:

$$L_{DPt} = (\sigma-1) \psi \lambda_F \gamma_F \bar{f}_F m_t^{1-\phi}$$

The amount of labour used in the innovation sector is determined from equation (3.14):

$$\dot{m}_{Dt} = \frac{L_{DIt}}{\lambda_D b_t \bar{f}_D}$$

$$\frac{\dot{m}_{Dt}}{m_{Dt}} = \frac{L_{DIt}}{\lambda_D m_{Dt} b_t \bar{f}_D}$$

$$L_{DIt} = g_D \lambda_D m_{Dt} b_t \bar{f}_D$$

$$L_{DIt} = g\lambda_D \bar{f}_D m_t^{1-\phi}$$

In the foreign market, we have:

$$L_{FIt} = g\lambda_F \bar{f}_F m_t^{1-\phi}$$

As the market clearing required $L_{it} = L_{iPt} + L_{iIt}$, we can find:

$$L_{Dt} = \lambda_D \gamma_D \bar{f}_D m_t^{1-\phi}(g + (\sigma - 1)\psi), \tag{3.20}$$

$$L_{Ft} = \lambda_F \gamma_F \bar{f}_F m_t^{1-\phi}(g + (\sigma - 1)\psi). \tag{3.21}$$

4 Learning Effects of Trade ?

4.1 Introduction

A branch of the literature linking productivity and export performances tries to identify a potential increase in firms' productivity due to their entry into the international market. This is known as a *learning-by-exporting* (LBE hereafter) effect, directly influenced by the *learning-by-doing* notion introduced by Arrow (1962). So far, the results of the empirical literature focusing on this issue are unclear. No strong evidences supporting the learning-by-exporting hypothesis has emerged. However, some studies identified some subgroups of firms that are found to benefit from learning-by-exporting, mainly young firms, in the first years of exporting and in developing countries only (Martins and Yang, 2009). A first series of studies typically use the residual of a OLS estimation to account for firms productivity and study whether it increases after export market entry (Bernard and Jensen, 1999). Two problems arise with these studies. The first one is that they suffer from an endogeneity problem in the selection of exporters. If better firms become exporters, it is not surprising that they remain better after export market entry and it is hard to attribute any effect to learning-by-exporting. A way to get rid of the selection problem is the matching technique approach, which is, at this time, the most common in the LBE literature since the works of (Wagner, 2002; Girma et al., 2004; De Loecker, 2007). This technique has the interesting advantage of avoiding the endogeneity problem of exporters selection by matching exporters and non exporters in a treatment evaluation framework with difference-in-differences. The idea is the following: if two firms i and j has similar characteristics including productivity in period t, and if firm i starts to export in $t+1$, one can attribute the productivity difference between i and j in $t+1$ to the change in the export status of the firm i. There is now a lot of papers using this type of framework, estimating LBE for a long list of developed as well as developing countries (see Silva et al. (2012b) for a survey). Evidences of LBE has only been found mostly in developing countries and no big picture emerges from these studies (Wagner, 2007). The second problem concerns the way of estimating firms productivity. The use of an exogenous productivity process could end up with an underestimation of LBE, the true effect of exporting being included in the error term of the regression (De Loecker, 2013).

In this paper, the productivity is estimated using a control function approach as in Olley and Pakes (1996) and Levinsohn and Petrin (2003) of Ackerberg et al. (2006) but I consider an endogenous productivity process that accounts for previous trading status as in De Loecker (2013). Besides solving the endogenous productivity process problem, the methodology has two advantages. First, it allows to derive directly a LBE estimates inside the productivity estimation process and no selection problem arise. Second, we can easily extend the method to account not only for exporting, but also for other trading variables.

Although the literature has focused, since the beginning of the 2000's, on the relation between export market participation and performances, it is not the only trading decision that can impact firms' productivity. More recently, some studies start to show the existence of an "import premium" i.e. an edge in productivity level of the importers over the non-importers (Kasahara and Rodrigue, 2008; Muûls and Pisu, 2009; Amiti and Konings, 2007). This finding raises again the question: are importers better because they start importing? In other words, can we identify any *learning-by-importing* (LBI hereafter) effect. Theoretically, the idea that importing intermediate inputs might raise productivity has been discussed in the new trade theory literature (Grossman and Helpman, 1991). Economists intuitions are that it may come from increasing input quality, increasing input variety or simply by technology adoption. Several recent studies try to explore the link between import and productivity. The channels are not obvious. For example, Andersson et al. (2008) or Bas and Strauss-Kahn (2010) check for the effect of product differentiation and imported product variety on productivity. They find that increasing the number of imported varieties has a positive impact on productivity.

This paper aims at providing evidence for learning-by-trading. I test for the existence of both LBE and LBI for French firm at the sector-level. Following the previously mentioned methodology, I use an endogenous productivity process that can account not only for past productivity but for other potential drivers of productivity such as exports and imports. I find significant learning effects for both exports and imports. Interestingly, the learning effects of importing seems to be greater then those for exporting in almost all sectors.

The paper is organised as follows: Section 4.2 presents the productivity estimation technique with the endogenous productivity process. Section 4.3 discusses the potential productivity drivers. Finally, Section 4.4 presents the estimation results and Section 4.5 concludes.

4.2 Productivity estimation procedure

4.2.1 The control function approach

As the purpose of this chapter is to determine the learning effect of trading on firms' productivity, the way I estimate productivity has to be discussed and described. Usually, to estimate productivity, one relies on a production function which is of the Cobb-Douglass form. It links the output Y_{it} to the capital stock K_{it} and the labour force L_{it} for each individual firm i at time t. Then, the productivity function can be written as follows:

$$Y_{it} = A_{it} L_{it}^{\beta_l} K_{it}^{\beta_k} \tag{4.1}$$

where β_l and β_k are the output elasticicities of capital and labour, respectively. In Equation (4.1), our parameter of interest is A_{it}. It represents the firm specific productivity of all inputs (the Hicks-neutral productivity). In the literature, A_{it} refers to the Total Factor Productivity (TFP hereafter). Taking the log of (4.1) yields the equation:

$$y_{it} = c + \beta_l l_{it} + \beta_k k_{it} + a_{it} \tag{4.2}$$

where small letters denote the logs of capital letters, and c is the estimation constant. The standard OLS regression relies on the estimation of this residual to capture productivity. This procedure suffers from several problems that may yield inconsistent estimates of the production function coefficients. The residual a_{it} contains an efficiency parameter that is known by firms (but unobserved by econometricians) and that might influence firms' decision of the optimal inputs quantities as well as their decision to continue or to shut down production. Then, the residual a_{it} is correlated with the regressors. These two problems are known as the *simultaneity* problem and the *selection* problem.

In order to estimate the production function of firms, I use the control function approach developed by Olley and Pakes (1996) (OP hereafter), and augmented by Levinsohn and Petrin (2003) (LP hereafter) and Ackerberg et al. (2006) (ACF hereafter). Basically, this method consists of estimating unobserved productivity using a commonly observable variable, namely firms' investment in OP and intermediate inputs in LP. It allows to solve both the simultaneity and the selection problems of the simple OLS estimations. Formally, the idea is to divide the residual a_{it} in equation 4.2 into two parts: the unobserved productivity term ω_{it} that is known by firms and can affect their decisions and the error term ϵ_{it} that no one observes (so it does not affect input decision of firms). One can think of the first term ω_{it} as the managerial ability of firms or expected change in firm's environment and the second term ϵ_{it} accounts for measurement errors or unexpected productivity shocks. Therefore, equation 4.2 can be rewritten as follows:

$$y_{it} = c + \beta_l l_{it} + \beta_k k_{it} + \omega_{it} + \epsilon_{it}. \tag{4.3}$$

The non-parametric estimation proposed by Olley and Pakes (1996) relies on an approximation the unobservable ω_{it} by an observable variable that is monotonically increasing in productivity. After having shown that investment is a monotonic increasing function of productivity, OP use it as the proxy variable for ω_{it}. The problem with investment – as exposed by Levinsohn and Petrin (2003) – is that one needs firms in the dataset to have strictly positive values of investment for every years in the panel. If it is not the case, one has to drop these observations out of the sample to preserve the strict monotonicity of the relationship between productivity and investment.

Levinsohn and Petrin (2003) argue that intermediate inputs also have a monotonic relationship with productivity and the demand for intermediate inputs is most of the time positive, if not always. Therefore, the approach of Levinsohn and Petrin (2003) uses intermediate inputs as the proxy for productivity. They define intermediate inputs as a function of unobserved productivity and capital: $m_{it} = f(\omega_{it}; k_{it})$. Monotonicity in ω_{it} allows to invert the function $\omega_{it} = f^{-1}(m_{it}; k_{it})$ and to substitute for ω_{it} in Equation (4.3). One key assumption here is the timing of the input choices. As in OP, the estimation procedure of LP implies that the capital stock k_{it} is chosen at $t-1$.[1] The labour l_{it}, and intermediate inputs m_{it} are considered as perfectly variable inputs and are chosen in t, alongside the observation of ω_{it}. However, Ackerberg et al. (2006) report serious collinearity problems in this approach. If employment l_{it} and materials m_{it} are the perfectly variable inputs, they should be both function of productivity and capital $(\omega_{it}; k_{it})$. Then, if we invert the intermediate inputs equation and plug it into the labour choice equation, it becomes a function of intermediate inputs and capital. The estimation of β_l in Equation (4.3) suffer from collinearity issues and its estimation would be inconsistent. [2]

To solve this problem, they suggest to change the timing assumption of the choice of labour l_{it}. Firms have to choose labour l_{it} prior to time t and intermediate inputs is the only perfectly variable inputs chosen in t. Therefore, I consider m_{it} as a function of the prior decisions of labour and capital and the observed productivity ω_{it} at time t. This can be written:

$$m_{it} = f(\omega_{it}; l_{it}; k_{it}) \tag{4.4}$$

Then, the monotonicity assumption allows to invert this equation to obtain:

$$\omega_{it} = f^{-1}(m_{it}, l_{it}; k_{it}), \tag{4.5}$$

and Equation (4.3) becomes:

$$\begin{aligned} y_{it} &= \beta_l l_{it} + \beta_k k_{it} + f^{-1}(m_{it}; k_{it}; l_{it}) + \epsilon_{it} \\ y_{it} &= \phi(m_{it}; k_{it}; l_{it}) + \epsilon_{it}, \end{aligned} \tag{4.6}$$

where the function $\phi(\cdot)$ is defined as:

$$\phi(m_{it}; k_{it}; l_{it}) = \beta_l l_{it} + \beta_k k_{it} + f^{-1}(m_{it}; l_{it}; k_{it}). \tag{4.7}$$

[1] From the classical investment function $k_t = (1-\delta)k_{t-1} + i_{t-1}$, it follows that capital stock at t is decided while making the investment decision at $t-1$.

[2] If $m_{it} = f(\omega_{it}; k_{it})$ and $l_{it} = g(\omega_{it}; k_{it})$ and if we can invert m_{it} to find $\omega_{it} = f^{-1}(m_{it}; k_{it})$, then, the labour choice can be written as a function of intermediate $l_{it} = g(f^{-1}(\omega_{it}; k_{it}); k_{it}) = h(m_{it}; k_{it})$. With this hypothesis, the estimation of β_l in Equation (4.3) would not be consistent.

Then, the estimation procedure has two steps, as in OP and LP.[3] However, the first step only consists of estimating the non-parametric model given by Equation (4.6) to obtain consistent estimates of the function $\phi(\cdot)$. As the parameters β_l and β_k are undefined in equation (4.6) (because labour and capital also appear in the non-parametric function), I need to identify them in a second step of estimation. To do so, I use information on firm dynamics to obtain at least two moment conditions. The productivity process is assumed to be a first order Markov process where productivity at time t depends on it's lagged value plus a deviation. That is:

$$\omega_{it} = g(\omega_{it-1}) + \xi_{it}, \tag{4.8}$$

where ξ_{it} represents a random innovation shock, which is, regarding the timing assumptions, orthogonal to l_{it-1}, k_{it-1} and k_{it}.

The estimation procedure of Ackerberg et al. (2006) consists on estimating this productivity process. Because ω_{it} is not observed, I need two candidate values $(\beta_l^0; \beta_k^0)$ to approximate it using equations (4.5) and (4.7). This approximation is:

$$\tilde{\omega}_{it} = \hat{\phi}_{it} - \beta_l^0 l_{it} - \beta_k^0 k_{it}. \tag{4.9}$$

Then, the optimisation consists of choosing the candidate values $(\beta_l^0; \beta_k^0)$ to approximate ω_{it} using Equation (4.9) and to estimate Equation (4.8). This is done until the residual $\xi_{it}(\beta_l^0; \beta_k^0)$ of (4.8) satisfies the following moments:

$$E\left\{ \xi_{it}(\beta_l^0; \beta_k^0) \begin{pmatrix} l_{it-1} \\ k_{it-1} \\ k_{it} \end{pmatrix} \right\} = 0. \tag{4.10}$$

To reinforce the generalised method of moment estimation, I consider three moments while two would have been enough for identification. The moment conditions are defined by the timing assumptions. Both capital and labour are chosen before the productivity shock ξ_{it}, so they are supposed to be orthogonal with it. Then, if the optimisation converges, I obtain consistent estimates of the production function technology parameters β_l and β_k.

[3] An alternative one-stage procedure also exists, see Wooldridge (2009).

This completes the description of the estimation technique based on Ackerberg et al.'s 2006 procedure. However, to identify potential effects of trading on productivity, I need to modify the assumptions on the productivity process. I expose, in the next section, the methodology for identifying learning-by-trading.

4.2.2 Identifying trading effects

Basically, previous literature on LBE using OLS regressions suffers from an selection problem: if more productive firms self-select into international markets, it is impossible to assess that new exporters productivity growth is due to their new exporting status. The treatment evaluation method with difference-in-differences (DID) was introduced in the LBE literature by Wagner (2002) and Greenaway et al. (2004). Considering new exporter at a certain period of time t as a *treated group* and non exporters as a *control group*, the treatment evaluation method consists of evaluating the Average Treatment Effect on the Treated (ATT) i.e. the effect of starting to export on new exporters performances compared to their performances had they not started to export. In recent papers, where matching and DID are used and productivity is estimated by control function approach techniques, the method implies a two step procedure: one needs to estimate the productivity before using it for the matching-DID estimation.

In this paper, I rely on the methodology of De Loecker (2013) and choose to compute directly the effects of trading while estimating productivity. If one looks at the productivity process given by Equation (4.8) that is used in OP and LP and ACF, the only explanatory variable of productivity is its lagged value. Therefore, any other variable that may explain productivity is included in the random productivity shock ξ_{it}. As I study the effect of starting to trade on firms' future productivity, all the interesting information (as for example, the effect of export participation in $t-1$, exp_{it-1}) is subsumed in the random productivity shock of (4.8): $\xi^*_{it} = \xi_{it} + \gamma exp_{it-1}$. Therefore, the basic idea is to extract this effect from the error term and to replace it in the productivity process. This way, one can recover the parameter value γ. It would yield the impact of starting exporting at $t-1$ on the productivity in t.

Following the method of De Loecker (2013), I endogenise the productivity process. Equation (4.8) then becomes:

$$\omega_{it} = g(\omega_{it-1}, V_{it-1}) + \xi_{it} \tag{4.11}$$

where I assume that productivity is determined by past productivity ω_{it-1} and by a vector of trading variables V_{it-1}. A first reason why one would add the vector of trading variable here is simply because firms do expect an impact of exporting in their output, and they are able to reconsider their input demand. If the productivity process is exogenous and only depends on its lagged values as in Equation (4.8), any productivity effect of trade is captured by ξ_{it} and would be considered as a productivity shock. So if one considers that the variables in our vector V_{it-1} (here, exporting for example) is correlated with labour and capital stock choices, one would end up with biased estimates of the coefficients β_l and β_k.[4]

Another advantage of this endogenous productivity process is that it allows to capture the effect of variables at time $t-1$ on the productivity at time t, and this is crucial for identifying learning effects. Moreover, with this way of identifying learning effects, one can control for the selection problem. The selection problem can be summarised as follows: the productivity difference between exporters and non exporters can already exist prior to the export decision. It is then impossible to attribute the current productivity difference to a learning effect. In my estimation, this is accounted for by the presence of the lagged value of productivity. It controls for productivity at time $t-1$, ensuring that the predicted effects of other variables included in the vector V_{it-1} on productivity cannot be attributed to prior productivity differences.

Given the endogenous productivity process of Equation (4.11), the productivity estimation also needs to satisfy the following moment conditions:

$$E\left\{\xi_{it}(\beta_l;\beta_k)V_{it-1}\right\} = 0 \tag{4.12}$$

Referring to the hysteresis hypothesis developed by Baldwin (1988), firms are not able to reconsider their trading status immediately while receiving the productivity shock ξ_{it}. Then, this moment condition is valid and allows identification of the learning effect.

4.3 Trading effects on firms' productivity

Most of the papers in the 2000's focus on explaining the exporter premium found in Bernard and Jensen (1995). Although results on learning-by-exporting are controversial (Wagner,

[4]See De Loecker (2013) for a discussion of this point.

