Intermediate goods and international trade with heterogeneous firms: theoretical developments and application to the French agrifood sector

Léo Le Mener

Université de Nantes

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Léo LE MENER

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Directeur de thèse : **Nicolas Péridy**
Co-directeur de thèse : **Emmanuelle Chevassus-Lozza**

Jury

Pr. Frédéric Robert-Nicoud,	Université de Genève
Pr. Fabien Tripier,	Université de Nantes
Pr. Lionel Fontagné,	Rapporteur, Université de Paris I
Pr. Farid Toubal,	Rapporteur, Université d'Angers
Pr. Nicolas Péridy,	Directeur de thèse, Université de Toulon
Pr. Emmanuelle Chevassus-Lozza,	Co-directeur de thèse, Agrocampus-Ouest

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Résumé

Dans cette thèse, nous étudions l'impact de la libéralisation des inputs sur les firmes du secteur final, en particulier l'impact de la libéralisation du secteur agricole sur le secteur agroalimentaire français. La contribution de cette thèse est aussi bien théorique qu'empirique. Le cadre théorique développé dans cet ouvrage reprend les concepts clés des nouvelles théories du commerce international, à savoir l'hétérogénéité des firmes et la sélection des firmes sur les différents marchés. Pour prendre en compte le lien entre la libéralisation du secteur intermédiaire et la structure du secteur final nous introduisons un secteur intermédiaire dans un modèle avec firmes hétérogènes. Ce cadre théorique est ensuite utilisé afin d'analyser l'impact de la libéralisation des inputs sur différents aspects du secteur final, que sont les performances des firmes à l'exportation, leurs modalités d'accès aux marchés étrangers (exportations ou investissements directs à l'étranger), et enfin les entrées et sorties du marché domestique. Nous confrontons les résultats obtenus à des données sur les firmes agroalimentaires françaises, ce qui nous permet de valider les propositions faites dans le modèle théorique. Nous montrons que la libéralisation des inputs a conduit à une baisse de la probabilité d'exporter dans le secteur agroalimentaire français et à une concentration des parts de marché sur les firmes les plus productives. Nous montrons également que la libéralisation des inputs pousse les firmes les moins productives à sortir du marché domestique. Enfin, nous montrons que les effets de la libéralisation des inputs dépendent fortement de la structure des coûts fixes.

Abstract

In this thesis, we analyze the impact of trade liberalization of intermediate goods on firms in the downstream sector, with a particular focus on the impact of agricultural trade liberalization on French agrifood firms. The contribution of this thesis is both theoretical and empirical. The theoretical framework developed here uses key points of new international trade theories, namely the heterogeneity of firms and the selection of firms in different markets due to the presence of fixed costs. To account for the link between the liberalization of inputs and the structure of the downstream industry, we introduce an intermediate good sector in a model with heterogeneous firms. This theoretical framework is then used to analyze the impact of input trade liberalization on different aspects of the final sector, such as the export performance of firms, the way they serve foreign markets (through exports or direct investment abroad), and finally the entry in and exit from the domestic market. We compare our results with firm level data on French agrifood firms validate the propositions made in the theoretical model. We show that input trade liberalization reduces the probability of in the French agrifood sector, and results in the concentration of market shares in the hands of the most productive firms. We also show that input trade liberalization forces less productive firms to exit the domestic market. Finally, we show that the effects of input trade liberalization depend on the structure of fixed costs to access markets.

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Introduction

1 Trade liberalization and performance of firms[1]

The growth of international trade has been one of the major phenomena in the world economy in recent decades. Today, international trade of goods and services represents more than 30% of the world GDP, while in the 1970s, it represented less than 13%.

Since Ricardo (1817), international trade liberalization has been shown to be a win-win situation for partner countries. In recent decades, most developed countries and some developing countries liberalized their economy leading to an increase in international activities. If, at the level of an individual country, international trade liberalization enables less expensive goods to be imported and provides additional income from exports, the analysis is much more complex from a microeconomic point of view. Even if globalization is a macroeconomic phenomenon and the competitiveness of nations is an important issue for politics, countries do not conduct trade, firms do. Thus, to investigate the overall impact of trade liberalization, we also need to understand its effect on firms.

The aim of this thesis is to provide new tools to understand the mechanisms through which firms are impacted by trade liberalization. The thesis is based on the new models of international trade theory.

With the development of firm level databases in the 1990s, several empirical studies revealed important facts about the characteristics of firms, particularly those engaged in international trade.

First, very few firms are able to access foreign markets ('the happy few' according to Mayer and Ottaviano, 2008), and only a small share of these firms are truly internationalized. In 2003, 40% of French exporting firms exported to only one foreign country and 68% of exports came from only 1% of French exporters (Crozet and Fontagné, 2011). Stylized facts are similar for firms that invest abroad, even

[1] This section is largely inspired by the special issue of Économie et Statistique (2011) n°435-436 on "Internationalization of French Business Firms"

though the lack of an exhaustive database on foreign direct investment (FDI) prevents us from citing precise figures. For example, in Gazaniol *et al.* (2011), firms that invested abroad represented 6% of their reduced sample, while firms that exported represented 70%. For the sake of comparison, Crozet *et al.* (2008), whose database was not limited by the size of firms, calculated that only 21% of French firms export, so we can deduce that the share of firms in their sample that invest abroad was around 2%.

A deeper analysis of the characteristics of firms engaged in international trade shows that they have some specificities: compared to non-exporting firms in the same sector they are larger, have higher productivity levels and pay higher wages. In other words, in the same sector and on the same market, firms with very different characteristics coexist.

Theoretical models of international trade that use the concept of a representative firm are not able to explain how such differences between firms can occur on a market. To answer this question, new theoretical models of international trade have been developed. These models leave aside the assumption of a representative firm by assuming that firms are heterogeneous, and are able to explain how exporting and non-exporting firms coexist on the same market.

The seminal paper of Melitz (2003) entitled *The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity* provides the basic framework of this "new new trade theory". It introduces heterogeneous firms based on their labor productivity in a monopolistic competition model of international trade à la Krugman (1980). In his paper, Melitz develops a model that explains both the stylized facts highlighted by empirical studies based on firm level data and the aggregated results obtained by Krugman and followers (intra-industry trade and trade liberalization leads to welfare gains driven by the increase in product variety). He shows that the heterogeneity of firms and the existence of fixed costs lead to segmentation of firms: only the most productive ones are able to export while less productive ones stay on their domestic market, and very low productivity firms cannot produce at all.

In this framework, international trade liberalization has two complementary effects: better access to foreign markets for national exporting firms and better access to the national market for foreign exporting firms. On the one hand, exporting firms can export at a lower cost, and consequently increase their production and export market shares. On the other hand, tougher competition on the domestic market due to foreign exporting firms reduces market shares and production levels for national firms, forcing less productive firms to exit the domestic market. These two mechanisms lead to better allocation of resources, a higher average level of productivity

and a rise in the aggregate production level. The Melitz model highlights the fact that the effect of international trade liberalization can be positive for some firms (most productive exporting firms) and negative for others (less productive firms).

This framework has also been used to investigate other phenomena in which the heterogeneity of firms matters. For instance, Helpman, Melitz and Yeaple (2004) focus on the trade-off between serving a foreign market through exports and through a local affiliate. They show both theoretically and empirically that only the most productive firms are able to serve foreign markets and that, among these firms, only the very productive ones serve foreign markets through horizontal FDI.

Internationalization of firms does not only consist in serving foreign markets. Globalization also gives firms the opportunity to exploit comparative advantages of foreign countries and to increase their competitiveness by importing intermediate or capital goods. Thus, globalization can also affect the performance of firms through their use of inputs.

In traditional models of international trade, input trade liberalization necessarily improves the performance of firms in the final good sector. Improvement can take place through different channels. First, if intermediate goods are homogeneous, input trade liberalization allows firms to use cheaper inputs, which then allows them to reduce their production costs and hence to be more competitive on both domestic and exports markets. If intermediate goods are differentiated, input trade liberalization can give firms access to more efficient inputs (embodied technology) or inputs of higher quality. Firms can also take advantage of the complementarity between domestic and imported inputs. In all cases, the use of foreign inputs can increase the competitiveness of firms and allow them to improve the quality of the goods they produce or to sell them at lower prices.

It was only recently that input trade liberalization was analyzed by taking the heterogeneity of firms into account.

Empirical studies have shown that input trade liberalization or imported inputs can impact the downstream sector in different ways, such as the geographical distribution of activities (Bagoulla *et al.*, 2010), the productivity of firms (Amiti and Konings, 2007, Kasahra and Rodrigue, 2008, Halpern *et al.*, 2009), their export performance (Bas and Strauss-Kahn 2011) and product scope (Goldberg *et al.* 2010). In some cases, input trade liberalization can have similar but bigger effects than output trade liberalization. For instance, using Indonesian data, Amiti and Konings (2007) showed that both output and input trade liberalization led to an increase in firm productivity, but that input trade liberalization increased downstream firms' productivity twice as much as output trade liberalization does.

Empirical studies often only focus on the impact of liberalization on importing firms. These studies have shown that, like for exporting firms, only sufficiently productive firms are able to import. However, Amiti and Konings (2007) showed that a fall in input tariffs also resulted in a (small) increase in the productivity of non-importing firms. As suggested by numerous studies and theoretical models with heterogeneous firms, when trade liberalization occurs in a given sector, it forces less efficient firms to exit, and improves the overall performance of the sector. Thus, by making competition tougher for firms producing this input, input trade liberalization should also improve performance in the domestic input sector. As a result of international competition, input prices should fall, which benefits all firms that use domestic inputs, whether they also import or not.

Empirical studies have shown that input trade liberalization is a major issue in international trade, and the heterogeneity of firms is now a key point in many international trade models. However, there are still very few theoretical models able to link the performance of heterogeneous firms and their inputs. The most relevant models are from Kasahara and Lapham (2008), Kasahara and Rodrigue (2008), Gibson and Graciano (2011) and Bas (2010).

These theoretical models have one result in common: the impact of input trade liberalization does not depend on the productivity of the firm, but only on its import status. This result comes from the production technology used in the models: they assume either Cobb-Douglas technology between inputs and the other production factor (generally labor), which is used heterogeneously by firms (Kasahara and Lapham, 2008, and Kasahara and Rodrigue, 2008), or that the heterogeneity of firms is a multiplicative term in the production function (Gibson and Graciano, 2011, and Bas, 2010). Both assumptions lead all importing firms to benefit equally from input trade liberalization.

The issue of input trade liberalization has also been addressed through Computable general equilibrium (CGE) models. For example, the impact of agricultural trade liberalization and European Common Agricultural Policy reforms have been widely investigated in this kind of model (see for example Decreux *et al.*, 2006, Gohin *et al.*,2006, Femenia and Gohin, 2009). These models are able to account for a huge number of interactions and links between agents or sectors and can be calibrated to reflect the specificities of a particular country or region. However, these models do not search for new mechanisms, but rather investigate which one of some opposite effects dominates when a change in the economic environment occurs (trade policy reform, supply or demand shock, etc.).

According to several empirical studies using firm level data, heterogeneous firms

may react differently to changes in their environment. For example, focusing on the spillover effect of multinationals on domestic Hungarian firms, Bekes *et al.*(2009) showed that more productive firms were positively impacted by the proximity of multinational firms, while less productive firms were negatively impacted. Another example is the study of Greenaway *et al.* (2010)), which focused on the impact of changes in exchange rates and showed that larger firms were more responsive to changes in the imported input-weighted exchange rate.

Thus, if firms are heterogeneous and react differently to changes in their environment, they may also respond heterogeneously to input trade liberalization. In this thesis, we show that input trade liberalization or a fall in input prices, allows downstream firms to reduce their production costs, and, because firms react differently, this also affects the structure of the final good sector.

In the following section, we show why the effect of input trade liberalization on downstream firms is an important issue in international trade, and we present our main contribution to the international trade literature.

2 Motivation and contributions

The liberalization of trade in services and agricultural goods is a controversial topic, as shown by recent policy debates in the European Union and the World Trade Organization. But the service and agricultural sectors are also specific, as they provide inputs to other sectors. Indeed, the agrifood sector relies on primary agricultural inputs and a wide range of manufacturing and services industries rely on service inputs (Arnold *et al.* 2011). In contrast to the large body of research on the impact of trade liberalization on final goods, little is known about the effects of allowing greater foreign entry in input sectors.

The literature on input trade liberalization has no doubt about the positive effect of input trade liberalization on downstream firms, since better access to foreign inputs improves the performance of downstream firms, via, for instance, a reduction in production costs, or complementarity between foreign and domestic inputs.

However, if we assume that firms are heterogeneous and may react differently to input trade liberalization, the effect of liberalization on downstream industry may be much more complex. Indeed, if firms belonging to the same sector react differently, the structure of the market may be affected by input trade liberalization, and this may have negative effects in the downstream industry (in terms of the competitiveness of domestic firms, the geographical distribution of activities and employment, etc.).

The aim of this thesis is to investigate how input trade liberalization could affect

downstream firms and the structure of downstream sectors, and to identify some characteristics of downstream industries that may affect the consequences of input trade liberalization. If, depending on these characteristics, input trade liberalization has different effects on downstream firms and sectors, a better knowledge of these characteristics should allow trade policies to be designed for increased efficiency and better control of the consequences of trade liberalization.

For instance, we show that even if input trade liberalization increases exports at sectoral level, if fixed export costs are low, the number of exporting firms (the extensive margin of trade) decreases. However Chaney (2008) showed that promoting aggregated exports, by increasing the number of exporting firms is more efficient than increasing the average level of exports per firm (the intensive margin). In other words, if policy makers wish to increase export performance in a given sector, they should focus on facilitating access to foreign markets rather than promoting exports by firms that already serve foreign markets. In this way, the positive effect of input trade liberalization on exports can be improved in sectors where fixed export costs are low by supporting weaker exporting firms, otherwise they are likely to exit the export market due to input trade liberalization.

This thesis contributes to public debate on agriculture and services liberalization and aims to highlight public choices on input trade liberalization.

This thesis also contributes to the academic trade literature. Firstly, because the issue has not been widely addressed to date and secondly, because we develop an original theoretical framework and provide new results. Finally, an application based on the theoretical framework contributes to the empirical literature on the effect of input trade liberalization.

First, this thesis investigates the impact of trade liberalization on the domestic market (export performance, production level, structure, etc.), rather than the effect of trade liberalization on access to foreign markets. Consequently, we do not focus on the factors that govern international trade, but rather on the effect of international trade, especially the effect of international trade in inputs. As studies of the impact of trade on market structures are rare (as are studies of the impact of inputs on firms 'performances), the primary contribution of this thesis is the issue addressed: the impact of input trade liberalization on downstream sectors and downstream firms.

Second, we develop our own theoretical framework. In this theoretical model, heterogeneous firms are heterogeneously impacted by input trade liberalization or by changes in input prices, whereas previous models with heterogeneous firms did not allow firms to react differently to these changes.

Although each chapter of this thesis deals with a specific issue, the theoretical models developed in each chapter are based on a common framework.

We start from a model *à la* Melitz (2003), where heterogeneous firms produce a differentiated good in monopolistic competition. Our main contribution is the introduction of an intermediate good sector, so that firms use two production factors: labor and intermediate goods. Unlike other models with heterogeneous firms and intermediate goods, we do not restrict our analysis to a Cobb-Douglas function of production. For simplicity's sake, we assume that labor and intermediate goods are complementary, but we show that our results hold as long as the production function is not a Cobb-Douglas.

As in Melitz (2003) and others, firms are heterogeneous with respect to labor use, so that more productive firms are able to produce the same amount of final good using less labor than less productive firms. In addition, for the sake of simplicity and without loss of generality, we assume that the use of intermediate goods is the same for all firms producing the same good and that intermediate goods are homogeneous. Thus, there are no variety effects due to imports of inputs, and all the mechanisms result from a price effect. However, we show that the same results can be obtained assuming complementarity across differentiated inputs.

Our assumptions on production costs follow those of Melitz (2003) and Helpman Melitz and Yeaple (2004). There are fixed costs to enter each market (even domestic markets), and firms pay different fixed costs to export and to invest abroad, if they are allowed and able to do so. The existence of these fixed costs results in selection on each market, so that only some firms are able to access each market.

This original framework produces original results.

We find that firms react differently to input trade liberalization, leading to the reallocation of market shares on each market, and forcing some firms to exit these markets. Thus, even if input trade liberalization can result in a fall in production costs for all firms, some firms suffer from this situation and are forced to exit either the domestic or the export market.

Finally, these developments provide the theoretical background for an empirical investigation of whether firms are heterogeneously impacted by changes in their input sector. In this thesis, we empirically test the effect of input trade liberalization on the export performance of downstream firms. We chose to compare the results with firm level data on French agrifood firms and show that the fall in input trade tariffs leads to reallocation of export market shares from low productivity firms to more productive ones, and to a fall in the share of firms able to access foreign markets via exports.

The choice of the agrifood sector is particularly appropriate to test this model

for several reasons.

First, the linkage between agrifood goods and their inputs is strong. Indeed, the agricultural sector is the main supplier of inputs for the agrifood sector (Gopinath, 1996) the share of intermediate consumption in production costs is very large (see Chapter 1). In addition, dependence on agricultural inputs is high in this sector. While substitutes exist for some inputs in manufacturing sectors, so that downstream firms may adapt their input bundle to reflect changes in input costs, the use of some agricultural inputs is unavoidable in certain agrifood sectors (like milk for cheese producers, cereals for flour producers, and so on).

Second, this choice is also appropriate for policy recommendations. The agricultural exception in the rules of the World Trade Organization (WTO) has allowed this sector to maintain a relatively high level of protection, unlike the majority of manufacturing sectors. Although the liberalization process is well advanced in developed countries, the agricultural and agrifood sectors are still protected by trade policies. They are sensitive sectors in international negotiations, where the past lack of consensus led -and continues to lead- to the failure of the ongoing round of negotiations in the WTO (Doha Round). Thus, the existance of trade protection in the agricultural sector means our application is of particular interest, as some results could be used to predict the consequences of future policy choices.

Finally, the structure of this sector is also relevant for our study. Heterogeneity exists between agrifood sectors, but also among the firms within each sector (see the appendix for some stylized facts and Chevassus and Latouche, 2011 for an empirical study on international trade in the French agrifood sector).

Thus, the aim of this application was to validate our framework, but also to contribute to the literature on agricultural trade liberalization and other studies focused on agrifood sectors. This includes studies on the impact of CAP reforms and agricultural trade liberalization on welfare, preference erosion, location of activities or even their redistribution effects (see for example Decreux *et al.*, 2006, Gohin *et al.*,2006, Femenia and Gohin, 2009, Bagoulla *et al.*, 2010, Emlinger *et al.*, 2008, Desquilbet and Guyomard, 2002 for studies on European markets, and Gopinath *et al.*, 1996, Gopinath *et al.* 2004, Ruan and Gopinath, 2008, Lorz and Wrede, 2008 for studies on US or OECD countries). To our knowledge, our study is the first to highlight heterogeneous responses of agrifood firms to input trade liberalization, and the first empirical study to show that input trade liberalization may negatively affect some final sector firms.

3 Organization of the thesis and main results

The first two chapters focus on the internationalization strategy of firms in the final good sector, and on the impact of the trade liberalization and prices of intermediate goods on the ability of firms to access foreign markets. The third and last chapter focuses on the impact of input trade liberalization on the structure of the domestic market.

3.1 Chapter 1: Does input trade liberalization boost downstream firms' exports ? Theory and evidence.

This chapter focuses on the impact of input trade liberalization on the performance of firms that export. It gives a preview of the theoretical model and compares theoretical predictions with firm level data.

The theoretical part of chapter 1 is a simple version of the model developed in the two following chapters. As mentioned above, the main assumptions follow the Melitz (2003) model. However, as our analysis focuses on export behavior, we use a simplified version of the model which does not account for the effect on domestic markets. Thus, the mass of domestic firms is exogenous and, as in Melitz, countries are symmetric.

Input trade liberalization is shown to result in a fall in input tariffs at the border of the home country. As inputs are homogeneous, a fall in input tariffs has a direct effect on the domestic price of inputs through fiercer competition. Thus, all firms pay the same price for the same input, and a fall in input tariffs reduces the input price for all firms.

In this model, more productive firms are more impacted by input trade liberalization, because they use relatively more inputs than less productive ones. Thus, input trade liberalization leads to a change in relative variety prices, as well as reallocation of export market shares from less productive firms to more productive ones. In some cases, depending on the level of fixed export costs, input trade liberalization may reduce the probability of exporting.

In the empirical part, we use firm level data on French agrifood firms to validate our theoretical predictions. Our dataset includes data from several sources: INSEE-EAE survey, French Customs Register and modified TARIC database.

With these firm level data, we validate the predictions of the model: input trade liberalization did lead to an increase in export market shares for more productive firms and to a decrease for less productive exporting firms, so that the probability of exporting decreased in the final sector.

This chapter makes two main contributions. From a theoretical point of view,

it shows that input trade liberalization benefits more productive exporting firms most and may reduce the ability of firms to access foreign markets. It includes an original empirical study that validates these theoretical results using firm level data on French agrifood firms.

3.2 Chapter 2: Intermediate goods, heterogeneous firms and Export/FDI trade-off.

While the first chapter only focuses on the impact of input trade liberalization on export performance, the second chapter improves the theoretical model presented in the first chapter by introducing the opportunity for firms to undertake foreign direct investment (FDI), and focuses on the impact of input price on the trade-off between serving the foreign markets via exporting or producing locally via an affiliate.

As multinational enterprise activity in the form of FDI has increased at a faster rate than trade flows, we cannot focus on firms' access to foreign markets without taking FDI into consideration. In addition, the location of activities is a key issue for industrial polices as it affect the national level of employment, the international distribution of activities, etc.

The assumptions on consumer preferences and production costs resemble those in the first model. Like in Melitz (2003), countries remain symmetric, and the mass of domestic firms is exogenous. In addition, as in Helpman Melitz and Yeaple (2004), firms can choose to set up an affiliate in the foreign country in order to avoid some transport costs. However, firms have to pay a new fixed cost to set up an affiliate abroad.

We first investigate the effect of a symmetric and identical fall in input prices in both countries, i.e. the domestic and the foreign one. Like in the first chapter, a reallocation process occurs, but this time, it not only concerns export market shares. Whatever the market, a fall in input prices leads to an increase in market shares for more productive firms and to a decrease in market shares for less productive firms. In addition, we show that a firm may gain or lose from this fall in input prices depending on its level of productivity, but not on its status. Finally, we show that the lower the price of the intermediate good, the bigger the differences between firms in terms of production or profit levels, and the bigger the share of FDI sales compared to export sales. This last mechanism is in line with the results of Helpman Melitz and Yeaple: the more heterogeneous the sector, the higher the share of FDI sales compared to export sales.

In the last section, we compare two policies to support each production factor. We show that while a subsidy on intermediate goods leads to reallocation from less

productive firms to more productive ones, a subsidy on labor leads to reallocation from high productive firms to less productive ones. In addition, if both subsidies are able to attract incoming FDI, only the subsidy on labor supports exports irrespective of fixed costs.

While in the literature the trade-off between exports and FDI is affected by differences in input costs, one contribution of this chapter is to show that, even if countries are perfectly symmetric and there are no differences in the prices of intermediate goods, the relative level of export and FDI varies with inputs prices. The other contribution is to highlight the impact of subsidies on firms' ability to access foreign markets and on the choice to serve them via exports or FDI.

3.3 Chapter 3: Agricultural market liberalization and entry/exit of agrifood firms in a global economy.

In the last chapter, we go deeper in the analysis of input trade liberalization and focus on its effect on the structure of the domestic market. This chapter shows that international trade is a major determinant of the structure of domestic markets, and that the vertical linkage between sectors can have significant effects on this structure since input trade liberalization and output trade liberalization can have different effects.

To investigate the effect of input trade liberalization on entry in and exit from domestic markets, unlike in previous chapters, the mass of domestic firms is considered to be endogenous. To this end, we introduce a domestic fixed cost that prevents less productive firms from accessing the domestic market. The other assumptions are the same as in chapter 1, except that countries are not symmetric as the intermediate good price differs among them.

The model is developed in three steps.

First, we investigate the impact of the price of inputs in a closed economy, and show that a fall in input prices still leads to reallocation from less productive firms to more productive ones, and that it reduces the number of firms able to produce. However, the fall in prices is greater than the fall in the number of varieties, and is consequently welfare improving.

Next, we introduce a foreign country. Unlike the models in the first two chapters, countries are not symmetric: here, the input price is higher in the home country. This difference in input price allows this model to account for the import behavior of firms. We compare free input trade, input trade with variable trade costs, and input trade with a fixed import cost. We show that, whatever the structure of import costs, input trade liberalization reduces the number of firms able to produce

in the input importing country, but is welfare improving.

Finally, we also include the fact that downstream firms are also competing with foreign firms, and on foreign markets. In this section, both the input good and the final good are internationally traded. We show that input trade liberalization reduces the number of firms able to produce on the domestic market in the input importing country, but also in the input exporting country. The fall in prices is always greater than the possible decrease in the number of available varieties, so that input trade liberalization is welfare improving in both countries.

In addition, we show that input trade liberalization always restricts the ability of firms to access the input importing country via exports, and may increase the number of firms able to access foreign markets in the input importing country only in very restrictive configurations of fixed import and export costs.

The main contribution of this chapter is to focus on the impact of international trade of inputs on the domestic market. The main result is that, whatever the structure of trade costs, input trade liberalization always forces less productive firms to exit the domestic market, but it always improves consumer welfare. In addition, this chapter goes deeper in the modelization of input trade openness and generalizes the results presented in chapter 1.

To sum up, we start from a simple model in which firms do not react equally to input prices, and we develop the model in order to use it to answer different questions related to international trade. Our main contributions are to highlight a microeconomic mechanism that is the opposite of the aggregated result (while the export or production level of a sector increases, for some firms, the level of production and export decreases), to show that depending on the structure of costs, input trade liberalization may have different effects, and finally, to investigate the effect of international trade on the structure of markets, highlighting the role of input trade.

Chapter 1

Does input trade liberalization boost downtream firms' exports? Theory and evidence.[1]

Abstract: In this chapter, we analyze the impact of input tariffs on the export status and export performance of processing firms. Based on a theoretical model with heterogeneous downstream firms, we show that a fall in input tariffs leads to reallocation of export market shares from low productivity firms to high productivity firms. In addition, when export fixed costs are high enough, a fall in input tariffs increases the probability of exporting and the most productive firms gain more than the less productive firms. In contrast, when export fixed costs are low enough, a fall in input tariffs decreases the probability of firms entering foreign markets. Under this configuration, exports by high productivity firms increase at the expense of low productivity firms. We compare the predictions of the theoretical model with firm-level data from the French agrifood sector by developing a two-stage estimation procedure that uses an equation for selection into export markets in the first stage and an export equation in the second stage. Liberalization of inputs trade appears to favor the exit of French firms from foreign markets. In addition, our result suggests that, all other things being equal, about 45% of the least productive exporting firms may lose from an additional decrease in agricultural product tariffs.

[1] with Emmanuelle Chevassus-Lozza and Carl Gaigné.

1 Introduction

Much attention has been paid to the impact of input trade liberalization on the domestic input sector, but relatively little to its impact on the final goods sector (Amiti, 2000, Goldberg *et al.*, 2009). Although standard and new trade theories do not agree on the impact of liberalization on the domestic upstream sector, they do predict that downstream industries would expand with a fall in tariffs in the intermediate inputs market. In this paper, we argue that tariff cuts on intermediate products may be detrimental to some downstream firms, depending on their labor productivity level.

Initially, it may seem reasonable to expect that a fall in input tariffs would reduce the production costs of downstream firms allowing them to increase their exports or to serve foreign markets. This simple mechanism is captured in all models of trade with perfect or imperfect competition with an intermediate sector. Yet the real story is much more complex. The standard trade literature considers all downstream firms to be equally productive, whereas in practice, their productivity differs considerably in productivity, and a more detailed analysis is required. Indeed, depending on its labor productivity, each downstream firm adjusts its output price differently in response to a change in input prices (under imperfect competition), leading to reallocation of market shares among downstream firms. In other words, *a priori* we have no prior knowledge of whether input tariff cuts favor the entry or the exit of exporters or boost or reduce firms' exports.[2] Hence, the effects of cuts in input tariffs on downstream firms deserve particular attention.

The effects of the reform of markets trade on productivity and export have been thoroughly analyzed in both theoretical and empirical studies (Pavcnik, 2002; Fernandes, 2007). Since the seminal paper of Melitz (2003), many theoretical models with heterogeneous firms analyzed the effects of reducing output tariffs on final goods, showing that it leads to reallocation of resources and market shares from less productive to more productive firms, and subsequently to increase in the average productivity of firms. But fewer theoretical models studied the effects of the liberalization of input trade on downstream firms. Some studies tested whether cuts in input tariffs would improve productivity of downstream firms by increasing imports of intermediate inputs (Amiti and Konings, 2007; Luong, 2008). The idea is that domestic firms can import higher quality inputs, leading to higher productivity. Hence, cuts in input tariffs can give a technological advantage to importing firms and lead to an increase in productivity. More recently, Goldberg *et al.* (2010) stud-

[2]For example, Greenaway, Kneller and Zhang (2010) show empirically that the impact of the exchange rate of an imported intermediate input on export sales differs depending on the size of firms.

ied the impact of input tariffs on the range of products produced by domestic firms. These authors showed that lower input tariffs led to the production of new goods by domestic importing firms. While these authors analyze the impact of input trade liberalization on a firm's productivity or product scope, we focus on the impact of lower input tariffs on export performance of downstream firms, i.e. on the impact of input tariffs on entry in/exit from foreign markets and intra-industry reallocation of exports.

In this paper, we theoretically and empirically analyze the effects of cuts in input tariffs on the export selection process and on the export performance of downstream firms with different levels of labor productivity. We first develop a model of trade with heterogeneous firms producing a differentiated good and using not only labor, as in Melitz (2003) or in Chaney (2008), but also an intermediate good. Contrary to recent trade literature with an intermediate sector (for instance, Luong, 2009 and Goldberg *et al.*, 2010), we do not consider the extreme case where labor and intermediate products are combined with a Cobb-Douglas technology. By allowing that the two production factors are not perfectly substitutable, we show that the elasticity of output prices to a change in input tariffs increases with an increase in the labor productivity of the firm concerned. These different responses lead to reallocation of export market shares from low productivity firms to high productivity firms following input tariff cuts. Our results also reveal that the impact of input tariffs on the probability of exporting depends on the level of fixed export costs. When fixed export costs are sufficiently high, a fall in input tariffs increases the probability of exporting. Under this configuration, the exports of all processing firms increase but the most productive firms gain more than less productive firms. In contrast, when fixed export costs are low enough, a fall in input tariffs decreases the probability of entering foreign markets. Under this configuration, exports by high productivity firms increase at the expense of low productivity firms.