2007), recent papers as Silva et al. (2012b) or De Loecker (2013) found positive effects of exporting on productivity. However, learning-by-exporting can be country specific and these papers study Portugal and Slovenia, respectively. It might also be sector specific or depends on firms' age (Martins and Yang, 2009). My first analysis concerns only exporting, and tries to determine if such an effect exist for French firms, and what is its magnitude. To do so, I rely on the following productivity process:

$$\omega_{it} = h_1(\omega_{it-1}) + \theta_{exp} exp_{it-1} + \xi_{1it}, \tag{4.13}$$

where $h_1(\omega_{it-1})$ is a non-parametric function, exp_{it-1} is a dummy variable indicating if the firm i exports in the period $t-1$. This semi-parametric approach allows me to recover the parameter θ_{exp}, that can be interpreted as the mean learning-by-exporting effect.

But trading is not only a matter of exporting. It also involves imports. There are good reasons to think of importing as a productivity-enhancing activity. Economic theory advances technology adoption as an important vector of productivity gains thought trade liberalisation. In growth models of trade (as the one used in Chapter 3), it often takes the form of technological spillover across countries (Grossman and Helpman, 1991). At the macro level, Eaton and Kortum (1999) among others, found empirical evidence on technology diffusion between countries and Coe and Helpman (1995) show that imports of intermediate inputs is a strong channel for technology diffusion. In the light of these findings, one can consider that learning-by-importing might occurs by technology adoption through imports of intermediate inputs. However, at the firm-level, imports have been first neglected by empirical studies. Researchers now start to investigate the import side of trade. As for export, they show that an import premium exists for manufacturing firms (Andersson et al., 2008; Muûls and Pisu, 2009; Castellani et al., 2010). Given the (growing) share of intermediate inputs in the total value of trade and the availability of firm-level data, it is interesting to replicate for imports the methodology used for detecting learning-by-exporting. Therefore, the second specification of my productivity process includes imports, and equation (4.11) now becomes:

$$\omega_{it} = h_2(\omega_{it-1}) + \theta_{imp} imp_{it-1} + \xi_{2it} \tag{4.14}$$

where $h_2(\omega_{it-1})$ is a non-parametric function and imp_{it-1} is a dummy variable indicating if the firm i imports in the period $t-1$. Again, the expected effect of exporting on firm productivity is given by θ_{imp}.

4.4 Estimation results

4.4.1 Productivity estimation

The data in use are those described in Section 2.4. It combines the EAE (*Enquète Annuelle d'Entreprises* provided by INSEE and the French Custom Services data. It is an unbalanced panel of more than 293,000 observations over the period 1996-2007. The productivity estimation is a value added version of the control function approach procedures. The estimation procedure needs information on value added, labour and capital and intermediate inputs. Labour is calculated as the number of employees. Capital stock is approximated by tangible capital assets whereas values for intermediate inputs are directly available in the data. All these variables are provided by the EAE database for manufacturing firms that have more than 20 employees. The trade data allow me to recognise domestic firms from exporters, importers, and two-ways traders. I can also use the information on the number of destination countries for exports and the number of countries of origin for imports.[5]

My productivity estimation follows the procedure described in Section 4.2. I compare in Table 4.1 the results of the technology parameters estimation obtained with the endogenous productivity processes given by Equations (4.13) and (4.14) to those obtained with the exogenous one given by Equation (4.8). I provide the estimation results sector by sector. This is important because the capital and labour intensities vary between sectors. Then it is more relevant to divide the database for the estimations. The estimates of β_l and β_k are in par with what is usually found in the literature and β_l is on average greater than β_k. I find decreasing return to scale in almost all sectors and with all specification of the productivity process. With these estimates of the production function parameters, one can recover an estimated TFP for each firm.

[5]For more details on the trade database, see Section 2.5

Table 4.1: Production function estimation per sector and productivity process

Sector	Observations	Exogenous β_l	Exogenous β_k	With exports β_l	With exports β_k	With imports β_l	With imports β_k
DA	38406	0.330	0.172	0.262	0.180	0.252	0.181
DB	26480	0.622	0.093	0.378	0.115	0.290	0.124
DC	3984	0.344	0.121	0.366	0.117	0.393	0.115
DD	12288	0.750	0.082	0.971	0.060	0.803	0.070
DE	27701	0.452	0.066	0.416	0.069	0.359	0.072
DF	639	0.483	0.155	0.495	0.192	0.859	0.094
DG	10906	0.660	0.071	0.625	0.076	0.562	0.080
DH	18155	0.942	0.083	0.517	0.124	0.049	0.127
DI	10589	0.752	0.108	0.745	0.105	0.732	0.104
DJ	59496	0.626	0.114	0.563	0.121	0.470	0.128
DK	26200	0.448	0.107	0.415	0.111	0.346	0.119
DL	25841	0.372	0.136	0.329	0.141	0.313	0.142
DM	10008	0.448	0.107	0.441	0.109	0.318	0.125
DN	15553	0.838	0.089	0.854	0.090	0.830	0.093
E	2209	0.758	0.131	0.723	0.134	0.671	0.138

Note: Sectors denominations are given in Table 2.8.
The "Exogenous" column corresponds to the productivity process given by (4.8). "With exports" and "With imports" correspond respectively to (4.13) and (4.14).
A next version of the paper will provide bootstrapped standard errors.

4.4.2 Learning-by-exporting

The next step to detect learning-by-trading is to recover the estimated parameter of the semi-parametric productivity processes. For LBE, I recover the parameter θ_{exp} from Equation (4.13). Results are reported in Table 4.2a.

The results suggest that learning-by-exporting exists for most of the French manufacturing sectors. The are no significant effects only in four of them. Note that the effect are not significant for the sector that have the fewer observations. For the other sectors, the expected productivity gains at t from starting to export at $t-1$ go from 0.44% in the manufacture of rubber and plastic products (DH) to 2.47% in the manufacture of textiles and textile products (DB).

(a) Learning-by-exporting per sector

Sector	Observations	LBE
DA	38406	1.04***
DB	26480	2.47***
DC	3984	0.42
DD	12288	0.78***
DE	27701	1.56***
DF	639	-0.68
DG	10906	1.69***
DH	18155	0.44*
DI	10589	-0.15
DJ	59496	0.69***
DK	26200	0.71***
DL	25841	1.46***
DM	10008	1.53***
DN	15553	1.33***
E	2209	0.11

Note: Results are in percent. For example, a firm from the Manufacture of machinery and equipment (DK) that starts to export at $t-1$, can expect a raise of 0.71% of its productivity in t.
*** are significant at 0.1%, ** at 1%, * at 5%.

(b) Learning-by-importing per sector

Sector	Observations	LBI
DA	38406	1.60***
DB	26480	3.36***
DC	3984	0.32
DD	12288	0.81***
DE	27701	1.92***
DF	639	-1.00
DG	10906	4.21***
DH	18155	2.25***
DI	10589	0.10
DJ	59496	1.46***
DK	26200	1.60***
DL	25841	1.82***
DM	10008	1.29***
DN	15553	0.97***
E	2209	3.28**

Note: Results are in percent. For example, a firm from the Manufacture of machinery and equipment (DK) that starts to import at $t-1$, can expect a raise of 1.60% of its productivity in t.
*** are significant at 0.1%, ** at 1%, * at 5%.

4.4.3 Learning-by-importing

As already discussed, we can also expect learning-by-importing to exist. I report for all sectors, the estimation of the parameter θ_{imp} from Equation (4.14) in Table 4.2b. Again, we observe that learning-by-importing is significant in most of the sectors. Except for the manufacture of transport equipment (DM) and "other manufacturing industries" (DN), the effect for import are stronger than that for export. It corroborate the intuition that technology transfer might be a strong channel for productivity gains. The effects are particularly large for the manufacture of textiles and textile products (DB), the manufacture of chemicals, chemical products and man-made fibres (DG) and for electricity, gas and water supply (E).

4.5 Conclusion

This chapter studies and quantifies the learning effects of trading. I find that French firms experience both learning-by-exporting and learning-by importing. The effects of exporting are often significantly different from 0, but rather low. I also report that the learning effects of trade are sector specific. The productivity gains from exporting one year after entering the export market can go from 0.44% to 2.47%. The magnitude is larger for learning-by-importing. It goes from 0.81% to 4.21%.

For example, on the import side, access to more variety or access to better input quality is a possible explanation for learning-by-importing. Andersson et al. (2008) or Bas and Strauss-Kahn (2010) try to analyse the effects of diversification of the varieties, and find a positive effect on firms' productivity. On the export side, the number of markets served seems to have a positive impact on firms' productivity. Including all these parameters simultaneously in our productivity process would allow to provide a richer specification for the determinants of productivity.

5 Does Productivity Affect Sunk Entry Costs?[1]

5.1 Introduction

Empirical evidence from various countries and time periods show that more productive, larger and more capital intensive firms have a higher probability to become exporters, as for example in Bernard and Jensen (1999) among others. A series of pioneer works by Baldwin (1988, 1989), Krugman (1989) and Roberts and Tybout (1997) introduced a sunk cost for entering into export market. In response to these findings, the seminal paper of Melitz (2003) provides a highly tractable theoretical framework for modelling firms' trade decisions, in which heterogeneous firms face sunk entry costs and uncertainty concerning their productivity. However, the drawbacks of his model are that all firms face the same entry costs and that heterogeneity only appears in total factor productivity. Empirical models of export behaviour also treat the sunk entry costs as a common parameter across firms and focus only on testing the existence of entry costs (see Roberts and Tybout (1997), Campa (2004) and Bernard and Jensen (2004)).

In this paper, we develop a Melitz-type model with heterogeneous entry costs for export markets. This heterogeneity is introduced into the cost structure through productivity. We

[1] This chapter has been circulated under the title "Self-selection into export market: Does productivity affect entry costs?"; Chen, Xi and Frédéric Olland (2013).

use an entry cost that is a function of firm's productivity. The underlying assumption is that the entry into export markets is less costly for more productive firms. The effect of productivity on entry costs is characterised by a constant elasticity (the productivity elasticity of entry costs) in our model. This assumption implies that the minimum entry requirement at equilibrium now also depends on the productivity elasticity of entry costs.[2] We find that, in a relative selective export market, a higher degree of dependence between productivity and entry costs yields a lower entry requirement. Conversely, in a relative open market, the productivity elasticity of entry costs plays the opposite role: a higher dependence increases the entry requirement. In order to test our working assumption that entry costs are affected by productivity, we develop an empirical strategy based on a treatment evaluation model for measuring entry costs and for evaluating the relationship between (neutral and non-neutral) productivity and entry costs. Our study sheds light on the determinants of entry barriers in the international market and how could entry barriers be reduced from the firm perspective.

The distinction between various types of fixed costs (per-period or sunk), firm-level differences in fixed costs and their impact on the market structure and trade behaviour are fundamental issues but quite neglected in both theoretical and empirical models. For example, the basic Melitz (2003) model assumes that firms have different marginal cost structures (depending on their productivity) but share the same operating fixed costs and the same sunk costs of entry, no matter how different they are in terms of productivity. In addition, neither operating nor entry fixed costs are affected by productivity (because additive separability between productivity and fixed costs is imposed by the production technology). Numerous theoretical and empirical evidence show that fixed cost structures may differ at the firm level (Chen and Koebel, 2013). For instance, the sunk costs associated with product adaptation and promotion (for the international market) may depend on firm's specific characteristics such as their innovation capacity and management skill. Considering that these characteristics are the key elements of productivity, we propose a trade model where firm's productivity partly determines the costs of entry. In such a way, we indirectly add firm-level heterogeneity into the fixed cost structures. We point out that the productivity elasticity of entry costs is a crucial parameter for determining equilibrium entry conditions. It adds an

[2] The minimum entry requirement in the Melitz-type trade model is defined in terms of productivity, and only the most productive firms can enter into the international market.

indirect channel through which the level of productivity determines the self-selection. Our empirical investigations focus on French manufacturing firms for the years 2003-2009, for which we find significant entry costs. We also find a significant relationship between productivity and the entry costs.

The theoretical models proposed by Krugman (1989), Dixit (1989b,a), Melitz (2003) and by Bernard et al. (2003) stimulate a large number of empirical studies for testing the sunk entry cost effects. Roberts and Tybout (1997) develop an empirical model of exporting decision with sunk costs. With the help of a dynamic discrete-choice framework, the authors quantify the impacts of sunk costs hysteresis by directly analysing the firm's entry and exit patterns (the so-called *direct approach*).[3] Based on Colombian manufacturing plants data over the period 1981-1989, Roberts and Tybout (1997) find strong evidence for sunk entry costs. A similar study conducted by Campa (2004) validates the sunk cost hysteresis assumption for Spanish manufacturing plants. In addition, he finds that sunk entry costs into the foreign market appear to be much larger than fixed costs of exit. Coinciding with a growing body of trade literature that emphasis the role of heterogeneity, Bernard and Jensen (2004) extend Roberts and Tybout's (1997) dynamic entry and exit decisions model by adding individual effects. They find that sunk entry costs are significant for U.S. manufacturing plants over the period 1984-1992, and the plants characteristics that reflect the past performance increase the probability of entry. However, a surprising result documented in Bernard and Jensen (2004), is that total factor productivity has no significant impacts on trade decision. This result may be due to their empirical model specification. Similar to Roberts and Tybout (1997) and Campa (2004), the dependent variable in Bernard and Jensen's (2004) study is the export participation (a binary variable), while the volume of export is not considered. Thus, this approach can only capture one aspect of firm's trade behaviour. A further contribution to the literature of sunk entry cost is made by Das et al. (2007) whose empirical results provide a series of policy recommendations for export-oriented reforms. Based on a dynamic structural model, their empirical investigation incorporates both aspects of trade behaviour, namely the participation and the volume. The estimates of structural parameters are obtained from a dynamic Tobit model and used to simulate trade flow responses to shocks on the exchange-

[3] Before the Robert and Tybout's (1997) model, the empirical investigations have rather focused on asymmetries in the responses of trade flows to exchange rate upward and downward variations (the so-called indirect approach).

rate and to several types of states export-promotion policies. Their simulations point out that policies targeting on export revenues are much more effective than the entry cost subsidies. Compared to previous empirical papers on the sunk entry costs, our empirical investigation differs in two aspects. First, our objective is not only to test the existence of sunk costs but also to explain the main factors that determines the sunk costs of entry. Second, we adopt a different and more flexible empirical methodology using the treatment evaluation model for estimating sunk entry costs and for revealing the impacts of firms' characteristics on the entry costs.

The remainder of this chapter is organised as follows: in the next section, we extend the Melitz (2003) model and show equilibrium with heterogeneous sunk entry costs and the implications. Section 5.3 describes our empirical methodology for measuring the effects of firm's characteristics on the entry costs. The data and estimation results are presented in Section 5.4. Section 5.5 concludes.

5.2 Theoretical model with heterogeneous entry costs

In this section, we review the basic trade model with heterogeneous firms and we point out the consequences of heterogeneity in firms' specific export sunk costs on the open economy equilibrium. We consider a simple two-country model where firms use labour as a unique factor to produce differentiated products in a monopolistic competition market as in Melitz (2003), Helpman et al. (2004) or Chaney (2008). Since productivity is drawn exogenously and does not change during firms' lifetime, this type of model focus on the self-selection mechanism and learning by exporting is not considered.

On the demand side, we follow the standard Dixit-Stiglitz framework. Consumers' preferences have the CES form with an elasticity of substitution $\epsilon > 1$ across varieties. Solving for consumers' maximisation problem yields the demand for a specific variety ω: $q(\omega) = Ap(\omega)^{-\epsilon}P^{\epsilon-1}$ where $P = \left(\int_{\omega\in\Omega} p(\omega)^{1-\epsilon}d\omega\right)^{1/(1-\epsilon)}$ is the aggregate price. A is an exogenous demand level that reflect market size and $p(\omega)$ is the optimal pricing for the variety ω with a constant mark-up. On the supply side, firms that pay the entry cost draw their productivity from a continuous cumulative distribution $G(a)$, where a denotes the marginal cost, that is the inverse of productivity. Then, given their productivity, firms can decide

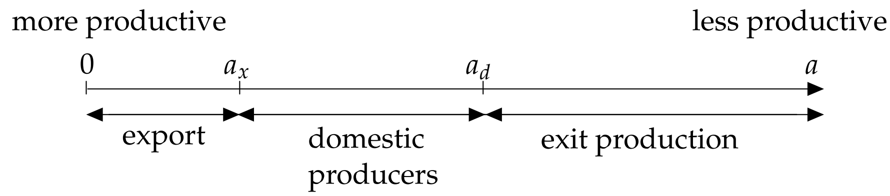


Figure 5.1: Cutoff values and the self-selection

whether they produce or not, and whether they export or not.

First, firms choose to produce and to serve the domestic market if and only if their operating profit is positive. The domestic operating profit is given by $\Pi_d = B^i a^{1-\epsilon} - f_d$ where $B^i = A^i \epsilon^{-\epsilon}(1-\epsilon)^{1-\epsilon}$ represents the demand in country i and f_d is the operating fixed cost of producing in the domestic market. Second, firms that export can earn an additional profit $\Pi_x = B^j(a\tau)^{1-\epsilon} - F_x$, where B^j represents the demand in country j and $\tau^{ij} > 1$ denotes iceberg transport costs for products that are exported from country i to j. F_x represents both the operating fixed cost and the entry cost for the export market. Therefore, three types of firms may exist (see Figure 1). Firms that draw a low productivity such as $a > a_D$ (where a_D is the marginal cost cutoff value for domestic market entry), choose to immediately exit production because their operating profits are negative. Firms that draw a productivity between a_d and the export cutoff value a_x, are serving the domestic market only. Firms with a high productivity $a < a_x$ serve the domestic market as well as the export market.

5.2.1 Heterogeneous export sunk cost

Usually, in the literature on heterogeneous firms, fixed production costs and sunk costs of entry are supposed to be identical for all firms. These assumptions seem to be very restrictive regarding the real situation of firms. The differences between two firms in their sunk costs might come from their own specificities or from some externalities. Thus, we suggest that a more productive firm is able to adapt products at a lower cost than less productive firms.

As we cannot empirically estimate sunk entry costs in the domestic market since we do not observe firms that are not producing, we let these start up costs f_e to be identical across firms. The operating fixed cost for domestic market f_d is also identical across firms. We focus on the fixed and sunk entry costs for the export market. We define these costs as function of firms' productivity $F_x(a) \equiv f_x h(a)$, where f_x represents the common sunk costs and $h(a)$ represents firm's deviation from these common sunk costs. We impose that $h(a)$ is an increasing function of a to satisfy our working assumption that sunk costs are lower for more productive firms. To ensure that a firm cannot export without being a domestic producer, we also impose that $f_d < F_x(a)$ for a particular marginal cost a. Therefore, both cutoff values a_d and a_x are determined by setting operating profit to zero in each market. The zero profit cutoff conditions for the domestic and export market, respectively, can be written as, respectively:

$$B^i a_d^{1-\epsilon} = f_d \tag{5.1}$$

$$B^j (\tau a_x)^{1-\epsilon} = f_x h(a_x) \tag{5.2}$$

Prior to the production, firms have to decide whether they incur or not the start up costs f_e. For a specific firm, the expected operating profit associated to a variety has to be larger than f_e. This free entry condition can be expressed as:

$$V(a_d)B^i + \tau^{1-\epsilon} V(a_x) B^j - \left[G(a_d) f_d + f_x \int_0^{a_x} h(a) dG(a) \right] = f_e \tag{5.3}$$

where $G(a)$ is the cumulative distribution function from which a potential market entrant draws its productivity and $V(a) = \int_0^a a^{1-\epsilon} dG(a)$ is the expected value of a firm that draws a productivity a. In line with Helpman et al. (2004), firms' productivity is drawn from a Pareto distribution, which is a good approximation of real world data and make the model more tractable. The Pareto function is defined as $G(a) \equiv (a/\bar{a})^k$ where a has a positive support over $[0; \bar{a}]$. $\bar{a}$ and $k > 0$ are the scale and shape parameters, respectively. Since we assume that countries are symmetric, the demand shifter is the same in both country so $B^i = B^j = B$. Then, from equation (5.1) and (5.2) we can derive the threshold value ratio to illustrate the self-selection bias of traditional models.

Result 1:

$$\frac{a_x}{a_d} = \left(\frac{f_x}{f_d \tau^{1-\epsilon}} \right)^{\frac{1}{1-\epsilon}} \times h(a_x)^{\frac{1}{1-\epsilon}} \tag{5.4}$$

where $\left(\frac{f_x}{f_d \tau^{1-\epsilon}} \right)^{\frac{1}{1-\epsilon}}$ is the threshold value ratio in the traditional model. Note that our equilibrium ratio in (5.4) is identical to a traditional model ratio except that $h(a)$ appears on the right-hand side of expressions. The predicted part of firms that have marginal costs between a_x and a_d (i.e. only domestic producers) deviates from the prediction of the traditional model by $h(a)^{1/1-\epsilon}$.

In order to derive more explicit results, we consider a simple functional form for $h(\cdot)$, $h(a) = a^{\gamma}$. The parameter $\gamma \geq 0$ is the productivity elasticity of entry costs. It measures how the change of the productivity affects the sunk costs of entry into export market. If $\gamma = 0$, then $h(a) = 1$ and we are back to the traditional model ($F_x = f_x$). For $\gamma > 0$, there is a deviation from the common fixed costs. The magnitude of the deviation depends on γ and a. For any $\gamma \neq 0$, there is no more analytical solution for a_d, a_x and B because the model becomes non-linear in a. From equation (5.1), (5.2), (5.3) and (5.4) we obtain the threshold values at equilibrium:[4]

Result 2:

$$a_d^k = \bar{a}^k \frac{f_e(\beta - 1)}{f_d[1 + \Omega(a_x^{\gamma})^{1-\beta}\Delta]} \tag{5.5}$$

$$a_x^k = \bar{a}^k \frac{f_e(\beta - 1)\Omega}{f_x(a_x^{\gamma\beta} + \Omega\Delta a_x^{\gamma})} \tag{5.6}$$

where $\beta \equiv \frac{k}{\epsilon - 1} > 1$, $\Delta \equiv (\beta - (\beta - 1)(k/k + \gamma)$ and $\Omega \equiv (\tau^{1-\epsilon})^{\beta}(f_x/f_d)^{1-\beta}$. $\Omega \in [0,1]$ is a trade openness parameter. $\Omega = 0$ corresponds to autarky and $\Omega = 1$ corresponds to free trade. Note that when $\gamma = 0$ our threshold values correspond to traditional model ones. It is easy to show that there is a unique equilibrium, the proof is given in Appendix A. From equations (5.5) and (5.6), we see that a_x also appears in the right-hand side of the equation whereas it does not in the traditional model. The additional parameter γ affects the equilibrium value of a_x, a_d and B, which will have an impact on the number of entrants (for both domestic and foreign markets), on the volume of trade and also on consumers welfare.

In this paper, we focus on the export market entry, which is characterised by a_x in (5.6). Thus, an important question is: what happens to the threshold value, a_x, at the equilibrium when the elasticity γ changes? The equilibrium is characterised by an implicit function and it is impossible to explicitly solve (5.6) for a_x. Therefore, in the next subsection, we firstly carry out the comparative statics by using the Implicit Function Theorem (IFT). Secondly, a

[4] See appendix for details of calculation.

numerical example is provided.

5.2.2 Comparative statics

We now investigate analytically the effects of an increase in γ on the equilibrium entry condition, a_x, in export markets. By fixing all other parameters, equation (5.6) can be rewritten as the following implicit function of a_x and γ:

$$F(a_x,\gamma) = \bar{a}^k \frac{f_e(\beta-1)\Omega}{f_x(a_x^{\gamma\beta} + \Omega\Delta a_x^{\gamma})} - a_x^k = 0. \tag{5.7}$$

Given some regularity conditions, the IFT provides the derivative of a_x *w.r.t* γ even if it is impossible to solve this implicit function explicitly:

$$\frac{\partial a_x}{\partial \gamma} = -\frac{\frac{\partial F}{\gamma}(a_x,\gamma)}{\frac{\partial F}{a_x}(a_x,\gamma)},$$

where

$$\begin{aligned}\frac{\partial F}{\partial \gamma}(a_x,\gamma) \quad &= \quad -\frac{\bar{a}^k f_e(\beta-1)\Omega}{f_x}\frac{1}{(a_x^{\gamma\beta}+\Omega\Delta a_x^{\gamma})^2} \\ &\left[\beta \log(a_x) a_x^{\gamma\beta} + \Omega \frac{a_x^r[\log(a_x)(k+\gamma)(\beta\gamma+k)+(\beta-1)k]}{(k+r)^2}\right];\end{aligned}$$

$$\frac{\partial F}{\partial a_x}(a_x,\gamma) = -\frac{\bar{a}^k f_e(\beta-1)\Omega}{f_x}\frac{(\gamma\beta a_x^{\gamma\beta-1}+\Omega\Delta\gamma a_x^{\gamma-1})}{(a_x^{\gamma\beta}+\Omega\Delta a_x^{\gamma})^2} - k a_x^{k-1}.$$

Using this result, we obtain the following proposition and the detailed proof is provided in Appendix A.

Proposition 1: *Equation 5.7 satisfies the three conditions of IFT: a) $F(.)$ is continuously differentiable function; b) $\partial F(a_x,\gamma)/\partial a_x \neq 0$; c) there is a unique equilibrium.*

i) For $a_x \in [1, +\infty[$, a_x is decreasing in γ, i.e., the slope $\partial a_x/\partial\gamma > 0$;

ii) For $a_x \in]0, \exp(\frac{1}{k+\gamma} - \frac{1}{\epsilon-1+\gamma})]$, a_x is increasing in γ, i.e., the slope $\partial a_x/\partial\gamma < 0$;

iii) For $a_x \in]\exp(\frac{1}{k+\gamma} - \frac{1}{\epsilon-1+\gamma}), 1[$, the sign of slope is undetermined.

This proposition shows that there are two schemes. If the export market is relatively open

Parameter	Value
k	3.2
ϵ	3.8
F_d	0.1
F_e	2
F_x	0.1
$\bar{a}$	1.3

Table 5.1: Parameters calibration

(the low entry barrier scheme, i.e. $a_x \in [1, +\infty[$), then Proposition 1 indicates that $\partial a_x/\partial\gamma > 0$, implying that the threshold productivity level for export market entry ($1/a_x$) increases as γ increases. Thus, this particular export market becomes more selective. Conversely, $\partial a_x/\partial\gamma < 0$ when the equilibrium is established in the high entry barrier scheme (i.e., $a_x \in]0, \exp(\frac{1}{k+\gamma} - \frac{1}{\epsilon-1+\gamma})]$, where $\exp(\frac{1}{k+\gamma} - \frac{1}{\epsilon-1+\gamma}) < 1$). This suggests that the export market becomes less selective as the parameter γ increases. We note that there is an interval, $a_x \in]\exp(\frac{1}{k+\gamma} - \frac{1}{\epsilon-1+\gamma}), 1[$, where the monotonicity is unclear. However, it does not affect our conclusion for two reasons. First, this unclear zone should be very small given a reasonable calibration of the model. Second, this interval is reducing rapidly as γ increases, i.e., $\lim_{\gamma\to+\infty} \exp(\frac{1}{k+\gamma} - \frac{1}{\epsilon-1+\gamma}) = 1$.[5]

In order to provide a graphical representation of the above proposition, we solve the model numerically for the variable of interest a_x. We follow calibrations of previous literature on heterogeneous firms models, such as Bernard et al. (2007) and Costantini and Melitz (2007). We report parameters calibration in Table 5.1.

Given the parameters calibration, we are able to plot the equilibrium values of a_x for different values of γ in Figures 5.2 and 5.3. Figure 5.2 plot the low entry barrier scheme, where $a_x \in [1, +\infty[$. In this case, entry becomes more difficult for a higher γ. Figure 5.3 is the relatively selective market situation ($a_x \in]0, \exp(\frac{1}{k+\gamma} - \frac{1}{\epsilon-1+\gamma})[$), with high fixed cost structure $f_x = 2.1$. We note that entry is easier for a higher γ in this case. The critical value of $\exp(\frac{1}{k+\gamma} - \frac{1}{\epsilon-1+\gamma})$ is also in Figure 5.3 (i.e., the green line). We see that it converges quickly to one as γ increases and the equilibrium value of a_x never falls into this critical interval. Thus, the sign of $\partial a_x/\partial\gamma$ can be determined for the full support in this example.

[5] Following Bernard et al. (2007), we assume that $k = 3$ and $\epsilon = 3.8$. Thus, even when γ is set to be zero, the unclear interval is $]0.976, 1[$.

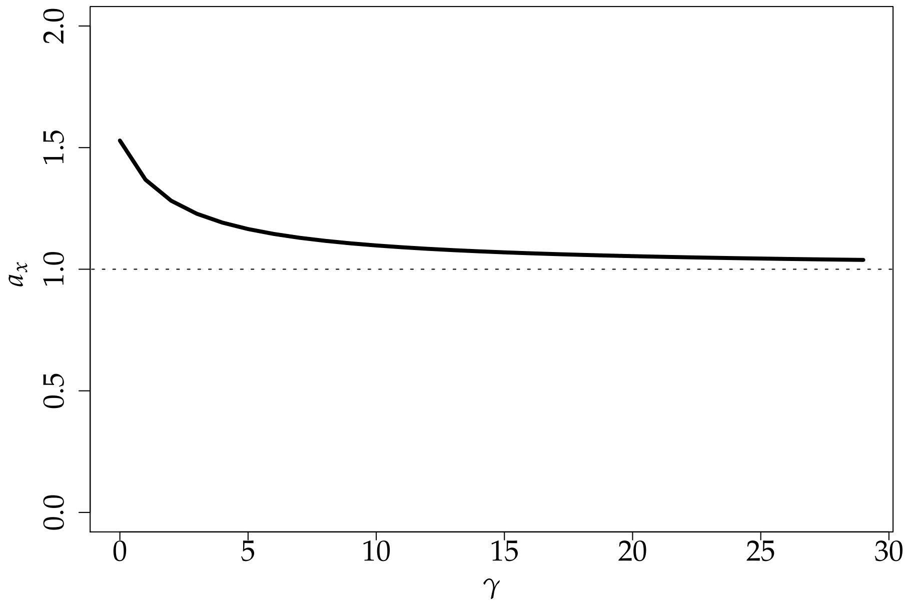


Figure 5.2: Low entry barrier scheme with $f_x = 0.1$

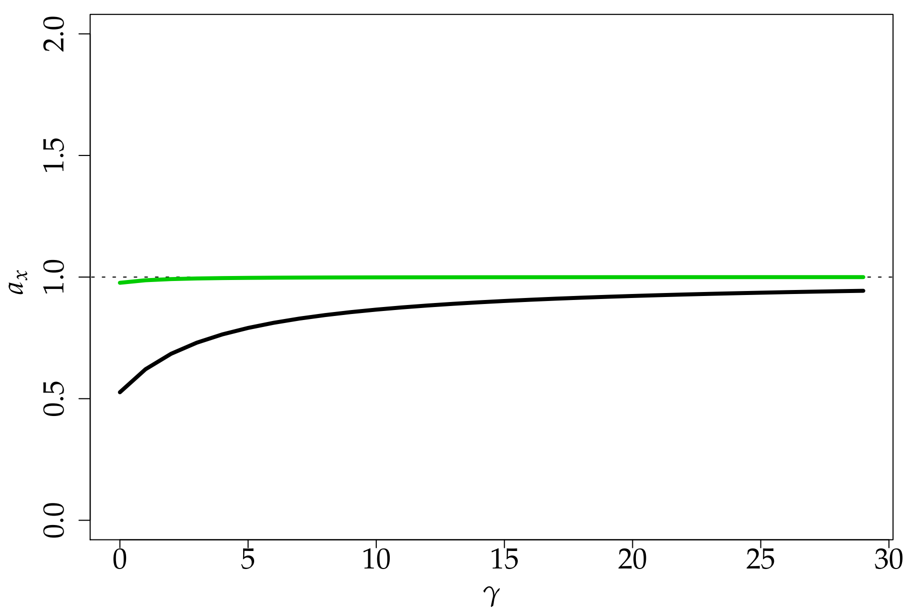


Figure 5.3: High entry barrier scheme with $f_x = 2.1$

Intuitively, the existence of the two schemes is due to the non-monotonicity of $F_x(a) = f_x a^\gamma$ in γ.[6] When the equilibrium value $a_x \in]0, \exp(\frac{1}{k+\gamma} - \frac{1}{\epsilon-1+\gamma})[$, potential entrants with productivity level $a_i < 1$ (in the neighbourhood of a_x) benefit from a higher γ (reduction of $F_x(a)$). In the opposite case, when $a_x \in [1, +\infty[$, potential entrants with productivity level $a_i > 1$ suffer from a higher γ (augmentation of $F_x(a)$). Without loss of generality, we can easily restrict our model to allow only for one of these two situations just by bounding the Pareto distribution differently.

In order to validate theoretical implications of heterogeneous fixed costs, we need to estimate sunk entry cost for the export market as well as productivity, and to test the link between them. In particular, we are interested in the questions: does productivity really influence sunk costs of entry and fixed costs of production? And in which direction? The answer to these questions is determinant to evaluate self-selection and the volume of trade.

5.3 Empirical methodology for measuring entry barriers

An extensive empirical literature, following Roberts and Tybout (1997), investigates the determinants of export market participation decision. Similar papers are, for example, Campa (2004), Bernard and Jensen (2004), Bernard and Wagner (2001) and Das et al. (2007). Although firm heterogeneity is often embodied in the trade decision process, the sunk entry cost is modelled as a common parameter in these empirical studies.[7]

In the basic Melitz (2003) model, firms may have different marginal cost structures (depending on their characteristics and productivity) but all firms face the same entry sunk costs. One of our contributions compared to the previous trade models is that we endogenise the sunk entry cost and assume that it is a function of firm-level characteristics. Therefore, the empirical objective of this chapter is to evaluate the impacts of firm's characteristics, in particular productivity, on entry costs. Our focus is to propose an empirical strategy that allows us to estimate the firm-specific entry costs and that keeps a minimum level of restrictions on the model.