We test the main predictions of our model from firm-level data on French agri-food sector. We chose of this sector for two reasons. First, in European and North American countries, unlike the manufacturing sector, the agri-food sector is still highly concerned by trade reforms. Indeed, in the last two decades, tariff barriers at European borders for agricultural products - which are mainly processed by agri-food firms - decreased considerably. For example, between 1995 and 2002, tariff barriers for agricultural products at European borders decreased by 30% and French imports of agricultural commodities increased by 25% (Bagoulla *et al.*, 2010). Second, we are able to identify the main agricultural products purchased by agri-food firms and, in turn, calculate tariffs applied to the inputs they process.

The econometrical analysis is based on a two-stage estimation procedure that

uses an equation for selection into export markets in the first stage and an export equation in the second. Our results reveal that a decrease in tariffs on intermediate products favors the exit of agri-food French firms from foreign markets. In addition, the results suggest that more productive exporting firms (about 55% of exporting firms) gain from a fall in input tariffs at the expense of less productive firms.

In the following section, we present the theoretical framework we use to identify some testable predictions. In section 3, we describe the empirical model and in section 4, we present the data. In section 5, we present our empirical results and their analysis. In the last section, we conclude.

2 Theoretical framework

The objective of this section is to build a simple model of trade with heterogeneous firms, which captures the main effects of input tariffs on exports. We consider a domestic country trading with n countries where each country hosts a representative consumer and a continuum of downstream heterogeneous firms. The mass of firms in the economy is assumed to be exogenously given while the mass of exporting firms is endogenous. Firms process an intermediate product in order to produce a differentiated product under monopolistic competition. Firms have to pay a fixed cost f_x to serve foreign markets, which represents the adaptation costs to foreign markets (distribution and servicing network). In addition, shipping the final product between any pair of countries results in an iceberg transport cost $\tau > 1$. The domestic economy puts a tariff T on the import of the intermediate product. The n foreign countries are identical in size and apply the same tariff on imported intermediate inputs.

2.1 Technology

The production of any variety requires two inputs, labor and intermediate inputs. For the sake of simplicity, we assume that intermediate inputs and labor are used *by each firm* in a fixed proportion. At the end of this section, we show that our results hold for different technologies as long as we exclude Cobb-Douglas.[3] Formally, we assume that to produce one unit of the final good, each firm i uses α units of

[3]Note that our approach differs from that of Bernard et al. (2007) and Bas (2009) who consider that the firms use two inputs. Bernard et al. (2007) consider skilled and unskilled labor in their trade model with heterogeneous firms. However, both factors are combined in a Cobb-Douglas technology. Bas (2009) also developed a trade model with heterogeneous downstream firms using two inputs: a local intermediate good and a foreign intermediate good combined in a CES technology. However, producing the final good does not require labor and the marginal requirement in each input does not vary across firms.

the intermediate good and, following Melitz (2003), draws a random unit labor productivity φ_i from a common distribution $g(\varphi)$.[4] Two comments are in order concerning the intermediate input. First, we consider that downstream firms differ only in labor productivity but not in the use of intermediate inputs. Our assumption captures the idea that to produce the same good, downstream firms have similar input requirements. Second, the intermediate good is assumed to be homogeneous. These different assumptions are discussed at the end of this section.

Hence, each downstream firm i is characterized by its own variety or by its labor productivity φ_i. As a result, the marginal cost of production is given by $z\alpha+w/\varphi_i$ where w and z are, respectively, the labor price and the prevailing domestic price of the intermediate product. While

$$z = (1+T)\bar{z},$$

$\bar{z}$ is the world price of the intermediate product and T the input tariff applied at entry to the home country.

2.2 Preferences, demand and prices

Because we study exports, our framework focuses on foreign demand. The preferences of a representative consumer located in a foreign country are given by a C.E.S. utility function over a continuum of varieties indexed by ω:

$$U_x = \left[\int_{\omega\in\Omega_x} y_x(\omega)^\rho \mathrm{d}\omega\right]^{1/\rho} \tag{1.1}$$

where Ω_x represents the set of available varieties in a foreign country. Varieties are substitutes, which implies that $0 < \rho < 1$, and the elasticity of substitution between any two varieties is given by $\sigma = 1/(1-\rho) > 1$. Considering the budget constraint in each foreign country $R_x = \int_{\omega\in\Omega} p_x(\omega)y_x(\omega)\mathrm{d}\omega$ where p_x is the price of a domestic variety prevailing in a foreign country, the demand of a foreign consumer for a variety produced by a firm with a labor productivity φ_i located in the home country is given by:

$$y_x(\varphi_i) = R_x P_x^{\sigma-1}[p_x(\varphi_i)]^{-\sigma}. \tag{1.2}$$

where P_x is the price index in a foreign country (defined in Appendix A). Note that, because foreign countries are symmetrical in size and input prices, the price index does not differ across foreign countries.

Under monopolistic competition with a CES utility, each firm i in the domestic

[4] It is worth stressing that it is not necessary to specify $g(\varphi)$.

country faces a residual demand curve with constant elasticity σ which leads to the pricing rule:

$$p(\varphi_i) = \frac{(1+T)\bar{z}\alpha + w/\varphi_i}{\rho} \tag{1.3}$$

where $1/\rho$ is the markup. As a result, the price prevailing in a given foreign country is expressed by $p_x(\varphi_i) = \tau p(\varphi_i)$. The main difference between Melitz (2003) and our approach is that we consider that the production cost function of a firm can be divided into two: the wage rate divided by its labor productivity and the unit cost of the intermediate good, where only labor productivity varies across firms. The elasticity of the output price to a change in the intermediate product price is then given by:

$$\varepsilon_{p(\varphi_i),T} \equiv \frac{\partial p(\varphi_i)}{\partial T}\frac{T}{p(\varphi_i)} = \frac{\bar{z}\alpha T}{(1+T)\bar{z}\alpha + w/\varphi_i} \tag{1.4}$$

where $\varepsilon_{p(\varphi_i),T}$ increases with φ_i. In other words:

Lemma 1. *The price of a downstream firm reacts more to a change in input tariffs than the price of a lower productivity firm.*

This is due to the fact that our model involves an increasing *share* of the cost of intermediate good in the total production cost with labor productivity (our dataset confirms this result, see Figure 1.3). Hence, the most productive firms are more impacted by input price variations because they use relatively less labor and more intermediate commodities to produce final goods.

2.3 Export revenues and intermediate product prices: some properties

Let r_i be the export revenue on any foreign market of a domestic firm i where $r_i = \tau p(\varphi_i) y_x(\varphi_i)$. Knowing (1.2) and (1.3), r_i can be rewritten as follows:

$$r_i = \tau^{1-\sigma} R_x \left[\frac{\rho P_x}{(1+T)\bar{z}\alpha + w/\varphi_i}\right]^{\sigma-1} \tag{1.5}$$

The impact of T on r_i at a given labor productivity (or for a firm) is not obvious. Indeed, input tariffs affect not only the variety price but also the foreign price index. Some standard calculations reveal that

$$\frac{\partial r_i}{\partial T} = (\sigma-1)\frac{r_i}{T}\left(\frac{\partial P_x}{\partial T}\frac{T}{P_x} - \frac{\partial p(\varphi_i)}{\partial T}\frac{T}{p(\varphi_i)}\right) \tag{1.6}$$

or, equivalently, $\varepsilon_{r_i,T} = (\sigma-1)\left(\varepsilon_{P_x,T} - \varepsilon_{p(\varphi_i),T}\right)$ where $\varepsilon_{r_i,T}$ and $\varepsilon_{P_x,T}$ are the elasticities of the revenue and foreign price index to input tariffs, respectively. In other words, the sign of the effect of input tariffs on exports depends on the gap between

the elasticity of the foreign price index and that of the variety price. In Appendix A, we show that

$$\operatorname{sign}\left\{\frac{\partial r_i}{\partial T}\right\} = \operatorname{sign}\left\{\tau^{1-\sigma}\int_{\varphi_x^*}^{\infty}\frac{p^{1-\sigma}(\varphi)}{p(\varphi)}g(\varphi)\mathrm{d}\varphi - \int_0^{\infty}\frac{p^{1-\sigma}(\varphi)}{p(\varphi_i)}g(\varphi)\mathrm{d}\varphi \right. \\ \left. - (n-1)\tau^{1-\sigma}\int_{\bar{\varphi}}^{\infty}\frac{p^{1-\sigma}(\varphi)}{p(\varphi_i)}g(\varphi)\mathrm{d}\varphi - \tau^{1-\sigma}\int_{\varphi_x^*}^{\infty}\frac{p^{1-\sigma}(\varphi)}{p(\varphi_i)}g(\varphi)\mathrm{d}\varphi\right\} \quad (1.7)$$

where φ_x^* is the threshold value of labor productivity above which it is profitable for a domestic firm to serve a foreign country and $\bar{\varphi}$ is the limit value of labor productivity above which it is profitable for a foreign firm to serve another foreign country. It is easy to check that $\partial r_i/\partial T < 0$ when $p(\varphi_i)$ is relatively low or, equivalently, when φ_i is relatively high. In contrast, we have $\partial r_i/\partial T > 0$ when $p(\varphi_i)$ is relatively high or, equivalently, when φ_i is low. In addition, because the expression of $\partial r_i/\partial T$ is continuous and monotone, labor productivity has a single value $\widehat{\varphi}$ such as $\partial r(\widehat{\varphi})/\partial T = 0$. In other words, the export revenues of a firm whose labor productivity is equal to $\widehat{\varphi}$ do not vary due to a change in input tariffs.

Figure 1.1: Impact of T on r_i.

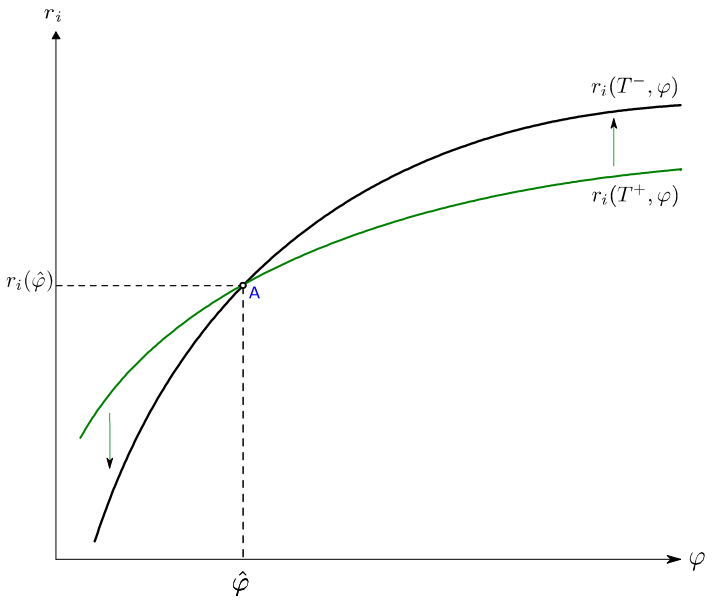


Figure 1.1 shows that the effect of a change in input tariffs on export sales varies with the level of labor productivity. Two export revenue curves are plotted against labor productivity for two different input tariffs (a high input tariff, T^+ and a low input tariff, T^-). The export revenue curve rotates around point $A(\widehat{\varphi}, r(\widehat{\varphi}))$ when the input tariffs vary. Export revenues increase when input tariffs shift from T^+ to T^- for firms whose labor productivity is greater than $\widehat{\varphi}$ ($r_i(T^-,\varphi) > r_i(T^+,\varphi)$). Conversely, export revenues decrease with a fall in input tariffs for firms whose labor productivity is less than $\widehat{\varphi}$. Consequently, decreasing input tariffs do not relocate the

export revenue curve upwards but rotates it anticlockwise. This reveals that there is a reallocation of export revenues from low productive firms to high productive firms. This mechanism arises from the different responses of variety prices to changes in input tariffs with respect to labor productivity (eq.1.4). The price of a downstream firm decreases more in response to a drop in input tariffs than the price of a firm with lower productivity, leading to the reallocation of shares in the export market.

2.4 Impact of input tariffs on export decisions: the role of fixed export costs

Our next task is to determine the impact of a variation in T on φ_x^* (or, equivalently, on the probability of exporting $1-G(\varphi_x^*)$ where $G(\varphi)$ is the cumulative distribution function of $g(\varphi)$) and on the equilibrium export revenues. The export profit of firm i serving a foreign country is given by

$$\pi_i = r_i/\sigma - \mathrm{f}_x. \tag{1.8}$$

A firm enters the foreign market as long as $\pi_i \geq 0$. We consider the export threshold φ_x^*, which is the labor productivity level such as $\pi(\varphi_x^*) = 0$ or, equivalently, $r(\varphi_x^*)/\sigma = \mathrm{f}_x$. Because $\partial r(\varphi)/\partial\varphi > 0$ (see (1.5)), $\pi_i > 0$ if and only if $\varphi_i > \varphi_x^*$. Because we have $r(\varphi_x^*) = \sigma \mathrm{f}_x$ at equilibrium, by using the envelope theorem, it appears that

$$\frac{\mathrm{d}\varphi_x^*}{\mathrm{d}T} = -\frac{\partial r(\varphi)}{\partial T} \Big/ \frac{\partial r(\varphi)}{\partial \varphi}. \tag{1.9}$$

We know that $\partial r(\varphi)/\partial\varphi > 0$ regardless of φ whereas $\partial r(\varphi)/\partial T < 0$ iff $\varphi > \widehat{\varphi}$ and $\partial r(\varphi)/\partial T > 0$ iff $\varphi < \widehat{\varphi}$. Thus, $\mathrm{d}\varphi_x^*/\mathrm{d}T > 0$ iff $\varphi_x^* > \widehat{\varphi}$ and $\mathrm{d}\varphi_x^*/\mathrm{d}T < 0$ otherwise. In other words, the impact of input tariffs on the probability of exporting depends on the relative values of $\widehat{\varphi}$ and φ_x^*. We show that the occurrence of $\varphi_x^* > \widehat{\varphi}$ or $\varphi_x^* < \widehat{\varphi}$ depends on fixed costs, f_x (see Figures 1.2a and 1.2b). Indeed, φ_x^* is equal to 0 when $\mathrm{f}_x = 0$ and rises when f_x increases, while the rotation point $\widehat{\varphi}$ decreases when f_x increases. When f_x increases, the share of imported varieties from country h in foreign countries is lower, so a fall in prices of imported varieties from this country will have a lower impact on foreign price indexes. Note that $\widehat{\varphi}$ is defined such as $\varepsilon_{r(\hat{\varphi}),T} = (\sigma-1)\left(\varepsilon_{P_x,T} - \varepsilon_{p(\hat{\varphi}),T}\right) = 0$, so when $\varepsilon_{P_x,T}$ decreases, $\varepsilon_{p(\hat{\varphi}),T}$ must also decrease, and as $\varepsilon_{p(\varphi),T}$ is an increasing function of φ, $\hat{\varphi}$ decreases when f_x increases. As φ_x^* increases with f_x and $\hat{\varphi}$ decreases with f_x, there is a fixed level of export costs $\widehat{\mathrm{f}_x}$ which is defined as $\widehat{\mathrm{f}_x} \equiv r(\widehat{\varphi})/\sigma$ so that if $\mathrm{f}_x = \widehat{\mathrm{f}_x}$, then $\varphi_x^* = \widehat{\varphi}$. When fixed export costs are higher than the critical level $\widehat{\mathrm{f}_x}$ (see Figure 1.2a), we have $\varphi_x^* > \widehat{\varphi}$ so that φ_x^* decreases with a decrease in T. In other words, a reduction in input tariffs allows

some non-exporting firms to enter foreign markets. In contrast, when fixed export costs are low enough, $f_x < \widehat{f}_x$ (see Figure 1.2b), we have $\varphi_x^* < \widehat{\varphi}$ so that φ_x^* increases with a decrease in T. In other words, a reduction in input tariffs forces some low productivity firms to exit foreign markets. To summarize,

Proposition 1 *A fall in input tariffs decreases the probability of exporting when fixed export costs are low enough. Conversely, falling input tariffs increase the probability of exporting when fixed export costs are high enough.*

Figure 1.2: Impact of T on φ_x^* with respect to fixed export costs.

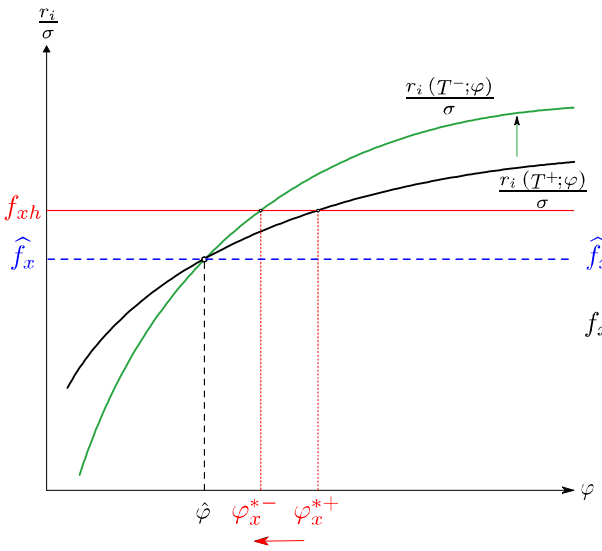


Figure 1.2a: High fixed export costs

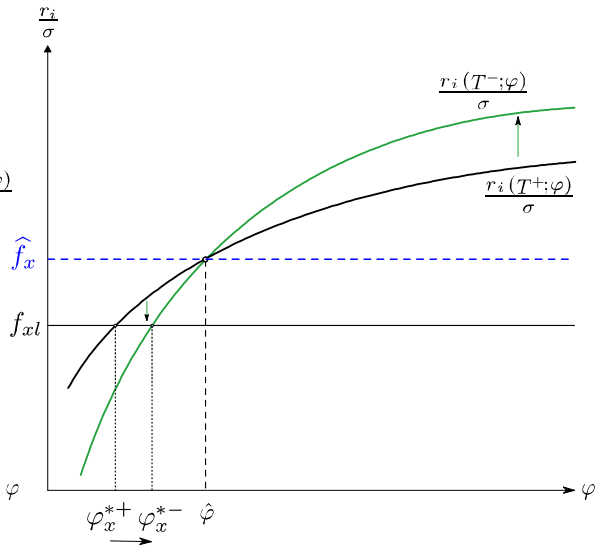


Figure 1.2b: Low fixed export costs

We can now evaluate the impact of input tariffs on equilibrium export revenues. When $\widehat{\varphi} > \varphi_x^*$ or, equivalently, $f_x < \widehat{f}_x$, a decrease in T increases the value of exports for firms with a productivity such that $\varphi_i > \widehat{\varphi} > \varphi_x^*$ and decreases the value of exports for firms with a labor productivity such that $\widehat{\varphi} > \varphi_i > \varphi_x^*$ (see Figure 1.2a). Hence, when fixed export costs are low enough ($f_x < \widehat{f}_x$), more productive firms increase their exports at the expense of less productive exporting firms when input tariffs decrease. When $\widehat{\varphi} < \varphi_x^*$ or, equivalently, $f_x > \widehat{f}_x$, the value of exports increases regardless of labor productivity of exporting firms (see Figure 1.2b). The value of exports increases at a higher proportion for more productive firms. Hence,

Proposition 2 *A fall in input tariffs leads to reallocation of exports from low productivity firms to high productivity firms when fixed export costs are low enough and to a bigger increase in exports for high productivity firms than for low productivity firms when fixed export costs are high enough.*

Our two propositions hold as long as the price set by high productivity firms reacts more to a change in input tariffs than the price set by low productivity firms (lemma 1). This result holds as long as labor and intermediate products are not combined in a Cobb-Douglas technology.[5] For example, if we consider they are combined according to the CES aggregator, we obtain the same result. In this case, the marginal cost is given by $\{(w/\varphi)^{\zeta-1} + [\alpha(1+T)\overline{z}]^{\boldsymbol{\zeta-1}}\}^{1/(\zeta-1)}$ where ζ is the elasticity substitution between labor and the intermediate product. It is easy to check that, in this case, $\varepsilon_{p(\varphi)}$ increases with labor productivity.

In addition, we could consider that the intermediate products differ in quality and are not homogeneous. Under this configuration, the marginal cost could be given by $w/\varphi + \{\int_{\Lambda}[a_i(1+T)z_i^w]^{\xi-1}\mathrm{d}i\}^{1/(\xi-1)}$ where ξ is the elasticity substitution between intermediate inputs, Λ is the set of inputs used by the firm, a_i is the quality parameter for a differentiated intermediate good i and z_i^w is the world price of the intermediate good of a quality i. Again, under this configuration, the price set by high productivity firms reacts more to a change in input tariffs than the price set by low productivity firms.

Further, we can consider that firms are heterogeneous in the use of the intermediate product. In other words, we can also assume that each firm draws α randomly from a common distribution. In this case, the price elasticity to a change in input tariffs increases with labor productivity, that is $\varepsilon_{p(\varphi_1,\alpha_1),T} > \varepsilon_{p(\varphi_2,\alpha_2),T}$ with $\varphi_1 > \varphi_2$, provided that:

$$\frac{\bar{z}\alpha_1 T}{(1+T)\bar{z}\alpha_1 + w/\varphi_1} > \frac{\bar{z}\alpha_2 T}{(1+T)\bar{z}\alpha_2 + w/\varphi_2} \tag{1.10}$$

or, equivalently, $\varphi_1/\varphi_2 > \alpha_2/\alpha_1$. If the ranking of firms with respect to labor productivity corresponds to the ranking of firms according to the intermediate input productivity $(1/\alpha)$, a sufficient condition is that heterogeneity in labor productivity be higher than heterogeneity in intermediate input productivity. More generally, inequality (1.10) means that the share of expenditure for the intermediate good in the total production cost must increase with labor productivity to obtain a positive relationship between $\varepsilon_{p(\varphi_1),T}$ and T.

3 Empirical model and estimation strategy

In this section, we describe how we test the main predictions of our model concerning the impact of input tariffs on exports (Propositions 1 and 2). Although data on fixed export costs are not available, we can check the validity of the two propositions by

[5] With a Cobb-Douglas technology, output price elasticity to a change in the price of an intermediate product does not differ among firms.

estimating an export sale equation taking into account the selection of firms into export markets. We proceed in two stages.

We first estimate the following system of equations:

$$\begin{cases} \Pr(r_{ist} > 0) = \Phi(\gamma_0 + \gamma_1 \ln T_{st} + \gamma_2 \ln \varphi_{it} + \gamma_3 \ln T_{st} \ln \varphi_{it} + \gamma_4 C + \gamma_5 \ln H_{st} + \varepsilon_{it}) \\ \ln r_{ist} = \beta_0 + \beta_1 \ln T_{st} + \beta_2 \ln \varphi_{it} + \beta_3 \ln T_{st} \times \ln \varphi_{it} + \beta_4 C + \nu_{it} \end{cases} \tag{1.11}$$

where subscripts i and s refer to firm i belonging to sector s, and t is the year. The variable r_{ist} is the value of total exports and T_{st} is the tariff on inputs processed by firms belonging to sector s, and φ_{it} is the labor productivity of firm i at time t where C represents control variables (time dummies, sector dummies, output tariff,...) and H_{st} is a selection variable (discussed below). Parameters γ_0, γ_1, γ_2, γ_3, γ_4 and γ_5 as well as β_0, β_1, β_2, β_3, and β_4 are the coefficients to be estimated. From Proposition 2, we expect firms with high labor productivity to gain (resp., lose) more when tariffs on inputs decrease (resp., increase), regardless of fixed costs, i.e. we expect $\beta_3 < 0$. It should be also noted that we expect that γ_2 is positive in accordance with the standard literature on the relationship between productivity and exports. More productive firms are more likely to export. Note also that $\mathrm{d}\ln r_{ist}/\mathrm{d}\ln \varphi_{it} = \beta_1 + \beta_3 \ln T_{st} > 0$ for all exporting firms. Even though $\beta_3 < 0$, in accordance with trade literature, a rise in labor productivity increases exports.

Second, we check that the sign of the total effect of input tariff on exports, given by

$$\Gamma(\varphi_{it}) \equiv \frac{\mathrm{d}\ln r_{ist}}{\mathrm{d}\ln T_{st}} = \beta_1 + \beta_3 \ln \varphi_{it}, \tag{1.12}$$

is consistent with γ_1, the sign of the coefficient associated with T_{st} in the probability of exporting $P(r_{ist} > 0)$. Indeed, when fixed export costs are relatively high, the probability of serving foreign markets decreases with T_{st} ($\gamma_1 < 0$), according to Proposition 1. Furthermore, according to Proposition 2, all firms gain from a fall in tariffs on inputs ($\Gamma(\varphi_{it}) < 0$). In other words, we must have $\Gamma(\varphi_{it}) < 0$ regardless of firms' labor productivity if $\gamma_1 < 0$.

However, according to Proposition 1, when fixed export costs are relatively low, the probability of serving foreign markets increases with T_{st} ($\gamma_1 > 0$). Additionally, according to Proposition 2, the total effect of input tariff on firms' exports is negative only for more productive firms. If $\gamma_1 > 0$, we must have $\Gamma(\varphi_{it} > \widehat{\varphi}) < 0$ and $\Gamma(\varphi_{it} < \widehat{\varphi}) > 0$ where the critical productivity level $\widehat{\varphi}$ is given by

$$\widehat{\varphi} = \exp(-\beta_3/\beta_1) \tag{1.13}$$

with $\max \varphi_{it} > \widehat{\varphi} > \min \varphi_{it}$.

Thus, the model is rejected if $\Gamma(\varphi_{it}) > 0$ for some observations and $\gamma_1 < 0$ or if $\Gamma(\varphi_{it}) < 0$ regardless of φ_{it} and $\gamma_1 > 0$. Table 1.1 summarizes the checks made in the second stage.

Table 1.1: Consistency of the model.

	$\gamma_1 < 0$ (High fixed costs)	$\gamma_1 > 0$ (Low fixed Costs)
$\varphi_x^* > \widehat{\varphi}$	consistent	*inconsistent*
$\max \varphi_{it} > \widehat{\varphi} > \varphi_x^*$	*inconsistent*	consistent

4 Data and variables

4.1 Firm data

Our main data source is the annual survey of firms (EAE) provided by the French National Institute of Statistics. This is a compulsory survey of all firms located in France with more than 20 employees or with total sales of over 5 million €. The EAE database includes a wide range of variables including total sales, total export sales, value added, the number of employees, capital, investment, expenditures for intermediates and some accounting data as well as the main activity of the firm at the 4-digit industry level (NACE code). Hence, the dependent variable is total export sales at the firm level. From this database, we can evaluate the firm's labor productivity. In our theoretical framework, the variable of interest is not total factor productivity (TFP), but labor productivity. As a result, we compute the ratio of total sales to the number of employees at the firm level. However, in order to check the robustness of our results, we also calculate the TFP for each firm using Olley and Pakes' method (1996).

4.2 Tariffs

The major concern is to calculate the input tariff associated with each agrifood firm. Ideally, we would use information on the structure of intermediate consumption for each firm. Unfortunately, such data are not available. Nevertheless, it is possible to identify the different inputs used and their proportion for each 4-digit industry (the EAE survey gives the main activity of the firm at the 4-digit level). As a result, we can compute the tariff applied at entry to the European market associated with each bundle of intermediate products processed by the 4-digit industry.

4.2.1 Input identification

Because there is no input/output table available at a disaggregated level in France, we have to build our own input-output table. To determine the set of products k processed by a 4-digit industry s, denoted by Ω_s^k, we use the French Customs Register which gives imports of all French firms, per product (at the 8-digit level of the combined nomenclature) in value and quantity. We selected all the agri-food firms included in the EAE survey. We identify all products imported by a given 4-digit industry using imports and main activity of firms included in the EAE survey. Knowing the main activity of the firm (NACE 4-digit) from the EAE survey, we identify all products imported by a given 4-digit industry. Note that a product is considered as a potential input of the industry if at least one firm in the sector imports this product in the period concerned (2001-2004). Among those imported goods, we drop goods identified as outputs of the 4-digit industry.[6] Hence, we obtain a bundle (Ω_s^k) of intermediate products associated with each agri-food industry.

4.2.2 Input tariff at the European border

Further, we must calculate tariffs applied to each product k at the European border at time t, denoted by T_t^k. Such a calculation is computed in two steps. First, we use the TARIC database (European Commission, DG Taxation and Customs Union) where all tariff measures potentially applied to each country by the European Union are reported.[7] From this database, we compute an *ad-valorem* equivalent tariff at the 8-digit level per country of origin j (T_{jt}^k) and for the year t. In this way, our measure takes into account not only the Most Favoured Nation (MFN) tariff but also preferential trade agreements between EU and foreign countries.[8]. Second, we must compute an average tariff at the 8-digit level at the European border T_t^k. In the literature, most papers use an average of tariffs weighted by the share of the country in European imports. This measure is biased since it excludes from the measure all countries that cannot export due to prohibitive tariffs (Bouet *et al.*, 2008). Our strategy is to introduce the potential effect of a decrease of tariffs, even for countries that are currently unable to export to the European Market due to

[6] For this purpose, we use a correspondence table from Ramon metadata (Eurostat)

[7] Note that for each country, we take the lowest tariff applied at entry to the EU, considering that exporters systematically choose the most favorable agreement. In fact, exporting countries to the European Market may benefit from different tariffs depending on their trade agreements with the EU.