Our study also differ from the empirical works, which follow the idea that firms can

[6]When $a < 1$, a higher parameter γ yields a low F_x. Conversely, when $a > 1$, F_x increases with a higher parameter γ.

[7]One exception is Das et al. (2007), where the sunk costs of entry depends on firm specific characteristics.

improve their productivity through exporting. This notion is refereed to as *learning-by-exporting*. In this literature, researchers test the effect of entry into exporting markets on firm's productivity (Bernard and Jensen, 1999; Van Biesebroeck, 2005; De Loecker, 2007). In contrast, we study the reverse causality of the productivity-exporting relationship, which consist of testing whether more productive firm can reduce their costs of entry into export markets.

In this paper, we first test for the existence of entry costs. Second, we evaluate the impact of firms' characteristics on their incurred entry costs. In particular, we focus on the impact of productivity (neutral and non-neutral productivity). Our empirical model extends the idea of heterogeneous firms in the "new new trade theory" (proposed by Melitz (2003) and Bernard et al. (2003)). It allows heterogeneity in the cost structure. These empirical investigations support the exported-oriented policies which favour to domestic productivity growth rather than subsidise entry costs. Such a subsidy policy will not be efficient, first, because entry costs are heterogeneous and the actual expenditure incurred by similar (in term of export volume) firms can differ significantly from the average level. Second, because a large part of these costs are unobserved for the national trade promotion agency.

5.3.1 Overview of our empirical model

The strategy for identifying the sunk costs of entry in our paper is similar to Roberts and Tybout (1997). This approach consists of comparing the net export profits of newly entered exporters to those of the established exporters. However, our paper differs from Roberts and Tybout (1997) in the way of estimating sunk costs of entry, and our empirical model allows for entry costs heterogeneity.

The logarithmic net export profits for i-th exporter at period t ($\pi_{it} \equiv \log\Pi_{it}$) can be written as:

$$\pi_{it} = \begin{cases} \pi_{0it} = \pi^*_{it} - \theta + v_{0it} & \text{if } D_{it-1} = 0 \\ \pi_{1it} = \pi^*_{it} - \theta - \theta_s + v_{1it} & \text{if } D_{it-1} = 1 \end{cases} \tag{5.8}$$

The net current profit depends on firm's previous exporting status, where we distinguish two cases that are denoted by π_{0it} and π_{1it}. The binary variable $D_{it-1} = 0$ indicates that the exporter is "in the export market" at period $t-1$ (so the established exporters since $t-1$)

and $D_{it-1} = 1$ indicates that the exporter is "out of the export market" at period $t-1$ (as the newly entered exporter at t). The logarithmic gross exporting profit is denoted as π^*_{it}. The term $\theta - v_{0it}$ denotes the fixed operating costs for exporting. The difference between the i-th newly entered exporter's net profits (observed) and his potential profits without incurring the entry costs (unobserved) defines the sunk cost of entry, i.e., $\pi_{0it} - \pi_{1it} = \theta_s + v_{0it} - v_{1it}$. If we have only data on newly entered exporters (with $D_{it-1} = 1$), it would be infeasible to identify the sunk costs of entry from the expected profits. Fortunately, it is generally possible to have a control group of established exporters (with $D_{it-1} = 0$), which are "already on the export market" at $t-1$. Thus, the sunk cost is identified as the difference in term of actual profits between the newly entered exporters and the established exporters, which have comparable potential profit streams.

An additional empirical difficulty in this framework is that our data set does not provide information on the export profit, but we observe instead the export revenue ($r_{it} \equiv \log R_{it}$). By following Das et al. (2007), we assume the classical markup equation:

$$p_{it}(1 - \eta_i^{-1}) = c_{it},$$

where p_{it} denotes the foreign output price, c_{it} is the marginal cost for the export production, and $\eta_i > 1$ denotes the firm-specific foreign markup. Multiplying both sides of the mark up equation by the export quantities yields:

$$R_{it}(1 - \eta_i^{-1}) = C_{it},$$

where C_{it} is the variable costs of exporting. Then we can express the export profit as:

$$\Pi_{it} = R_{it} - C_{it} = \eta_i^{-1} R_{it}.$$

Substituting the above equation into model (5.8), we obtain the corresponding empirical model in terms of revenues:

$$r_{it} = \log\eta_i + \pi_{it} = \begin{cases} r_{0it} = \log\eta_i + \pi^*_{it} - \theta + v_{0it} & \text{if } D_{it-1} = 0 \\ r_{1it} = \log\eta_i + \pi^*_{it} - \theta - \theta_s + v_{1it} & \text{if } D_{it-1} = 1. \end{cases} \tag{5.9}$$

In the earlier empirical literature, researchers estimate the sunk costs as an average constant term by imposing homogeneity in the model. Several attempts to incorporate the firm-level heterogeneity have focused on the heterogeneity in the trade decision process rather than in the sunk cost structures (see for example, Bernard and Jensen (2004)). In our theoretical model, sunk cost of entry is not only a constant but a function of firm's characteristics. To capture this endogenous sunk entry costs feature, our empirical model allows firms to deviate from the average entry requirement. The average sunk costs of entry (θ_s) are estimated along with the firm's deviation ($v_{0it} - v_{1it}$) from the average sunk costs. Compared to the dynamic discrete-choice model proposed by Roberts and Tybout (1997), our estimation method follows the treatment evaluation literature (Heckman and Hotz, 1989), that matches pairs of newcomers and established exporters with similar characteristics. The structural model proposed by Das et al. (2007) can also be used to characterise the heterogeneity in the sunk costs of entry. However, we prefer the treatment evaluation approach because it avoids imposing *ad hoc* assumptions on functional forms and on dynamic stochastic process for expected profits and sunk costs.

The matching method compares the current export revenue of the two groups (the treated group with the control group) based on a series of criteria, that are embodied in a vector of pretreatment variables. These variables should reflect the firm's financial and production information as well as its productivity. An additional novelty of this paper is that we consider two types of productivity that are the so-called Hick-neutral (Total Factor Productivity, TFP) and non-neutral (Relative Factor-augmenting Productivity, RFP) productivity. By following Chen (2012), two measurements of productivity are estimated and we evaluate their impacts on firm-specific entry costs. In the next subsections, we firstly present the treatment evaluation model for testing the sunk entry costs and for quantifying the impact of firm-level characteristics on the sunk cost of entry. Secondly, we describe the estimation method for productivity measurement.

5.3.2 Treatment evaluation model

Now, we define formally the sunk cost of entry for export markets:

Definition 1: *At period t, sunk entry costs for the* i*-th newly entered firm is defined as the difference between the actual (observed) export revenue (r_{1it}) and its potential (unobserved) export revenue without incurring the entry costs (r_{0it}):*

$$r_{0it} - r_{1it} = \theta_s + (v_{0it} - v_{1it}), \tag{5.10}$$

where θ_s represents the average sunk costs of entry into the exporting market. The term $(v_{0it} - v_{1it})$ that is time-varying and firm-specific, represents the individual deviation from the average sunk costs.

If the same firms can be observed in both states, the sunk cost of entry could simply be computed. However, the difficulty is that an individual cannot be been in both states simultaneously, we observe only r_{0it} or r_{1it} for i-th individual at t. Basically, we are facing a missing data problem. To overcome this problem, we use the matching technique to estimate the effect of entry. Our group of interest (the treated group) includes newly entered exporters with $D_{it-1} = 1$ that earn r_{1it} in the export market at t. The control group includes established exporters with $D_{jt-1} = 0$ that earn r_{0jt}, for $i \neq j$. Intuitively, the sunk costs of entry are revealed by comparing the differences in the actual exporting revenue at t across exporters that have comparable expected profits and characteristics, but differ in whether they exported in the previous period, $t - 1$. The underlying hypothesis here is that the sunk cost of entry are borne completely within one year after the entry. This is supported by Roberts and Tybout's (1997) empirical evidence.

Our empirical objective is not to obtain the structural parameters as in Das et al. (2007), but to evaluate the effect of entry and to study how this effect changes with some firm's characteristics. At the same time, we keep a low level of restriction on the model. More specifically, the two quantities of interest are the average treatment effects (ATE):

$$ATE = \mathrm{E}[r_1 - r_0], \tag{5.11}$$

and the average treatment effects conditional on firm's *pretreatment characteristics* (x_{it-1}) :

$$ATE(x_{it-1}) = \mathrm{E}[r_1 - r_0 \mid x_{it-1}]. \tag{5.12}$$

The vector of covariates x, may include firm's past productivity, size and other externalities. The first quantity measures the average effect of entry cost on the firm's exporting performance (the negative value of entry costs). The second one characterises how the ATE changes for various level of x. In particular, we are interesting in the impacts of TFP and RFP.

The difficulty to estimate ATE and $ATE(x_{it-1})$ is that the treatment (the previous exporting experience, D_{it-1}) is certainly not random across firms and firms' decision variable at $t-1$ (D_{it-1}) may be related to the effects of entry. To deal with this problem, several approaches have been suggested in the literature. Wooldridge, (2002, p602), Heckman and Vytlacil (2007) and Imbens and Wooldridge (2009) provide recent reviews on this rapidly growing literature. We use the Heckman and Hotz's (1989) approach to estimate the treatment evaluation model. The fundamental assumption of this approach is the *ignorability of treatment* assumption (see Rosenbaum and Rubin (1983)):

Assumption (Ignorability of treatment): *Conditional on pretreatment characteristics x_{it-1}, the decision variable D_{it-1} and the outcome r_{it} are independent.*

To see the implication of this assumption, we recall the export revenue equations of equation (5.9). This can be seen as a switching regression model, and the observed outcome can be rewritten as:

$$\begin{aligned} r_{it} &= (1-D_{it-1})r_{0it} + D_{it-1}r_{1it} \\ &= r_{0it} + D_{it-1}(r_{1it} - r_{0it}) \\ &= \log\eta_i + \pi^*_{it} - \theta + v_{0it} - \theta_s D_{it-1} + D_{it-1}(v_{1it} - v_{0it}), \end{aligned}$$

The endogeneity arises because the previous entry decision (D_{it-1}) is related to the firm's expectation about the entry benefits or costs, which is reflected in the unobserved term $(v_{1it} - v_{0it})$. Under the ignorability of treatment assumption, the conditional expectation of outcome becomes:

$$\begin{aligned} &\mathrm{E}[r_{it} \mid D_{it-1}, v_{1it}, v_{0it}, x_{it-1}] = \mathrm{E}[r_{it} \mid D_{it-1}, x_{it-1}] \\ &\quad = f(x_{it-1}) - \theta + g_0(x_{it-1}) - \theta_s D_{it-1} + D_{it-1}[g_1(x_{it-1}) - g_0(x_{it-1})] \end{aligned}$$

where we define the function $g_0(x_{it-1}) \equiv \mathrm{E}[v_{0it} \mid D_{it-1}, x_{it-1}] = \mathrm{E}[v_{0it} \mid x_{it-1}]$ and the function $g_1(x_{it-1}) \equiv \mathrm{E}[v_{1it} \mid D_{it-1}, x_{it-1}] = \mathrm{E}[v_{1it} \mid x_{it-1}]$. Naturally, the expected exporting profit function and the mark up are also function of firm's characteristics, i.e., $f(x_{it-1}) \equiv \log\eta_i + \pi^*_{it}$. By rearranging the terms, the above equation yields:

$$\mathrm{E}[r_{it} \mid D_{it-1}, x_{it-1}] = G_0(x_{it-1}) - \theta_s D_{it-1} + D_{it-1} G_1(x_{it-1})$$

where $G_0(x_{it-1}) \equiv f(x_{it-1}) - \theta + g_0(x_{it-1})$ and $G_1(x_{it-1}) \equiv g_1(x_{it-1}) - g_0(x_{it-1})$. From the above equations, we note that the dependence between D_{it-1} and the unobserved terms, v_{0it} and v_{1it} are eliminated by conditioning on x_{it-1}. The ATE and the conditional ATE in this model are:

$$ATE = -\theta_s \text{ and } ATE(x_{it}) = -\theta_s + G_1(x_{it-1}).$$

The two quantities of interest can be estimated in a fairly flexible fashion without imposing any distributional restrictions on the observed outcome. However, in order to simplify the estimation, we consider a linear model where the parameters of interest are obtained by regressing r_{it} on x_{it-1}, D_{it-1} and $D_{it-1} \cdot (x_{it-1} - \bar{x})$:

$$r_{it} = \lambda_1' x_{it-1} - \theta_s D_{it-1} + \lambda_2' D_{it-1} \cdot (x_{it-1} - \bar{x}) + e_{it}, \tag{5.13}$$

where $\bar{x}$ denotes the sample average of x_{it-1} and the error term, e_{it}, is assumed to be i.i.d. Thus, consistent estimators of treatment effects ATE and $ATE(x_{it-1})$ are given by: $\widehat{ATE} = -\hat{\theta}_s$ and $\widehat{ATE}(x_{it-1}) = -\hat{\theta}_s + \hat{\lambda}_2' D_{it-1} \cdot (x_{it-1} - \bar{x})$. Now we can provide an interpretation rule for these parameters of interest. The ATE measures the effect of entry for the newly entered exporters *w.r.t* the established exporters. If the estimated ATE is significantly positive, it suggests that there is a potential entry cost. Otherwise, there is a potential entry benefit. The consistent estimates of $\widehat{ATE}(x_{it-1})$ allows us to evaluate how the ATE given x_{it-1} changes with a particular element of x_{it-1}. The estimated parameter $\hat{\lambda}_2$ indicates the impact of pretreatment variables on the entry effect. If $\widehat{ATE}$ is significantly negative (the existence of sunk cost of entry), a positive value of $\hat{\lambda}_2$ suggests that x_{it-1} can contribute for reducing the sunk costs of entry. Otherwise, x_{it-1} contributes for increasing the sunk costs of entry.

A more practical question now is: what are the suitable pretreatment variables in x_{it-1}?

Given the data at hand, we could include firm's characteristics that may affect the decision of entry into the export market and past performances. For instance, the firm's size, business sector, as well as the two measurements of productivity are the variables of interest at period $t-1$.[8]

5.3.3 Estimating the productivity

In the productivity-exporting relationship literature, most of the time, Cobb-Douglas production functions are considered and productivity refers to TFP (Crozet and Trionfetti (2011) is an exception).[9] In this study, we take into account a second type of productivity measurement, relative factor productivity (RFP), for analysing firm's trade behaviours.

Chen (2012) proposes a structural semi-parametric estimation method for recovering the firm-level productivity. This approach extends the Olley and Pakes (1996) estimator to the more flexible and realistic specification of CES production function with biased technical change. The advantage of this semi-parametric approach is that not only the TFP can be estimated, it also yields time-varying and firm-specific estimates of RFP without prior assumption on its functional form. Chen's (2012) estimation method deals with two sources of endogeneity through Hicks-neutral and non-neutral productivity. By using the first order conditions derived from competitive factor market, this method allows consistent estimation of the degree of returns to scale, the elasticity of substitution, and the bias in technical change.

By relaxing a series of neutrality assumptions, the CES production function of two factors, labour (L_{it}) and capital stock (K_{it}) with the value-added output, Y_{it} can be written as:

$$Y_{it} = A_{it}[\alpha(B_{it}K_{it})^{\frac{\sigma-1}{\sigma}} + (1-\alpha)L_{it}{}^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma\rho}{\sigma-1}}, \tag{5.14}$$

where the parameters α, σ and ρ are respectively the income distribution parameter, the degree of returns to scale and the elasticity of substitution. A_{it} is the relative Hicks-neutral productivity (TFP), and B_{it} is the relative capital-augmenting productivity (RFP). We assume that the productivity term A_{it} follows a first-order Markov process. Given the assumption

[8] x_{it-1} includes only the pretreatment variables. Thus, we assume that firms chose to entry into export markets at $t-1(D_{it-1})$, after knowing their size and productivity of period $t-1$.

[9] Syverson (2011) and Van Beveren (2012) provide recent surveys on this literature.

that firms minimise costs, firms set marginal products equal to input prices. The first order conditions of the CES production function under cost minimisation problem imply that:

$$\frac{K_{it}}{L_{it}} = \left(\frac{\alpha}{1-\alpha}\right)^{\sigma} \left(\frac{W_{lit}}{W_{kit}}\right)^{\sigma} B_{it}^{\sigma-1}, \tag{5.15}$$

where W_l and W_k denote the wage and the rental rate of capital, respectively. By following Chen (2012), the logarithmic CES production function can be rewritten as:

$$\log Y_{it} = \rho \log L_{it} + \frac{\sigma\rho}{\sigma-1} \log[\alpha(B_{it}\frac{K_{it}}{L_{it}})^{\frac{\sigma-1}{\sigma}} + (1-\alpha)] + \log A_{it},$$

and the capital-labour ratio equation yields:

$$\log[\alpha(B_{it}\frac{K_{it}}{L_{it}})^{\frac{\sigma-1}{\sigma}} + (1-\alpha)] = \log(1-\alpha) + \log S_{it}, \tag{5.16}$$

where the variable S_{it} is defined as $\frac{W_{kit}K_{it}}{W_{lit}L_{it}} + 1$ that reflects the factor costs ratio. Then, we can use (5.16) to substitute the unobservable productivity shock B_{it} from the production function and to obtain the following regression equation:

$$y_{it} = c + \rho l_{it} + \gamma s_{it} + a_{it} + \varepsilon_{it}. \tag{5.17}$$

The scalar disturbance term ε_{it} is the exogenous shock that is not anticipated by firms. The lower cases letters denote the logarithmic values. The re-parametrisation is defined as $c \equiv \frac{\rho\sigma}{\sigma-1} \log(1-\alpha)$ and $\gamma \equiv \frac{\rho\sigma}{\sigma-1}$.

Now, we have a log-linear model, in which we need to deal with two sources of endogeneity through $a_{it} \equiv \log A_{it}$ and $b_{it} \equiv \log B_{it}$. The seminal paper of Olley and Pakes (1996) introduces the so-called control function approach to deal with the endogeneity problem for estimating production functions. The idea behind this approach is to use a control function of proxies for inverting out the unobserved productivity term from the production function. Levinsohn and Petrin (2003) assume the monotonicity of material demand equation in a_{it}, thus use the material demand as the proxy. Note that Olley and Pakes (1996) as well as Levinsohn and Petrin (2003) do not allow for biased technical change in their model, because of the Cobb-Douglas specification of the production function. Therefore, we follow

Chen (2012) to consider a generalised material demand equation, i.e., $m_{it} = M_t(a_{it}, b_{it}, k_{it})$ where both terms a_{it} and b_{it} are included in this equation.[10] One technical difficulty of this generalisation is that the inversion trick in Levinsohn and Petrin (2003) is no longer working for a_{it}. Because the unobserved term b_{it} is added, the monotonicity of the material demand equation is not sufficient. Fortunately, we have the expression of b_{it} as a function of the observed variable S_{it} and the input price ratio.[11] Thus, we can obtain a generalised invertible relationship as: $\mathrm{E}[a_{it} \mid s_{it}, k_{it}, w_{kit}, w_{lit}] = M_t^{-1}(s_{it}, k_{it}, w_{kit}, w_{lit})$. [12] Plugging this function into equation (5.17), we have our final regression equation:

$$\begin{aligned} y_{it} &= c + \rho l_{it} + \gamma s_{it} + M_t^{-1}(s_{it}, k_{it}, w_{kit}, w_{lit}) + \varepsilon_{it} \\ &= \rho l_{it} + \Phi_t(s_{it}, k_{it}, w_{kit}, w_{lit}) + \varepsilon_{it}, \end{aligned}$$

which is a partial linear model. It is clear that the parameter c and γ are not identified separately from the nonparametric function. Thus, only the parameter ρ and the nonparametric function $\Phi_t(.)$ are estimated in the first-stage by using Robinson's (1988) estimator. Then given any candidate value of γ, the estimates of a_{it} can be expressed as: $\hat{a}_{it}(\gamma) = \hat{\Phi}_t - \gamma s_{it}$.

At the second stage, we need at least one additional moment condition for the estimation of γ. For this purpose, we impose the first-order Markov assumption on a_{it}, then the current TFP can be decomposed as: $a_{it} = \mathrm{E}[a_{it} \mid a_{it-1}] + \xi_{it}$. The term ξ_{it} is the innovation shock, which represents a deviation of a_{it} from the its expectation at $t-1$. We assume that the current composition of factor costs (s_{it}) is chosen by firms at $t-1$.[13] This leads to the second-stage moment condition: $\mathrm{E}[\xi_{it} \mid s_{it}] = 0$. Given the first-stage estimation, the innovation

[10]The considered model differs slightly from Chen (2012) in two aspects. First, we follows Levinsohn and Petrin (2003) by using material input as proxy. Second, the control function includes now the additional term, b_{it}, which allows the interaction between inputs demands and RFP. Therefore, the corresponding estimation method is also modified.

[11]Inverting the capital-labour ratio equation yields:

$$B_{it} = \left(\frac{1-\alpha}{\alpha}\right)^{\frac{\sigma}{\sigma-1}} (S_{it} - 1)^{\frac{1}{\sigma-1}} \left(\frac{W_{Kit}}{W_{lit}}\right)$$

.

[12]The corresponding production timing assumption is that the material demand is fully flexible (and monotone in a_{it}), which is decided after knowing the capital stock (k_{it}) and the factor costs ratio (s_{it}).

[13]This assumption might be justified by the fact that labour is quasi-fixed. Typically, the capital-labour costs composition (s_{it}) is chosen prior to t, if there is a training process before worker can actually enter production at t or if there is a significant hiring cost. More discussion about the production timing can be found in Ackerberg et al. (2006).

shock ξ_{it} can be written as: $\hat{\xi}_{it}(\gamma) = \hat{a}_{it}(\gamma) - f(\hat{a}_{it}(\gamma))$, where $f(.)$ is a flexible function that characterises the first-order Markov process of a_{it}. We estimate the parameter γ by minimising the sample analogues of $\mathrm{E}[\hat{\xi}_{it}(\gamma) \cdot s_{it}] = 0$.

Given the estimates of ρ and γ, we can recover the measurement of TFP ($\hat{a}_{it}$) up to a constant term as:

$$\widehat{TFP} = \hat{a}_{it} = y_{it} - \hat{\rho} l_{it} - \hat{\gamma} s_{it}. \tag{5.18}$$

For the estimates of RFP ($\hat{b}_{it}$), we compute the Relative Labour-augmenting Production (RLP). Given the implicit estimate of σ, the relative labour-augmenting productivity is:

$$\widehat{RLP} = -\hat{b}_{it} = \frac{1}{(1-\hat{\sigma})} \log(\frac{K_{it}}{L_{it}}) - \log(\frac{W_{kit}}{W_{lit}}) \tag{5.19}$$

In the next sections, the proposed empirical strategy is applied to the French manufacturing data.

5.4 Empirical investigations

For our empirical investigation, we use two different sources of data. The Amadeus database provides us with production and financial informations for more than 7000 large and very large French manufacturing firms over the period of 2003-2009.[14] The variables included in our data set are operating revenue, export revenue, sales, capital stock, number and cost of employee and cost of materials. We merge these informations with the price index constructed based on INSEE's sector-level series in order to deflate revenues and intermediate inputs demands. Our dataset allows us to estimate productivity, sunk entry costs as well as effects of different factors on the entry cost.

Table 5.2 displays the macroeconomic conditions for trade in France and the distribution of exporting status across firms in the sample. We compare the export participation rates of large and very large firms with the macroeconomic trade index, i.e., the export volume of manufactured goods in France (with base year in 2005) and the exchange rate index of

[14]The original data set includes 8196 firms. Only 7140 French firms (1056 "Credit needed" firms are excluded) for the period 2003-2009 are downloaded from Amadeus database. The definitions of large and very large firms: *very large* firms are defined as the firms that have: *Turnover* > 100 million euros or *Total assets* > 200 million euros or *Employees* > 1000. *Large* firms are defined as the firms that have *Turnover* > 10 million euros, or *Total assets* > 20 million euros, or *Employees* > 150.

Table 5.2: Export participation of French manufacturing firms 2003-2009

	2003	2004	2005	2006	2007	2008	2009
Exchange rate index (1)	110.1	100.1	100	99.1	90.8	84.9	89.4
Export volume index (2)	93.1	97.2	100	107.9	109.1	107.8	93.8
Exporters in % (3)	76.5	76.4	77.2	76.4	76.0	75.0	74.0

Note: (1) - Exchange rate index is the annual average exchange rate of of U.S. dollar (for 1 dollar) against Euro with base year in 2005. (2) - Export volume index is the French export volume index with base year in 2005 for all manufactured goods. (3) - Exporters in % indicates the percentage of exporters in the sample.

U.S. dollar against Euro (with base year in 2005). Despite changes in the foreign trade environment for French manufacturing firms over the sample period (for instance, the exchange rate of U.S. dollar against Euro decreases from 110.1 to 89.4), we observe that the proportion of exporters is relatively stable (in average this proportion are 76% of exporters and 24% of non-exporters). Typically, this can be explained by the fact that the sunk costs of entry into the export market produce hysteresis in firm's trade behaviour (see Baldwin and Krugman (1989)). The entry and exit (in export market) transition matrix for each pair of two years are reported in Table 5.3. We can see that export market entry and exit dynamics are also stable over the period 2003-2009.

Our empirical investigation focus on the entry of firms into export markets. Based on this dataset, our estimation method follows the treatment evaluation literature, that matches pairs of newly entered and established exports with similar characteristics. For each panel of two years, the control group includes the established exporters and the treated group includes the newly entered exporters. For example, for the period 2003 to 2004, the control group includes 3234 firms that are already on the export market in 2003 and continue to serve the foreign market in 2004. The treated group are the 220 newly entered firms in 2004. In this study we consider only pairs of two years, mainly because it is the case where we have the most significant number of new entrants and controls.

Table 5.3: Transition rates in the export market 2003-2009

	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
Outsider (1)	616	616	628	603	549	477
Insider (2)	3234	3254	3141	2996	2561	2120
Entry	220	175	153	175	131	120
Exit	161	171	189	167	174	149
Total firms (5)	4231	4216	4111	3941	3415	2866
Outsider in %	14.6	14.6	15.3	15.3	16.1	16.6
Insider in %	76.4	77.2	76.4	76.0	75.0	74.0
Entry in %	5.2	4.2	3.7	4.4	3.8	4.2
Exit in %	3.8	4.1	4.6	4.2	5.1	5.2

Note: For the firms that are included in this table, we observe the necessary production and financial information for conducting our econometric analysis. (1) - *Outsider* indicates the number of non-exporting firms. (2) - *Insider* indicates the number of exporters. (3) - *Total firms* indicates the total number of firms in the sample, whose production and trade information are available in both years.

5.4.1 Estimation of productivity

Following the methodology that is described in Section 5.3.3, we estimate both the Cobb-Douglas and the CES production function. Chen's (2012) method is based on the CES production function and the Levinsohn and Petrin (2003) method is based on the Cobb-Douglas specification.

Given the estimates of parameters, TFP and RLP are recovered using equations (5.18) and (5.19). The estimated productivity is used in the second stage for the matching model, and the matching consists of comparing the firms with the comparable characteristics of the period $t-1$. Therefore, we need to find the comparable productivity measurement between the treated and control groups. The considered measurement is the domestic market productivity of $t-1$, because at period $t-1$ the control group (including established firms) serves both foreign and domestic markets while the treated group (including newly entered firms) serves only the domestic market. Formally, it implies that the dependent variable of production functions (5.17) is the domestic value-added.[15]

[15]The domestic intermediate materials is calculated as the total intermediate materials weighted by domestic production share. Thus, the domestic value-added is defined as gross domestic output net of domestic intermediate materials.

Columns 2 and 3 of Table 5.4 present estimates of technology parameters. β_l and β_k denote the coefficients of labour and capital in the Cobb-Douglas production function. ρ, γ and σ are the technology parameters in the CES specification (5.14). The elasticity of substitution (σ) is the fundamental difference between the Cobb-Douglas and CES production functions. This elasticity is imposed to be one in the Cobb-Douglas specification while it is a free parameter in the CES case. From the estimation results of Table 5.4, we note that the estimated elasticity of substitution is significantly below one. This finding rejects the use of Cobb-Douglas specification in favour of the CES model and suggests that the capital and labour are complements for production. Chen (2012) points out that, compared to the CES model, the Cobb-Douglas model yields a lower estimate of returns to scale and this bias is essentially due to the omitted-variable-bias. In our data, we confirm Chen's (2012) prediction that the estimates of returns to scale in the Cobb-Douglas case ($\beta_l + \beta_k = 0.591$) is lower than the estimates of returns to scale in the CES one ($\rho = 0.736$). The estimates of technology parameters for other periods are summarised in Table 5.9 of Appendix B, where we obtain the similar results.

Given the estimates of technology parameters, we compute the correlation coefficients between estimated domestic productivity, domestic output, labour, capital stock and the export revenue. The correlation matrix for 2003-2004 is reported in Table 5.5. Table 5.10 and Figure 5.4 in Appendix B provide the correlation matrix in other periods and the distributions of estimated productivity, respectively. The two estimated TFP that are obtained from the Cobb-Douglas and CES models are highly correlated and have the similar distribution shape. The CES model provides an additional productivity measurement, RLP, which is positively correlated with TFP and its distribution is flatter distribution than those of TFP. We note that RLP is highly correlated with the capital stock. This may reflect the fact that the labour-augmenting innovation is realised mainly by heavily investing in capital. The RLP is also positively correlated with the next period exporting revenue.

5.4.2 Entry costs and productivity

In our matching model, the treated group are firms which become exporter at period t and serve only the domestic market at period $t-1$. The control group consists of established exporters which serve both foreign and domestic markets for t and $t-1$. The treatment

Table 5.4: Estimation of technology parameters

2003-2004	**Levinsohn-Petrin method**	**Chen method**
Specification	Cobb-Douglas	CES
β_l	0.511 (0.024)	-
β_k	0.080 (0.030)	-
$\beta_l + \beta_k$	0.591	-
ρ	-	0.736 (0.034)
γ	-	-0.319 (0.172)
σ	1	0.302 (0.133)

Note: the estimated standard errors are reported in parenthesis.

Table 5.5: Correlation matrix between productivity and firm's characteristics

2003-2004	$\widehat{TFP}^{CB}_{t-1}$	$\widehat{TFP}^{CES}_{t-1}$	$\widehat{RLP}^{CES}_{t-1}$	Y_{t-1}	L_{t-1}	K_{t-1}
$\widehat{TFP}^{CES}_{t-1}$	0.94					
$\widehat{RLP}^{CES}_{t-1}$	0.07	0.31				
Y_{t-1}	0.83	0.73	0.17			
L_{t-1}	0.39	0.18	0.03	0.73		
K_{t-1}	0.33	0.36	0.71	0.64	0.72	
r_t	0.06	-0.01	0.18	0.34	0.53	0.51

Note: the subscript "t" and "$t-1$" indicate the 2004 and 2003 variables, respectively.

indicator variables D is defined as $D = 1$ for the individuals in the treated sample and $D = 0$ for the individuals in the control sample. The ATE and $ATE(x)$ are estimated using the regression-based method, see Heckman and Hotz (1989). Thus, we specify the empirical model (5.13) such as the following:

$$\begin{aligned} r_{it} &= \beta_0 + \beta_1 D_{it-1} + \beta_2 \widehat{TFP}_{it-1} + \beta_3 \widehat{RLP}_{it-1} + \beta_4 Sector + \beta_5 l_{it-1} + \beta_6 l^2_{it-1} \\ &+ \beta_7 w_{l\,it-1} + \beta_8 w^2_{l\,it-1} + \beta_9 D_{it-1} \cdot \widetilde{\widehat{TFP}}_{it-1} + \beta_{10} D_{it-1} \cdot \widetilde{\widehat{RLP}}_{it-1} + \beta_{11} D_{it-1} \cdot \widetilde{Sector} \\ &+ \beta_{12} D_{it-1} \cdot \widetilde{l_{it-1}} + \beta_{13} D_{it-1} \cdot \widetilde{l^2_{it-1}} + \beta_{14} D_{it-1} \cdot \widetilde{w_{l\,it-1}} + \beta_{15} D_{it-1} \cdot \widetilde{w^2_{l\,it-1}} + e_{it} \end{aligned}$$

where the regressors matrix x_{it-1} of (5.13) contains an indicator for sectoral group ($Sector$), labour (l), wage (w_l), squared labour (l^2), squared wage (w_l^2) and the estimated productivity $\widehat{TFP}$ and $\widehat{RLP}$.[16] The "tilde" denotes the zero mean variables, i.e., $(x_{it-1} - \bar{x})$. In this case, the ATE is the coefficient of the treatment indicator D_{it-1} and the $ATE(x)$ can be computed using the estimates of β_9- β_{15}. The following table summarises the estimation results as well as the estimated standard deviations (that reported in parenthesis). Since the estimates are obtained by using a step-wise estimation approach (a first-stage for obtaining TFP and RLP; a second-stage for estimating ATE and $ATE(x)$), the estimated standard deviations are carried out by the panel bootstrapping. The robustness check is reported in Appendix B, where the treatment evaluation model is re-estimated by using the propensity score matching.

First, we note that the estimated ATE ($\hat{\beta}_1$) in Table 5.6, are significantly negative for all panels. These estimates correspond to the (negative) sunk costs of entry defined in (5.11), which represent the expectation of the difference between the treated group (newly entered firms) and the control group (established exporters) in term of export revenue. Therefore, the negative and significant estimates of β_1 suggest the existence of sunk costs of entry for the newly entered firms.[17] The alternative method - the propensity score matching, provides very similar results, see Table 5.8 in Appendix B. Second, we examine the impacts of productivity on the sunk costs. The estimates of β_9 are significantly positive for all panels, which

[16] The squared variables (l^2 and w_l^2) are introduced in order to capture the potential non-linearity. However, we cannot plug the productivity measurements into the non-linear function, because they are estimated variables.