[8] A simpler method would be to assess the protection level on the basis of the Most Favored Nation (MFN) tariff only. All countries belonging to the WTO are suject to this tariff, which is the highest tariff countries face. With this MFN tariff, we miss all trade agreements between European countries and their partners. However, over the period considered, trade liberalization came from bilateral or regional trade agreements rather than from multilateral negotiations.

high tariffs. Thus, our measure T_{jt}^k is weighted by the potential supply of country j relative to the world potential supply for product k. The potential supply of country j is measured as the exports of country j (X_j^k) divided by the distance between this country and France ($Dist_j$).[9] We compute T_t^k as follows:

$$T_t^k = \frac{\sum_j \left(\frac{X_j^k}{Dist_j} T_{jt}^k\right)}{\sum_j \frac{X_j^k}{Dist_j}}. \tag{1.14}$$

Last, knowing the protection at the 8-digit level at the European border (T_t^k) and the different 8-digit inputs of the bundle (Ω_s^k) processed by 4-digit industries, we compute the tariff for each bundle of inputs (T_{st}). However, we must account for the fact that the weight of each input within a bundle is not the same. As a result, we consider that the share of inputs in the industry imports reflects the relative importance of inputs in the production process. Consequently, we propose to weight the tariffs calculated at the product level by the share of imports of inputs (M_s^k) at the 4-digit industry level. In order to avoid variations over the period concerned, the weight used in the average is calculated from the total imports over the period 2001-2004. Hence, we have

$$T_{st} = \sum_{k \in \Omega_s^k} \left(\frac{T_t^k M_s^k}{\sum_{k \in \Omega_s^k} M_s^k} \right) \tag{1.15}$$

where T_{st} is the applied tariff associated with the input bundle of a 4-digit industry s at time t and M_s^k is the imports of product k by industry s.

4.2.3 Alternative measures of input tariffs

To check the robustness of our results, we consider other measures of input tariffs. The first alternative measure is based on the Most Favored Nation (MFN) tariff. This tariff is the same for all countries. By using the strategy mentioned above, we obtain the following index

$$T_{st}^{MFN} = \sum_{k \in \Omega_s^k} \left(\frac{T_t^{k^{MFN}} M_s^k}{\sum_{k \in \Omega_s^k} M_s^k} \right) \tag{1.16}$$

The second alternative measure is commonly used in the trade literature: tariffs are weighted by the share of the trading partner in the total imports of the EU.

[9] Data on exports come from BACI database, the United Nations Commodity Trade Statistics Database (Comtrade) harmonized by the Centre for Prospective Studies and International Information (CEPII), which gives the bilateral trade at world level for each product (HS 4-digit level) in value and quantity.

Thus, only tariffs applied to countries that export to the EU are taken into account. Using the same approach, the tariff of the input bundle is given by:

$$T'_{st} = \sum_{k \in \Omega_s^k} \left(\frac{T_t^{k\prime} M_s^k}{\sum_{k \in \Omega_s^k} M_s^k} \right) \tag{1.17}$$

where T_{jt}^k is the tariff at the 8-digit level applied to country j at the European border given by:

$$T_t^{k\prime} = \sum_j \left(\frac{M_j^k}{\sum_j M_j^k} T_{jt}^k \right) \tag{1.18}$$

with M_j^k the EU imports of product k from country j.

4.3 Selection variable

We have to account for the selection of firms into export markets. To do so, we need a selection variable. A firm exports if and only if $r_i/\sigma > \mathrm{f}_x$ (see section 2). Ideally, we would use the fixed export cost as the selection variable because it influences the decision to export but does not affect the level of exports. Unfortunately, data on factors that directly influence fixed export costs are not available. However, we know empirically that fixed export costs are incurred by the firm before it benefits from export sales. This means that a firm is more likely to export when its profit on the domestic market is high enough. Because profits decrease with the degree of competition in the sector, more competition increases the difficulty to pay fixed export costs, and thus to access foreign markets. To capture this effect, we use the following Herfindhal index

$$H_{st} = \sum_i \left(\frac{y_d\left(\varphi_{ist}\right)}{\sum_i y_d\left(\varphi_{ist}\right)} \right)^2 \tag{1.19}$$

where $y_d\left(\varphi_{ist}\right)$ represents the domestic sales of firm i of industry s at time t which represent the ability of firms to pay these fixed export costs.

4.4 Descriptive statistics

The final dataset is an unbalanced panel of 3,716 exporting and non-exporting firms with a total of 12,531 observations. Table 1.2 lists some descriptive statistics concerning our main variables. The three first variables are computed at the 4-digit industry level. Input tariffs are very heterogeneous across industries with an average of 24.5% for the whole agrifood sector. Agri-food industries also differ with respect to their labor productivity. Further, for a considerable proportion of firms,

the share of intermediate consumption in their total costs is relatively high. On average, intermediate consumption accounts for nearly 85% of the total costs of a firm (intermediate consumption plus wages and salaries).

We compute quartile at the 4-digit industry level in order to understand the relationship between export performance and labor productivity (table 1.3). Thus, Q1 represents all firms belonging to the first quarter of their 4-digit industry according to their labor productivity level. Table 1.3 shows that the average export rate and the share of exporting firms increase with average labor productivity. In other words, more productive firms export more and are more likely to export than less productive firms.

Table 1.2: Descriptive statistics on main variables

variables	mean	standard deviation	Q1	Median	Q3
Input tariff*	24.50%	13.06	12.69%	27.79%	32.03%
Export rate*	14.95%	12.03	8.36%	10.10%	19.08%
Share of exporting firms*	44.10%	18.60	26.22%	42%	61.25%
Labor-Productivity	362.1	948.4	123.8	212.4	378.6
Intermediate consumption share in total cost	84.49%	12.94	81.06%	87.94%	92.91%

* at the 4-digit industry level.

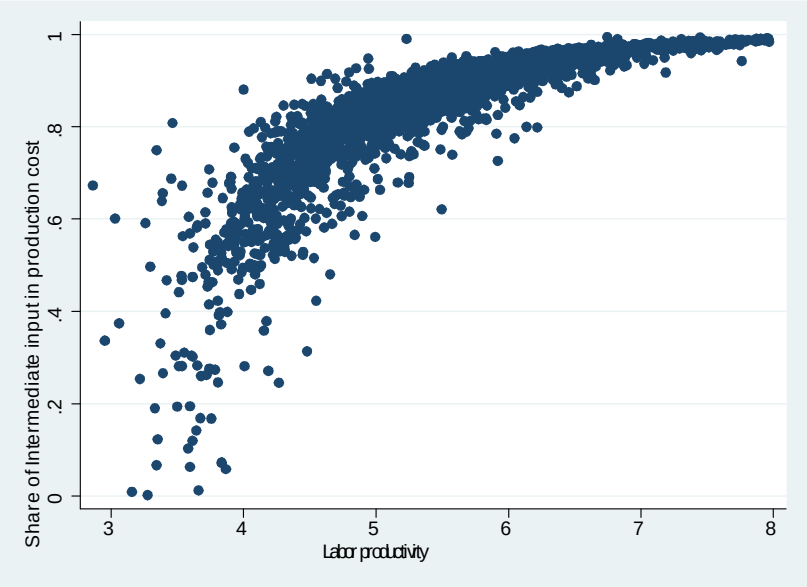
Table 1.3: Descriptive statistics on labor productivity distribution.

3-digit sectoral quartile on labor-productivity	Average labor productivity	Average export rate	Exporting firms
Q1	102.13	6.83%	30.99%
Q2	188.66	9.57%	42.29%
Q3	294.11	11.58%	50.50%
Q4	867.07	12.05%	52.72%

Our dataset supports one of our main hypotheses. It will be recalled that in our theoretical model, the introduction of an intermediate good used in a fixed proportion implies that the more productive firms are more impacted by changes in input tariffs. This is due to the fact that the share of intermediate goods in the total cost increases with an increase in labor productivity. Figure 1.3 illustrates the link between the labor productivity of French agrifood firms and the share of intermediate inputs in their production costs. *The ratio of expenditure for intermediate products to total cost increases with an increase in labor productivity.* Figure 1.3 illustrates and supports this assumption.

As shown in figure 1.4, our data also reveal that the ratio of exports by the top 20% of firms with the highest labor productivity to total export within 4-digit industries decreases with a fall in input tariffs. In other words, without controlling for the impact of the other factors, a fall in input tariffs appears to lead to reallocation of exports from low productivity firms to high productivity firms, as suggested above.

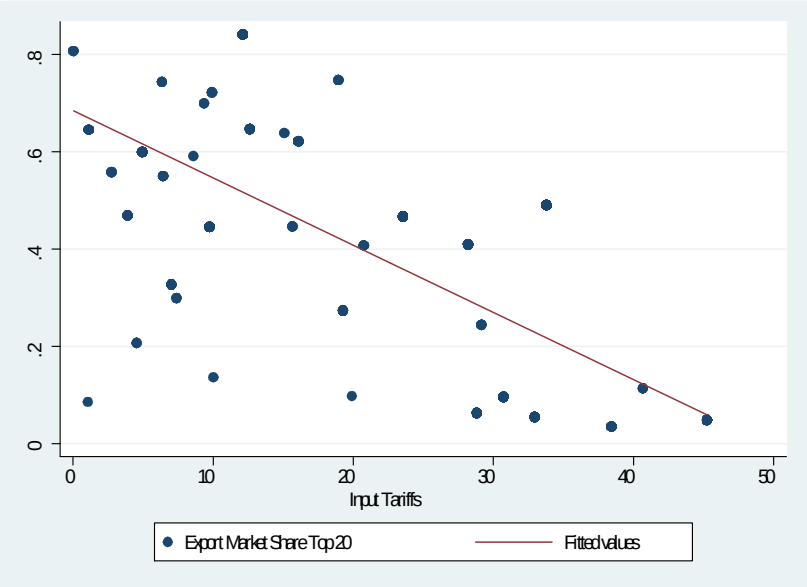
Figure 1.3: Share of intermediate inputs in total costs against labor productivity at the firm level.



5 Results

Here we estimate the system of equations (1.11). Because we have a selection problem, we use a Heckman procedure where the model (1.11) is estimated by maximum likelihood. Tables 1.4 and 1.5 show the results of these estimations. From an econometric point of view, the two steps in modeling (selection procedure through probit and regression on exports) are interdependent (the inverse Mills ratio is statistically significant) regardless of estimations, which justifies the use of the Heckman procedure. Moreover, the coefficients associated with the Herfindhal index are all significant only for the export decision and have the expected sign, which highlights different processes involved in the selection and in the level of exports. It should also be noted that all estimations control for year fixed effects and 3-digit industry fixed effects and robust standard errors are corrected by clustering at the industry-year level. The sign of the coefficients associated with labor productivity are in line with expectations from the literature on the impact of productivity on exports, regardless of estimations. The higher the productivity of a firm, the higher its probability of exporting ($\gamma_2 > 0$, non-significativity of the interaction term in the selection equation is shown in appendix B), and the higher its export value ($\beta_2 + \beta_3 T_{st} > 0 \; \forall \; T_{st}$). Figure 1.5 illustrates the total effect of labor productivity on the level of exports.

Figure 1.4: Export market share of the top 20 percent of most productive exporters against input tariffs.



5.1 Input tariffs, export status and exports

We now focus on the impact of input tariffs on export status and on the level of exports and discuss the results given in table 1.4. According to the results in column I, table 1.4 (system I), the coefficient associated with the interaction term ($\beta_3 = -0.205$) is negative and significant for the level of exports. As predicted by the theoretical model, the effect on exports of changes in input tariffs depends on the level of labor productivity of the firm concerned. In addition, the more productive firms are more impacted by a decrease in input tariffs. In other words, input trade liberalization appears to lead to reallocation of exports from less productive firms to more productive firms. This is to be expected because the more productive firms use relatively more intermediate goods, as shown in the theoretical model (see Figure 1.2a and 1.2b) and by our data (see Figure 1.3). In addition, in system I, the coefficient associated with input tariff ($\gamma_1 = 0.393$) is positive while the marginal crossed effect on the probability of exporting is not significant. Note that we cannot directly interpret the sign and the significance of the coefficient associated with the crossed variable ($\gamma_3 = -0.059$) because the probit model is not linear. Following the procedure of Ai and Norton (2003), we calculate the real marginal effect on the regression IV and test its significance for each observation. The test concludes that the crossed effect is not significant for all observations (see Appendix B). Hence, a fall in input tariffs decreases the probability of exporting.

Because we focus on the effect of input tariffs, we must control for the fact that some firms in each sector do not import intermediate products. To this end,

Figure 1.5: Total effect of labor productivity on export level according to input tariffs.

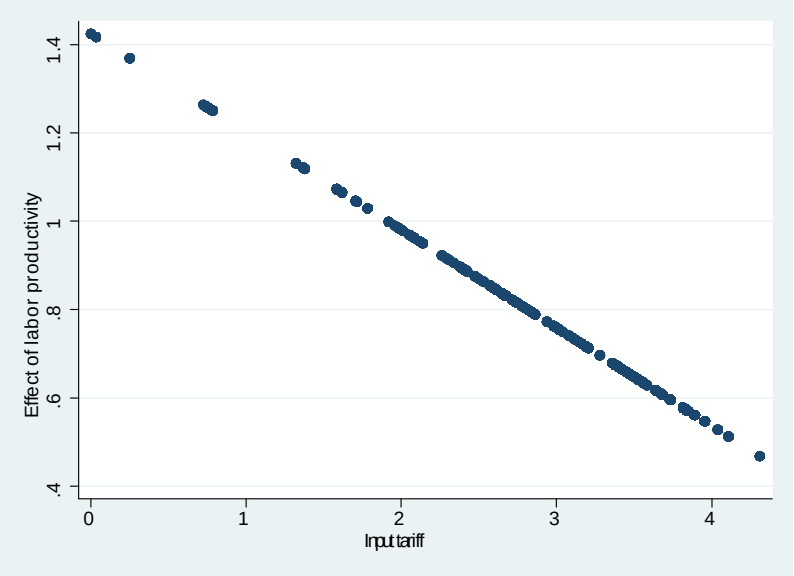


Table 1.4: Econometric results.

	I		II		III		IV	
VARIABLES	Select	Reg	Select	Reg	Select	Reg	Select	Reg
Input tariff	0.393	1.069	0.486	1.166	0.388	1.074	0.493	1.199
	(0.222)*	(0.323)***	(0.215)**	(0.300)***	(0.222)*	(0.323)***	(0.213)**	(0.304)***
Labor productivity	0.468	1.383	0.448	1.405	0.471	1.398	0.455	1.425
	(0.0955)***	(0.154)***	(0.0959)***	(0.144)***	(0.0958)***	(0.153)***	(0.0955)***	(0.144)***
Input Tariff × productivity	-0.0594	-0.205	-0.0639	-0.214	-0.0632	-0.208	-0.0701	-0.222
	(0.0371)	(0.0566)***	(0.0363)*	(0.0527)***	(0.0378)*	(0.0566)***	(0.0366)*	(0.0532)***
Output tariff					0.0717	0.0352	0.111	0.0779
					(0.0803)	(0.0649)	(0.0912)	(0.0730)
Herfindhal	0.346		0.344		0.317		0.309	
	(0.0406)***		(0.0487)***		(0.0571)***		(0.0698)***	
Import dummy			0.400	0.497			0.411	0.498
			(0.0379)***	(0.0765)***			(0.0411)***	(0.0818)***
Constant	-1.801	1.392	-2.034	0.910	-2.061	1.189	-2.454	0.552
	(0.570)***	(0.914)	(0.559)***	(0.859)	(0.685)***	(0.939)	(0.689)***	(0.943)
Observations	12,437	12,437	12,437	12,437	12,337	12,337	12,337	12,337
lambda		-0.925		-0.856		-0.857		-0.803
rho		-0.547		-0.523		-0.515		-0.496
sigma		1.689		1.635		1.665		1.618

Significance levels: $*$: 10% $**$: 5% $***$: 1%. All regressions include industry fixed effects (3-digit) and year fixed effects. Robust standard errors corrected for clustering at industry-year level in parentheses.

we introduce a dummy variable that controls for import status in each equation of the system (1.11). Firms are importers if they import any of their intermediate products. The results in column II, table 1.4 (system II) show that our main findings hold when we control for import status. Moreover, the dummy variable associated with the import status of the firm reveals that importing firms are more likely to export and export more than non-importing firms (as highlighted in Bas, 2009, from data on Chile and Argentina's manufacturing sector). In addition, taking the

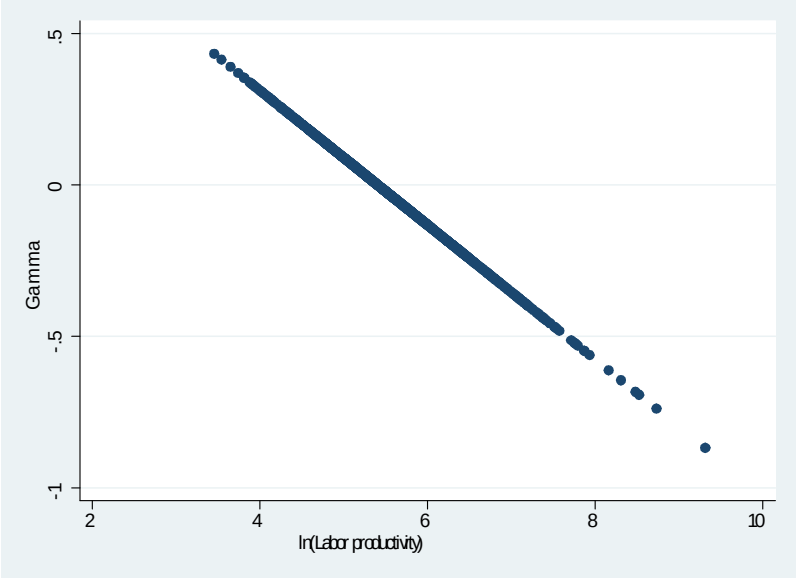
import status of the firm into account does not significantly modify the coefficients associated with input tariffs in the export equation. We also re-estimate the system of equations (1.11) for importing firms only (see table 1.7 in Appendix C). It appears that the positive impact of input tariffs on the probability of exporting is higher for importing firms than for the whole sample (γ_1 progresses from 0.393 to 0.682). However, the impact on export revenues does not significantly differ.

Like Amiti and Konings (2007), we also control for the effect of output tariffs on export decisions and export revenues (see column III, table 1.4). Indeed, a decrease in output tariffs at the EU border may force less productive firms to exit the domestic market and thus mechanically increase the probability of exporting.[10] After controlling for output tariffs, our main findings hold.

Let us now turn to the consistency of the signs of the coefficients associated with input tariffs in the selection equation and in the exports equation according to our theoretical model. According to our theoretical predictions, the positive sign of γ_1 (a fall in input tariffs decreases the probability of exporting) suggests that in the French agrifood sector, fixed export costs are relatively low. Thus, as illustrated by Figure 1.2b, we would expect the most productive firms to gain from a decrease in input tariffs and the less productive firms to be negatively impacted. We determine the total effect of input tariffs on exports $\Gamma(\varphi_{it})$ from the results of the estimation in column IV of table 1.4 (system IV which corresponds to system I plus the two control variables). Hence, we have $\Gamma(\varphi_{it}) = 1.199 - 0,222 \ln \varphi_{it}$ which is illustrated from our data in Figure 5 for the year 2004. It appears that the rotation point $\ln \widehat{\varphi} = 5.40$ (given by $\Gamma(\varphi_{it}) = 0$) with $\max \varphi_{it} > \widehat{\varphi}_t > \min \varphi_{it}$ (of exporting firms). Hence, Γ is positive for less productive firms with a labor productivity below $\ln \widehat{\varphi} = 5.40$ and negative for more productive firms ($\ln \varphi_{it} > 5.40$). In other words, the coefficients associated with input tariffs in the export equation and in the selection equation are consistent ($\gamma_1 > 0$ and $\max \varphi_{it} > \widehat{\varphi}_t > \min \varphi_{it}$). In accordance with our theoretical model, all other things being equal, a fall in input tariffs would reduce the number of exporting firms and lead to reallocation of exports from low productivity firms to high productivity firms. In addition, our result suggests that, all other things being equal, about 55% of more productive French agrifood firms can potentially gain from agricultural trade liberalization. In other words, a considerable proportion of French agrifood exporting firms may loose from liberalization of agricultural goods trade.

[10] The measure of output tariffs at the European border is calculated using the same method as for input tariffs.

Figure 1.6: Total effect of T on export level against labor-productivity.



5.2 Alternative measures

We now check if our results hold when we use other measures for input tariffs, productivity or exports. Results are listed in table 1.5. In the estimation of systems V and VI, we use two alternative measures of input tariffs. In system V, only tariffs of the most favored nation (MFN input tariff) are taken into account (preferential tariffs are excluded from our calculations). Results show that coefficients associated with input tariffs are no longer significant in the selection equation, but remain significant in the export equation. This result reveals that we need to account for all the preferential trade agreements in the calculation of input tariffs. In the estimation of system VI, we consider another strategy of aggregation of tariffs widely used in the literature (only tariffs applied to EU partners are taken into account and are weighted by the share of the country in EU imports). Our main conclusions hold, but the overall impact of tariffs is reduced.

In addition to alternative measures of input tariffs, we need to check if our results are robust to a change in the measure of productivity. Instead of labor productivity, we use the total factor productivity (TFP) of firms, calculated according to Olley and Pakes (1996). When TFP is considered instead of labor productivity (see system VII in table 1.5), our main results still agree with our predictions. There is still a reallocation process of foreign market share due to input trade liberalization from less productive firms to more productive firms and the probability of exporting decreases with a fall in input tariffs. However, the share of firms with a TFP above $\hat{\varphi}$ (the share of firms gaining from a fall in input tariffs) changes substantially. The share of firms above $\hat{\varphi}$ increases from 55% to 77%. This finding suggests that the

Table 1.5: Alternative econometric results.

	V		VI		VII		VIII	
VARIABLES	Select	Reg	Select	Reg	Select	Reg	Select	Reg
MFN input tariff	0.217	0.989						
	(0.257)***	(0.347)***						
UE weighted input tariff			0.295	0.798				
			(0.236)***	(0.240)***				
MS weighted input tariff					0.202	0.433	0.410	0.0698
					(0.107)*	(0.192)**	(0.406)	(0.0544)
Labor productivity	0.439	1.427	0.392	1.164			0.475	0.102
	(0.125)***	(0.180)***	(0.0948)***	(0.127)****			(0.165)***	(0.0256)***
TFP					1.112	6.714		
					(0.305)***	(0.678)***		
MFN input tariff × productivity	-0.0467	-0.198						
	(0.0429)	(0.0608)***						
UE input tariff × productivity			-0.0381	-0.143				
			(0.0410)	(0.0437)***				
MS input tariff × TFP					-0.304	-0.639		
					(0.0981)***	(0.297)**		
MS input tariff × productivity							-0.0613	-0.0157
							(0.0675)	(0.00934)*
Herfindhal	0.302		0.355		0.317		0.347	
	(0.0387)***		(0.0354)***		(0.0464)***		(0.0628)***	
Constant	-1.454	1.284	-1.349	2.399	0.0927	4.753	-1.856	0.147
	(0.740)**	(1.071)	(0.556)**	(0.686)***	(0.299)	(0.510)***	(1.003)*	(0.162)
Observations	12,437	12,437	12,437	12,437	11,968	11,968 ‡	12,437	12,437
lambda		-0.889		-0.963		-0.921		-0.0781
rho		-0.530		-0.564		-0.558		-0.595
sigma		1.678		1.706		1.652		0.131

‡ A lack of data needed to compute Olley and Pakes TFP reduces the number of observations.

Significance levels: $*$: 10% $**$: 5% $***$: 1% All regressions include industry fixed effects (3-digit) and year fixed effects. Robust standard errors corrected for clustering at industry-year level in parentheses.

TFP measure of productivity reduces the heterogeneity of firms more than labor productivity. The choice of the productivity measure is thus not neutral and, in our case, labor productivity is more appropriate than TFP.

Finally, in the estimation of system VIII, the dependent variable becomes the ratio of exports of firm i to total exports of 4-digit industry s. Here the aim is to account for the heterogeneity of the level of exports at the 4-digit industry level. Indeed, some 4-digit industries export much more than others, which can lead to misspecification. The selection equation is the same as the equation used in system I. Concerning the export share equation, all coefficients are significant and have the expected sign. The reallocation process of the share of exports between firms at the expense of less productive firms is at work again.

All these results do not invalidate the predictions highlighted by our theoretical model. In the agrifood industry, input trade liberalization has a negative impact on the probability of exporting and leads to reallocation of export sales from less productive firms to more productive ones. Even though the share of firms gaining from input trade liberalization may vary with respect to the estimated models, the share of agrifood firms that lose due to trade liberalization of agricultural products

is not negligible in most of our regressions.

6 Conclusion

We studied the impact of input tariffs on export status and export performance. Based on a theoretical model with heterogeneous firms, we show that changes in input tariffs do not have a clear impact on the export level and export decision of food processing firms. The effect depends on fixed export costs. When fixed export costs are low enough, a fall in input tariffs decreases the probability of entering foreign markets and leads to reallocation of exports from low productivity firms to high productivity firms. Exports by high productivity firms increase while exports by low productivity firms decrease. When fixed export costs are sufficiently high, a fall in input tariffs increases the probability of exporting and increases the exports of all firms. Nevertheless, the most productive firms gain more than the least productive firms. This model can be applied to all processing industries that use a fixed proportion of intermediate goods to produce a differentiated output. We then compared the predictions of the theoretical model to firm-level data. We selected agribusiness firms because this sector depends on the agricultural sector, which is currently undergoing trade liberalization. Our empirical findings do not invalidate the conclusions of our theoretical model. It appears that liberalization of agricultural trade favors the exit of French firms from foreign markets and favours more productive firms at the expense of less productive firms.

In our approach, we consider that the total mass of firms is exogenously given (only the share of exporting firms is endogenous). It would be interesting to explore the impact of input trade on the structure of the domestic market. For example, our approach could be extended to theoretically and empirically analyze the impact of input trade liberalization on entry-exit decisions of domestic firms.

Appendix

A The impact of T on r_i.

The price index in a foreign country is given by:

$$P_x = (MG)^{\frac{1}{1-\sigma}} \tag{1.20}$$

where M is the mass of firms in each country which is assumed to be identical in each country and:

$$G \equiv \int_0^{\infty} p(\varphi)^{1-\sigma} g(\varphi) \mathrm{d}\varphi + (n-1)\tau^{1-\sigma} \int_{\overline{\varphi}}^{\infty} p(\varphi)^{1-\sigma} g(\varphi) \mathrm{d}\varphi + \tau^{1-\sigma} \int_{\varphi_x^*}^{\infty} p(\varphi)^{1-\sigma} g(\varphi) \mathrm{d}\varphi$$

where the first term corresponds to the price of varieties produced in the foreign country, the second term corresponds to the price of varieties imported from the other foreign countries and the last term corresponds to the price of varieties imported from the home country. Standard calculations reveal that:

$$\varepsilon_{P_x,T} = \frac{\alpha \bar{z} T}{\rho} \frac{\tau^{1-\sigma} \int_{\varphi_x^*}^{\infty} \frac{p(\varphi)^{1-\sigma}}{p(\varphi)} g(\varphi) \mathrm{d}\varphi}{G}$$

Knowing that

$$\varepsilon_{p(\varphi_i),T} = \frac{\bar{z} \alpha T}{\rho} \frac{1}{p(\varphi_i)},$$

we have:

$$\begin{aligned} \varepsilon_{P_x,T} - \varepsilon_{p(\varphi_i),T} = \frac{\alpha \bar{z} T}{G\rho} \Bigg[& \tau^{1-\sigma} \int_{\varphi_x^*}^{\infty} \frac{p(\varphi)^{1-\sigma}}{p(\varphi)} g(\varphi) \mathrm{d}\varphi - \tau^{1-\sigma} \int_{\varphi_x^*}^{\infty} \frac{p(\varphi)^{1-\sigma}}{p(\varphi_i)} g(\varphi) \mathrm{d}\varphi \\ & - \int_0^{\infty} \frac{p(\varphi)^{1-\sigma}}{p(\varphi_i)} g(\varphi) \mathrm{d}\varphi - (n-1)\tau^{1-\sigma} \int_{\overline{\varphi}}^{\infty} \frac{p(\varphi)^{1-\sigma}}{p(\varphi_i)} g(\varphi) \mathrm{d}\varphi \end{aligned}$$

B The crossed effect in the probit model

Ai and Norton (2003) showed that interaction terms in probit models are frequently subject to misinterpretation in the literature due to the difficulty of computing and interpreting their coefficient and their significativity. Their demonstration is given below:

Let the dummy dependent variable y depend on two independent variables x_1 and x_2, their interaction. γs are unknown parameters.

The conditional mean of the dependent variable is:

$$E[y|x_1, x_2] = \Phi(\gamma_1 x_1 + \gamma_2 x_2 + \gamma_{12} x_1 x_2) = \Phi(\cdot)$$

where Φ is the standard normal cumulative distribution. Assume that x_1 and x_2 are continuous. The interaction effect is the cross derivative of the expected value of y:

$$\frac{\partial^2 \Phi(\cdot)}{\partial x_1 \partial x_2} = \gamma_{12}\Phi'(\cdot) + (\gamma_1 + \gamma_{12}x_2)(\gamma_2 + \gamma_{12}x_1)\Phi''(\cdot) \neq \gamma_{12} \tag{1.21}$$

There are four important implications of Eq.1.21 for nonlinear models.

1. The interaction effect could be non-zero, even if $\gamma_{12} = 0$. For the probit model with $\gamma_{12} = 0$, the interaction effect is:

$$\left.\frac{\partial^2 \Phi(\cdot)}{\partial x_1 \partial x_2}\right|_{\gamma_{12}=0} = \gamma_1\gamma_2\Phi''(\cdot)$$

2. The statistical significance of the interaction effect cannot be tested with a simple t-test on the coefficient of the interaction term γ_{12}.

3. The interaction effect depends on the independent variables, unlike the interaction effect in linear models.

4. The interaction effect may have different signs for different values of covariates. Consequently the sign of γ_{12} does not necessarily indicate the sign of the interaction effect.

In order to test the significativity and the sign of our interaction term in the selection equation, we use the method developed by Norton, Wang and Ai (2004) for Stata.

The table below give indicators for the interaction coefficients computed using the Ai and Norton procedure.

Table 1.6: Ai and Norton effects of interaction term.

Variable	Obs	Mean	Std. Dev.	Min	Max
_probit_ie	12437	-.0156407	0.0038071	-0.0213484	0.0091718
_probit_se	12437	0.0128792	0.0016877	0.0032044	0.0157954
_probit_z	12437	-1.194289	0.1961228	-1.470523	0.9836022

The following figure gives the value of the interaction effect depending on the predicted probability. For most firms, the interaction effect is negative, which is consistent with our model. Indeed, as the interaction effect is negative for the export level of firms, we expect that the probability to export depends positively on the latent export level, and thus negatively on the interaction term. However, the second figure shows that the interaction term is not significant for a large proportion of our sample. It appears that the interaction effect is relevant only for firms with a higher probability of exporting.

Figure 1.7: Ai and Norton effects of interaction term.

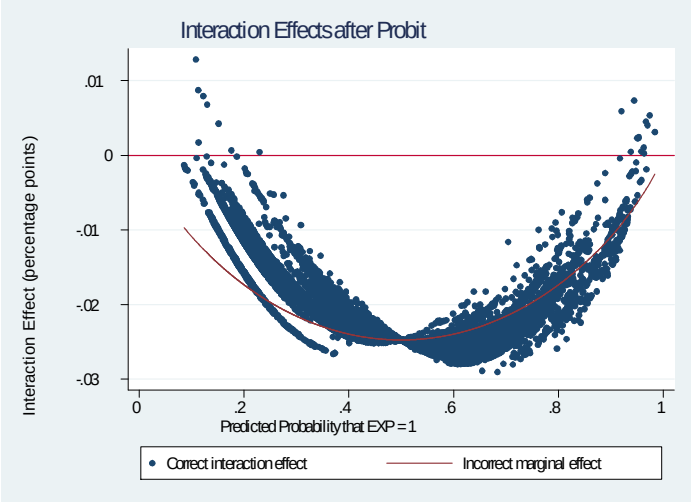
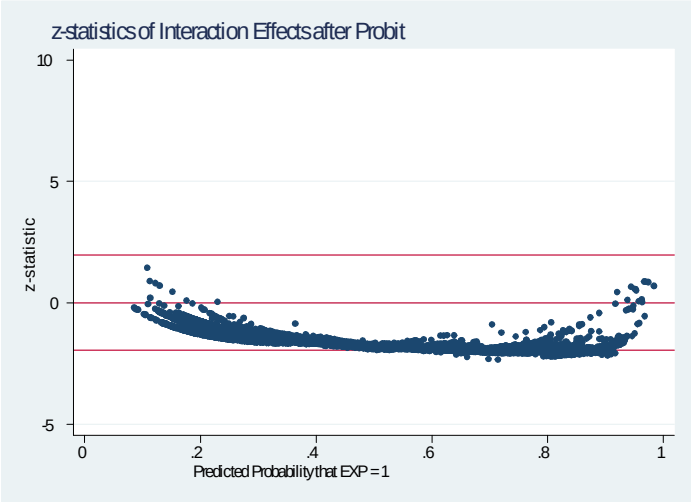


Figure 1.8: Ai and Norton significativity of interaction term.



C Results with only importing firms

Table 1.7: Alternative regression on importing firms only.

VARIABLES	Select	Reg
Input tariff	0.682	1.448
	(0.251)***	(0.326)***
Labor productivity	0.417	1.778
	(0.106)***	(0.152)***
Tariff × productivity	-0.0849	-0.239
	(0.0407)**	(0.0561)***
Herfindhal		0.328
		(0.0594)***
Constant	-1.884	-1.765
	(0.630)***	(0.922)*
Observations	4,532	4,532
lambda		-0.521
rho		-0.345
sigma		1.511

Chapter 2

Intermediate goods, heterogeneous firms and Export/FDI trade-off.

Abstract: In this chapter, we analyze how a change in input prices affects the selection process and market shares in foreign markets for firms in the final good sector. To do so, we build a model with heterogeneous firms with an intermediate good in which the use of inputs is technologically constrained. We show that the effect of input prices depends on labor productivity and on fixed costs and leads to a reallocation process between firms in the final good sector. We also show that a decrease in input price in all countries can reduce the probability to enter foreign markets through exports or HFDI. Finally, we show that a decrease in the price of intermediate goods always increases the share of HFDI compared to exports, even if it can modify the HFDI-export trade-off in favor of HFDI or in favor of exports. To conclude, we compare two policies consisting in a subsidy on intermediate goods and a subsidy on wages in the final good sector with the aim of attracting FDI and supporting exports.

1 Introduction

In the previous chapter, we focused on the impact of intermediate goods tariffs on the export performance of firms in the final good sector. We showed that a fall in input tariff leads to changes in the structure of exports in the final good sector: it may reduce the probability of exporting and reallocate export market shares from less productive firms to more productive firms. However, exporting is not the only way to access foreign markets. Instead, a firm may decide to relocate part of its production abroad in order to serve foreign markets directly through a local affiliate. As intermediate goods prices and tariffs affect the ability of firms to export as well as their export performance, it may also affect the opportunities of firms to serve foreign markets through foreign direct investment (FDI) instead of exports.

Over the last two decades, the growth of multinational enterprise activity in the form of foreign direct investment has grown at a faster rate than trade flows between countries (see UNCTAD 2002). This trend has several implications for policy makers as the local economy is affected in various ways by outgoing and incoming FDI (employment, economic growth, etc.). These facts explain the increasing interest of the international economics literature in explaining the fundamental factors that drive FDI behavior (Blonigen 2005, Helpman 2006).It appears that an analysis of the determinants of FDI should not be based on a single theoretical model but on a combination of factors from a variety of theoretical models such as ownership advantages or agglomeration economics, market size and characteristics, the cost of production factors, transport costs, protection, risk factors and policy variables.

Theoretical models that analyze factors that determine whether a firm becomes a multinational firm fall into two main groups[1]. The first group deals with the vertical fragmentation of the production process, and focuses on the sourcing strategy of firms. This approach is based on comparative advantages and intangible assets, or on the theory of incomplete contracts, and mainly explains outsourcing and vertical FDI strategies. The second group deals with the choice to serve foreign markets, and is based on the proximity-concentration or horizontal model (Markusen 1984, Horstmann and Markusen 1987 and 1992, Brainard 1993, Markusen and Venables 1998 and 2000). This literature explains why some firms choose to export while others invest abroad to serve foreign markets.

The proximity-concentration model considers multi-plant firms that produce the same good in different countries to serve local markets. Firms choose between producing at home and exporting to a foreign market with variable trade costs (custom tariff, transport costs, etc.), and producing abroad with additional fixed

[1]See Markusen (2004), Barba Navaretti and Venables (2004), Blonigen (2005) and Helpman (2006) for surveys of this literature.

costs of setting up a plant in the host country but with a lower variable cost to serve the market.

In proximity-concentration models, the cost of intermediate goods affects the strategy of firms if prices differ between the home country and the destination market. Different input prices affect the trade-off between producing at home and investing abroad in favor of locating production in the country where intermediate goods are less expensive. Indeed, it seems obvious that, as the choice of setting up an affiliate abroad is driven by a reduction of variable costs, firms are more likely to make horizontal FDI in countries where intermediate goods are less expensive.

However, while intermediate good costs are a major determinant of vertical FDI (Zhang and Markusen 1999 and Markusen and Maskus 2002), the impact of these costs on horizontal FDI (HFDI) has not received much attention. To our knowledge, no study has investigated the impact of these costs when countries are perfectly symmetric. In the previous chapter, we showed that the price of intermediate goods affects the structures of firms' export market shares. In this chapter, we argue that the same mechanism may influence FDI sales. Thus, due to firm heterogeneity, the trade-off between export and HFDI may be affected by input prices even if the countries remain perfectly symmetric.

In Melitz's (2003) model, less productive firms remain on domestic markets while more productive firms produce more and thus are able to pay fixed export costs to access foreign markets. Helpman, Melitz and Yeaple (2004) (hereafter HMY) extended the proximity-concentration models of Brainard (1993, 1997) by introducing firm heterogeneity according to Melitz in order to include the decision to set up an overseas affiliate. They built a proximity-concentration theoretical model with heterogeneous firms, and tested their predictions econometrically. They found that, compared to foreign affiliates sales, export sales are negatively impacted by the heterogeneity of the domestic sector. In other words, the higher the heterogeneity of firms, or the higher the elasticity of substitution, the more FDI sales there will be compared to export sales. They validated their theoretical predictions with firm level data. This result highlights a new determinant of HFDI. However, this result is not very useful for policy makers as it is difficult to influence total factor productivity distribution and elasticity of substitution.

In models with heterogeneous firms, the only production factor is labor. In order to go further in the analysis, some authors include other production factors to account for comparative advantages or for differences in factor endowment (Bernard 2007). To investigate the effect of input characteristics, some models use an intermediate good as the second factor of production. However, both theoretical models and empirical studies (Amiti and Konings 2007 or Halpern et al. 2009) always as-

sume that either the elasticity of substitution between production factors is equal to one (Cobb-Douglas production function), or that heterogeneity applies to the whole marginal cost, so that more productive firms are more efficient with respect to both production factors. Thus, in these models, a fall in prices of one of the production factor affects all firms without affecting the share of final demand across varieties.

As in the previous chapter, we assume that production factors are not substitutes, and that the heterogeneity applies only to labor use while the use of the intermediate good is homogeneous across firms. Under this assumption, firms react differently to a change in the price of the intermediate good or in the cost of labor, leading to a change in relative prices and to a reallocation of market shares.

Consequently, depending on the relative prices of production factors, some firms are able (or not) to access foreign markets while others serve them through exports or HFDI. In this chapter, we show that production heterogeneity also depends on the price of the intermediate good and on wages in the final good sector. Consequently, as in HMY (2004), more heterogeneity leads to a higher share of FDI compared to exports.

These results may be useful for policy makers since, although they are not able to modify the distribution of labor productivity, they can affect production factor prices through several policies. For example, policy makers can subsidize final sector firms in order to reduce wages or the cost of intermediate goods.

In this chapter, we investigate the effect of such subsidies on the export performance of national firms and FDI. We show that both subsidies on intermediate goods and on wages support total exports, reduce outgoing FDI and attract incoming FDI. However, reducing the cost of intermediate goods leads to reallocation of market shares from less productive national firms to more productive affiliates of foreign firms, and decreasing wages leads to reallocation from more productive firms to less productive ones.

For this investigation, we extend the Helpman Melitz and Yeaple (2004) model with heterogeneous firms by introducing an upstream sector. As in the previous chapter, the linkage between the final good sector and the intermediate good sector is made via a fixed proportion technology, thus, whatever the level of final good production, firms need a constant fraction of the intermediate good to produce one unit of the final good.

In the first part of this chapter, we build the model and give some results in open economy where firms can access foreign markets through exports or HFDI. We show that the reallocation process that results from a simultaneous and identical change in the intermediate good price in both countries is highly dependent on fixed costs. In the second part, we analyze the impacts of subsidies depending if they are on

labor or on the intermediate good and give some policy recommendations. The last part concludes.

2 Set-up of the model

This model is based on chapter 1 and on HMY (2004) models. We consider a world with two vertically related sectors. The intermediate sector uses labor to produce a homogeneous good, and the final sector uses labor and the intermediate good to produce a differentiated good in monopolistic competition. The intermediate good is used entirely by the final sector, so the representative consumer only consumes the final good.

The quantity of intermediate good used to produce one unit of final good is exogenously determined by the nature of the good and the final sector activity, so there is a technological constraint on the composition of the final good. For a given sector, all firms use the same quantity of homogeneous good to produce one unit of differentiated good. As in Melitz (2003) and HMY (2004), firms in the final sector are heterogeneous in their labor productivity. In other words, the quantity of labor used by a firm to produce one unit of final good depends on its labor productivity which differs among firms.

To ensure full employment, the amount of labor available in the economy is given inelastically at its aggregate level by the size of the country, and is used by the two sectors. For the sake of simplicity and without loss of generality, here we assume that the number of domestic firms is exogenous and is the same in both countries. The effect of intermediate good prices on domestic markets is investigated in the next chapter (chapter 3).

In this chapter, the world is assumed to be composed of two symmetric countries, namely the home country h and the foreign country f. To simplify the presentation, we focus on the results of firms in country h, keeping in mind that the results are exactly the same for firms in country f.

The assumption of symmetric countries ensures that wages and the price of the intermediate good are the same in each country, and that the consumption of this intermediate good by firms in the final sector is also the same. Thus, for a given level of labor productivity, production costs are the same in the two countries. Assuming that input trade costs are strictly positive and that the intermediate good is homogeneous, there is no international trade in this sector. Thus, in this chapter, firms use locally produced intermediate goods.

Firms in the final good sector can choose to sell part of their output in foreign countries via exports. To do so, firms pay a fixed cost, f_{ex}, which represents the

adaptation costs to international markets (distribution and servicing network) and an iceberg transport cost $\tau > 1$. We assume that firms are indifferent between paying the export cost f_{ex} and paying the amortized per period portion of this cost $f_x = \delta f_{ex}$ in each period.

Alternatively, firms can serve foreign markets by creating an affiliate abroad. To do so, they must pay a fixed cost f_I. As in HMY (2004), this fixed cost includes the adaptation costs to foreign markets (distribution and servicing network) like for f_x, as well as the cost of creating or acquiring an affiliate overseas, so $f_I > f_x$.

The location of production does not affect the characteristics of the varieties or the productivity of the firms. Each firm still produces only one variety, regardless of which country the variety is produced in. As multinational firms produce the same variety in each of their plants, there is no intra-firm trade and these varieties are provided by local plants only. Thus, a firm remains on its domestic market and does not serve foreign markets, or it exports, or it sets up an affiliate abroad. Thus, while all firms produce for their domestic market, domestic firms only sell in the home country and do not access the foreign market; exporting firms produce in the home country and sell part of their production abroad; multinational firms serve both the country with a local plant: domestic production is sold on the domestic market, and the production of the foreign affiliate is sold in the foreign country.

2.1 Demand

The preferences of a representative consumer are given by a C.E.S. utility function over a continuum of goods indexed by ω:

$$U = \left[\int_{\omega\in\Omega} y(\omega)^{\rho} d\omega\right]^{1/\rho} \tag{2.1}$$

This utility function only depends on final good consumption and Ω represents the set of available varieties. Varieties are substitutes; this implies that $0 < \rho < 1$, and the elasticity of substitution between any two varieties is given by $\sigma = \frac{1}{1-\rho} > 1$. As in the Dixit-Stiglitz model, we can consider the set of varieties consumed as an aggregated good $Y \equiv U$ associated with an aggregated price P.

Optimization of consumer preferences leads to the optimal consumption of each variety ω: $y(\omega) = \frac{p(\omega)^{-\sigma}}{\int p(\omega)^{1-\sigma} d\omega} R$, which can be written with the aggregated price index $P = \left[\int_{\omega\in\Omega} p(\omega)^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}}$

$$y(\omega) = Y\left(\frac{p(\omega)}{P}\right)^{-\sigma} \tag{2.2}$$

The expenditure for each variety is given by

$$r(\omega) = R\left(\frac{p(\omega)}{P}\right)^{1-\sigma} \tag{2.3}$$

where R is aggregate expenditure. These results are standard in monopolistic competition.

2.2 Production

2.2.1 Intermediate good sector

The intermediate good sector is perfectly competitive. Firms produce a homogeneous good by using a single input, labor, and its entire production will be processed to produce the final good.

Let A be the quantity of intermediate good produced, which is a function of the labor used by the representative firm L_A and of z which is the labor needed to produce one unit of intermediate good. w is the common wage of the economy.

The profit function of a representative firm is given by

$$\pi_A = zA - wL_A \tag{2.4}$$

In perfect competition, the representative firm will sell its production at its marginal cost, so by normalizing the common wage to 1 we have the price of the intermediate good $p_A = z$

2.2.2 Final good sector

There is a continuum of firms, each choosing to produce a different variety ω. The production of variety ω requires two inputs, labor l_ω and intermediate goods a_ω.

The focus of this model is on sectors closely related to their intermediate goods, so, as in the previous chapter, we assume that inputs are complementary. However, as shown in chapter 1, the main mechanisms hold as long as inputs are not perfect substitutes.

As previously, we also assume that each unit of final good produced in a given sector requires the same amount of intermediate good (α), so there is a technological constraint on the production of the final good. Each firm uses α units of the intermediate good and $1/\varphi$ units of labor to produce one unit of final good. Nevertheless, a firm can be more efficient, than others and use a less labor-intensive technology to produce its variety. So, like in Melitz (2003), the marginal productivity of labor φ differs across firms. Hence, each firm produces its own variety (ω), and each firm

varies with respect to its labor productivity φ. As for a given φ we have one ω, we can refer to a firm either by its variety (ω), or by its labor productivity (φ). Indeed, even if a firm decides to set up an affiliate abroad, this multinational firm will produce the same variety in the affiliate as at its headquarters, and will use the same amount of labor to produce one unit of the variety.

For a firm in the final good sector, the total cost function to serve a market will differ according to the modality to access it:

- on the domestic market, this is given by

$$TC_d(\varphi) = \left(z\alpha + \frac{1}{\varphi}\right) y_d(\varphi) \tag{2.5}$$

- to serve the foreign market through export, the cost function is given by

$$TC_x(\varphi) = \tau \left(z\alpha + \frac{1}{\varphi}\right) y_x(\varphi) + \mathrm{f}_x \tag{2.6}$$

- and to serve it by FDI:

$$TC_I(\varphi) = \left(z\alpha + \frac{1}{\varphi}\right) y_I(\varphi) + \mathrm{f}_I \tag{2.7}$$

where z is the price of the intermediate good, α is the amount of intermediate good needed to produce one unit of final good, φ is the labor productivity of the firm, and $y_d(\varphi)$ is its production destined for the domestic market.

Under monopolistic competition, each firm faces a residual demand curve with constant elasticity σ. Thus, whatever the market, a firm sells its production with a markup $\frac{1}{\rho}$ over its marginal cost and the pricing rules in each market become:

$$\begin{array}{ll} p_d = \frac{1}{\rho} MC_d = \frac{1}{\rho}(z\alpha + 1/\varphi) & \text{For varieties produced by domestic firms} \\ p_x = \frac{1}{\rho} MC_x = \frac{1}{\rho}(z\alpha + 1/\varphi)\,\tau & \text{For imported varieties} \\ p_I = \frac{1}{\rho} MC_I = \frac{1}{\rho}(z\alpha + 1/\varphi) & \text{For varieties produced by affiliates of foreign firms} \end{array} \tag{2.8}$$

We observe that when a firm invests abroad, the pricing rule for the domestic market and for the foreign market is the same ($p_I(\varphi) = p_d(\varphi)$). In other words, on a given market, the price depends on the location of production, but not on the nationality of the firm. Thus, as the price of a good produced at the firm's headquarter and at its affiliates is the same, and as countries are symmetric, the level of production and revenues are also the same for the headquarter and its affiliates: $y_d(\varphi) = y_I(\varphi)$ and $r_d(\varphi) = r_I(\varphi)$.

The price elasticity to a change in the intermediate product price is the same for each market and is given by:

$$\varepsilon_{p(\varphi),z} \equiv \frac{\partial p(\varphi)}{\partial z}\frac{z}{p(\varphi)} = \frac{z\alpha}{z\alpha + 1/\varphi} \tag{2.9}$$

where $\mathrm{d}\varepsilon_{p(\varphi),z}/\mathrm{d}z$ increases with φ. As in the previous chapter, high productivity firms react more to a change in intermediate good prices than low productivity firms because the share of the cost of intermediate goods in total production costs is higher for high productivity firms. Thus, a change in intermediate product price leads to a change in relative prices in the final good sector.

2.2.2.1 Revenue levels The firm revenue can be broken down into what it earns on each market: namely domestic sales and export sales or affiliate sales if the firm is able to access the foreign market.

The combined revenue of a firm $r(\varphi)$, depends on its status.

$$r(\varphi) = \begin{cases} \text{For domestic firms} & r_d(\varphi) \\ \text{For exporting firms} & r_d(\varphi) + r_x(\varphi) = (1+\tau^{1-\sigma})\, r_d(\varphi) \\ \text{For multinational firms} & r_d(\varphi) + r_I(\varphi) = 2r_d(\varphi) \end{cases} \tag{2.10}$$

The ratios of any two firms' outputs or revenues associated with each market are the same for each status[2] and can be written as a function of their labor productivity only

$$\begin{aligned} \frac{y_d(\varphi_1)}{y_d(\varphi_2)} &= \frac{y_x(\varphi_1)}{y_x(\varphi_2)} = \frac{y_I(\varphi_1)}{y_I(\varphi_2)} = \left[\frac{\varphi_1}{\varphi_2}\frac{(1+z\alpha\varphi_2)}{(1+z\alpha\varphi_1)}\right]^{\sigma} \\ \frac{r_d(\varphi_1)}{r_d(\varphi_2)} &= \frac{r_x(\varphi_1)}{r_x(\varphi_2)} = \frac{r_I(\varphi_1)}{r_i(\varphi_2)} = \left[\frac{\varphi_1}{\varphi_2}\frac{(1+z\alpha\varphi_2)}{(1+z\alpha\varphi_1)}\right]^{\sigma-1} \end{aligned} \tag{2.11}$$

Output and revenue ratios depend not only on labor productivity but also on the price of the intermediate good and its use in production process. Greater use of the intermediate good to produce the final good or a higher price of the intermediate good reduces these ratios. In other words,

Proposition 1 *The use of an intermediate good at a fixed proportion reduces the advantage of more productive firms.*

Proposition 2 *A fall in prices of an intermediate good increases the differences between firms in terms of production and revenues.*

[2]Because firms are either only domestic firms, or exporters, or multinational, these ratios do not represent effective output and revenues but potential ones.

Thus, the price of intermediate goods affects the impact of heterogeneous labor productivity. The lower the price of the intermediate good, the greater the heterogeneity of output, revenue and profit.

2.2.3 Effect of intermediate good price on revenues and profits.

The impact of z on $r(\varphi)$ at a given labor productivity (or for a given firm) is not obvious. Input price affects not only the variety price but also price indexes. Let φ_ω be the labor productivity of the firm producing the variety ω. According to the calculations in Appendix A, the effect of the price of the intermediate good on the domestic revenue of this firm is given by

$$\frac{\partial r_d(\varphi_\omega)}{\partial z} = (\sigma-1)\frac{r_d(\varphi_\omega)}{z}\left(\frac{\partial P}{\partial z}\frac{z}{P} - \frac{\partial p(\varphi_\omega)}{\partial z}\frac{z}{p(\varphi_\omega)}\right) \tag{2.12}$$

or, equivalently,

$$\varepsilon_{r_d(\varphi),z} = (\sigma-1)\left(\varepsilon_{P,z} - \varepsilon_{p(\varphi),z}\right) \tag{2.13}$$

where $\varepsilon_{r_d,z}$ and $\varepsilon_{P,z}$ are the elasticities of the domestic revenue and price index to input price, respectively. In other words, the effect of input price on domestic revenue can be positive or negative depending on the gap between the elasticity of the price index and that of the variety price. If the fall in the variety price is greater than the fall in the price index, the variety ω will be relatively more competitive, and the firm φ_ω will increase its market share. Conversely, if the fall in price index is greater, then the variety ω will become relatively less competitive and market share of the firm φ_ω will shrink with a fall in input price.

It will be recalled that more productive firms are more affected by changes in intermediate good prices. Thus, $\varepsilon_{p(\varphi),z}$ is more likely to be higher than $\varepsilon_{P,z}$ for high productive firms. Indeed, we show in appendix B that the sign of the effect of intermediate good price on the revenue of the firm φ_ω is given by:

$$\begin{aligned} & \operatorname{sign}\left\{\frac{\partial r_d(\varphi_\omega)}{\partial z}\right\} \qquad (2.14)\\ = \ & \operatorname{sign}\left\{\left[\int_0^\infty \frac{p(\varphi)^{1-\sigma}}{p(\varphi)}g(\varphi)\mathrm{d}\varphi + \tau^{1-\sigma}\int_{\varphi_x^*}^{\varphi_I^*}\frac{p(\varphi)^{1-\sigma}}{p(\varphi)}g(\varphi)\mathrm{d}\varphi + \int_{\varphi_I^*}^{+\infty}\frac{p(\varphi)^{1-\sigma}}{p(\varphi)}g(\varphi)\mathrm{d}\varphi\right]\right.\\ & \left. - \left[\int_0^\infty \frac{p(\varphi)^{1-\sigma}}{p(\varphi_\omega)}g(\varphi)\mathrm{d}\varphi + \tau^{1-\sigma}\int_{\varphi_x^*}^{\varphi_I^*}\frac{p(\varphi)^{1-\sigma}}{p(\varphi_\omega)}g(\varphi)\mathrm{d}\varphi + \int_{\varphi_I^*}^{+\infty}\frac{p(\varphi)^{1-\sigma}}{p(\varphi_\omega)}g(\varphi)\mathrm{d}\varphi\right]\right\} \end{aligned}$$

The impact of the intermediate good price on domestic revenue and profit is positive when the price of the variety is high (when the labor productivity of the

firm is low), and is negative when the price of the variety is low (when the labor productivity of the firm is high).

This result can also be used to determine the effect of intermediate good prices on exports and affiliate revenues.

As $r_x(\varphi) = \tau^{1-\sigma} r_d(\varphi)$, thus $\text{sign}\left\{\frac{\partial r_x(\varphi_\omega)}{\partial z}\right\} = \text{sign}\left\{\frac{\partial \tau^{1-\sigma} r_d(\varphi_\omega)}{\partial z}\right\} = \text{sign}\left\{\frac{\partial r_d(\varphi_\omega)}{\partial z}\right\}$

Moreover, as $r_I(\varphi) = r_d(\varphi)$, $\text{sign}\left\{\frac{\partial r_I(\varphi_\omega)}{\partial z}\right\} = \text{sign}\left\{\frac{\partial r_d(\varphi_\omega)}{\partial z}\right\}$.

$$\text{sign}\left\{\frac{\partial r_d(\varphi_\omega)}{\partial z}\right\} = \text{sign}\left\{\frac{\partial r_x(\varphi_\omega)}{\partial z}\right\} = \text{sign}\left\{\frac{\partial r_I(\varphi_\omega)}{\partial z}\right\} \tag{2.15}$$

The sign of the effect of intermediate good prices on sales is the same for domestic, export and FDI sales. It is positive when the price of the variety is high (when the labor productivity of the firm is low), and is negative when the price of the variety is low (when the labor productivity of the firm is high).

Thus,a unique labor productivity value $\hat{\varphi}$ exists such that the revenue on each market of a firm with this labor productivity is not affected by variations in the pr ofices intermediate good $\partial r(\hat{\varphi})/\partial z = 0$. Regardless of the destination market, every firm whose labor productivity is greater than $\hat{\varphi}$ will benefit from a decrease in the price of the intermediate good, at the expense of less productive firms.

The marginal costs of more productive firms are more affected by variations in the price of the intermediate good. Thus, when the price of the intermediate good falls, the marginal cost and the variety price of more productive firms decrease more than those of less productive firms. Thus, changes in relative prices between varieties lead to a reallocation of market shares from less productive firms ($\varphi < \hat{\varphi}$) to more productive ones ($\varphi > \hat{\varphi}$).

Proposition 3 *Regardless of the destination market, a symmetric fall in prices of the intermediate good leads to market share reallocations from less productive firms to more productive ones in both countries.*

2.3 Entry and exit of firms on foreign markets

We separate the domestic profit from the export and FDI profit.

$$\begin{array}{ll} \text{Domestic profit:} & \pi_d(\varphi) = r_d(\varphi)/\sigma \\ \text{Export profit:} & \pi_x(\varphi) = r_x(\varphi)/\sigma - \mathrm{f}_x \\ \text{Affiliate profit:} & \pi_I(\varphi) = r_I(\varphi)/\sigma - \mathrm{f}_I \end{array} \tag{2.16}$$

The combined profit of a firm, $\pi(\varphi)$, then depends on its status.

$$\pi(\varphi) = \begin{cases} \pi_d(\varphi) = r_d(\varphi)/\sigma & \text{For domestic firms} \\ \pi_d(\varphi) + \pi_x(\varphi) = (1+\tau^{1-\sigma})\, r_d(\varphi)/\sigma - \mathrm{f}_x & \text{For exporting firms} \\ \pi_d(\varphi) + \pi_I(\varphi) = 2r_d(\varphi)/\sigma - \mathrm{f}_I & \text{For multinational firms} \end{cases} \tag{2.17}$$

Labor productivity threshold φ_x^* and φ_I^*:

A firm will export only if its export profit is positive $\pi_x(\varphi) \geq 0$ and will invest abroad only if its investing profit is positive $\pi_I(\varphi) \geq 0$ and higher than its export profit $\pi_I(\varphi) \geq \pi_x(\varphi)$. Then, for a successful entrant, combined profit can be written as:

$$\pi(\varphi) = \pi_d(\varphi) + \max\{0, \pi_x(\varphi), \pi_I(\varphi)\} \tag{2.18}$$

Thus, we define the export cutoff level as the labor productivity level below which a firm will not export:

$$\varphi_x^* = \inf\{\varphi : \pi_x(\varphi) \geq 0\} \tag{2.19}$$

and the FDI cutoff level as the labor productivity level below which a firm will not invest abroad:

$$\varphi_I^* = \inf\{\varphi : \pi_I(\varphi) \geq 0 \text{ and } \pi_I(\varphi) \geq \pi_x(\varphi)\} \tag{2.20}$$

Coexistence of exporting firms and multinational firms

If $\varphi_x^* = \varphi_I^*$, all firms which can serve the foreign market will do so by FDI, and there will be no exporting firms. For exporting and multinational firms ot coexist, we must have $\varphi_I^* > \varphi_x^*$. To do so, we assume a cost structure such as:

$$\mathrm{f}_I > \tau_x^{\sigma-1}\mathrm{f}_x. \tag{2.21}$$

Then, if $\tau_x^{\sigma-1}\mathrm{f}_x < \mathrm{f}_I$, there will be a range of thresholds such as $\varphi_x^* < \varphi_I^*$, and less productive firms will serve only domestic markets, more productive firms will serve the foreign market through exports, and the most productive firms will serve the foreign market through FDI.

Hence we assume that the structure of costs satisfies this inequality. Thus, we have a partitioning of firms by export and FDI status.

Distribution of labor productivity and the status of the firm

Equilibrium is characterized by a mass M of firms in each country and a distribution $g(\varphi)$ of labor productivity over a subset of $[0, \infty[$. M and $g(\varphi)$ are exogenous.

Moreover, we set $\upsilon(\varphi)$ as the conditional distribution of $g(\varphi)$ on $[\varphi_I^*; +\infty[$:

$$\upsilon(\varphi) = \begin{cases} \frac{g(\varphi)}{1-G\left(\varphi_I^*\right)} = \frac{g(\varphi)}{\theta_I} & \text{if } \varphi \geq \varphi_I^* \\ 0 & \text{if } \varphi < \varphi_I^* \end{cases} \tag{2.22}$$

The probability that a successful entrant invests abroad is equal to $\theta_I = 1 - G(\varphi_I^*)$. There is thus a proportion θ_I of firms which invest abroad, and hence an endogenous mass $M_I = \theta_I M$ of multinational firms.

Only firms whose labor productivity lies between φ_x^* and φ_I^* export. The probability that a successful entrant exports is given by $\theta_x = 1 - G(\varphi_x^*) - [1 - G(\varphi_I^*)] = G(\varphi_I^*) - G(\varphi_x^*)$.