[17] The estimates of β_0 and $\beta_2 - \beta_7$ are not interpretable in our model, they correspond to a composite function, i.e., $G_0(x_{it-1}) \equiv f(x_{it-1}) - \theta + g_0(x_{it-1})$.

Table 5.6: Estimation of ATE and $ATE(x)$

	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
Intercept (β_0)	6.27 (4.00)	4.40 (4.66)	7.30 (2.44)	7.99 (3.00)	2.10 (3.84)	−3.41 (3.11)
ATE (β_1)	−1.12 (0.18)	−2.07 (0.26)	−1.26 (0.33)	−2.08 (0.34)	−1.51 (0.27)	−2.01 (0.33)
TFP$_{t-1}$ (β_2)	−0.91 (0.05)	−0.87 (0.05)	−0.81 (0.05)	−0.83 (0.05)	−0.86 (0.06)	−0.70 (0.06)
RLP$_{t-1}$ (β_3)	0.27 (0.03)	0.25 (0.03)	0.20 (0.02)	0.23 (0.03)	0.22 (0.03)	0.20 (0.03)
Sector (β_4)	$-1.82e^{-5}$ ($5.23e^{-5}$)	$-5.00e^{-6}$ ($5.21e^{-5}$)	$5.51e^{-5}$ ($5.63e^{-5}$)	$5.48e^{-5}$ ($5.56e^{-5}$)	$3.73e^{-5}$ ($5.80e^{-5}$)	$4.59e^{-6}$ ($6.25e^{-5}$)
Labor$_{t-1}$ (β_5)	0.35 (0.20)	−0.02 (0.20)	−0.19 (0.25)	−0.19 (0.28)	−0.14 (0.23)	−0.19 (0.25)
Squared labor$_{t-1}$ (β_6)	0.09 (0.02)	0.12 (0.02)	0.14 (0.02)	0.14 (0.03)	0.13 (0.02)	0.12 (0.02)
Wage$_{t-1}$ (β_7)	−1.12 (2.13)	0.34 (2.62)	−0.73 (1.31)	−0.92 (1.58)	2.09 (1.96)	4.27 (1.59)
Squared wage$_{t-1}$ (β_8)	0.51 (0.29)	0.31 (0.37)	0.43 (0.18)	0.44 (0.21)	0.06 (0.30)	−0.22 (0.20)
D_{it-1}·**TFP**$_{t-1}$ (β_9)	1.05 (0.35)	2.28 (0.37)	0.66 (0.56)	2.09 (0.59)	1.35 (0.46)	2.35 (0.56)
D_{it-1}·**RLP**$_{t-1}$ (β_{10})	−0.09 (0.11)	−0.32 (0.15)	0.03 (0.15)	−0.19 (0.14)	−0.14 (0.16)	−0.15 (0.19)
D_{it-1}·Sector (β_{11})	$9.57e^{-4}$ ($2.35e^{-4}$)	$7.96e^{-4}$ ($3.56e^{-4}$)	$2.28e^{-4}$ ($3.12e^{-4}$)	$1.28e^{-3}$ ($3.85e^{-4}$)	$1.90e^{-4}$ ($3.95e^{-4}$)	$9.65e^{-4}$ ($3.70e^{-4}$)
D_{it-1}·Labor$_{t-1}$ (β_{12})	0.89 (0.58)	1.44 (0.99)	1.96 (1.10)	−0.16 (1.00)	0.57 (0.83)	−0.17 (1.12)
D_{it-1}·Squared labor$_{t-1}$ (β_{13})	−0.09 (0.05)	−0.20 (0.10)	−0.18 (0.12)	−0.03 (0.11)	−0.06 (0.08)	−0.02 (0.10)
D_{it-1}·Wage$_{t-1}$ (β_{14})	6.63 (4.93)	−15.10 (7.84)	−1.77 (9.45)	−12.19 (6.19)	−2.17 (7.01)	−8.68 (7.57)
D_{it-1}·Squared wage$_{t-1}$ (β_{15})	−0.89 (0.64)	1.81 (1.03)	0.21 (1.29)	1.49 (0.86)	0.19 (0.90)	0.82 (1.00)

indicate that the ATE $(-\theta_s)$ is increasing with TFP.[18] In other words, this suggests that firms with higher TFP level incur significantly less entry costs than the average. Thus, this empirical evidence supports our theoretical framework, in which the sunk cost of entry is modelled as a function of firm-level productivity. The empirical results on the impacts of RLP are less conclusive. Although the estimates of β_{10} are negative in five out of six cases, the bootstrap shows that they are not precisely estimated.

5.5 Conclusion

The estimation results in this paper suggests that the firms in our sample face a significant sunk costs of entry into foreign market. There is a significant link between productivity and sunk costs, which confirms empirically our idea of heterogeneous sunk entry costs. Given this empirical evidence, we show theoretically that the Melitz model with homogeneous entry costs may misestimate the self-selection in export market. The minimum entry requirement at equilibrium now is determined by the relationship between productivity and entry costs, which in turn has effects on the number of firms and on volume of trade. Further research may take a direction towards a more dynamic trade model, where productivity level evolves over time as a stochastic process (see Costantini and Melitz, 2007). Thus, both entry and exit decisions could be modelled.

[18]Typically, $-\theta_s$ (negative sunk costs) varies from $-\infty$ to 0.

5.6 Appendix

Appendix A: Theoretical model derivations

Appendix A.1: Derivation of the Equilibrium

Before presenting derivation of equilibrium, we provide a summary of all parameters used in our theoretical model and the corresponding restrictions.

Table 5.7: Summary of parameters

Notation	Definition	Support
$\bar{a}$	scale parameter of Pareto dist.	$[0, +\infty[$
k	slope parameter of Pareto dist.	$[0, +\infty[$
ϵ	elasticity of substitution across varieties	$[1, +\infty[$
γ	productivity elasticity of entry costs	$[0, +\infty[$
f_X	export fixed costs	$]0, +\infty[$
f_E	domestic entry costs	$]0, +\infty[$
f_D	production fixed costs	$]0, +\infty[$
τ	iceberg cost	$[0, +\infty[$
β	$k/\epsilon - 1$	$[1, +\infty[$
Δ	-	$[0, +\infty[$
Ω	indicator of openness,$\Omega \equiv (\tau^{1-\epsilon})^{\beta}(f_X/f_D)^{1-\beta}$	$[0, 1]$

To solve for the equilibrium values of a_D, a_X and B, we use the free entry condition and the zero cutoff profit condition for both domestic and export market:

$$Ba_D^{1-\epsilon} = f_D \tag{5.20}$$

$$B(\tau a_X)^{1-\epsilon} = f_X h(a) \tag{5.21}$$

$$V(a_D) \cdot B + \tau^{1-\epsilon} V(a_X) \cdot B - \left[G(a_D) f_D + f_X \int_0^{a_X} h(a) dG(a) \right] = f_E. \tag{5.22}$$

Using the definition of the expected value of firms, we can solve for $V(a_i)$ $(i = D, X)$:

$$V(a_i) = \int_0^{a_i} a^{1-\epsilon} dG(a) = \int_0^{a_i} a^{1-\epsilon} g(a) da = \left(\frac{\beta}{\beta - 1} \right) \bar{a}^{-k} a_i^{k-\epsilon+1}. \tag{5.23}$$

From (5.20) and (5.21), we can find the relative threshold value:

$$\frac{a_X}{a_D} = \left(\frac{f_X h(a_X)}{f_D \tau^{1-\epsilon}}\right)^{\frac{1}{1-\epsilon}} \tag{5.24}$$

Also from (5.20) and (5.21) we have:

$$B = f_D a_D^{\epsilon-1} = f_X h(a_X)(\tau a)^{\epsilon-1} \tag{5.25}$$

Equation (5.22) can be rewritten as:

$$f_E + f_D G(a_D) + f_X \int_0^{a_X} h(a)g(a)da = B\left[V(a_D) + \tau^{1-\epsilon} V(a_X)\right]$$

Using equation (5.25) and dividing both side by $f_D G(a_D)$ yields:

$$\frac{f_E}{f_D G(a_D)} + 1 + \frac{f_X \int_0^{a_X} h(a)g(a)da}{f_D G(a_D)} = a_D^{\epsilon-1}\left[\frac{V(a_D)}{G(a_D)} + \tau^{1-\epsilon}\frac{V(a_X)}{G(a_D)}\right]$$

Replacing $V(a_D)$ and $V(a_X)$ by (5.23) and using the definition of $G(a) = (a/\bar{a})^k$, we can write:

$$\frac{f_E}{f_D}\left(\frac{\bar{a}}{a_D}\right)^k + 1 + \frac{f_X}{f_D}\left(\frac{\bar{a}}{a_D}\right)^k \int_0^{a_X} h(a)g(a)da = \left(\frac{\beta}{\beta-1}\right)\left[1 + \tau^{1-\epsilon}\left(\frac{a_X}{a_D}\right)^{k-\epsilon+1}\right]$$

where $\beta \equiv k/\epsilon - 1$. Then using (5.24) we find:

$$\frac{f_E}{f_D}\left(\frac{\bar{a}}{a_D}\right)^k + 1 + \frac{f_X}{f_D}\left(\frac{\bar{a}}{a_D}\right)^k \int_0^{a_X} h(a)g(a)da = \left(\frac{\beta}{\beta-1}\right)\left[1 + \tau^{1-\epsilon}\left(\frac{f_X h(a_X)}{f_D \tau^{1-\epsilon}}\right)^{\frac{k-\epsilon+1}{1-\epsilon}}\right]$$

$$\frac{f_E}{f_D}\left(\frac{\bar{a}}{a_D}\right)^k + 1 + \frac{f_X}{f_D}\left(\frac{\bar{a}}{a_D}\right)^k \int_0^{a_X} h(a)g(a)da = \left(\frac{\beta}{\beta-1}\right)\left[1 + \Omega h(a_X)^{1-\beta}\right]$$

where $\Omega \equiv (\tau^{1-\epsilon})^{\beta}(f_X/f_D)^{1-\beta}$. Now consider the functional form $h(a) = a^{\gamma}$. We have that $f_X \int_0^{a_X} h(a)g(a)da = f_X G(a_X)\frac{k}{k+\gamma}a^{\gamma}$. This yields:

$$\begin{aligned}
&\frac{f_E}{f_D}\left(\frac{\bar{a}}{a_D}\right)^k + 1 + \frac{f_X}{f_D}\left(\frac{\bar{a}}{a_D}\right)^k \frac{k}{k+\gamma}(a_X^{\gamma})G(a_X) = \left(\frac{\beta}{\beta-1}\right)\left[1+\Omega(a_X^{\gamma})^{1-\beta}\right]\\
&\frac{f_E}{f_D}\left(\frac{\bar{a}}{a_D}\right)^k + 1 + \frac{f_X}{f_D}\left(\frac{a_X}{a_D}\right)^k \frac{k}{k+\gamma}(a_X^{\gamma}) = \left(\frac{\beta}{\beta-1}\right)\left[1+\Omega(a_X^{\gamma})^{1-\beta}\right]\\
&\frac{f_E}{f_D}\left(\frac{\bar{a}}{a_D}\right)^k + 1 + \Omega\frac{k}{k+\gamma}(a_X^{\gamma})^{1-\beta} = \left(\frac{\beta}{\beta-1}\right)\left[1+\Omega(a_X^{\gamma})^{1-\beta}\right]\\
&\frac{f_D}{f_E}\left[\left(\frac{\beta}{\beta-1}\right)\left[1+\Omega(a_X^{\gamma})^{1-\beta}\right] - 1 - \Omega\frac{k}{k+\gamma}(a_X^{\gamma})^{1-\beta}\right] = \left(\frac{\bar{a}}{a_D}\right)^k\\
&\frac{f_D}{f_E(\beta-1)}\left[1+\Omega(a_X^{\gamma})^{1-\beta}(\beta-(\beta-1)\frac{k}{k+\gamma})\right] = \left(\frac{\bar{a}}{a_D}\right)^k
\end{aligned}$$

Finally we obtain:

$$a_D^k = \bar{a}^k \frac{f_E(\beta-1)}{f_D[1+\Omega(a_X^{\gamma})^{1-\beta}\Delta]}$$

where $\Delta \equiv (\beta - (\beta-1)(k/k+\gamma)$. Using equation (4) and the specification of $h(a)$, we can an equilibrium value for a_X:

$$\begin{aligned}
&\frac{a_X^{k+\gamma\beta}\left(\frac{f_X}{f_D\tau^{1-\epsilon}}\right)^{\beta}}{\bar{a}^k} = \frac{f_E(\beta-1)}{f_D[1+\Omega(a_X^{\gamma})^{1-\beta}\Delta]}\\
&a_X^{k+\gamma\beta} = \bar{a}^k \frac{f_D}{f_X}\frac{f_E(\beta-1)}{f_D[1+\Omega(a_X^{\gamma})^{1-\beta}\Delta]}\frac{f_X}{f_D}\left(\frac{f_X}{f_D\tau^{1-\epsilon}}\right)^{-\beta}\\
&a_X^{k+\gamma\beta} = \bar{a}^k \frac{f_E(\beta-1)}{f_X[1+\Omega(a_X^{\gamma})^{1-\beta}\Delta]}\Omega\\
&a_X^{k+\gamma\beta} + \Omega\Delta a_X^{k+\gamma} = \bar{a}^k \frac{f_E(\beta-1)\Omega}{f_X}\\
&a_X^k = \bar{a}^k \frac{f_E(\beta-1)\Omega}{f_X(a_X^{\gamma\beta}+\Omega\Delta a_X^{\gamma})}
\end{aligned}$$

Note that if $\gamma = 0$ our model returns to the linear model because $\Delta = 1$ if $\gamma = 0$.

$$a_D = \bar{a}\left[\frac{f_E(\beta-1)}{f_D(1+\Omega)}\right]^{\frac{1}{k}} \quad \text{and} \quad a_X = \bar{a}\left[\frac{f_E(\beta-1)\Omega}{f_D(1+\Omega)}\right]^{\frac{1}{k}}$$

Appendix A.2: Uniqueness of the Equilibrium

To show the uniqueness, we examine the monotonicity of the implicit function (5.6) that characterize the equilibrium of a_x.

$$\bar{a}^k \frac{f_E(\beta-1)\Omega}{f_X(a_X^{\gamma\beta}+\Omega\Delta a_X^{\gamma})} - a_X^k = 0,$$

and the derivative *w.r.t.* a_x is:

$$-\frac{\bar{a}^k f_E(\beta-1)\Omega}{f_X}\frac{(\gamma\beta a_X^{\gamma\beta-1}+\Omega\Delta\gamma a_X^{\gamma-1})}{(a_X^{\gamma\beta}+\Omega\Delta a_X^{\gamma})^2} - k a_x^{k-1} < 0.$$

Thus, there is a unique solution for a_x. Since the equilibrium value of other variables is defined by a_x, we can conclude that the equilibrium is unique.

Appendix A.3: Proof of the Proposition

Given the implicit function of equilibrium for a_x:

$$F(a_x,\gamma) = \bar{a}^k \frac{f_E(\beta-1)\Omega}{f_X(a_X^{\gamma\beta}+\Omega\Delta a_X^{\gamma})} - a_X^k = 0,$$

by using the Implicit Function Theorem, we have:

$$\frac{\partial a_x}{\partial\gamma} = -\frac{\frac{\partial F}{\gamma}(a_x,\gamma)}{\frac{\partial F}{a_x}(a_x,\gamma)},$$

where

$$\begin{aligned}\frac{\partial F}{\partial\gamma}(a_x,\gamma) &= -\frac{\bar{a}^k f_E(\beta-1)\Omega}{f_X}\frac{1}{(a_X^{\gamma\beta}+\Omega\Delta a_X^{\gamma})^2} \\ &\quad \left[\beta\log(a_x)a_x^{\gamma\beta}+\Omega\frac{a_x^r[\log(a_x)(k+\gamma)(\beta\gamma+k)+(\beta-1)k]}{(k+r)^2}\right] \\ &= \Lambda\cdot\left[\beta\log(a_x)a_x^{\gamma\beta}+\Omega\frac{a_x^r[\log(a_x)(k+\gamma)(\beta\gamma+k)+(\beta-1)k]}{(k+r)^2}\right];\end{aligned}$$

$$\begin{aligned}\frac{\partial F}{\partial a_x}(a_x,\gamma) &= -\frac{\bar{a}^k f_E(\beta-1)\Omega}{f_X}\frac{(\gamma\beta a_X^{\gamma\beta-1}+\Omega\Delta\gamma a_X^{\gamma-1})}{(a_X^{\gamma\beta}+\Omega\Delta a_X^{\gamma})^2} - k a_x^{k-1} \\ &= \Lambda\cdot(\gamma\beta a_X^{\gamma\beta-1}+\Omega\Delta\gamma a_X^{\gamma-1}) - k a_x^{k-1},\end{aligned}$$

where

$$\Lambda \equiv -\frac{\bar{a}^k f_E(\beta-1)\Omega}{f_X}\frac{1}{(a_X^{\gamma\beta}+\Omega\Delta a_X^{\gamma})^2}$$

In order to conclude on the sign of the slope, $\partial a_x/\partial\gamma$, we have to discuss the sign of $\partial F/\partial\gamma$ and $\partial F/\partial a_x$. We start with the latter. Firstly, it is easy to see that Λ is always negative given a reasonable support of parameters. Secondly, we note that $(\gamma\beta a_X^{\gamma\beta-1}+\Omega\Delta\gamma a_X^{\gamma-1})$ and $k a_x^{k-1}$ are positive. Thus, we can safely say that $\partial F/\partial a_x$ is negative for the full support of a_x and γ.

Sign of $\partial F/\partial\gamma$: The sign of $\partial F/\partial\gamma$ is less obvious. First, if we only consider the interval $a_x \in [1,+\infty[$, $\partial F/\partial\gamma$ is negative. For the interval $a_x \in [0,1[$, $log(a_x)$ is negative. Thus, we need to solve the following equation for a_x :

$$\beta\log(a_x)a_x^{\gamma\beta} + \Omega\frac{a_x^r[\log(a_x)(k+\gamma)(\beta\gamma+k)+(\beta-1)k]}{(k+r)^2} = 0.$$

Unfortunately, there is no analytical solution for this equation. However, we can conclude on the sign of $\partial a_x/\partial\gamma$ if we can find a condition that ensure $\log(a_x)(k+\gamma)(\beta\gamma+k)+(\beta-1)k$ to be negative. This is because $\beta\log(a_x)a_x^{\gamma\beta}$ is always negative for $a_x \in [0,1[$. This condition is:

$$\log(a_x) < -\frac{(\beta-1)k}{(k+\gamma)(\beta\gamma+k)} = \frac{1}{k+\gamma} - \frac{1}{\epsilon-1+\gamma} < 1.$$

Therefore we have:

- i) For $a_x \in [1, +\infty[$, a_x is decreasing in γ, i.e., the slope $\partial a_x/\partial\gamma > 0$;
- ii) For $a_x \in]0, \exp(\frac{1}{k+\gamma} - \frac{1}{\epsilon-1+\gamma})]$, a_x is increasing in γ, i.e., the slope $\partial a_x/\partial\gamma < 0$;
- iii) For $a_x \in]\exp(\frac{1}{k+\gamma} - \frac{1}{\epsilon-1+\gamma}), 1[$, the sign of slope is undetermined.

Appendix B: Estimation results of productivity and Robustness checks

Table 5.8: Estimates of ATE by Propensity score matching

	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
Intercept	-5.710 (0.896)	-4.995 (1.055)	-1.500 (1.053)	-1.940 (1.035)	-5.085 (1.126)	-3.207 (1.219)
Sector	$2.867e^{-4}$ ($1.187e^{-4}$)	$3.367e^{-4}$ ($1.303e^{-4}$)	$1.262e^{-4}$ ($1.365e^{-4}$)	$1.048e^{-5}$ ($1.273e^{-4}$)	$5.953e^{-5}$ ($1.480e^{-4}$)	$1.686e^{-4}$ ($1.563e^{-4}$)
TFP_{t-1}	0.809 (0.199)	0.882 (0.222)	0.699 (0.224)	1.152 (0.2339)	0.714 (0.256)	1.043 (0.288)
RLP_{t-1}	1.739 (0.592)	1.979 (0.514)	1.338 (0.289)	1.939 (0.401)	1.684 (0.500)	3.285 (0.815)
Labor_{t-1}	2.235 (0.843)	3.036 (0.828)	2.050 (0.557)	3.146 (0.673)	2.236 (0.809)	4.657 (1.179)
Capital_{t-1}	-2.670 (0.848)	-3.390 (0.826)	-2.753 (0.569)	-3.428 (0.678)	-2.832 (0.819)	-4.816 (1.165)
Output_{t-1}	0.301 (0.180)	0.276 (0.201)	0.196 (0.212)	-0.193 (0.219)	0.425 (0.232)	0.033 (0.248)
ATE	-1.603 (0.408)	-2.484 (0.457)	-0.501 (0.498)	-2.165 (0.64383)	-1.680 (0.580)	-1.125 (0.617)

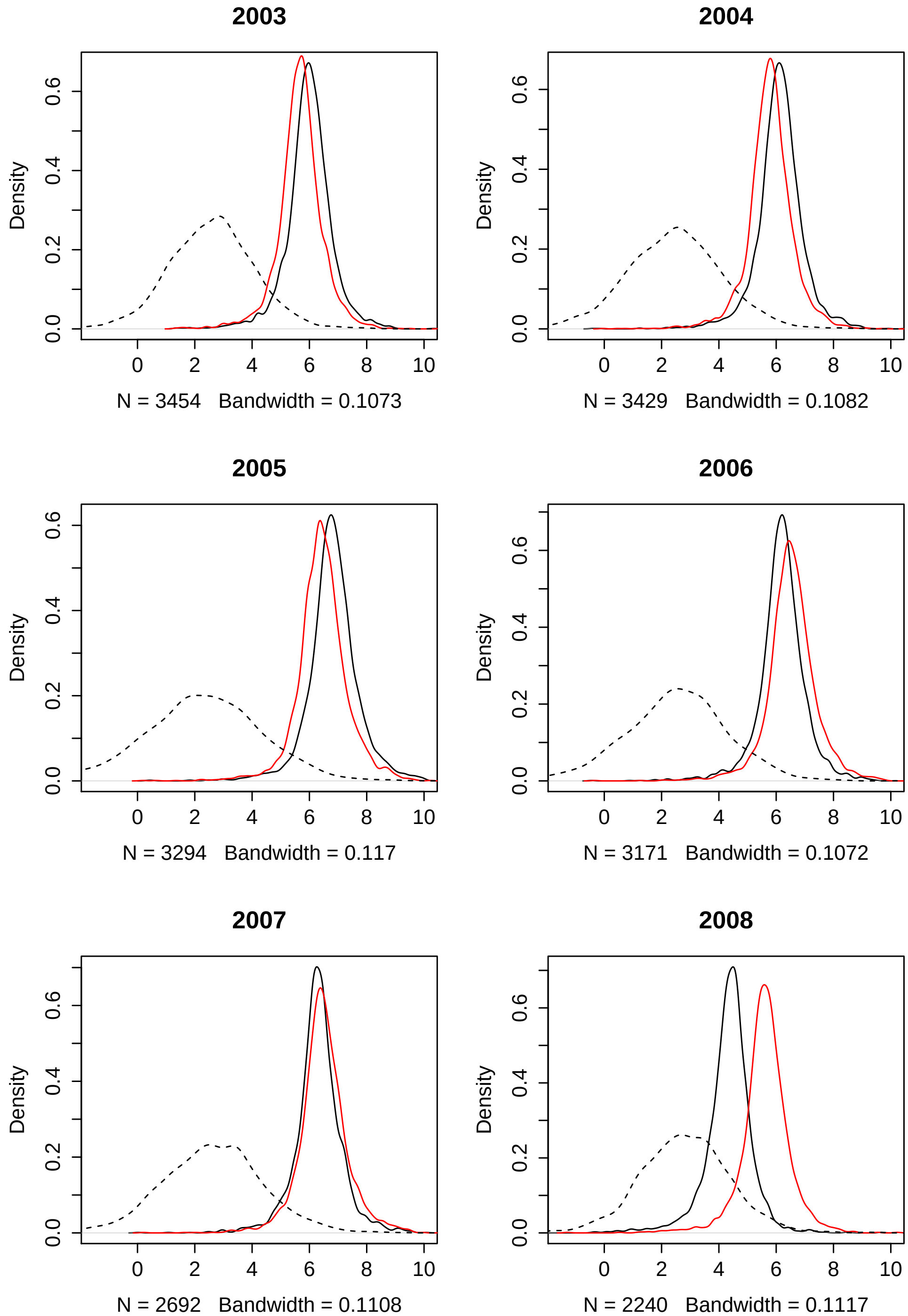
Note: the propensity score is computed using a logit regression in the first-stage. The logistic regression results are reported in Lines 2-8.

Table 5.9: Estimation of technology parameters

	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
Cobb-Douglas						
β_l	0.511 (0.024)	0.510 (0.021)	0.468 (0.024)	0.492 (0.021)	0.493 (0.025)	0.511 (0.029)
β_k	0.080 (0.030)	0.068 (0.040)	0.006 (0.030)	0.077 (0.041)	0.067 (0.057)	0.304 (0.120)
$\beta_k + \beta_l$	0.591	0.578	0.474	0.569	0.560	0.815
CES						
ρ	0.736 (0.034)	0.731 (0.036)	0.615 (0.037)	0.589 (0.039)	0.607 (0.051)	0.780 (0.053)
γ	-0.319 (0.172)	-0.440 (0.169)	-0.579 (0.141)	-0.405 (0.122)	-0.386 (0.131)	-0.332 (0.257)
σ	0.302 (0.133)	0.376 (0.095)	0.485 (0.071)	0.407 (0.081)	0.389 (0.091)	0.298 (0.230)

Note: the bootstrap estimated standards deviations are reported in parenthesis.

Figure 5.4: Distributions of estimated productivity



Note: the black line is the distribution of TFP based on Cobb-Douglas; the red line is the distribution of TFP based on CES; the dash line is the distribution of RLP.

Table 5.10: Correlation matrices

2004-5	$\widehat{TFP}^{CB}_{t-1}$	$\widehat{TFP}^{CES}_{t-1}$	$\widehat{RLP}^{CES}_{t-1}$	Y_{t-1}	L_{t-1}	K_{t-1}
$\widehat{TFP}^{CES}_{t-1}$	0.935					
$\widehat{RLP}^{CES}_{t-1}$	0.057	0.327				
Y_{t-1}	0.844	0.734	0.166			
L_{t-1}	0.383	0.173	0.046	0.722		
K_{t-1}	0.323	0.364	0.724	0.623	0.719	
r_t	0.048	-0.013	0.170	0.306	0.504	0.484

2005-6	$\widehat{TFP}^{CB}_{t-1}$	$\widehat{TFP}^{CES}_{t-1}$	$\widehat{RLP}^{CES}_{t-1}$	Y_{t-1}	L_{t-1}	K_{t-1}
$\widehat{TFP}^{CES}_{t-1}$	0.947					
$\widehat{RLP}^{CES}_{t-1}$	0.150	0.382				
Y_{t-1}	0.893	0.801	0.175			
L_{t-1}	0.460	0.277	0.037	0.708		
K_{t-1}	0.446	0.481	0.726	0.622	0.708	
r_t	0.113	0.048	0.137	0.300	0.516	0.475

2006-7	$\widehat{TFP}^{CB}_{t-1}$	$\widehat{TFP}^{CES}_{t-1}$	$\widehat{RLP}^{CES}_{t-1}$	Y_{t-1}	L_{t-1}	K_{t-1}
$\widehat{TFP}^{CES}_{t-1}$	0.960					
$\widehat{RLP}^{CES}_{t-1}$	0.056	0.318				
Y_{t-1}	0.849	0.838	0.189			
L_{t-1}	0.366	0.327	0.060	0.706		
K_{t-1}	0.308	0.462	0.736	0.620	0.715	
r_t	0.029	0.053	0.156	0.281	0.487	0.458

2007-8	$\widehat{TFP}^{CB}_{t-1}$	$\widehat{TFP}^{CES}_{t-1}$	$\widehat{RLP}^{CES}_{t-1}$	Y_{t-1}	L_{t-1}	K_{t-1}
$\widehat{TFP}^{CES}_{t-1}$	0.962					
$\widehat{RLP}^{CES}_{t-1}$	0.083	0.331				
Y_{t-1}	0.857	0.831	0.196			
L_{t-1}	0.402	0.331	0.060	0.715		
K_{t-1}	0.352	0.474	0.732	0.634	0.720	
r_t	0.067	0.069	0.165	0.303	0.506	0.480

2008-9	$\widehat{TFP}^{CB}_{t-1}$	$\widehat{TFP}^{CES}_{t-1}$	$\widehat{RLP}^{CES}_{t-1}$	Y_{t-1}	L_{t-1}	K_{t-1}
$\widehat{TFP}^{CES}_{t-1}$	0.844					
$\widehat{RLP}^{CES}_{t-1}$	-0.260	0.293				
Y_{t-1}	0.608	0.725	0.187			
L_{t-1}	0.000	0.053	0.038	0.650		
K_{t-1}	-0.170	0.264	0.746	0.577	0.691	
r_t	-0.164	-0.054	0.153	0.268	0.474	0.445

6 Conclusion

6.1 Main findings

In this thesis, I contribute to both theoretical and empirical aspects of the literature on firm heterogeneity in international trade. The contributions mainly concern the following points:

- Asymmetric effects of trade liberalisation when firms matters
- Learning effects of exporting and importing on productivity
- Fixed costs identification and measurement
- Extensive margin evaluation

There are still substantial differences in worlds' trading economies. Intuitively, assuming that different countries do not react the same way to a structural change in trade costs seems reasonable. In Chapter 3, I show that **the effects of trade liberalisation are asymmetric** and country-specific. I extend a growth model of trade to allow the analysis of both the short-run and the long-run effects of trade liberalisation on the aggregate productivity of asymmetric countries. My findings first suggest that in the short-run, trade liberalisation opens new profit opportunities. Low productivity domestic firms are replaced by high productive foreign firms. This have a positive effect on the aggregate productivity and this effect is stronger in the more advanced country. Second, as trade costs fall, competition on the market becomes stronger, and productivity growth slows down because firms have less incentives to invest in R&D activities. This negative effect is stronger in the more advanced country. The overall effect remains ambiguous and depends on parameter values.

In Chapters 4 and 5, I contribute to the literature that tries to explain the productivity superiority of exporters. I find evidence for both the learning-by-trading and the self-selection, confirming that both processes are not mutually exclusive.

In Chapter 4, I estimate firm-level productivity and provide results on the learning effects of trade for French manufacturing firms. I find **significant learning-by-exporting and learning-by-importing effects** in almost all manufacturing sectors. Interestingly, the learning effects from importing are stronger than the one from exporting.

In Chapter 5, we confirm previous evidence of the **existence of sunk entry costs** for the export market (Roberts and Tybout, 1997). We also validate the hypothesis of self-selection of most productive firms in the international market. Moreover, we show that these sunk entry costs have a firm-specific component that depends on firm's productivity. Our theoretical model with heterogeneous sunk entry costs suggests that the evaluation of **the extensive margin of trade** depends on the relationship between sunk entry costs and productivity.

6.2 Limitations and future works

Although the work made in this thesis contributes to several aspects of the literature as previously mentioned, it faces some limitations that deserve to be discussed and that motivate my future research.

First, the theoretical models used in Chapters 3 and 5 are silent on the determinants of importing behaviour of firms. However, trade in intermediate inputs has experienced a fast growth in the three last decades that is referenced in the literature as vertical specialisation and that can explain about one-third of the growth of trade (as documented by Hummels et al., 2001). This vertical specialisation or outsourcing emphasises the need to model trade in intermediates inputs. An underlying important question is the impact of importing intermediate inputs on employment and wages. An ongoing work analyses the potential substitution between the labour demand and imported intermediate inputs. The EAE database allows to analyse this substitution directly at the firm level rather than at the sector level.

A second limitation concerns the extensive margin of trade. As in Chaney (2008), the literature on heterogeneous firms associates the extensive margin of trade to firm entry in the international market, and considers that incumbent firms exogenously disappear while being hit by a bad productivity shock. In Chapters 3 and 5, I follow this way of modelling firms' exit. However, studying how and why firms exit the international market is also important when it comes to the extensive margin of trade. From a policy point of view, it could be more interesting to support exporters and help them to face international competition rather than to promote export of domestic firms. Therefore, it is important to study firms' decision to exit the international market and the determinants of such a choice.

In Chapter 4, I study the learning-by-trading effects on productivity. However, I conclude on the effects of exporting and importing on productivity but I remain silent on the determinants of such effects. In a literature review Silva et al. (2012a) suggest that "future development and studies may focus on the analysis of particular learning channels instead of analysing learning-by-exporting in an abstract way". What are the channel through which learning-by-trading occurs? The methodology used in the paper allows to use other variables in the productivity process that could identify some of these channels. A future improvement of this work includes some tests on the potential learning channels. These channels could be the diversification of the input varieties, the increasing input quality or the number of market served by the firms.

Bibliography

ACKERBERG, D., K. CAVES AND G. FRAZER, "Structural identification of production functions," (2006).

ALVAREZ, R. AND R. LÓPEZ, "Exporting and performance: evidence from Chilean plants," *Canadian Journal of Economics* 38 (2005), 1384–1400.

AMITI, M. AND D. R. DAVIS, "Trade, firms, and wages: Theory and evidence," *The Review of economic studies* 79 (2012), 1–36.

AMITI, M. AND J. KONINGS, "Trade Liberalization, Intermediate Inputs, and Productivity: Evidence from Indonesia," *American Economic Review* 97 (2007), 1611–1638.

ANDERSSON, M., H. LÖÖF AND S. JOHANSSON, "Productivity and International Trade: Firm Level Evidence from a Small Open Economy," *Review of World Economics* 144 (2008), 774–801.

ANTRÀS, P. AND E. HELPMAN, "Global Sourcing," *Journal of Political Economy* 112 (2004), 552–580.