We set $\eta(\varphi)$ as the ex-ante distribution $g(\varphi)$ conditional on export status:

$$\eta(\varphi) = \begin{cases} 0 & \text{if } \varphi \geq \varphi_I^* \\ \frac{g(\varphi)}{G\left(\varphi_I^*\right)-G(\varphi_x^*)} = \frac{g(\varphi)}{\theta_x} & \text{if } \varphi_x^* \leq \varphi < \varphi_I^* \\ 0 & \text{if } \varphi < \varphi_x^* \end{cases} \tag{2.23}$$

So there is a fraction θ_x of firms which export and hence an endogenous mass $M_x = \theta_x M$ of exporting firms. The total mass of available varieties in a country (M_t) is given by the mass of varieties produced by national firms (M), the mass of imported varieties (M_x) and the mass of affiliates producing in the country (M_I) : $M_t = M + M_x + M_I$.

2.4 Market equilibrium

2.4.1 Effect of intermediate good price on threshold values

Impact of intermediate good price on the export threshold

We now are in a position to determine the impact of the price of intermediate goods on the export threshold.

At equilibrium, $r_x(\varphi_x^*) = \mathrm{f}_x/\sigma$, we thus have

$$\frac{\mathrm{d}r(\varphi_x^*)}{\mathrm{d}z} = \frac{\partial r_x(\varphi)}{\partial \varphi}\frac{\mathrm{d}\varphi_x^*}{\mathrm{d}z} + \frac{\partial r_x(\varphi)}{\partial z} = 0 \tag{2.24}$$

And we can write

$$\frac{\mathrm{d}\varphi_x^*}{\mathrm{d}z} = \underbrace{-\frac{\partial r_x(\varphi)}{\partial z}}_{\begin{array}{l} >0 \ \ \forall \varphi < \hat{\varphi} \\ <0 \ \ \forall \varphi > \hat{\varphi} \end{array}} \Big/ \underbrace{\frac{\partial r_x(\varphi)}{\partial \varphi}}_{>0} \tag{2.25}$$

where $\hat{\varphi}$ is the labor productivity of the firm whose revenues are not affected by variations of the price of intermediate goods (see section 2.2.3). Let $\widehat{\mathrm{f}_x}$ be the

export fixed costs such as $\widehat{f_x} = r_x(\hat{\varphi})/\sigma$. For such a value of export fixed costs, the export profit of the firm with productivity $\hat{\varphi}$ is zero. Thus, at this level of fixed costs, the productivity threshold $\varphi_x^* = \hat{\varphi}$ and does not vary with the input price $\left(\frac{\mathrm{d}\varphi_x^*}{\mathrm{d}z} = \frac{\mathrm{d}\hat{\varphi}}{\mathrm{d}z} = 0\right)$. Thus, there is a unique level of export fixed costs $\widehat{f_x}$ such that the probability to export is not affected by variations in the price of inputs.

Impact of intermediate good price on FDI threshold

Keeping in mind that the FDI labor productivity threshold is given by the equalization of export and FDI profit, we can determine the impact of intermediate good prices on the FDI threshold.

$$\frac{\mathrm{d}\varphi_I^*}{\mathrm{d}z} = -\left[\frac{\partial r_I(\varphi)}{\partial z} - \frac{\partial r_x(\varphi)}{\partial z}\right] \Big/ \underbrace{\left[\frac{\partial r_I(\varphi)}{\partial \varphi} - \frac{\partial r_x(\varphi)}{\partial \varphi}\right]}_{>0} \tag{2.26}$$
$$> 0 \quad \forall \varphi < \hat{\varphi}$$
$$< 0 \quad \forall \varphi > \hat{\varphi}$$

As for export fixed costs, let $\widehat{f_I}$ be the FDI fixed costs such as $\pi_I(\hat{\varphi}) = \pi_x(\hat{\varphi}) \Leftrightarrow \widehat{f_I} = [r_I(\hat{\varphi}) - r_x(\hat{\varphi})]/\sigma + f_x$. For such a value of FDI fixed costs, the FDI profit of the firm with productivity $\hat{\varphi}$ is equal to its export profit so that $\hat{\varphi} = \varphi_I^*$. We know that the firm with a labor productivity $\hat{\varphi}$ is not affected by input price variation whatever its destination market. Thus, as its export revenue and its investing revenue do not vary, the trade-off between exporting and investing abroad remains unchanged for this firm. Thus, at this level of FDI fixed costs, the productivity threshold φ_I^* does not vary with the input price $\left(\frac{\mathrm{d}\varphi_I^*}{\mathrm{d}z} = \frac{\mathrm{d}\hat{\varphi}}{\mathrm{d}z} = 0\right)$. Thus, for a given export fixed cost, there is a unique level of FDI fixed costs $\widehat{f_I}$ such that the probability to invest abroad is not affected by an input price variation. Note that $\widehat{f_I} = \tau^{\sigma-1}\widehat{f_x}$.

Impact of intermediate good price on Export/FDI trade-off

We know that if a firm has a productivity level above $\hat{\varphi}$, a fall in intermediate good price increases its market share on the domestic market and on the foreign market, if the firm can access it. However, the export FDI trade off may be affected if export and FDI profit do not vary in exactly the same way. In order to compare the effect on export and FDI sales and profits, we know that

$$\begin{aligned} \frac{\partial \pi_I(\varphi)}{\partial z} &= \frac{\partial r_d(\varphi)}{\partial z} \\ \frac{\partial \pi_x(\varphi)}{\partial z} &= \frac{\partial \tau^{1-\sigma} r_d(\varphi)}{\partial z} \end{aligned}$$

Thus,

$$\left|\frac{\partial \pi_I(\varphi)}{\partial z}\right| > \left|\frac{\partial \pi_x(\varphi)}{\partial z}\right| \tag{2.27}$$

The effect of the intermediate good price is always greater on FDI revenue and profit than on export revenue and profit.

In other words, when $\frac{\partial r_d(\varphi)}{\partial z} > 0$, i.e. $\varphi < \hat{\varphi}$

$$\frac{\partial \pi_I(\varphi)}{\partial z} > \frac{\partial \pi_x(\varphi)}{\partial z} \tag{2.28}$$

but when $\varphi > \hat{\varphi}$, then $\frac{\partial r_d(\varphi)}{\partial z} < 0$ and

$$\frac{\partial \pi_I(\varphi)}{\partial z} < \frac{\partial \pi_x(\varphi)}{\partial z} \tag{2.29}$$

On the one hand, for less productive firms, a fall in the intermediate good price will decrease FDI and export profit and sales, but export sales will decrease less. Thus, the FDI/export trade-off will change in favor of export.

On the other hand, for high productive firms $(\varphi > \hat{\varphi})$, a fall in the intermediate good price will increase FDI and export profit and sales, but export sales will increase less. Thus, the FDI/export trade-off will change in favor of FDI.

Thus, if the less productive firm which invests abroad is a low productivity firm $(\varphi_I^* < \hat{\varphi})$, a fall in intermediate good price will change its export/FDI trade-off in favor of export, and the labor productivity threshold above which the firm decides to invest abroad will increase; and if the less productive firm investing abroad is a high productivity firm $(\varphi_I^* > \hat{\varphi})$, a fall in intermediate good price will change its export/FDI trade-off in favor of FDI, and the labor productivity threshold above which the firm decides to invest abroad will decrease.

2.4.2 Levels of fixed costs and reallocation process

The status of the firm which is not affected by a fall in input price $(\varphi = \hat{\varphi})$ depends on fixed costs. Indeed, if $\mathrm{f}_I > \widehat{\mathrm{f}_I}$ the firm with a labor productivity $\hat{\varphi}$ is not able to invest abroad $(\varphi_I^* > \hat{\varphi})$ and if $\mathrm{f}_x > \widehat{\mathrm{f}_x}$ this firm is not able to export $(\varphi_x^* > \hat{\varphi})$. As we assume that exporting firms and multinational firms coexist (i.e. $\mathrm{f}_I > \tau_x^{\sigma-1}\mathrm{f}_x$) and knowing that $\widehat{\mathrm{f}_I} = \tau^{\sigma-1}\widehat{\mathrm{f}_x}$, we cannot have both $\mathrm{f}_x > \widehat{\mathrm{f}_x}$ and $\mathrm{f}_I < \widehat{\mathrm{f}_I}$, and three cases are possible depending on the level of fixed costs:

- *High* fixed export and *high* fixed FDI costs.($\mathrm{f}_x > \widehat{\mathrm{f}_x}$ and $\mathrm{f}_I > \widehat{\mathrm{f}_I}$):

In this case, the selection process on foreign market is tough, only highly productive firms are able to access them. Thus both export and FDI labor productivity

thresholds are above $\hat{\varphi}$ ($\hat{\varphi} < \varphi_x^* < \varphi_I^*$). More productive domestic firms benefit from a fall in input prices ($\varphi \in]\hat{\varphi}, \varphi_x^*[$), like all firms, and firms which export and invest abroad. The market share of all these firms increases both on their domestic market and on the foreign market at the expense of less productive domestic firms ($\varphi < \hat{\varphi}$). The less productive exporting firm (φ_x^*) increase its market share so that its profit also increases and becomes strictly positive and the threshold labor productivity to export decreases in order to have $\pi(\varphi_x^*) = 0$. Due to these new imported varieties, the share of firms that can access foreign markets increases and the number of available varieties increases in both countries. In addition, as shown in eq. 2.28, export revenue increases less than that of affiliates, the FDI/export trade-off is modified in favor of FDI for all firms accessing the foreign market so that φ_I^* decreases.

- *Low* fixed export and *high* fixed FDI costs. ($\mathrm{f}_x < \widehat{\mathrm{f}_x}$ and $\mathrm{f}_I > \widehat{\mathrm{f}_I}$):

In this case, the export labor productivity threshold is below $\hat{\varphi}$ and the FDI labor productivity threshold is above $\hat{\varphi}$ ($\varphi_x^* < \hat{\varphi} < \varphi_I^*$). More productive exporting firms ($\varphi \in]\hat{\varphi}, \varphi_I^*[$) benefit from a decrease in input prices, like all firms investing abroad, and their market share increases on each market at the expense of both domestic firms and less productive exporting firms ($\varphi < \hat{\varphi}$). As the export labor productivity threshold is below $\hat{\varphi}$, it increases in order to have $\pi(\varphi_x^*) = 0$. Thus, the probability to export $\theta_x = (G(\varphi_I^*) - G(\varphi_x^*))$ shrinks. In this case, the share of firms which can access foreign markets decreases and the number of available varieties decreases in both countries. Moreover, as in the previous case, the export revenue of more productive exporting firms increases less than that of affiliates (see eq. 2.28) so that the FDI/Export trade-off evolves in favor of FDI leading to a fall in φ_I^* and an increase in the probability of investing abroad.

- *Low* fixed export and *low* fixed FDI costs.($\mathrm{f}_x < \widehat{\mathrm{f}_x}$ and $\mathrm{f}_I < \widehat{\mathrm{f}_I}$):

In this case, both export and FDI labor productivity thresholds are below $\hat{\varphi}$ ($\varphi_x^* < \varphi_I^* < \hat{\varphi}$). Only the most productive firms investing abroad ($\varphi_I^* > \varphi > \hat{\varphi}$) benefit from a fall in input prices. The market shares of these multinational firms increase on each market at the expense of domestic firms, exporting firms and less productive investing firms.

As φ_x^* is under $\hat{\varphi}$, the firm with this labor productivity sees its market share shrink and its profit becomes strictly negative. Thus, the firm is no longer able to export and φ_x^* increases in order to have $\pi(\varphi_x^*) = 0$. Thus, the share of firms that can access foreign markets decreases. Moreover, for more productive exporting firms and less productive investing ones ($\varphi < \hat{\varphi}$), the export revenue and the investment revenue decrease. However, the export revenue decreases less than the

investing revenue (see eq. 2.29) so that the FDI/export trade-off evolves in favor of export for these firms, while for more productive firms which invest abroad ($\varphi > \hat{\varphi}$), the investment revenue increases more than the export revenue (see eq. 2.28), and the FDI/export trade-off changes in favor of FDI. Thus, less productive multinational firms will close their affiliates and serve the foreign market through exports, while more productive multinational firms will see their decision to invest abroad reinforced.

Whatever the level of fixed costs, a fall in the intermediate good price leads to a bigger increase in total FDI revenues than the possible increase in total export revenue. Thus, at the aggregated level, a multilateral decrease in the intermediate good price leads to an increase in FDI sales over exports.

This result is in line with the result of Helpman, Melitz and Yeaple (2004): the ratio of FDI sales on exports increases with sectorial heterogeneity, due to higher dispersion of labor productivity ($g(\varphi)$) or higher elasticity of substitution (σ). In the model presented in this chapter, a fall in intermediate good price leads to an increase in the heterogeneity of revenues and production (as shown in equation 2.11) and increases FDI sales over exports.

Thus, intermediate good price level affects international strategy of firms, even if country are perfectly symmetric and without any comparative advantages. Moreover, in this chapter, the sectorial heterogeneity plays a similar role as in HMY (2004) model, but while the elasticity of substitution and the dispersion of labor productivity may be parameters on which policy makers do not have influence, several policy tools may affect intermediate good price and thus export/FDI trade-off. These tools can be international trade policies, e.g., a decrease in input tariffs may decrease intermediate good prices on the domestic market and lead to an increase in FDI sales compared to exports, but also subsidies on intermediate goods purchased by firms in the domestic final good sector. However, these policies may also affect the symmetry of countries if they apply in only one country. Thus, a deeper analysis is required. In the next section, a comparison is made between two alternative subsidies: one on intermediate good costs, and the other on wages paid by firms in the final good sector. These subsidies only apply in country h.

3 Impact of intermediate good and labor subsidies

In the previous section, we saw that changes in intermediate good price affect both the export performance of firms and their choice between exporting and investing

abroad, even if the intermediate good price remains the same in all countries. This new determinant of HFDI can help policy makers attract foreign capital, support export, or reduce outgoing FDI.

In this section, we compare two policies, the first consists in a subsidy for final good producers on their intermediate good costs, and the second on their labor costs. Investigating these two policies is interesting in this model because, as shown in previous sections, the impact of a change in a production factor price depends on the share of the production factor in a firm's marginal costs. We show that the share of an intermediate good in marginal costs increases with the labor productivity of the firm, so that more productive firms are more affected by variations in the price of the intermediate good, and, conversely, are less affected by changes in the price of labor. Thus, we expect different allocations of revenues depending on policies.

We assume that policy makers are concerned by consumers' welfare, export performance of national firms, and by the attraction of foreign capital through incoming FDI. In addition, for employment considerations, they may be concerned by the reduction in outgoing FDI.[3]

Assuming that these subsidies are paid in country h, only firms producing in this country will see their marginal costs decreasing. Consequently, changes in production costs of firms depend on where they produce, and not on their nationality.

The aim of this section is not to assess whether it is efficient for policy makers to pay subsidies, but to investigate the different effects of subsidies. Thus, we are not concerned with how policy makers finance the subsidies and we assume that all other things remain equal: countries remain symmetric with respect to all variables, except intermediate good price and wages[4].

3.1 Intermediate good subsidy

Here, the policy consists in subsidizing the purchase of the intermediate good to decrease the production costs of final good firms. The Common Agricultural Policy (CAP) is such a policy in Europe. Even if the CAP does not finance the purchase of agricultural goods, the 2003 "decoupling" reform enabled a decrease in agricultural prices for consumers and for firms that process agricultural goods while preserving farmers' income.

New prices

[3]Note that this model does not take effects on the labor market into account because it assumes full employment.

[4]A custom tariff can be integrated in the variable cost of final goods τ, and the revenue generated by this tax can be redistributed through subsidies. In order to achieve symmetric trade costs between countries, firms in country h can have additional variable costs to export to country f so that $\tau_h = \tau_f = \tau$. This may be the case if export infrastructures are more efficient in country h (higher container capacity for shipping for example).

Let s_A be the subvention, expressed as the ad-valorem part of the intermediate good price. The price of intermediate goods in country h is now given by

$$p_{Ah} = (1 - s_A)\, z \tag{2.30}$$

while in country f it is still $p_{Af} = z$, consequently $p_{Ah} < p_{Af}$
This policy leads to the following pricing rules:

- in country h

$$\begin{array}{ll} p_{hd} = \frac{1}{\rho}\left((1 - s_A)\, z\alpha + w/\varphi\right) & \text{For varieties produced by national firms} \\ p_{fx} = \frac{1}{\rho}\left(z\alpha + w/\varphi\right)\tau & \text{For imported varieties from } f \\ p_{fI} = \frac{1}{\rho}\left((1 - s_A)\, z\alpha + w/\varphi\right) & \text{For varieties produced by affiliates of foreign firms} \end{array} \tag{2.31}$$

- in country f

$$\begin{array}{ll} p_{fd} = \frac{1}{\rho}\left(z\alpha + w/\varphi\right) & \text{For varieties produced by national firms} \\ p_{hx} = \frac{1}{\rho}\left((1 - s_A)\, z\alpha + w/\varphi\right)\tau & \text{For imported varieties from } h \\ p_{hI} = \frac{1}{\rho}\left(z\alpha + w/\varphi\right) & \text{For varieties produced by affiliates of foreign firms} \end{array} \tag{2.32}$$

Impact on price indexes and domestic revenues

Marginal costs of firms producing in country h decrease thanks to the subsidy, leading to a fall in the price index in this country due to the lower price of domestic varieties and of varieties sold by foreign affiliates. Firms producing in country f still have the same marginal costs and variety prices. However, the price index in country f also decreases due to the fall in prices of imported varieties from country h.

Thus, in country h, imported varieties from country f lose market shares because their prices remain constant while the price index decreases. In country f, varieties produced locally (domestic varieties and varieties produced by affiliates) also lose market shares. Thus, all firms producing in country f lose market shares, whatever their destination market, because their marginal costs remain constant while price indexes decrease in both countries.

In addition to firms producing in country f, some firms in country h will also lose market shares even if they are able to reduce their variety price. Indeed, we saw in previous sections that more productive firms are more affected by changes in intermediate good prices. Thus, in country h, less productive firms will not reduce their variety price sufficiently relative to the fall in the price index, and their market share will decrease to the benefit of more productive firms. The higher the productivity of firms, the higher the gain due to the subsidy. Thus, the gain in the share of the market will be higher for affiliates of multinational firms from country f and headquarters of multinational firms in country h. In addition, the loss will be greater for less productive domestic firms. This reallocation process from low productivity firms to high productivity firms leads to a better allocation of resources among firms in country h.

Impact on exports

The extent to which a firm is affected by the reallocation process depends on the relative variation of its variety price with respect to the variation of the price index of its destination market. Export fixed costs and fixed costs to invest abroad influence the share of firms able to export from country h to country f, and hence the fall in the price index in country f and the reallocation process.

When export fixed costs are high or when fixed costs to invest abroad are low, φ_x^* and φ_I^* are close and the share of firms exporting from country h to country f is low ($\theta_{hx} = G(\varphi_I^*) - G(\varphi_x^*)$). In country f, only prices of imported varieties produced in country h decrease. As the share of varieties with falling prices is low in country f, the fall in the price index is low. If this fall in the price index is low enough, the variety prices of all exporting firms from country h decrease more than the price index, and the export market shares of all firms exporting from country h to country f increase. The subsidy on the price of the intermediate good in country h leads to a decrease in the labor productivity threshold above which a firm is able to export. In other words, when export fixed costs are high enough or when fixed costs to invest abroad are low enough, a subsidy reducing the intermediate good price paid by final good sector firms increases the share of national firms able to access the foreign country.

When export fixed costs are low enough or fixed costs to invest abroad are high enough, the share of firms exporting from country h to country f is high, and the drop in the price index in country f is high. Consequently, some low productive exporting firms will reduce their variety price less than the fall in price index of country f and will lose market shares. Thus, even if the aggregated market share of exporting firms increases, less productive exporting firms lose export market shares and are forced to exit the country f: the labor productivity threshold above which

a firm is able to export to country f rises. In other words, when export fixed costs are low enough or fixed costs to invest abroad are high enough, a subsidy reducing the intermediate good price paid by final good sector firms decreases the share of national firms able to access the foreign country.

In both cases, aggregated exports increase, but the number of exporting firms varies depending on export fixed costs. In other words, the share of firms able to access foreign markets increases only if subsidized firms are few enough so they do not have too much impact on the foreign price index.

Impact on the export/FDI trade-off

As the intermediate good price is lower in country h, the trade-off between export and FDI for firms in country h is modified in favor of exporting (the potential gain in variable cost is lower because of the higher price of the intermediate good in country f). This leads to relocation in country h of a share of the production destined for country f. For firms in country f, the reduction in marginal cost due to less expensive inputs is an additional incentive to serve country h through FDI. Thus, for firms in country f, the trade-off between export and FDI is modified in favor of FDI. However, if fixed costs to invest abroad are low enough, some MNF have a low productivity and lose market shares. Thus, the number of varieties produced in country h by affiliates of firms from country f can decrease, even if the aggregated sales of these affiliates constantly increase.

The policy consisting in decreasing input costs has the expected results when export fixed costs are high enough: the number of exporting firms and the number of foreign affiliates increase in country h, aggregated incoming FDI and aggregated exports increase, outgoing FDI decreases and the price index decreases leading to an increase in consumer welfare. When export fixed costs are low enough, the number of exporting firms in country h decreases, but the effect on aggregated exports and other variable remains positive. In addition, if fixed costs to invest abroad are also low enough, the number of affiliates of firms from country f decreases, but the aggregated market share of these affiliates nevertheless increases.

Proposition 4 *A policy that decreases the cost of inputs for the final good sector firms leads to a reallocation of market shares in a subsidized country from low productive firms to high productive ones, supports incoming FDI and aggregated exports, reduces outgoing FDI, and increases the share of firms able to access foreign markets provided that these firms are not too numerous.*

The following table summarizes the impact of a subsidy on an intermediate good on final sector firms.

Table 2.1: Effects of intermediate good subsidy on revenues and thesholds.

	Thresholds and firms' revenues in country h		
Level of fixed costs	Domestic revenues	Export revenues	FDI revenues
(1) f_x high enough and f_I low enough	$r_{hd} \searrow \forall \varphi < \hat{\varphi}_{hd}$ $r_{hd} \nearrow \forall \varphi \in]\hat{\varphi}_{hd}, \infty[$	$r_{hx} \nearrow \forall \varphi \in [\varphi^*_{hx}, \hat{\varphi}_{hx}[$ $\varphi^*_{hx} \searrow$	$r_{hI} \searrow \forall \varphi \in]\varphi^*_{hI}, \infty[$ $\varphi^*_{hI} \nearrow$
(2) f_x low enough and f_I high enough	$r_{hd} \searrow \forall \varphi < \hat{\varphi}_{hd}$ $r_{hd} \nearrow \forall \varphi \in]\hat{\varphi}_{hd}, \infty[$	$r_{hx} \searrow \forall \varphi \in [\varphi^*_{hx}, \hat{\varphi}_x[$ $r_{hx} \nearrow \forall \varphi \in]\hat{\varphi}_{hx}, \varphi^*_{hI}[$ $\varphi^*_{hx} \nearrow$	$r_{hI} \searrow \forall \varphi \in]\varphi^*_{hI}, \infty[$ $\varphi^*_{hI} \nearrow$
	Thresholds and firms' revenues in country f		
Level of fixed costs	Domestic revenues	Export revenues	FDI revenues
f_I low ($\mathrm{f}_I < \widehat{\mathrm{f}_I}$)	$r_{fd} \searrow \forall \varphi$	$r_{fx} \searrow \forall \varphi$ $\varphi^*_{fx} \nearrow$	$r_{fI} \searrow \forall \varphi \in [\varphi^*_{fI}, \hat{\varphi}_{hd}[$ $r_{fI} \nearrow \forall \varphi \in [\hat{\varphi}_{hd}, \infty[$ $\varphi^*_{fI} \searrow$
f_I high ($\mathrm{f}_I > \widehat{\mathrm{f}_I}$)	$r_{fd} \searrow \forall \varphi$	$r_{fx} \searrow \forall \varphi$ $\varphi^*_{fx} \nearrow$	$r_{fI} \nearrow$ $\varphi^*_{fI} \searrow$

As the subsidy is only paid in country h, the labor productivity threshold above which firms gain or lose from the subsidy is not the same for exporting firms and for firms producing in country h. Thus, $\hat{\varphi}_{hd}$ represents the labor productivity threshold above which a firm producing and selling in country h (national firms and affiliates of f) gain from the fall in input prices, while $\hat{\varphi}_{hx}$ represents the labor productivity threshold above which exporting firms from country h gain from the fall in input prices.

It is important to note that the level of fixed costs changes the effect of a subsidy on an intermediate good only for exporting firms in country h, and only for firms investing abroad in country f. While for exporting firms in country h, the share of exporting firms (the relative level of fixed costs) determines the triggering of a reallocation process among exporting firms, for firms in country f, only the (absolute) level of fixed costs to invest abroad determines the triggering of a reallocation process among multinational firms.

3.2 Wage subsidy

Policy makers may also support firms in the final good sector by reducing the cost of labor. This policy could be a decrease in labor taxes.

New prices

Let s_l be the subsidy expressed as a share of wages in the final good sector. Thus wages in country h are now given by

$$w_h = (1 - s_l)\, w \tag{2.33}$$

while wages in country f remain unchanged so that $w_h < w_f = 1$.

This wage policy leads to the following pricing rules:

- in country h

$$\begin{aligned} p_{hd} &= \tfrac{1}{\rho} MC_{hd} = \tfrac{1}{\rho}\left(z\alpha + (1-s_l)\, w/\varphi\right) && \text{For varieties produced by national firms} \\ p_{fx} &= \tfrac{1}{\rho} MC_{fx} = \tfrac{1}{\rho}\left(z\alpha + w/\varphi\right)\tau && \text{For imported varieties from country } f \\ p_{fI} &= \tfrac{1}{\rho} MC_{fI} = \tfrac{1}{\rho}\left(z\alpha + (1-s_l)\, w/\varphi\right) && \text{For varieties produced by affiliates of foreign firms} \end{aligned} \tag{2.34}$$

- in country f

$$\begin{aligned} p_{fd} &= \tfrac{1}{\rho} MC_{fd} = \tfrac{1}{\rho}\left(z\alpha + w/\varphi\right) && \text{For varieties produced by national firms} \\ p_{hx} &= \tfrac{1}{\rho} MC_{hx} = \tfrac{1}{\rho}\left(z\alpha + (1-s_l)\, w/\varphi\right)\tau && \text{For imported varieties from country } h \\ p_{hI} &= \tfrac{1}{\rho} MC_{hI} = \tfrac{1}{\rho}\left(z\alpha + w/\varphi\right) && \text{For varieties produced by affiliates of foreign firms} \end{aligned} \tag{2.35}$$

Impact on price indexes and domestic revenues

As was the case with a subsidy on the intermediate good, marginal costs of firms producing in country h decrease, leading to a decrease in the price index in country h, while firms producing in country f have similar marginal costs and the price remains the same as in previous sections. As before, the price index in country f also decreases due to less expensive imported varieties. Thus, all firms producing in country f lose market shares whatever their destination market (domestic or export market) and whatever their nationality (national firms or affiliates of firms from country h).

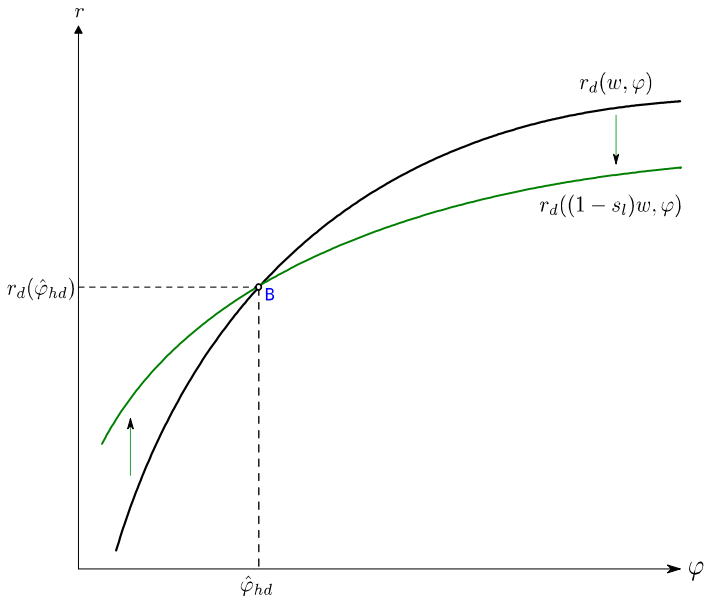
We saw in the previous section that more productive firms are more affected by changes in intermediate good prices because they use relatively more intermediate goods, and less labor. Conversely, as less productive firms use relatively more labor to produce one unit of final good, they will be more affected by a fall in labor price. Thus, their prices will decrease more than prices of varieties produced by more productive firms, leading to reallocation of market shares from more productive firms to less productive ones, and to unsatisfactory allocation of resources. This

market share reallocation favors less productive national firms, at the expense of more productive multinational firms.

Thus, while a fall in agricultural price leads to an anticlockwise rotation of revenue, a fall in labor prices leads to a clockwise rotation of revenues. (see fig. 2.1)

However, the impact on firms' revenue still depends on how the price of the variety varies with respect to the price index of the destination market.

Figure 2.1: Impact of wage subsidy on domestic revenues



In country h, the fall in the price index is always lower than the fall in the price of varieties of less productive firms (as they are more affected), but is greater than the fall in the price of varieties of more productive affiliates from country f (as they are less affected) and of exporting firms from country f (as their prices remain constant). Thus, less productive domestic firms always benefit from a fall in labor prices, while exporting firms from country f and more productive affiliates always lose market shares. However, if export fixed costs are high enough, some domestic firms are highly productive and may reduce their market share, and if fixed costs to invest abroad are also low enough, some less productive affiliates from country f increase their market share.

In country f, the price index will decrease because of less expensive imported varieties from country h. Thus, as firms producing in country f have constant variety prices, domestic firms and affiliates of multinational firms from country h lose market shares in this country.

Impact on exports

The impact of a fall in labor price on firms producing in country h and exporting to country f is more complex.

In country f, the fall in the price index will be greater if the market share of imported varieties is large.

If fixed export costs are high enough or if fixed costs to invest abroad are low enough, few firms export to country f, and the fall in production costs in country h leads to a limited decrease in the price index in country f. If the share of imported varieties is small enough, the fall in the variety price is higher than the fall in the price index, leading to an increase in the market shares of all firms exporting to country f. All firms exporting from country h increase their market share in country f so that the labor productivity threshold above which a firm is able to export is lowered. In this case, all exporting firms benefit from the fall in wages, and more firms are able to export to country f. However, the gain is greater for less productive exporting firms.

Alternatively, when fixed export costs are low enough and fixed costs of investing abroad are high enough, many firms in country h export to country f, and the fall in the price of imported varieties in country f leads to a relatively large fall in its price index. As the fixed costs of investing abroad are high, some exporting firms are highly productive, and are little affected by the fall in wages. If these firms are productive enough, the fall in their variety price may be lower than the fall in the price index in country f. These high productive exporting firms thus lose market shares in favor of less productive exporting firms. Both mechanisms (a lower marginal cost and a reallocation process) increase the market share of less productive exporting firms, leading to a drop in the labor productivity threshold above which a firm is able to export to country f. In this case, even if some exporting firms lose market shares (the most productive firms), aggregated exports increase because of the increased competitiveness of firms producing in country h, and more firms are able to export to country f.

To sum up, a subsidy on wages always increases the share of firms able to access foreign markets. However, if the share of exporting firms is high enough, some high productive exporting firms may see their market share decrease to the advantage of less productive exporting firms.

Impact on the export/FDI trade-off

Focusing on the trade-off between export and FDI, as before marginal costs are lower for firms producing in country h. Thus, the subsidy on wages in country h favors exports from firms in country h and favors FDI for firms in country f.

Indeed, for firms in country h, the potential gain in variable trade cost from switching from export to FDI is reduced by the higher labor cost in country f. Thus, outgoing FDI from country h is reduced.

For firms in country f, when fixed costs to invest abroad are low enough, some low productivity firms investing in country h reduce their price more than the fall in the price index. These multinational firms thus increase their market share whereas their market share would decrease if they were exporting. This leads to a clear effect on the export/FDI trade-off in favor of FDI for firms in country f.

When fixed costs to invest abroad are high enough, all firms investing in country h reduce their price less than the price index, and reallocation occurs leading to a decrease in the market share of all affiliates located in country h. However, the fall in market shares of affiliates is less than if they were exporting. Thus, even if less productive firms investing in country h have their market share reduced, the trade-off between export and FDI still changes in favor of FDI.

The policy consisting in decreasing labor costs has the expected results for policy makers: a drop in the price index leading to an increase in welfare, access to foreign markets is facilitated and exports are supported at the expense of outgoing FDI. Moreover, incoming FDI are supported because firms in the foreign country will switch from export to FDI in order to serve the subsidized country. However, the allocation of resources is not optimal as more efficient firms will see their market share reduced.

Proposition 5 *A policy that decreases labor costs for firms in the final good sector leads to a reallocation of market shares in the subsidized country from high productive firms to low productive ones, supports incoming FDI and aggregated exports, reduces outgoing FDI, and increases the share of firms able to access foreign markets whatever the fixed costs.*

The following table summarizes the impact of a wage subsidy on final sector firms.

As the subsidy is only paid in country h, the labor productivity threshold above which firms gain or lose from the subsidy is not the same for exporting firms and for firms producing in country h. Thus, $\hat{\varphi}_{hd}$ represents the labor productivity threshold above which a firm producing and selling in country h (national firms and affiliates of f) lose from the fall in wages, while $\hat{\varphi}_{hx}$ represents the labor productivity threshold above which exporting firms in country h lose from the fall in wages.

Like for subsidies on intermediate good, fixed cost levels change the effect of a subsidy on labor only for exporting firms in country h, and only for firms investing abroad in country f. For exporting firms in country h, the share of exporting firms (the relative level of fixed costs) determines the existence of a reallocation process

Table 2.2: Effects of wage subsidy depending on fixed costs level.

	Thresholds and firms revenues in country h		
Level of fixed costs	Domestic revenues	Export revenues	FDI revenues
(1) f_x high enough and f_I low enough	$r_{hd} \nearrow \forall \varphi < \hat{\varphi}_{hd}$ $r_{hd} \searrow \forall \varphi \in]\hat{\varphi}_{hd}, \infty[$	$r_{hx} \nearrow \forall \varphi \in [\varphi^*_{hx}, \hat{\varphi}_{hx}[$ $\varphi^*_{hx} \searrow$	$r_{hI} \searrow \forall \varphi \in]\varphi^*_{hI}, \infty[$ $\varphi^*_{hI} \nearrow$
(2) f_x low enough and f_I high enough	$r_{hd} \nearrow \forall \varphi < \hat{\varphi}_{hd}$ $r_{hd} \searrow \forall \varphi \in]\hat{\varphi}_{hd}, \infty[$	$r_{hx} \nearrow \forall \varphi \in [\varphi^*_{hx}, \hat{\varphi}_x[$ $r_{hx} \searrow \forall \varphi \in]\hat{\varphi}_{hx}, \varphi^*_{hI}[$ $\varphi^*_{hx} \searrow$	$r_{hI} \searrow \forall \varphi \in]\varphi^*_{hI}, \infty[$ $\varphi^*_{hI} \nearrow$
	Thresholds and firms revenues in country f		
Level of fixed costs	Domestic revenues	Export revenues	FDI revenues
f_I low ($\mathrm{f}_I < \widehat{\mathrm{f}_I}$)	$r_{fd} \searrow \forall \varphi$	$r_{fx} \searrow \forall \varphi \in [\varphi^*_{fx}, \varphi^*_{fI}[$ $\varphi^*_{fx} \nearrow$	$r_{fI} \nearrow \forall \varphi \in [\varphi^*_{fI}, \hat{\varphi}_{hd}[$ $r_{fI} \searrow \forall \varphi \in [\hat{\varphi}_{hd}, \infty[$ $\varphi^*_{fI} \searrow$
f_I high ($\mathrm{f}_I > \widehat{\mathrm{f}_I}$)	$r_{fd} \searrow \forall \varphi$	$r_{fx} \searrow \forall \varphi \in [\varphi^*_{fx}, \varphi^*_{fI}[$ $\varphi^*_{fx} \nearrow$	$r_{fI} \searrow \forall \varphi \in [\varphi^*_{fI}, \infty[$ $\varphi^*_{fI} \searrow$

among exporting firms, for firms in country f, only the (absolute) level of fixed costs to invest abroad determines the triggering of a reallocation process among multinational firms.

3.3 Comparison of the two policies and discussion

To sum up, both policies favor aggregated export by national firms and incoming FDI, and reduce outgoing FDI. However, as firms from country f do not benefit from these subsidies, it becomes more difficult to access country h through export and φ^*_{xf} increases. As we assume that $\varphi^*_x < \varphi^*_I$ in both countries, all firms with a labor productivity above φ^*_x serve the other market. Thus, the amount of available varieties in country h only depends on φ^*_{xf}, and decreases with both policies. However, both policies decrease the price index of both countries, leading to an increase in consumer' welfare. Note that the fall in the price index is greater in the country whith the subsidy, so consumer welfare increases more in the subsidized country, namely country h.

The two policies have different effects on the allocation of revenues among firms and on the ability of firms to access foreign markets. On one hand, the subsidy on intermediate goods favors more productive firms (affiliates of foreign firms), and leads to a better allocation of resources, but it may reduce the ability of national firms to access foreign markets if export fixed costs are low. On other hand, the subsidy on wages favors small national firms leading to unsatisfactory allocation of resources. However, it increases the share of firms able to access foreign markets whatever the fixed costs.

Proposition 6 *A subsidy on wages always increases the share of firms in the final good sector able to access foreign markets while a subsidy on intermediate good may decrease the share of firms accessing foreign markets*

Proposition 7 *A subsidy on wages favors less productive domestic firms while a subsidy on the price of an intermediate good favors affiliates of more productive foreign firms.*

To conclude, the choice between these two policies depends on the aim of the policy makers.

If the aim is to favor domestic production and small producers (in order to decrease market power and concentration in the final good sector), a subsidy on wages appears to be a better choice, as it induces market share reallocation from high productive firms to low productive ones, leading to a reduction of differences between firms in terms of revenue and production levels.

If the aim is to support exports of national firms, the subsidy on wages may be the preferred policy. Indeed, a subsidy on an intermediate good can decrease the share of firms able to access foreign markets provided that export fixed costs are low and investment costs are high. However, it may be difficult for policy makers to know the level of fixed costs, all the more because they differ depending on the destination market (see Chevassus-Lozza and Latouche 2011). Thus, a subsidy on an intermediate good may increase the ability of firms to export to more selective foreign markets (high export fixed costs), but reduce the ability to export to less selective foreign markets (low export fixed costs). This may be detrimental to firms in the final good sector and to the exporting process of firms. Less productive firms accessing less selective markets may increase their productivity thanks to confrontation with other exporters (learning by exporting), and this may allow them to subsequently access more selective markets. Thus, a subsidy on wages may be preferred because it favors exports whatever the fixed export costs, and, even though it may be detrimental to high productive firms, it does not force them to exit foreign markets.

Even if this model does not account for the effect of attracting FDI because the employment level is exogenously given by the size of the country, the attraction of incoming FDI can have several positive externalities (see Barry and Bradley, 1997 or Buckley and Ruane, 2006 for Ireland) supplying foreign capital to the economy and leading to increased competition and a better allocation of resources. Thus, the aim of policy makers may be to attract foreign capital through incoming FDI, and in this case both policies may be appropriate.

However, even if the subsidy on wages favors incoming FDI with respect to imports from foreign countries, more productive firms lose market shares due to the reallocation process, unlike in the case of a subsidy on an intermediate good, which favors more productive firms. Thus, if there is competition between countries to attract FDI, firms may choose to invest in the country that subsidizes intermediate goods, as their market share will be higher.

Finally, these policies may affect entry to the domestic market. In the next chapter, we introduce fixed domestic costs and show that, since a fall in intermediate good price decreases the domestic revenues of less productive firms, some of them will be forced to exit the market. A subsidy on intermediate goods may have exactly the same effect. Conversely, a subsidy on wages triggers reallocation of market share from more productive firms to less productive ones. Thus, less productive firms may increase their market shares, and if there are fixed domestic costs, the labor productivity threshold above which a firm is able to produce would be lowered, leading to an increase in the number of domestic varieties.

4 Conclusion

In this chapter, we described an extension of the Helpman Melitz and Yeaple (2004) model of heterogeneous firms with intermediate goods. We showed that the characteristics of intermediate goods can shape the international strategy of firms aside from any consideration of comparative advantages. Indeed, as firms are assumed to use one input heterogeneously and one input homogeneously, the greater the use of either input in the final good, or the higher its price, the greater the impact of this input. At aggregated level, an increase in the share of an intermediate good in production costs, which depends on its share in the production process and on its price, reduces differences in production levels and in revenues between firms in the final good sector.

Moreover, all firms do not respond to a change in the price of an intermediate good in the same way. As more productive firms use relatively less labor to produce the final good, the share of intermediate good in their total cost is higher, and they react more to variations in the price of an intermediate good. In this case, a fall in input price leads to a bigger fall in the variety price for high productive firms than for low productive firms. This effect, by leading to a change in relative prices between varieties in the final good sector, affects the allocation of the demand for final goods. Market shares are reallocated from less productive firms to more productive ones, resulting in better allocation of resources and an increase in the aggregate production level.

The effect on access to foreign markets through export or FDI is more complex. When countries are perfectly symmetric, the reallocation process does not depend on the firms' status but only on their labor productivity. Thus, when fixed costs are high enough, selection on foreign markets is strong and only very productive firms can access them. As more productive firms benefit from a fall in the price of intermediate goods, if fixed costs are high enough, all firms that access foreign markets benefit from the decrease in production costs, and the probability of serving foreign markets increases.

Alternatively, when fixed cost to access foreign markets are low, the selection process is weak and some low productivity firms are able to access foreign markets. In this case, some of these low productive firms will suffer from the fall in intermediate good prices, some will be forced to exit foreign markets, and the probability of accessing foreign markets decreases.

Concerning the effect of the price of intermediate goods on the export/FDI trade-off, a fall in the price of intermediate goods always increases the share of FDI sales over export sales. However, depending on the level of fixed costs, the impact on the probability to invest abroad can vary: the effect of a fall in intermediate good price increases the probability of investing abroad when fixed investment costs are high, and decreases this probability when fixed investment costs are low. As in Helpman, Melitz and Yeaple's (2004) model, increased heterogeneity leads to a higher share of FDI compared to exports.

Moreover, production factors used in a fixed proportion (here an intermediate good) and heterogeneously (here labor) have opposite effects on the heterogeneity of firms and on reallocation processes. While a fall in intermediate good price increases the heterogeneity of production and revenues and triggers a reallocation process from less productive firms to more productive ones, a fall in wages reduces heterogeneity of production and revenues and triggers a reallocation process from more productive firms to less productive ones.

In this chapter, we also compared two policies: a subsidy on the intermediate good price and a subsidy on the price of labor. The introduction of subsidies causes asymmetry between countries depending on the wages and intermediate good prices paid by firms in the final good sector. Such subsidies generate advantages for firms producing in the subsidized country.

However, even if these two types of subsidies increase aggregated exports of national firms, attract FDI from foreign countries, reduce outgoing FDI and improve consumer welfare, they have different effects on the reallocation of market shares.

On the one hand, subsidizing the price of intermediate goods triggers a reallocation process from low productivity firms to high productivity firms, but may also

force some exporting firms to exit foreign markets and increase the concentration of market shares in the hands of a few highly productive firms. On the other hand, subsidizing wages triggers a reallocation process from high productivity firms to low productivity firms, making the allocation of resources less efficient, but increasing the ability of domestic firms to access foreign markets whatever the level of fixed costs, and reducing the concentration of market shares in the final good sector.

To sum up, this chapter introduces a new determinant of FDI with symmetric countries. The relative share of production factors in production costs affects the heterogeneity of firms, which has an impact on both the allocation of market shares and on the share of FDI sales compared to exports. As in Helpman, Melitz and Yeaple (2004), the greater the heterogeneity, the higher the share of FDI sales compared to exports.

Appendix

A Proof that $\varepsilon_{r_d,z} = (\sigma - 1)\left(\varepsilon_{P,z} - \varepsilon_{p(\varphi_\omega),z}\right)$

The domestic revenue of a firm with labor productivity φ_ω is given by

$$r_d(\varphi_\omega) = R\left(\frac{P}{p(\varphi_\omega)}\right)^{\sigma-1}$$

The effect of input price variation on its revenue is given by

$$\begin{aligned}
\frac{\partial r_d(\varphi_\omega)}{\partial z} &= (\sigma-1) R \left(\frac{P}{p(\varphi_\omega)}\right)^{\sigma-2} \left[\frac{\frac{\partial P}{\partial z} p(\varphi_\omega) - P\frac{\partial p(\varphi_\omega)}{\partial z}}{p(\varphi_\omega)^2}\right] \\
&= (\sigma-1) r_d(\varphi_\omega) \frac{p(\varphi_\omega)}{P}\left[\frac{\partial P}{\partial z}\frac{p(\varphi_\omega)}{p(\varphi_\omega)^2} - \frac{\partial p(\varphi_\omega)}{\partial z}\frac{P}{p(\varphi_\omega)^2}\right] \\
&= (\sigma-1) r_d(\varphi_\omega)\left[\frac{\partial P}{\partial z}\frac{1}{P} - \frac{\partial p(\varphi_\omega)}{\partial z}\frac{1}{p(\varphi_\omega)}\right] \\
\frac{\partial r_d(\varphi_\omega)}{\partial z} &= (\sigma-1)\frac{r_d(\varphi_\omega)}{z}\left(\frac{\partial P}{\partial z}\frac{z}{P} - \frac{\partial p(\varphi_\omega)}{\partial z}\frac{z}{p(\varphi_\omega)}\right)
\end{aligned}$$

so that

$$\begin{aligned}
\frac{\partial r_d(\varphi_\omega)}{\partial z}\frac{z}{r_d(\varphi_\omega)} &= (\sigma-1)\left(\frac{\partial P}{\partial z}\frac{z}{P} - \frac{\partial p_d(\varphi_\omega)}{\partial z}\frac{z}{p_d(\varphi_\omega)}\right) \\
\varepsilon_{r_d,z} &= (\sigma-1)\left(\varepsilon_{P,z} - \varepsilon_{p_d(\varphi_\omega),z}\right)
\end{aligned}$$

B Sign of $\varepsilon_{r_d,z}$

From previous appendix, we know that $\varepsilon_{r_d,z} = (\sigma-1)\left(\varepsilon_{P,z} - \varepsilon_{p_d(\varphi_\omega),z}\right)$.

The price index in both countries is given by:

$$P = (MG)^{\frac{1}{1-\sigma}} \tag{2.36}$$

where M is the mass of firms in each country and:

$$G \equiv \int_0^\infty p_d(\varphi)^{1-\sigma} g(\varphi)\, d\varphi + \tau^{1-\sigma}\int_{\varphi_x^*}^{\varphi_I^*} p_d(\varphi)^{1-\sigma} g(\varphi)\, d\varphi + \int_{\varphi_I^*}^\infty p_d(\varphi)^{1-\sigma} g(\varphi)\, d\varphi$$

where the first term corresponds to the price of varieties produced by domestic firms, the second term corresponds to the price of varieties imported from the other country and the last term corresponds to the price of varieties produced by affiliates

of foreign firms. The elasticity of the price index to input price is given by

$$\begin{aligned}\varepsilon_{P,z} &= \frac{\partial P}{\partial z}\frac{z}{P} \\ &= \frac{\partial (MG)^{\frac{1}{1-\sigma}}}{\partial z}\frac{z}{(MG)^{\frac{1}{1-\sigma}}} \\ &= \frac{1}{1-\sigma}\frac{z}{G}\frac{\partial G}{\partial z}\end{aligned}$$

We have $\frac{\partial G}{\partial z}$ such that

$$\frac{\partial G}{\partial z} = \int_0^{\infty} \frac{\partial p_d(\varphi)^{1-\sigma}}{\partial z} g(\varphi)\, d\varphi + \tau^{1-\sigma} \int_{\varphi_x^*}^{\varphi_I^*} \frac{\partial p_d(\varphi)^{1-\sigma}}{\partial z} g(\varphi)\, d\varphi + \int_{\varphi_I^*}^{\infty} \frac{\partial p_d(\varphi)^{1-\sigma}}{\partial z} g(\varphi)\, d\varphi$$

where

$$\frac{\partial p_d(\varphi)^{1-\sigma}}{\partial z} = (1-\sigma)\frac{\alpha}{\rho}\frac{p_d(\varphi)^{1-\sigma}}{p_d(\varphi)}$$

So $\frac{\partial G}{\partial z}$ is given by

$$\begin{aligned}\frac{\partial G}{\partial z} &= (1-\sigma)\frac{\alpha}{\rho}\left[\int_0^{\infty} \frac{p_d(\varphi)^{1-\sigma}}{p_d(\varphi)} g(\varphi)\, d\varphi + \tau^{1-\sigma}\int_{\varphi_x^*}^{\varphi_I^*} \frac{p_d(\varphi)^{1-\sigma}}{p_d(\varphi)} g(\varphi)\, d\varphi \right. \\ &\quad \left. + \int_{\varphi_I^*}^{\infty} \frac{p_d(\varphi)^{1-\sigma}}{p_d(\varphi)} g(\varphi)\, d\varphi\right]\end{aligned}$$

and the elasticity of the price index to input price can be written as

$$\begin{aligned}\varepsilon_{P,z} &= \frac{z\alpha}{\rho G}\left[\int_0^{\infty} \frac{p_d(\varphi)^{1-\sigma}}{p_d(\varphi)} g(\varphi)\, d\varphi + \tau^{1-\sigma}\int_{\varphi_x^*}^{\varphi_I^*} \frac{p_d(\varphi)^{1-\sigma}}{p_d(\varphi)} g(\varphi)\, d\varphi \right. \\ &\quad \left. + \int_{\varphi_I^*}^{\infty} \frac{p_d(\varphi)^{1-\sigma}}{p_d(\varphi)} g(\varphi)\, d\varphi\right]\end{aligned}$$

Knowing that

$$\varepsilon_{p_d(\varphi_\omega),z} = \frac{z\alpha}{\rho}\frac{1}{p_d(\varphi_\omega)} = \frac{z\alpha}{\rho G}\frac{G}{p_d(\varphi_\omega)}$$

we have:

$$\begin{aligned}\varepsilon_{P,T} - \varepsilon_{p_d(\varphi_\omega),T} &= \frac{z\alpha}{\rho G}\left[\int_0^{\infty} \frac{p_d(\varphi)^{1-\sigma}}{p_d(\varphi)} g(\varphi)\, d\varphi + \tau^{1-\sigma}\int_{\varphi_x^*}^{\varphi_I^*} \frac{p_d(\varphi)^{1-\sigma}}{p_d(\varphi)} g(\varphi)\, d\varphi \right. \\ &\quad + \int_{\varphi_I^*}^{\infty} \frac{p_d(\varphi)^{1-\sigma}}{p_d(\varphi)} g(\varphi)\, d\varphi - \int_0^{\infty} \frac{p_d(\varphi)^{1-\sigma}}{p_d(\varphi_\omega)} g(\varphi)\, d\varphi \\ &\quad \left. -\tau^{1-\sigma}\int_{\varphi_x^*}^{\varphi_I^*} \frac{p_d(\varphi)^{1-\sigma}}{p_d(\varphi_\omega)} g(\varphi)\, d\varphi - \int_{\varphi_I^*}^{\infty} \frac{p_d(\varphi)^{1-\sigma}}{p_d(\varphi_\omega)} g(\varphi)\, d\varphi\right]\end{aligned}$$

And the elasticity of the firm φ_ω domestic revenue to input price $\varepsilon_{r_d,z} = (\sigma - 1)\left(\varepsilon_{P,z} - \varepsilon_{p_d(\varphi_\omega),z}\right)$ is given by:

$$\begin{aligned}\varepsilon_{r_d,z} &= \sigma\frac{z\alpha}{G}\left[\int_0^\infty \frac{p_d(\varphi)^{1-\sigma}}{p_d(\varphi)}g(\varphi)\,d\varphi + \tau^{1-\sigma}\int_{\varphi_x^*}^{\varphi_I^*}\frac{p_d(\varphi)^{1-\sigma}}{p_d(\varphi)}g(\varphi)\,d\varphi\right.\\ &\quad + \int_{\varphi_I^*}^\infty \frac{p_d(\varphi)^{1-\sigma}}{p_d(\varphi)}g(\varphi)\,d\varphi - \int_0^\infty \frac{p_d(\varphi)^{1-\sigma}}{p_d(\varphi_\omega)}g(\varphi)\,d\varphi\\ &\quad \left.-\tau^{1-\sigma}\int_{\varphi_x^*}^{\varphi_I^*}\frac{p_d(\varphi)^{1-\sigma}}{p_d(\varphi_\omega)}g(\varphi)\,d\varphi - \int_{\varphi_I^*}^\infty \frac{p_d(\varphi)^{1-\sigma}}{p_d(\varphi_\omega)}g(\varphi)\,d\varphi\right].\end{aligned}$$

C Effect of intermediate good price on the investment threshold

At equilibrium, the firm with labor productivity φ_I^* is indifferent between exporting or investing abroad, thus $\pi_x(\varphi_I^*) = \pi_I(\varphi_I^*)$ where:

$$\begin{aligned}\pi_x(\varphi_I^*) &= \frac{r_x(\varphi_I^*)}{\sigma} - f_x\\ \pi_I(\varphi_I^*) &= \frac{r_I(\varphi_I^*)}{\sigma} - f_I\end{aligned}$$

Thus, at the equilibrium we have:

$$\begin{aligned}\frac{\mathrm{d}\left[r_I(\varphi_I^*) - r_x(\varphi_I^*)\right]}{\mathrm{d}z} &= \frac{\mathrm{d}r_I(\varphi_I^*)}{\mathrm{d}z} - \frac{\mathrm{d}r_x(\varphi_I^*)}{\mathrm{d}z} = 0\\ &= \frac{\partial r_I(\varphi)}{\partial\varphi}\frac{\mathrm{d}\varphi_I^*}{\mathrm{d}z} + \frac{\partial r_I(\varphi)}{\partial z} - \frac{\partial r_x(\varphi)}{\partial\varphi}\frac{\mathrm{d}\varphi_I^*}{\mathrm{d}z} - \frac{\partial r_x(\varphi)}{\partial z} = 0\end{aligned}$$

So we can write

$$\frac{\mathrm{d}\varphi_I^*}{\mathrm{d}z} = -\left[\frac{\partial r_I(\varphi)}{\partial z} - \frac{\partial r_x(\varphi)}{\partial z}\right] \Big/ \left[\frac{\partial r_I(\varphi)}{\partial\varphi} - \frac{\partial r_x(\varphi)}{\partial\varphi}\right]$$

We know that $r_I(\varphi) = r_d(\varphi)$ and $r_x(\varphi) = \tau^{1-\sigma} r_d(\varphi)$, thus $\partial r_I(\varphi)/\partial\varphi - \partial r_x(\varphi)/\partial\varphi = (1-\tau^{1-\sigma})\,\partial r_d(\varphi)/\partial\varphi > 0$.

Moreover,

$$\operatorname{sign}\left\{\frac{\partial r_I(\varphi_\omega)}{\partial z} - \frac{\partial r_x(\varphi_\omega)}{\partial z}\right\} = \operatorname{sign}\left\{\left(1-\tau^{1-\sigma}\right)\frac{\partial r_d(\varphi_\omega)}{\partial z}\right\} = \operatorname{sign}\left\{\frac{\partial r_d(\varphi_\omega)}{\partial z}\right\}$$

so we have:

$$\begin{aligned}
\frac{\mathrm{d}\varphi_I^*}{\mathrm{d}z} &= -\left[\left(1-\tau^{1-\sigma}\right)\frac{\partial r_d(\varphi)}{\partial z}\right] \Big/ \left[\left(1-\tau^{1-\sigma}\right)\frac{\partial r_d(\varphi)}{\partial \varphi}\right] \\
\frac{\mathrm{d}\varphi_I^*}{\mathrm{d}z} &= -\left[\frac{\partial r_I(\varphi)}{\partial z} - \frac{\partial r_x(\varphi)}{\partial z}\right] \Big/ \left[\underbrace{\frac{\partial r_I(\varphi)}{\partial \varphi}}_{>0} - \frac{\partial r_x(\varphi)}{\partial \varphi}\right] \\
&\quad > 0 \quad \forall \varphi < \hat{\varphi} \\
&\quad < 0 \quad \forall \varphi > \hat{\varphi}
\end{aligned}$$

Chapter 3

Agricultural market liberalization and entry/exit of agrifood firms in a global economy.[1]

Abstract: In this chapter, we analyze the impact of input trade liberalization on the performance of firms in the final good sector in their domestic market. While in the two previous chapters we focused on the access to foreign markets, here we focus on the effect of intermediate goods on the entry/exit and performance of firms in final good sector in their domestic market. Using a theoretical model with heterogeneous firms, we show that a fall in the price of intermediate goods, or input trade liberalization, lead to reallocation of domestic market shares from less productive firms to more productive ones, reducing the probability of entering the domestic market and resulting in the concentration of market shares. We generalize the results reported in the first chapter on the probability of entering foreign markets through exports, and take into account different modalities of input trade liberalization, namely a fall in variable import costs and lower fixed import costs. We also show that input trade liberalization generates positive international externalities. Indeed, input trade liberalization decreases production costs and prices in the final good sector, and thus increases consumer welfare in the input importing country. Input trade liberalization also improves consumer welfare in the input exporting country, through the fall in prices of imported varieties from the input importing country.

[1] with Carl Gaigné.

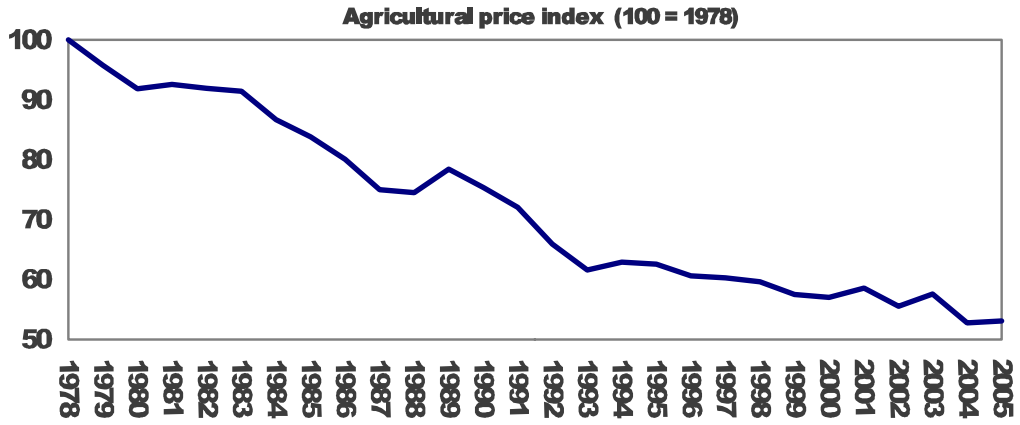
1 Introduction

Recent literature on industrial organization provided evidence for marked heterogeneity in firms' behavior, even in narrowly defined industries or markets (see Bartelsman et al, 2002). The position of individual firms with respect to distribution may vary so that even in expanding industries, many firms undergo substantial decline. The exit of firms is a common phenomenon, e.g. Bartelsman et al. (2002) showed that the firm turnover rate in OECD countries varies from 16% in the Netherlands to 23% in the United States. The theoretical literature on exit from and concentration in particular markets mainly focuses on determinants such as sunk costs, the degree of competition in the sector, the age of a firm, its productivity level or its status (a domestic, exporter or multinational firm). Although the heterogeneity of firms is currently being taken into account, the impact of international trade or input prices on the structure of markets has not received much attention. Indeed, most studies assume that if all firms in a sector share the same input prices and the same production function, the heterogeneity of firms should not be affected by variations in input prices.

As in the two previous chapters, we focus on the agrifood sector in order to provide stylized facts on the linkage between agrifood goods and agricultural commodities and to illustrate the correlation between the structure of a final good sector and the characteristics of the corresponding intermediate good sectors.