ARISTEI, D., D. CASTELLANI AND C. FRANCO, "Firms' exporting and importing activities: is there a two-way relationship?," *Review of World Economics (Weltwirtschaftliches Archiv)* 149 (2013), 55–84.

ARKOLAKIS, C., "Market Penetration Costs and the New Consumers Margin in International Trade," *Journal of Political Economy* 118 (2010), 1151 – 1199.

ARNOLD, J. M. AND K. HUSSINGER, "Export behavior and firm productivity in German manufacturing: a firm-level analysis," *Review of World Economics* 141 (2005), 219–243.

ARROW, K. J., "The economic implications of learning by doing," *The review of economic studies* (1962), 155–173.

AW, B. Y. AND A. R. HWANG, "Productivity and the export market: A firm-level analysis," *Journal of Development Economics* 47 (1995), 313–332.

BALDWIN, R., "Hysteresis in Import Prices: The Beachhead Effect," *The American Economic Review* 78 (1988), 773–785.

———, "Sunk-Cost Hysteresis," NBER Working Papers 2911, National Bureau of Economic Research, Inc, 1989.

BALDWIN, R. AND P. KRUGMAN, "Persistent Trade Effects of Large Exchange Rate Shocks," *The Quarterly Journal of Economics* 104 (1989), 635–54.

BALDWIN, R. E. AND F. ROBERT-NICOUD, "Trade and growth with heterogeneous firms," *Journal of International Economics* 74 (2008), 21 – 34.

BAS, M. AND V. STRAUSS-KAHN, "Does importing more inputs raise exports? Firm level evidence from France.," *(MPRA Paper No. 27315). University Library of Munich: Munich Personal RePEc Archive.* (2010).

BEKES, G., P. HARASZTOSI AND B. MURAKOZY, "Firms and Products in International Trade: Data and Patterns for Hungary," IEHAS Discussion Papers 0919, Institute of Economics, Centre for Economic and Regional Studies, Hungarian Academy of Sciences, 2009.

BELLONE, F., P. MUSSO, L. NESTA AND M. QUERE, "The U-Shaped Productivity Dynamics of French Exporters," *Review of World Economics* 144 (2008), 636–659.

BERNARD, A., J. EATON, J. JENSEN AND S. KORTUM, "Plants and Productivity in International Trade," *American Economic Review* 93 (2003), 1268.

BERNARD, A. B. AND J. B. JENSEN, "Exporters, Jobs, and Wages in U.S. Manufacturing: 1976-1987," *Brookings Papers on Economic Activity. Microeconomics* (1995), 67–119.

———, "Exceptional exporter performance: cause, effect, or both?," *Journal of International Economics* 47 (1999), 1 – 25.

———, "Why Some Firms Export," *The Review of Economics and Statistics* 86 (2004), 561–569.

BERNARD, A. B., S. J. REDDING AND S. P. K., "Comparative Advantage and Heterogeneous Firms," *Review of Economic Studies* 74 (2007), 31–66.

BERNARD, A. B. AND J. WAGNER, "Export entry and exit by German firms," *Weltwirtschaftliches Archiv* 137 (2001), 105–123.

BUSTOS, P., "Trade Liberalization, Exports, and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinian Firms," *American Economic Review* 101 (2011), 304–40.

CAMPA, J. M., "Exchange rates and trade: How important is hysteresis in trade?," *European Economic Review* 48 (2004), 527–548.

CASTELLANI, D., F. SERTI AND C. TOMASI, "Firms in International Trade: Importers' and Exporters' Heterogeneity in Italian Manufacturing Industry," *The World Economy* 33 (2010), 424–457.

CHANEY, T., "Distorted Gravity: The Intensive and Extensive Margins of International Trade," *The American Economic Review* 98 (2008), 1707–1721.

CHEN, X., "Estimation of the CES Production Function with Biased Technical Change: A Control Function Approach," Technical Report, 2012.

CHEN, X. AND B. KOEBEL, "Fixed cost, variable cost and the markup," Technical Report, 2013.

CLERIDES, S. K., S. LACH AND J. R. TYBOUT, "Is Learning By Exporting Important? Micro-Dynamic Evidence From Colombia, Mexico, And Morocco," *The Quarterly Journal of Economics* 113 (1998), 903–947.

COE, D. T. AND E. HELPMAN, "International r&d spillovers," *European Economic Review* 39 (1995), 859–887.

COSTANTINI, J. AND M. MELITZ, "The dynamics of firm-level adjustment to trade liberalization," *The organization of firms in a global economy* (2007), 107–141.

CROZET, M., I. MÉJEAN AND S. ZIGNAGO, "Plus grandes, plus fortes, plus loin.... Les performances des firmes exportatrices françaises," *Revue économique, Presses de Sciences-Po* 62 (2011), 717–736.

CROZET, M. AND F. TRIONFETTI, "Comparative Advantage and Within-Industry Firms Performance," Degit conference papers, DEGIT, Dynamics, Economic Growth, and International Trade, 2011.

DAS, S., M. J. ROBERTS AND J. R. TYBOUT, "Market Entry Costs, Producer Heterogeneity, and Export Dynamics," *Econometrica* 75 (2007), 837–873.

DE LOECKER, J., "Do exports generate higher productivity? Evidence from Slovenia," *Journal of International Economics* 73 (2007), 69–98.

———, "Detecting Learning by Exporting," *American Economic Journal: Microeconomics* (2013).

DELGADO, M. A., J. C. FARINAS AND S. RUANO, "Firm productivity and export markets: a non-parametric approach," *Journal of International Economics* 57 (2002), 397–422.

DIXIT, A., "Entry and Exit Decisions under Uncertainty," *Journal of Political Economy* 97 (1989a), pp. 620–638.

———, "Hysteresis, Import Penetration, and Exchange Rate Pass-Through," *The Quarterly Journal of Economics* 104 (1989b), 205–228.

DIXIT, A. K. AND J. E. STIGLITZ, "Monopolistic Competition and Optimum Product Diversity," *American Economic Review* 67 (1977), 297–308.

EATON, J. AND S. KORTUM, "International Technology Diffusion: Theory and Measurement," *International Economic Review* 40 (1999), 537–570.

———, "Technology, Geography, and Trade," *Econometrica* 70 (2002), 1741–1779.

EATON, J., S. KORTUM AND F. KRAMARZ, "An Anatomy of International Trade: Evidence From French Firms," *Econometrica* Vol. 79 (2011), 1453–1498.

ELIASSON, K., P. HANSSON AND M. LINDVERT, "Do firms learn by exporting or learn to export? Evidence from small and medium-sized enterprises," *Small Business Economics* 39 (2012), 453–472.

FALVEY, R., D. GREENAWAY AND Z. YU, "Catching Up or Pulling Away: Intra-Industry Trade, Productivity Gaps and Heterogeneous Firms," *Open Economies Review* 22 (2011), 17–38.

FERNANDES, A. M. AND A. E. ISGUT, "Learning-by-doing, learning-by-exporting, and productivity : evidence from Colombia," Policy Research Working Paper Series 3544, The World Bank, 2005.

GIRMA, S., D. GREENAWAY AND R. KNELLER, "Export market exit and performance dynamics: a causality analysis of matched firms," *Economics Letters* 80 (2003), 181–187.

———, "Does Exporting Increase Productivity? A Microeconometric Analysis of Matched Firms," *Review of International Economics* 12 (2004), 855–866.

GREENAWAY, D., N. SOUSA AND K. WAKELIN, "Do domestic firms learn to export from multinationals?," *European Journal of Political Economy* 20 (2004), 1027–1043.

GROSSMAN, G. AND E. HELPMAN, *Innovation and Growth in the Global Economy* (MIT PRESS, 1991).

GUSTAFSSON, P. AND P. SEGERSTROM, "Trade liberalization and productivity growth," *Review of International Economics* 18 (2010), 207–228.

HALPERN, L., M. KOREN AND A. SZEIDL, "Imports and Productivity," CEPR Discussion Papers 5139, C.E.P.R. Discussion Papers, 2005.

HECKMAN, J. J. AND V. J. HOTZ, "Choosing among alternative nonexperimental methods for estimating the impact of social programs: The case of manpower training," *Journal of the American statistical Association* 84 (1989), 862–874.

HECKMAN, J. J. AND E. J. VYTLACIL, "Econometric Evaluation of Social Programs, Part I: Causal Models, Structural Models and Econometric Policy Evaluation," in J. Heckman and E. Leamer, eds., *Handbook of Econometrics*volume 6, chapter 70 (Elsevier, 2007).

HELPMAN, E. AND O. ITSKHOKI, "Labour Market Rigidities, Trade and Unemployment," *Review of Economic Studies* 77 (2010), 1100–1137.

HELPMAN, E. AND P. R. KRUGMAN, *Market structure and foreign trade: Increasing returns, imperfect competition, and the international economy* (MIT press, 1985).

HELPMAN, E., M. MELITZ AND Y. RUBINSTEIN, "Estimating Trade Flows: Trading Partners and Trading Volumes," *The Quarterly Journal of Economics* 123 (2008), 441–487.

HELPMAN, E., S. YEAPLE AND M. MELITZ, "Export versus FDI with Heterogeneous Firms," *American Economic Review* 94 (2004), 300–316.

HOPENHAYN, H. A., "Entry, Exit, and Firm Dynamics in Long Run Equilibrium," *Econometrica* 60 (1992a), 1127–1150.

———, "Exit, selection, and the value of firms," *Journal of Economic Dynamics and Control* 16 (1992b), 621–653.

HUMMELS, D., J. ISHII AND K.-M. YI, "The nature and growth of vertical specialization in world trade," *Journal of international Economics* 54 (2001), 75–96.

IACOVONE, L. AND B. JAVORCIK, "Getting Ready: Preparation for Exporting," CEPR Discussion Papers 8926, C.E.P.R. Discussion Papers, 2012.

IMBENS, G. W. AND J. M. WOOLDRIDGE, "Recent Developments in the Econometrics of Program Evaluation," *Journal of Economic Literature* 47 (2009), 5–86.

ISGUT, A., "What's Different about Exporters? Evidence from Colombian Manufacturing," *The Journal of Development Studies* 37 (2001), 57–82.

JONES, C., "R&D-based models of economic growth," *Journal of political Economy* (1995), 759–784.

KASAHARA, H. AND B. LAPHAM, "Productivity and the decision to import and export: Theory and evidence," *Journal of International Economics* 89 (2013), 297–316.

KASAHARA, H. AND J. RODRIGUE, "Does the use of imported intermediates increase productivity? Plant-level evidence," *Journal of Development Economics* 87 (2008), 106–118.

KRUGMAN, P., *Exchange-Rate Instability*, The Lionel Robbins Lectures (Mit Press, 1989).

———, "R., Obstfeld, M. en Melitz, MJ (2012)," *International Economics: Theory and Policy* (2012).

LAWLESS, M., "Geography and firm exports: new evidence on the nature of sunk costs," *Review of World Economics (Weltwirtschaftliches Archiv)* 146 (2010), 691–707.

LEVINSOHN, J. AND A. PETRIN, "Estimating Production Functions Using Inputs to Control for Unobservables," *The Review of Economic Studies* 70 (2003), 317–341.

LILEEVA, A. AND D. TREFLER, "Improved Access to Foreign Markets Raises Plant-level Productivity. . . For Some Plants," *The Quarterly Journal of Economics* 125 (2010), 1051–1099.

MARTINS, P. AND Y. YANG, "The impact of exporting on firm productivity: a meta-analysis of the learning-by-exporting hypothesis," *Review of World Economics* 145 (2009), 431–445.

MAYER, T., M. J. MELITZ AND G. I. P. OTTAVIANO, "Market Size, Competition, and the Product Mix of Exporters," *American Economic Review* 104 (2014), 495–536.

MELITZ, M., "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica* 71 (2003).

MELITZ, M. J. AND G. I. P. OTTAVIANO, "Market Size, Trade, and Productivity," *Review of Economic Studies* 75 (2008), 295–316.

MUÛLS, M. AND M. PISU, "Imports and Exports at the Level of the Firm: Evidence from Belgium," *World Economy* 32 (2009), 692–734.

OLLEY, G. S. AND A. PAKES, "The Dynamics of Productivity in the Telecommunications Equipment Industry," *Econometrica* 64 (1996), 1263–1297.

RHEE, Y. W., B. C. ROSS-LARSON AND G. PURSELL, *Korea's competitive edge: Managing the entry into world markets* (World Bank, 1984).

ROBERTS, M. J. AND J. R. TYBOUT, "The Decision to Export in Colombia: An Empirical Model of Entry with Sunk Costs," *American Economic Review* 87 (1997), 545–564.

ROBINSON, P. M., "Root-N-Consistent Semiparametric Regression," *Econometrica* 56 (1988), 931–954.

ROSENBAUM, P. R. AND D. B. RUBIN, "The Central Role of the Propensity Score in Observational Studies for Causal Effects," *Biometrika* 70 (1983), 41–55.

SEGERSTROM, P., "Endogenous Growth without Scale Effects," *American Economic Review* 88 (1998), 1290–1310.

SILVA, A., O. AFONSO AND A. P. AFRICANO, "Learning-by-Exporting: What We Know and What We Would Like to Know," *The International Trade Journal* 26 (2012a), 255–288.

———, "Which manufacturing firms learn by exporting?," *The Journal of International Trade & Economic Development* 21 (2012b), 773–805.

SYVERSON, C., "What Determines Productivity?," *Journal of Economic Literature* 49 (2011), 326–65.

UNEL, B., "Technology diffusion through trade with heterogeneous firms," *Review of International Economics* 18 (2010), 465–481.

VAN BEVEREN, I., "Total factor productivity estimation: a practical review," *Journal of Economic Surveys* 26 (2012), 98–128.

VAN BIESEBROECK, J., "Exporting raises productivity in sub-Saharan African manufacturing firms," *Journal of International Economics* 67 (2005), 373–391.

VOGEL, A. AND J. WAGNER, "Higher productivity in importing German manufacturing firms: self-selection, learning from importing, or both?," *Review of World Economics (Weltwirtschaftliches Archiv)* 145 (2010), 641–665.

WAGNER, J., "The causal effects of exports on firm size and labor productivity: first evidence from a matching approach," *Economics Letters* 77 (2002), 287–292.

———, "Exports and Productivity: A Survey of the Evidence from Firm-level Data," *The World Economy* 30 (01 2007), 60–82.

WESTPHAL, L. E., Y. W. RHEE AND G. PURSELL, "Foreign influences on Korean industrial development," *Oxford Bulletin of Economics and Statistics* 41 (1979), 359–388.

WOOLDRIDGE, J. M., *Econometric Analysis Cross Section Panel* (MIT press, 2002).

———, "On estimating firm-level production functions using proxy variables to control for unobservables," *Economics Letters* 104 (2009), 112–114.

YEAPLE, S. R., "A simple model of firm heterogeneity, international trade, and wages," *Journal of International Economics* 65 (2005), 1 – 20.

Résumé

Cette thèse contribue à la littérature théorique et empirique concernant l'hétérogénéité des entreprises et le commerce international. La partie théorique analyse les conséquences de la libéralisation du commerce lorsque les entreprises sont hétérogènes et les pays asymétriques. La partie empirique discute le sens de causalité de la relation entre la performance des entreprises et leur statut international. Les entreprises sont-elles plus performantes parce qu'elles exportent et/ou importent ? Ou sont-ce les entreprises les plus performantes qui s'auto-sélectionnent sur le marché international ? Les deux hypothèses ne s'excluent pas mutuellement et ce travail les accrédite toutes deux.

Abstract

This thesis contributes to both theoretical and empirical aspects of the literature on firm heterogeneity in international trade. On the theoretical side, I provide insights of the consequences of trade liberalisation when firms are heterogeneous and countries are asymmetric. On the empirical side, I discuss the causality of the relationship between performances and trading status of firms. Do more productive firms self-select into international markets? Do firms become more productive because they enter international markets? These hypotheses are not mutually exclusive and my work provides support for both of them.

University of Strasbourg

Decembre 2014

UNIVERSITÉ DE STRASBOURG

Frédéric Olland

Essais sur les firmes hétérogènes

Bureau d'économie théorique et appliquée (BETA) UMR 7522

Résumé

Cette thèse contribue à la littérature théorique et empirique concernant l'hétérogénéité des entreprises et le commerce international. La partie théorique analyse les conséquences de la libéralisation du commerce lorsque les entreprises sont hétérogènes et les pays asymétriques. La partie empirique discute le sens de causalité de la relation entre la performance des entreprises et leur statut international. Les entreprises sont-elles plus performantes parce qu'elles exportent et/ou importent ? Ou sont-ce les entreprises les plus performantes qui s'auto-sélectionnent sur le marché international ? Les deux hypothèses ne s'excluent pas mutuellement et ce travail les accrédite toutes deux.

Résumé en anglais

This thesis contributes to both theoretical and empirical aspects of the literature on firm heterogeneity in international trade. On the theoretical side, I provide insights of the consequences of trade liberalisation when firms are heterogeneous and countries are asymmetric. On the empirical side, I discuss the causality of the relationship between performances and trading status of firms. Do more productive firms self-select into international markets? Do firms become more productive because they enter international markets? These hypotheses are not mutually exclusive and my work provides support for both of them.