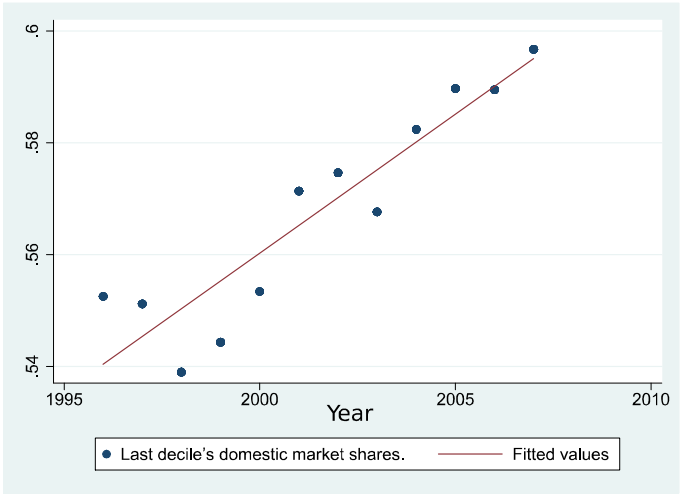
During the last 30 years, there has been a fall in agricultural prices (see figure 3.1), and an increase in productivity and in the concentration of market shares in agrifood sectors (see figure 3.2 and Gopinath et al. 1996 and 2004). The fall in agricultural prices was mainly due to productivity gains in this sector, and has been reinforced by the recent trade liberalization process (such as the successive Common Agricultural Policy reforms) in the main agricultural producing countries. From an economic point of view, the fall in agricultural prices, which led to a fall in production costs in agrifood sectors, should have reduced the exit rate of firms. Gopinath et al. (1996) showed that material inputs alone, which include primary agricultural goods, account for almost all of the growth and of the increase in competitiveness in agrifood sectors, but it appears that all firms did not gain to the same extent, as the concentration in market shares continued to increase.

Figure 3.1: Agricultural price index evolution since 1978.



Source : INSEE

Figure 3.2: Last decile French market shares' evolution



Source : INSEE-EAE database[2]

In the international trade literature, the relationship between a firm's productivity and its entry and survival in export and domestic markets has received much attention. The key point of this literature is that the interaction between sunk costs and heterogeneous productivity is a determinant of why only some firms enter the domestic market and also of why only some firms export.

Recent literature on heterogeneous firms explains the exit and the reallocation process by the global trade liberalization of output sectors (see appendix A for a survey on how international trade literature can explain stylized facts and evolutions in the French agrifood sector). Indeed, a symmetric fall in trade barriers leads to an increase in market shares for more productive firms through their exports, and favors the exit of less productive firms from the domestic market due to fiercer

[2]In figure 3.2, the market shares of the last decile are computed for each of the nine sub-agrifood sectors (NACE code 3-digit level). It shows that the market shares of the 10% biggest firms in terms of production increased between 1996 and 2007.

competition from new imported varieties. However, these models predict that on domestic markets, all domestic firms reduce their market shares in favor of imported varieties. However, as shown in figure 3.2, a reallocation and concentration process also occurred on domestic markets: the 10% bestselling firms increased their domestic market shares between 1996 and 2008. According to models with heterogeneous firms, output trade liberalization cannot explain this concentration process, as all firms should lose the same domestic market shares due to fiercer foreign competition.

Even if we know that low productivity firms exit export markets with an increase in trade openness on the output market, we do not know the impact of input trade liberalization on the domestic market. Amiti and Konings (2007) showed that trade liberalization can explain the increase in productivity in the final good market, and that input trade liberalization explains this increase twice as much as output trade liberalization. Several studies have shown that importing inputs increases productivity (Halpern et al. 2009, Goldberg et al. 2009), and favors the introduction of new varieties of final goods (Goldberg et al. 2010). However, in these studies, the impact of input trade liberalization, or of imported inputs, is the same for all firms and does not depend on the heterogeneity of firms.

In the two previous chapters, we developed a model where firms are heterogeneously impacted by input trade liberalization and input prices, and we showed that a fall in input tariffs can decrease the market shares of less productive firms. However, the previous chapters focused on access to foreign markets and assumed an exogenous mass of firms on domestic markets, and thus cannot explain the exit and concentration process on these markets.

The theoretical model developed in this chapter shows that a fall in input prices along with input trade liberalization can explain both the concentration process on domestic and export markets and the increase in production and in the productivity of the average firm at sectoral level. While in the first chapter, we assumed that the price in the home country is given by the world price plus a border tariff, in this chapter we generalize these results taking the effect of different modalities of input trade liberalization on domestic markets into account and introducing an endogenous mass of firms able to import less expensive inputs.

In this chapter, we also find classical aggregated effects of input trade liberalization. By providing less expensive inputs to final sector firms, input trade liberalization increases the global performance of firms located in the liberalizing country, in terms of average productivity, production and exports. However, if the main effect of liberalizing the input market is increasing the size of the output sector due to more effective use of resources and to increased competitiveness on export markets, the structure of the output market is also affected by the liberalization process.

Thus, for some firms, changes in the structure of the market can offset the positive effects of the liberalization of input trade. The structure of the chapter and our main results can be summarized as follows.

In the first section, we develop a simple model in a *closed economy* with an endogenous mass of firms in order to investigate how input prices affect the entry and exit process in the domestic market. We show that a fall in input prices forces less productive firms to exit the market, and leads to reallocation of market shares from low productive firms to high productive ones, reinforcing the concentration on the latter, but increasing consumer welfare due to a fall in final good prices and better allocation of resources.

In the second section, we introduce a second country in order to investigate how input trade liberalization affects domestic firms when *only the intermediate good is internationally traded*. In this section, we first focus on free input trade, then introduce a variable trade cost and, finally, a fixed import cost. The intermediate good may be produced in only one country or in both countries depending on the structure of import costs. First, we show that, regardless of the structure of import costs, input trade openness decreases the probability of entering the domestic market in the input importing country. Second, a marginal decrease in fixed import costs hurts small firms and favors large firms located in the input importing country, except when all firms are already able to import, i.e. when fixed production costs are high relative to fixed import costs. Indeed, when all firms are able to import, an increasing fraction of small firms (with lower labor productivity) exits when fixed import costs increase.

In the third section, we investigate how input prices and input trade liberalization affects domestic firms when *the final good is internationally traded*. We show that the results of the first section hold in an open economy: a fall in prices of intermediate goods encourages the exit from the domestic market of downstream firms and increases the profit of more productive firms at the expense of less productive ones. More precisely, a simultaneous and identical fall in prices of intermediate goods in both countries always favors more productive firms at the expense of less productive ones and forces the latter to exit the domestic market in each country. We also show that a fall in the price of intermediate goods in the home country favors the exit of less productive domestic firms and increases the size of more productive ones. Finally, a fall in the price of intermediate goods in trade partner countries leads to the exit of domestic firms and reduces the size of surviving firms due to fiercer foreign competition.

Then, *both the final good and the intermediate good are internationally traded* and we investigate how input trade liberalization impacts output firms in both the input

importing country and the input exporting country. We first focus on free input trade, then introduce a variable trade cost and, finally, a fixed import cost. First, we show that the results of the section concerning only trade in inputs hold and that input trade openness decreases the probability of entering domestic markets regardless of the structure of trade costs, even in the country with advantageous production costs. Second, we generalize the results obtained in chapter 1. A move from no input trade to input trade, or a fall in import trade costs, increases the exit from export markets of firms located in the input importing country, except for a fall in fixed import costs if all exporting firms are already able to import, i.e. if fixed export costs are high in relation to fixed import costs. In addition, whatever import trade costs, input trade openness favors the exit from the export market of firms located in the input exporting country.

Finally, our analysis reveals that consumers gain from lower prices of intermediate goods or lower trade import costs, even though these encourage concentration in the downstream industry. In addition, input trade openness improves consumer welfare in the input exporting country. Due to a fall in the prices of imported varieties, input trade liberalization leads to positive international externalities.

The last section concludes.

2 Model in a closed economy

2.1 Preferences, technology and market structure

We consider a model with one country (h) and three goods: a numeraire (N)[3], an intermediate good (A) and a final differentiated good (Y). The numeraire is produced by a representative firm in perfect competition using labor. The intermediate good sector uses labor to produce a homogeneous intermediate good, and the final sector produces a differentiated final good by using labor plus the intermediate good. As in Melitz (2003), we consider that labor productivity differs across firms while, as in the previous chapter, the requirement in the intermediate good sector to produce one unit of final good is exogenous and identical for all firms. The amount of labor available in the economy L is inelastically given at its aggregate level by the size of the country, and is used by all three sectors. The units of labor are divided between the numeraire L^N, the intermediate L^A, and the final sector L^Y, with $L = L^N + L^A + L^Y$.

Consumers. The preferences of representative consumers living in country h are given by a Cobb-Douglas utility function U_h between the numeraire N_h and

[3]Including this sector is not obligatory in this section but will be necessary in the following sections in order to reach macroeconomic equilibrium.

differentiated goods. The intermediate good is not consumed by the consumer, so it is entirely processed by firms in the final good sector. The utility resulting from the consumption of differentiated goods is given by a C.E.S. sub-utility function.

$$U_h = N_h^{1-\beta} Y_h^{\beta} \quad \text{with} \quad Y_h \equiv \left[\int_{\omega \in \Omega_h} y_h(\omega)^{\rho} d\omega \right]^{1/\rho} \tag{3.1}$$

where $\beta \in [0;1]$, Y_h is the set of varieties consumed as an aggregated good associated with an aggregated price P_h and Ω_h represents the set of available varieties in the country. Varieties are substitutes, which implies that $0 < \rho < 1$, and the elasticity of substitution between any two varieties is given by $\sigma = 1/(1-\rho) > 1$. Considering the budget constraint $w_h L = p_{Nh} N_h + P_h Y_h$ where w_h is the wage in country h, p_{Nh} is the price of the numeraire and $P_h = \left(\int_{\omega \in \Omega_h} p(\omega)^{1-\sigma} \mathrm{d}\omega \right)^{\frac{1}{1-\sigma}}$. Optimization of consumer preferences leads to a constant share of expenditure dedicated to the final good equal to β and to the optimal consumption of each variety ω:

$$y_{dh}(\omega) = \frac{w_h \beta L}{P_h} \left(\frac{p_{dh}(\omega)}{P_h} \right)^{-\sigma} \tag{3.2}$$

$$p_{Nh} N_h = (1-\beta)\, w_h L \tag{3.3}$$

where $p_{dh}(\omega)$ is the price of the variety ω produced in country h on its domestic market, $y_{dh}(\omega)$ is the quantity of variety ω sold in country h.

The numeraire. The numeraire sector is perfectly competitive. A representative firm produces the numeraire good with constant return to scale using one unit of labor to produce one unit of N assuming that $w_h = 1$, N is used as the numeraire.

The intermediate good sector. The intermediate good sector is perfectly competitive. Firms produce a homogeneous good using a single input, labor. The profit function of a representative firm in country h is given by $\pi_{Ah} = z_h y_{Ah} - l_{Ah}$. At equilibrium, we have $z_h y_{Ah} = l_{Ah}$.

The final sector. There is a continuum of firms, each choosing to produce a different variety ω. To produce for their domestic market, firms have to pay an overhead fixed cost f_d. All fixed costs are in terms of labor units.

Like in the model presented in chapter 1, the production of variety ω requires two inputs, labor l_ω and intermediate goods a_ω. As in the previous chapter, inputs are complementary[4] so there is a technological constraint on the production of the final good. Each firm uses α units of the intermediate good and $1/\varphi$ units of labor to produce one unit of final good. Nevertheless, a firm can be more efficient, and use a less labor-intensive technology to produce its variety. So the marginal productivity

[4]Results hold as long as the elasticity of substitution between production factors is lower than the unit. See chapter 1.

of labor φ differs across firms. Hence, each firm produces its own variety, and each firm varies with respect to its labor productivity φ. Hereafter, we refer to a given firm by its labor productivity. The marginal cost of production of a firm in country h is given by

$$MC\left(\varphi, z_h\right) = z_h\alpha + 1/\varphi \tag{3.4}$$

where z_h is the intermediate good price in the country.

Under monopolistic competition, each firm faces a residual demand curve with constant elasticity σ leading to the pricing rule:

$$p_{dh}(\varphi) = \frac{z_h\alpha + 1/\varphi}{\rho} \tag{3.5}$$

where $1/\rho$ is the markup.

As there is no international trade, the profit of a firm φ producing in country h is given by the profit level on its domestic market only: $\pi_h\left(\varphi\right) = \pi_{dh}\left(\varphi\right)$ with

$$\pi_{dh}\left(\varphi\right) = \frac{r_{dh}\left(\varphi\right)}{\sigma} - \mathrm{f}_d \tag{3.6}$$

$$r_{dh}(\varphi) = \beta L\left[\frac{\rho P_h}{z_h\alpha + 1/\varphi}\right]^{\sigma-1} \tag{3.7}$$

corresponding to the profits and sales on the domestic market.

We can write the ratios of any two firms' outputs and revenues as a function of their labor productivity only with

$$\frac{y_{dh}\left(\varphi_1\right)}{y_{dh}\left(\varphi_2\right)} = \left[\frac{\varphi_1}{\varphi_2}\frac{\left(w_h + z_h\alpha\varphi_2\right)}{\left(w_h + z_h\alpha\varphi_1\right)}\right]^{\sigma} \tag{3.8}$$

$$\frac{r_{dh}(\varphi_1)}{r_{dh}(\varphi_2)} = \left[\frac{\left(w_h + z_h\alpha\varphi_2\right)}{\left(w_h + z_h\alpha\varphi_1\right)}\frac{\varphi_1}{\varphi_2}\right]^{\sigma-1} \tag{3.9}$$

When a second input is introduced, output and revenue ratios depend not only on labor productivity but also on the price and use of intermediate goods. Increased use of an intermediate good to produce the final good or more expensive intermediate goods reduces these ratios. In other words, the existence of an intermediate good used at a fixed proportion reduces the advantage of more productive firms.

2.2 Firms' entry in and exit from the final good sector.

To enter the market, final sector firms have to pay a sunk entry cost equal to f_e units of labor, but firms do not know their productivity prior to starting production. The labor productivity level φ of each firm is randomly drawn from a common distribution $g\left(\varphi\right)$ where $g(\varphi)$ is positive over $(0, \infty)$ and has a continuous cumulative

function $G(\varphi)$. Firms then decide to produce or not. If a firm does produce, a productivity shock may force it to exit with a probability of δ. This probability is common to each producing firm and is constant over time. As the productivity of a firm remains constant over time, its optimal profit level is constant too, until a shock forces it to exit. The value function of a firm is given by their discounted profit flows:

$$v_h(\varphi) = \max\left\{0, \sum_{t=0}^{\infty}(1-\delta)^t \pi_h(\varphi)\right\} = \max\left\{0, \frac{1}{\delta}\pi_h(\varphi)\right\} \tag{3.10}$$

If the labor productivity of a firm is too low, its discounted profit flow will be negative, and, in turn, the firm will fail to enter the market. Thus, there is a threshold of labor productivity φ_{hd} above which a firm can enter the domestic market and make a profit. In other words, a threshold φ_{hd}, defined as the minimum value of labor productivity, leads to a non-negative firm value such as

$$\varphi_{hd} = \inf\{\varphi : v_h(\varphi, z_h) \geq 0\} = \inf\{\varphi : \pi_h(\varphi, z_h) \geq 0\}. \tag{3.11}$$

Hence, equilibrium is characterized by a mass M_h of firms and a distribution $\mu_h(\varphi)$ of labor productivity over a subset of $[0, \infty[$ where $\mu_h(\varphi)$ is the conditional distribution of $g(\varphi)$ on $[\varphi_{hd}, \infty[$ with

$$\mu_h(\varphi) = \begin{cases} \frac{g(\varphi)}{\theta_{hd}} & \text{if } \varphi \geq \varphi_{hd} \\ 0 & \text{if } \varphi < \varphi_{hd} \end{cases} \tag{3.12}$$

where $\theta_{hd} \equiv 1 - G(\varphi_{hd})$ is the ex-ante probability of successful entry in country h.

Hence, the expected profit of a firm prior to entering the market is given by $\theta_{hd}\bar{\pi}_h$ with

$$\bar{\pi}_h = \int_0^{\infty} \pi_{hd}(\varphi)\,\mu_h(\varphi)\,\mathrm{d}\varphi \tag{3.13}$$

A firm enters the market as long as $\theta_{hd}\bar{\pi}_h/\delta - \mathrm{f}_e \geq 0$. If a firm wants to enter, it will finally serve the domestic market if and only if $\pi_{hd}(\varphi) \geq 0$ or equivalently $\varphi \geq \varphi_{hd}$.

2.3 The impact of input prices on entry in/exit from the domestic market

At equilibrium, we have $\bar{\pi}_h = \delta \mathrm{f}_e/\theta_{hd}$ and $\pi_{hd}(\varphi_{hd}) = 0$. By using the latter condition as well as (3.6), we have $r_{hd}(\varphi_{hd}) = \sigma \mathrm{f}_d$

By using the equalities above, we show in Appendix B.1 that $\bar{\pi}_h$ can be rewritten as a function of φ_{hd}:

$$\bar{\pi}_h = \mathrm{f}_d \left(\frac{1}{\varphi_{hd}} + \alpha z \right)^{\sigma-1} \int_{\varphi_{hd}}^{\infty} \left(\frac{1}{\varphi} + \alpha z \right)^{1-\sigma} \mu_h(\varphi) \, \mathrm{d}\varphi - \mathrm{f}_d \tag{3.14}$$

Thus, we have φ_{hd} such that

$$\bar{\pi}_h(\varphi_{hd}) - \frac{\delta \mathrm{f}_e}{\theta_{hd}(\varphi_{hd})} = 0 \tag{3.15}$$

We show in Appendix B.2 that φ_{hd} exists, is positive and unique and in Appendix B.3 that, knowing (3.15),

$$\frac{\mathrm{d}\varphi_{hd}}{\mathrm{d}z} = \frac{\mathrm{d}\bar{\pi}_{hd}}{\mathrm{d}z} \frac{\theta_{hd}^2}{\delta \mathrm{f}_e g(\varphi_{hd})} < 0. \tag{3.16}$$

Proposition 1 *A decline in the price of the intermediate good reduces the probability of entering the domestic market and increases average productivity.*

This result arises from the fact that the share of intermediate products in total costs ($\alpha z/(\alpha z + w/\varphi)$) increases with an increase in labor productivity. Indeed, the elasticity of the price of the manufactured good to a change in the intermediate good price is given by

$$\varepsilon_{p(\varphi),z} \equiv -\frac{\partial p(\varphi)}{\partial z} \frac{z}{p(\varphi)} = \frac{\alpha z \varphi}{\alpha z \varphi + w} \tag{3.17}$$

where $\partial \varepsilon_{p,z}/\partial z > 0$ and $\partial^2 \varepsilon_{p,z}/\partial z \partial \varphi > 0$. In other words, a fall in the price of the intermediate good leads to a higher decrease in the price of the final product produced by high productivity firms which, in turn, leads to reallocation of production from low productivity firms to high productivity firms.

As in chapter 1, the elasticity of revenues is determined by the elasticity of the variety price in relation with the elasticity of the price index of the destination market.

$$\varepsilon_{r(\varphi),z} = \varepsilon_{P,z} - \varepsilon_{p(\varphi),z} \tag{3.18}$$

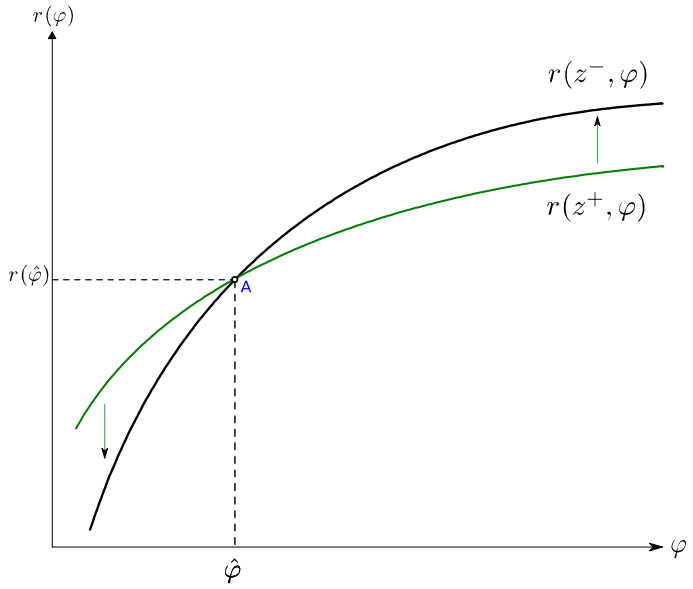
When the price of the intermediate good decreases, low productivity firms reduce their variety prices less than the fall in the price index, as a result, they become relatively less competitive and lose market shares (see fig. 3.3).

2.4 Welfare

Number of varieties. At stationary equilibrium, all variables remain constant. The mass of new entrants M_h^e must successfully replace the mass of firms that leave the market $\theta_{hd} M_h^e = \delta M_h$.

Trivially, we have $M_h = R_h/\bar{r}_h$ where R_h (resp., $\bar{r}_h$) is the total (resp., average)

Figure 3.3: Fall in input price and domestic revenues



income of the final sector firms in country h. Some calculations reveal that

$$M_h = \frac{\beta L}{\sigma\left(\bar{\pi}_h + \mathrm{f}_d\right)}. \tag{3.19}$$

Indeed, by plugging (3.6) into (3.13), we obtain

$$\bar{\pi}_h = \frac{\bar{r}_h}{\sigma} - \mathrm{f}_d \tag{3.20}$$

so that $\bar{r}_h = \sigma\left(\bar{\pi}_h + \mathrm{f}_d\right)$. In addition, it is easy to check that $R_h = \beta L$. At each period, the demand for labor units in the final sector is given by

$$L_h^Y = M_h^e \mathrm{f}_e + L_{ph}^Y + M_h \mathrm{f}_d \tag{3.21}$$

where $M_h^e \mathrm{f}_e$ is the units of labor used to enter the market (sunk entry costs), L_{ph}^Y is the sum of labor units allocated to production, and $M_h \mathrm{f}_d$ is the units of labor required to pay the fixed domestic costs. The sum of wages paid by final sector firms is equal to the aggregated revenue minus aggregated profits and total expenditures for the intermediate products, that is

$$L_{ph}^Y + M_h \mathrm{f}_d = R_h - \Pi_h - zA_h \tag{3.22}$$

where A_h is the mass of intermediate goods purchased by national firms. Note that $zA_h = wL_h^A = L_h^A$ (no pure profit in the intermediate sector) and $\Pi_h = \bar{\pi}_h M_h = M_h^e \mathrm{f}_e$

(because $\bar{\pi}_h = \delta \mathrm{f}_e/\theta_{hd}$ and $M_h = \theta_{hd} M_h^e/\delta$).

$$R_h = L_{ph}^Y + M_h \mathrm{f}_d + M_h^e \mathrm{f}_e + L_h^A = L - L_h^N \tag{3.23}$$

In appendix B.4 we show that

$$L_h^N = N_h = (1-\beta)\, L \tag{3.24}$$

Thus $R_h = \bar{r}_h M_h = \beta L$ and

$$\frac{\mathrm{d}M_h}{\mathrm{d}z} = \frac{-M_h}{\bar{r}_h}\frac{\mathrm{d}\bar{r}_h}{\mathrm{d}z} = \frac{-M_h\left(\frac{\mathrm{d}\bar{\pi}_h}{\mathrm{d}z}\right)}{\bar{\pi}_h + \mathrm{f}_d} > 0 \tag{3.25}$$

with

$$\frac{\mathrm{d}\bar{\pi}_h}{\mathrm{d}z} = \frac{\partial \bar{\pi}_h}{\partial z} + \frac{\partial \bar{\pi}_h}{\partial \varphi_{hd}}\frac{\partial \varphi_{hd}}{\partial z} < 0 \tag{3.26}$$

where $\frac{\partial \bar{\pi}_h}{\partial z} < 0$ and $\frac{\partial \varphi_{hd}}{\partial z} < 0$, as shown in Appendix B.3.

Thus, in a closed economy, a fall in the price of an intermediate good reduces the number of varieties ($\mathrm{d}M_h/\mathrm{d}z > 0$).

Aggregated production

As less productive firms exit the domestic market, the average productivity (defined as $\tilde{\varphi}^{-1} = \int_{\varphi_{hd}}^{\infty} \varphi^{-1} \frac{y_{hd}(\varphi)}{y_{hd}(\tilde{\varphi})} \mu(\varphi)\, d\varphi$) increases with a fall in the price of intermediate goods. In addition, the reallocation process of market shares from low productivity firms to high productivity ones results in a higher increase in average labor productivity than if only the threshold value was impacted (which is the case when output sector is liberalized, see Melitz 2003).

As average productivity increases, aggregated production in the final good sector can increase using the same amount of labor. Moreover, knowing that $z_h y_{Ah} = l_{Ah}$, a fall in intermediate good prices decreases the amount of labor needed to produce the intermediate good. Thus, as the demand for the numeraire remains constant, the amount of labor available in the final good sector increases, so that the aggregated production of final good increases even more.

Price index

The effect of the price of the intermediate good on the price of the variety sold by the less productive firm is given by

$$\frac{\mathrm{d}p_{hd}(\varphi_{hd})}{\mathrm{d}z} = \alpha + \frac{\partial p_{hd}(\varphi)}{\partial \varphi}\frac{\partial \varphi_{hd}}{\partial z} = \alpha - \frac{1}{\varphi_{hd}^2}\frac{\partial \varphi_{hd}}{\partial z} > 0 \tag{3.27}$$

Indeed, when the price of the intermediate good decreases, the production cost decreases as does the price of this variety. In addition, the domestic threshold φ_{hd} increases so that the price of the variety sold by the less productive domestic firm

decreases even more.

Because $r_{hd}(\varphi_{hd}) = \sigma \mathrm{f}_d$ and $r_{dh}(\varphi) = \beta L \left[\frac{P_h}{p_{hd}(\varphi)}\right]^{\sigma-1}$, we can write

$$P_h = (\sigma \mathrm{f}_d / \beta L)^{\frac{1}{\sigma-1}} p_{hd}(\varphi_{hd})$$

Knowing that $\mathrm{d}p_{hd}(\varphi_{hd})/\mathrm{d}z > 0$ a fall in intermediate good price decreases the price index ($\mathrm{d}P_h/\mathrm{d}z > 0$).

With a C.E.S. utility function, consumer welfare is given by the reciprocal of the price index. Consequently, a fall in prices of intermediate goods increases consumer welfare ($\mathrm{d}W_h/\mathrm{d}z < 0$) and the effect of the fall in prices is greater than the decrease in the number of varieties available for consumers.

Proposition 2 *In a closed economy, a fall in intermediate good prices increases consumer welfare even if the mass of firms producing in the domestic market, and thus the number of available varieties, decreases.*

In this section, we show that a fall in input prices favors the exit from the market of less productive firms and benefits more productive firms. This result recalls the effect of output trade liberalization in models of trade with heterogeneous firms (see Melitz 2003 for example). However, unlike in the Melitz model, the exit of firms is not due to increased competition from imported varieties but to a change in the structure of the output market. In the trade literature with heterogeneous firms, the openness to output trade decreases shares of all firms on the domestic market, and increases the export market revenues of firms that are able to export.

The aim of the following section is to analyze how input trade affects the results presented above. In other words, does the reallocation process occur with input trade liberalization, and if so, does it depend on the structure of import costs?

3 International trade in intermediate goods only

3.1 Preferences, technology and market structure

We now consider a world with two symmetric countries h and f (the European Union and the United States, for example). The other assumptions hold, so the same three sectors presented above stll exist.

Consumers

The preferences of representative consumers living in both countries are given by the same Cobb-Douglas utility function between the numeraire and differentiated good, leading to the same demand for each variety as presented in section 2.

The numeraire

The numeraire is now produced in both countries and is internationally traded without any cost. Assuming that $w_f = w_h = 1$, N is used as numeraire and ensures the same wages in both countries.

The intermediate good sector

In both countries, intermediate good firms produce the same homogeneous intermediate good using a single input, labor. Hereafter, we assume that the input price is higher in country h $(z_h > z_f)$.

The final sector

Given the results presented in the previous section, when $z_h > z_f$ and if firms produce using local inputs, the domestic labor productivity threshold is higher in country f $\left(\varphi_{fd} > \varphi_{hd}\right)$. In other words, the probability of entering the domestic market is higher in the country with the higher input costs, namely country h. In addition, the price index is higher in country h, so consumer welfare is lower than in country f even if the number of varieties is higher. In future comparisons, the threshold values of labor productivity and endogenous variables with asymmetric countries in a closed economy are listed without a superscript.

In this section, firms located in country h can import the intermediate product from country f.

Importing firms incur the following import costs

$$\tau_A z_f \alpha y(\varphi, z_f) + \mathrm{f}_M. \tag{3.28}$$

while firms that do not import incur the following cost $z_h \alpha y(\varphi, z_h)$ for using their intermediate good as in the previous section. To import the intermediate good from the foreign country, a firm must pay a fixed import cost f_M in labor units and an iceberg transport cost $\tau_A \geq 1$. Because the intermediate good is homogenous, firms producing in country f do not import inputs. In other words, the input trade (if there is any) is unilateral from country f to country h.

If a firm imports, its marginal cost (and thus its output price up to $1/\rho$) is given by $\tau_A z_f + w/\varphi$. Hence, the decision to import cannot be determined by comparing $z_h y(\varphi)$ and $\tau_A z_f y(\varphi) + \mathrm{f}_M$ because $y(\varphi)$ depends on the import status of the firm for the same level of labor productivity. For a given level of labor productivity, different input prices result in different output prices and, in turn, in different sales.

In what follows, we first investigate the effects of free input trade ($\tau_A = 1$ and $\mathrm{f}_M = 0$). Then we include only a positive variable cost ($\tau_A > 1$ and $\mathrm{f}_M = 0$). Finally, we include only a positive import fixed cost ($\tau_A = 1$ and $\mathrm{f}_M > 0$).

In this section, output trade costs are prohibitive so there is no output trade.

3.2 Intermediate good price and entry/exit with free input trade ($\tau_A = 1$ and $\mathbf{f}_M = 0$)

In this section, we assume that all firms can import intermediate goods without any costs so that all firms producing in country h import the intermediate product and firms producing in the foreign country purchase their intermediate goods locally. From a situation where the price of the intermediate good is higher in country h $(z_h > z_f)$, the openness to trade in the intermediate good sector leads to imports of this good from country f to country h.

We show in appendix C.1 that the total value of imports (resp. exports) of intermediate goods equals the total value of exports (resp. imports) of numeraire, implying that in both countries, the amount of labor available to produce the final good is the same. Consequently, threshold values are equal.

Indeed, as imports of intermediate goods do not involve additional costs, firms in both countries purchase intermediate goods at the same price and the marginal costs are the same in the two countries for the same level of labor productivity. Given that the mass of firms and the demand is the same in both countries, the structure of the final good sector is also the same.

Threshold values of labor productivity and endogenous variables with free input trade are denoted with the superscript FT.

From a situation with no input trade, the fall in marginal costs in country h reduces the price index of this country, and as a result, also decreases the probability of entering the domestic market (see eq.3.16). In country f, the openness to trade in the intermediate good sector does not affect final good firms: the amount of labor available, the demand and the production costs remain unchanged.

Previously, the probability of entering the domestic market was higher in country h, and the decrease in this probability leads to a convergence of the price index and domestic thresholds. As the distribution of labor productivity, the cost structure, the consumer revenues and the substitution between varieties are the same in both countries, price indexes, productivity thresholds, and other variables in the final good sector are also equal:

$$\begin{aligned} P_h^{FT} &= P_f^{FT} \\ \varphi_{hd}^{FT} &= \varphi_{fd}^{FT} \end{aligned} \tag{3.29}$$

Remember that before the opening of the intermediate good sector to trade, the price index was higher in country h $(P_f < P_h)$, as the probability of entering the domestic market $\left(\varphi_{fd} > \varphi_{hd}\right)$.

We know that due to lower marginal costs, P_h decreases with openness to trade,

$$P_h^{FT} = P_f^{FT} = P_f < P_h \tag{3.30}$$

Knowing that domestic revenues at domestic thresholds are equal to σf_d in both countries, we can write

$$\frac{P_h^{FT}}{P_f^{FT}} = \frac{p_{fd}\left(\varphi_{fd}^{FT}\right)}{p_{hd}\left(\varphi_{hd}^{FT}\right)} = 1$$

and

$$\begin{aligned} & p_{hd}\left(\varphi_{hd}^{FT}\right) = p_{fd}\left(\varphi_{fd}^{FT}\right) = p_{fd}\left(\varphi_{fd}\right) < p_{hd}\left(\varphi_{hd}\right) \\ \iff \quad & \varphi_{hd}^{FT} = \varphi_{fd}^{FT} = \varphi_{fd} > \varphi_{hd} \end{aligned} \tag{3.31}$$

To sum up, the labor productivity threshold above which firms can produce rises in the input importing country when the economy shifts from no input trade to input trade ($\varphi_{hd}^{T} > \varphi_{hd}$). In other words, *when there is no trade in the output sector, input trade openness decreases the probability of entering the domestic market in the input importing country but does not affect the input exporting country.*

Moreover, a shift from no input trade to free input trade results in a fall in the price index and increases consumer welfare in the input importing country.

To sum up, the effect of a switch from no input trade to free input trade without output trade has the same effects as a unilateral fall in the price of inputs in the input importing country, except for international trade structure which leads to unilateral trade in numeraire and in intermediate goods. The probability of entering domestic markets decreases in the input importing country.

3.3 Intermediate good prices and entry/exit with variable input trade cost ($\tau_A > 1$ and $\mathbf{f}_M = 0$)

In this case, firms located in country h import if and only if $\tau_A \leq z_h/z_f$. Threshold values of labor productivity and endogenous variables with variable input trade costs only are denoted with the superscript V.

As in the previous section, total exports of numeraire from country h are the same as total imports of intermediate goods from country f. Thus, the amount of labor available to produce the final good is the same in both countries and the threshold values are the same. Thus, except for exchanges of intermediate goods and numeraire, the configuration is the same as that of two asymmetric countries in a closed economy. However, the marginal cost of firms in country h see decreases thanks to access to less expensive inputs from country f.

Because the fall in marginal costs in the input importing country is lower than with free input trade, the impact on price indexes is also reduced and the situation is intermediate between the one without input trade and the one with free input trade.

Thus, it appears that

$$\varphi_{hd} < \varphi_{hd}^{V} < \varphi_{hd}^{FT} \qquad \varphi_{fd} = \varphi_{fd}^{V} = \varphi_{fd}^{FT} \tag{3.32}$$

The fall in prices of intermediate goods purchased by firms in country h leads to a decrease in the price index in this country, and to a decrease in the probability of entering the domestic market.

Moreover, a fall in τ_A, as long as $\tau_A > 1$, leads to a convergence in the threshold values of labor productivity in both countries, without leading to the equality acquired with free input trade.

3.4 Intermediate good prices and entry/exit with fixed input trade costs. ($\tau_A = 1$ and $\mathrm{f}_M > 0$)

We assume that $z_f \leq z_h$ and $\mathrm{f}_M > 0$. Remember that $\mathrm{f}_M = 0$ corresponds to free input trade (see section 3.2 and that $\mathrm{f}_M \to \infty$ is equivalent to the configuration where there is no input trade (asymmetric countries in a closed economy, see section 2). Threshold values of labor productivity and endogenous variables with fixed input trade costs only are denoted with the superscript F. A firm decides to import the intermediate good as long as its profit is higher with the imported intermediate good than with the domestic one.

$$\pi\left(\varphi, z_f\right) - \mathrm{f}_M \geq \pi\left(\varphi, z_h\right) \tag{3.33}$$

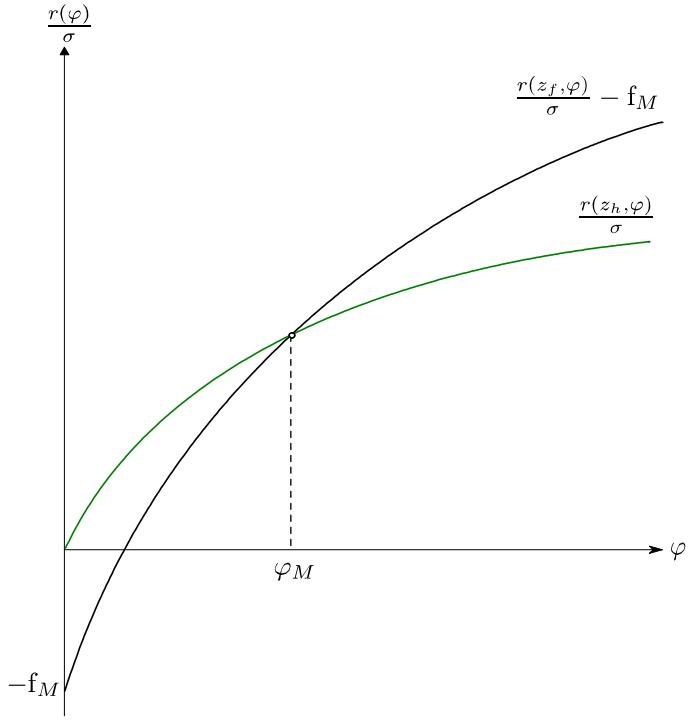
There are two opposite effects. On the one hand, the existence of a fixed import cost encourages the purchase of the intermediate good in the domestic country even though its price is higher than that of the foreign intermediate good. On the other hand, each firm is encouraged to import the intermediate product to reduce its marginal cost and consequently to increase its market share.

Note that, like for fixed export costs, a firm will be able to import only if its revenue is high enough to amortize this import fixed cost, thus if $\varphi > \varphi_M$, where φ_M is the labor productivity threshold for which a firm located in the input importing country is indifferent between importing and purchasing locally the intermediate product. So that

$$\varphi_M = \inf\left\{\varphi : \pi_h\left(\varphi, z_f\right) - \mathrm{f}_M \geq \pi_h\left(\varphi, z_h\right)\right\} \tag{3.34}$$

Note that φ_M increases with an increase in fixed import costs, so if fixed import costs are extremely high, no firm is able to import.

Figure 3.4: Selection process on import market



The effect of input trade with fixed import costs on the probability of entering domestic markets

Regardless of the value of φ_M and as long as $f_M \in]0;\infty[$, the probability of entering the input importing country decreases when input trade is allowed with a fixed import cost.

Indeed, openness to input trade results in a higher fall in the price index than the fall in the variety price of the less productive domestic firm, which undergoes a decrease in its market share and is forced to exit the market. Entry in and exit from the domestic market are driven by changes in the price of the most expensive variety ($p_{hd}(\varphi_{hd})$) in relation with changes in the price index.

If fixed import costs are extremely high, at least the most productive firm is able to import less expensive intermediate goods from country f, so its marginal costs and variety price decrease. Thus, the fall in its variety price will decrease the price index in country h, leading to a reduction in the market share of the less productive firm, and to raising the domestic labor productivity threshold. The fall in the price index in country h increases when fixed import costs decrease, as the share of firms that reduce their variety price increases. In other words, the increase in the domestic threshold resulting from a switch from no input trade to input trade with fixed costs is higher when fixed import costs are low.

When fixed import costs are low enough so that $\varphi_M \leq \varphi_{hd}^F$, all firms producing in country h import, and openness to input trade has the same effect as free input trade, reducing the probability of entering the domestic market. However, domestic labor productivity thresholds are not the same in the two countries because of higher fixed costs in country h. In addition to fixed domestic costs, firms have to pay fixed import costs. In this case, the domestic profit of a firm in country h is given by

$$\pi_{hd}^F = \frac{r_{hd}\left(\varphi, z_f\right)}{\sigma} - \mathrm{f}_d - \mathrm{f}_M \tag{3.35}$$

while in country f we still have

$$\pi_{fd}^F = \frac{r_{hd}\left(\varphi, z_f\right)}{\sigma} - \mathrm{f}_d \tag{3.36}$$

Thus, the domestic labor productivity threshold is higher in the input importing country, but decreases with a fall in fixed import costs.

To sum up, a move from no input trade to input trade with fixed import costs increases φ_{hd}, and the effects of input trade openness decrease with fixed import costs.

Proposition 3 *A shift from no input trade to input trade with fixed import costs favors the exit from domestic markets of firms in the input importing country.*

Proposition 4 *Starting from high fixed import costs, the probability of entering the domestic market in the input importing country decreases with falling fixed import costs as long as* $\varphi_M > \varphi_{hd}^F$ *and increases once* $\varphi_M < \varphi_{hd}^F$.

The gain in consumer welfare that results from a switch from no input trade to input trade with import fixed costs depends on the fall in the price index. Thus, input trade openness increases consumer welfare in country h, and consumer welfare gain decreases with fixed import costs.

The effect of fixed import cost on firms' revenues

As previously, the impact of input trade on firms' revenues depends on the extent to which firms decrease their variety price relative to the fall in the price index.

In country f, the price index and production costs remain unchanged, so that firms in this country are not affected by openness to input trade.

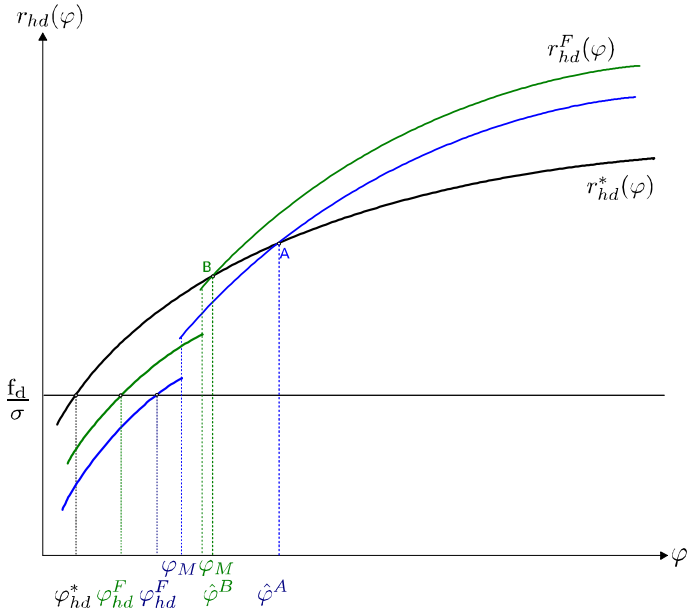
In country h, importing firms decrease their variety price, causing a fall in the price index, while non-importing firms keep the same variety price. Thus, when some firms are not able to import ($\varphi_M > \varphi_{hd}^F$), they lose market shares in favor to importing firms. In addition, reallocation between importing firms may occur

if a large share of domestic firms is able to import. Indeed, the higher the share of importing firms, the higher the fall in the price index. Then, as the fall in the variety price is lower for less productive firms, some low productivity importing firms may not decrease their variety price enough relative to the fall in the price index. Consequently, these firms lose market shares. In other words, when fixed import costs are low enough, reallocation occurs between importing firms ($\varphi_M < \hat{\varphi}$). However, an increase in fixed import costs reduces reallocation between importing firms, and increases the share of firms that benefit from openness to input trade.

Alternatively, when fixed import costs are high enough, reallocation between importing firms no longer occurs, and all importing firms gain from input trade openness at the expense of non-importing firms Thus, the share of firms that gain from input trade decreases with import fixed costs.

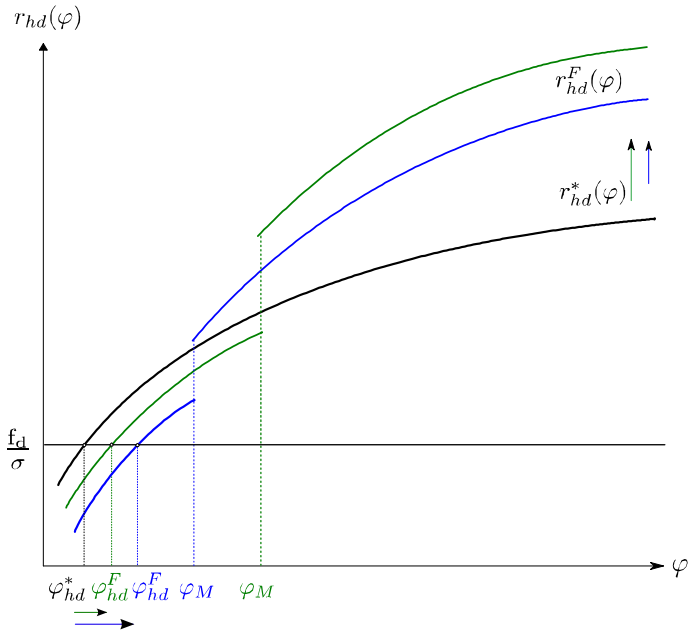
Figures 3.5 and 3.6 show the effect of increasing import fixed costs with and without reallocation. The black curve represents revenues without input trade, the blue curve represents revenues with input trade and fixed import costs, and the green curve represents revenues with higher fixed import costs.

Figure 3.5: Impact of fixed import cost level on domestic revenue. Low import fixed costs ($\varphi^*_{hd} < \varphi_M < \hat{\varphi}$)



In both cases, less productive firms suffer from the reallocation process caused by less expensive inputs, but their loss are even greater if they are not able to import due to high fixed import costs. However, when fixed import costs increase, both non-importing firms and high productive importing ones benefit. The share of importing firms decreases and the price index increases. Thus, all firms whose variety prices are not affected by this change increase their market shares (i.e. firms

Figure 3.6: Impact of fixed import cost level on domestic revenue. High import fixed costs ($\varphi^*_{hd} < \hat{\varphi} < \varphi_M$)



that are still able to import and firms that were previously unable to import), at the expense of firms forced to exit the import market because of higher import costs $\left(\varphi \in \left[\varphi_{M_{low}}, \varphi_{M_{high}}\right[\right)$.

Note that reallocation is highest when $\varphi_M = \hat{\varphi}$. In this case, all importing firms increase their market share at the expense of all non-exporting firms. When $\varphi_M = \hat{\varphi}$, any change in fixed import costs reduces the share of firms that benefit from openness to input trade.

In this section, we show that input costs and input trade liberalization change the structure of the domestic market in the input importing country. Less productive firms always suffer from input trade openness to an even greater extent if they are excluded from import markets due to fixed import costs.

However, as there is no output trade in this section, we focus on local competition and it is really important to take into account the fact that firms evolve in an open economy, and that additional competition from foreign countries also affects the structure of domestic markets. In what follows, we investigate how input trade openness affects firms in a global economy. We first present the model with output trade between symmetric countries. Next, countries are allowed to have different intermediate good prices. Finally, international trade in intermediate goods is also allowed.

4 International trade in final goods

4.1 Preferences, technology and market structure

We now consider that output trade costs are lower than in the previous section, so that output trade occurs. The other assumptions hold, so we still have three sectors as above.

Consumers

The preferences of representative consumers living in both countries are given by the same Cobb-Douglas utility function between the numeraire and differentiated good. However, the set of available varieties now includes some imported varieties from the foreign country. For example, in country h, optimization of consumer preferences leads to the optimal consumption of each variety ω:

$$y_{dh}(\omega) = \frac{w_h \beta L}{P_h} \left(\frac{p_{dh}(\omega)}{P_h} \right)^{-\sigma} \tag{3.37}$$

$$y_{xf}(\omega) = \frac{w_h \beta L}{P_h} \left(\frac{p_{xf}(\omega)}{P_h} \right)^{-\sigma} \tag{3.38}$$

where $p_{dh}(\omega)$ is the price of the variety ω produced in country h on its domestic market, $y_{dh}(\omega)$ is the quantity of variety ω produced in country h and consumed by a consumer located in country h. $p_{xf}(\omega)$ is the price on the export market of the variety ω produced in country f and $y_{xf}(\omega)$ is the quantity of variety ω exported from country f and consumed by a consumer in country h.

The final sector

In addition to their domestic sales, firms now have the opportunity to export. To do so, they have to pay an additional fixed export cost, f_{ex}, which represents the adaptation costs to international markets (distribution and servicing network) and an iceberg transport cost $\tau > 1$. We assume that firms are indifferent between paying the export cost f_{ex} and paying the amortized per period portion of this cost $\mathrm{f}_x = \delta \mathrm{f}_{ex}$ in every period. Trade costs are equal in both countries so that final goods are exported from both.

When a firm in country h exports to country f, the price of its product in the foreign market is given by

$$p_{xh}(\varphi) = \tau \frac{z_h \alpha + 1/\varphi}{\rho} \tag{3.39}$$

The total profit of a firm φ producing in country h is now given by $\pi_h(\varphi) =$

$\pi_{dh}(\varphi) + \max\{0, \pi_{xh}(\varphi)\}$ with

$$\pi_{dh}(\varphi) = \frac{r_{dh}(\varphi)}{\sigma} - \mathrm{f}_d \tag{3.40}$$

$$r_{dh}(\varphi) = \beta L \left[\frac{\rho P_h}{z_h \alpha + 1/\varphi}\right]^{\sigma-1} \tag{3.41}$$

corresponding to the profits and sales on the domestic market and with

$$\pi_{xh}(\varphi) = \frac{r_{xh}(\varphi)}{\sigma} - \mathrm{f}_x \tag{3.42}$$

$$r_{xh}(\varphi) = \tau^{1-\sigma} \beta L \left[\frac{\rho P_f}{z_h \alpha + 1/\varphi}\right]^{\sigma-1} \tag{3.43}$$

being the value of profits and exports to country f. The ratios of any two firms' outputs and the revenues associated with the domestic market (located in the same country) equal the ratios of these two firms' outputs and the revenues associated with the export market[5]

$$\frac{y_{hd}(\varphi_1)}{y_{hd}(\varphi_2)} = \left[\frac{\varphi_1}{\varphi_2}\frac{(w_h + z_h \alpha \varphi_2)}{(w_h + z_h \alpha \varphi_1)}\right]^{\sigma} = \frac{y_{hx}(\varphi_1)}{y_{hx}(\varphi_2)} \tag{3.44}$$

$$\frac{r_{hd}(\varphi_1)}{r_{hd}(\varphi_2)} = \left[\frac{(w_h + z_h \alpha \varphi_2)}{(w_h + z_h \alpha \varphi_1)}\frac{\varphi_1}{\varphi_2}\right]^{\sigma-1} = \frac{r_{hx}(\varphi_1)}{r_{hx}(\varphi_2)} \tag{3.45}$$

Increased use of an intermediate good to produce the final good or more expensive intermediate goods also reduce the ratios on export markets so that the existence of an intermediate good used at a fixed proportion reduces the advantage of more productive firms even if they are exporting firms.

4.2 Firm entry and exit in the final good sector

The value function of a firm is still given by its discounted profit flows

$$v_h(\varphi) = \max\left\{0, \sum_{t=0}^{\infty} (1-\delta)^t \pi_h(\varphi)\right\} = \max\left\{0, \frac{1}{\delta}\pi_h(\varphi)\right\} \tag{3.46}$$

and φ_{hd} remains the labor productivity threshold above which a firm can enter the domestic market and make profit defined such that

$$\varphi_{hd} = \inf\{\varphi : v_h(\varphi, z_h) \geq 0\}. \tag{3.47}$$

[5]The equality between domestic and export ratios is observed for exporting firms only. However, for domestic firms and firms which are not able to enter the domestic market, revenues and outputs function follow the same rules.

and $\mu_h(\varphi)$ is the conditional distribution of $g(\varphi)$ on $[\varphi_{hd}, \infty[$ with

$$\mu_h(\varphi) = \begin{cases} \frac{g(\varphi)}{\theta_{hd}} & \text{if } \varphi \geq \varphi_{hd} \\ 0 & \text{if } \varphi < \varphi_{hd} \end{cases} \tag{3.48}$$

where $\theta_{hd} \equiv 1 - G(\varphi_{hd})$.

In addition, to export, firms pay a fixed export cost f_x. We consider the export cutoff level, which is the labor productivity threshold below which a firm does not export, to be:

$$\varphi_{hx} = \inf \{\varphi > \varphi_{hd} : \pi_{hx}(\varphi, z_h) > 0\} \tag{3.49}$$

where we assume that $\varphi_{hx} > \varphi_{hd}$, or equivalently $\mathrm{f}_x > \mathrm{f}_d(\tau P_h/P_f)^{1-\sigma}$, to enable the coexistence of domestic and exporting firms. In this case, the probability that one of these successful entrants exports is given by

$$\theta_{hx} \equiv \frac{1 - G(\varphi_{hx})}{1 - G(\varphi_{hd})}. \tag{3.50}$$

So a fraction θ_{hx} of firms produces in country h and exports to country f, hence a mass $M_{hx} = \theta_{hx} M_h$ of exporting firms. We set $\eta_h(\varphi)$ as the conditional distribution of $g(\varphi)$ on $[\varphi_{hx}, \infty[$, which is the distribution of exporting firms and can be written as follows:

$$\eta_h(\varphi) = \begin{cases} \frac{g(\varphi)}{1-G(\varphi_{hx})} = \frac{\mu_h(\varphi)}{\theta_{hx}} & \text{if } \varphi \geq \varphi_{hx} \\ 0 & \text{if } \varphi < \varphi_{hx} \end{cases} \tag{3.51}$$

Hence, the expected profit of a firm prior to entering the market is given by $\theta_{hd}\bar{\pi}_h$ with

$$\bar{\pi}_h = \int_0^\infty \pi_{hd}(\varphi)\, \mu_h(\varphi)\, \mathrm{d}\varphi + \theta_{hx} \int_0^\infty \pi_{hx}(\varphi)\, \eta_h(\varphi)\, \mathrm{d}\varphi \tag{3.52}$$

As previously, a firm enters the market as long as $\theta_{hd}\bar{\pi}_h/\delta - \mathrm{f}_e \geq 0$. When a firm decides to enter, it produces final goods to serve the domestic market if and only if $\pi_{hd}(\varphi) \geq 0$ or equivalently $\varphi \geq \varphi_{hd}$, and serves the foreign market if and only if $\pi_{hx}(\varphi) \geq 0$ or equivalently $\varphi \geq \varphi_{hx}$.

In the following sections, we use the framework described above, and all mechanisms presented in this section hold.

4.3 The impact of intermediate good prices on entry in/exit from markets in symmetric countries

In this section, we assume that countries are perfectly symmetric and share the same price of intermediate goods. Thus, $z_h = z_f = z$ and domestic and export

thresholds, like all aggregated variables, are the same in the two countries ($\varphi'_{hd} = \varphi'_{fd}$ and $\varphi'_{hx} = \varphi'_{fx}$). Note that for further comparison, when output trade is allowed, threshold values and aggregated variables are denoted with an apostrophe $'$. To simplify the presentation, we focus on the results of firms in country h, keeping in mind that the results of firms in country f are exactly the same

4.3.1 Entry in/exit from domestic and export markets

At equilibrium, we have $\bar{\pi}_h = \delta \mathrm{f}_e/\theta_{hd}$, $\pi_{hd}(\varphi_{hd}) = 0$ and $\pi_{hx}(\varphi_{hx}) = 0$. By using the two latter conditions as well as (3.40) and (3.42), we have $r_{hd}(\varphi_{hd}) = r_{fd}(\varphi_{fd}) = \sigma \mathrm{f}_d$ and $r_{hx}(\varphi_{hx}) = r_{fx}(\varphi_{fx}) = \sigma \mathrm{f}_x$.

$$\frac{P'_h}{P'_f} = \frac{p_{hd}(\varphi'_{hd})}{p_{fd}(\varphi'_{fd})} = \frac{p_{fx}(\varphi'_{fx})}{p_{hx}(\varphi'_{hx})} = 1 \tag{3.53}$$

and

$$\frac{p_{hx}(\varphi'_{hx})}{p_{fd}(\varphi'_{fd})} = \frac{p_{fx}(\varphi'_{fx})}{p_{hd}(\varphi'_{hd})} = \left(\frac{\mathrm{f}_x}{\mathrm{f}_d}\right)^{\frac{1}{1-\sigma}} \tag{3.54}$$

$$\varphi'_{hx} = \left[\frac{1}{\tau}\left(\frac{\mathrm{f}_x}{\mathrm{f}_d}\right)^{\frac{1}{1-\sigma}} \frac{1}{\varphi'_{fd}} + \left(\frac{1}{\tau}\left(\frac{\mathrm{f}_x}{\mathrm{f}_d}\right)^{\frac{1}{1-\sigma}} - 1\right)\alpha z\right]^{-1} \tag{3.55}$$

$$\varphi'_{fx} = \left[\frac{1}{\tau}\left(\frac{\mathrm{f}_x}{\mathrm{f}_d}\right)^{\frac{1}{1-\sigma}} \frac{1}{\varphi'_{hd}} + \left(\frac{1}{\tau}\left(\frac{\mathrm{f}_x}{\mathrm{f}_d}\right)^{\frac{1}{1-\sigma}} - 1\right)\alpha z\right]^{-1} \tag{3.56}$$

By using these equalities, in Appendix D.1 we show that $\bar{\pi}_h$ can be rewritten as a function of φ'_{hd} and φ'_{hx}:

$$\begin{aligned}\bar{\pi}_h = {} & \mathrm{f}_d \left(\frac{1}{\varphi'_{hd}} + \alpha z\right)^{\sigma-1} \int_{\varphi'_{hd}}^{\infty} \left(\frac{1}{\varphi} + \alpha z\right)^{1-\sigma} \mu_h(\varphi)\, \mathrm{d}\varphi - \mathrm{f}_d \\ & + \mathrm{f}_x \left(\frac{1}{\varphi'_{hx}} + \alpha z\right)^{\sigma-1} \int_{\varphi'_{hx}}^{\infty} \left(\frac{1}{\varphi} + \alpha z\right)^{1-\sigma} \mu_h(\varphi)\, \mathrm{d}\varphi - \theta_{hx} n \mathrm{f}_x\end{aligned} \tag{3.57}$$

where $\mathrm{d}\varphi'_{hx}/\mathrm{d}\varphi'_{hd} > 0$ (see Appendix D.2).

Thus, we have φ'_{hd} such that

$$\bar{\pi}_h(\varphi'_{hd}) - \frac{\delta \mathrm{f}_e}{\theta_{hd}(\varphi'_{hd})} = 0 \tag{3.58}$$

In Appendix D.3, we show that φ_{hd} exists, is positive and unique, and in Appendix

D.4, that, knowing (3.58),

$$\frac{\mathrm{d}\varphi'_{hd}}{\mathrm{d}z} = \frac{\mathrm{d}\bar{\pi}_{hd}}{\mathrm{d}z}\frac{\theta^2_{hd}}{\delta \mathrm{f}_e g(\varphi'_{hd})} < 0.$$

Like in a closed economy, a simultaneous and identical decline in the price of the intermediate good reduces the probability of entering the domestic market and increases average productivity in both countries.

We now are equipped to determine the impact of the price of an intermediate good on the probability of exporting. It appears that

$$\frac{\mathrm{d}\varphi'_{hx}}{\mathrm{d}z} = \underbrace{\frac{\partial \varphi'_{hx}}{\partial z}}_{>0} + \underbrace{\frac{\partial \varphi'_{hx}}{\partial \varphi'_{hd}}}_{>0}\underbrace{\frac{\mathrm{d}\varphi'_{hd}}{\mathrm{d}z}}_{<0} = \alpha(1-B)\left(\varphi'_{hx}\right)^2 + \frac{B}{\varphi\left('_{hd}\right)^2}\left(\varphi'_{hx}\right)^2\frac{\mathrm{d}\varphi'_{hd}}{\mathrm{d}z} \tag{3.59}$$

The effect of the price of an intermediate good on the probability of exporting is ambiguous. In chapter 1, we showed that a fall in the intermediate good price may reduce the probability of exporting if fixed export costs are low enough. Indeed, when fixed export costs are low enough, selection on the export market is low, and some exporting firms have low labor productivity. These low productivity firms reduce their variety price less than the fall in the foreign price index and as a result, their export market shares decrease in favor of more productive firms. In this model, we have an additional effect due to the effect on the probability of entering the domestic market. When the entry in domestic market is endogenous, the negative effect of a fall in the intermediate good price on the probability of exporting increases ($\partial\varphi'_{hx}/\partial\varphi'_{hd} > 0$ and $\mathrm{d}\varphi'_{hd}/\mathrm{d}z < 0$). Thus, for the export threshold to go down when the price of the intermediate good decreases, fixed export costs need to be even higher.

To summarize,

Proposition 5 *A simultaneous and identical decline in prices of the intermediate good reduces the probability of entering the foreign market and leads to reallocation of exports from low productivity firms to high productivity firms in both countries, provided that export fixed costs are low enough.*

4.3.2 Welfare

Number of varieties. At stationary equilibrium, all variables remain constant. The mass of new entrants M_h^e must successfully replace the mass of firms that exit $\theta_{hd}M_h^e = \delta M_h$.

Remember that $M_h = R_h/\bar{r}_h$ where R_h (resp., $\bar{r}_h$) is the total (resp., average)

income of the final sector firms in country h. Some calculations reveal that

$$M_h = \frac{\beta L}{\sigma\left(\bar{\pi}_h + \mathrm{f}_d + \theta_{hx}\mathrm{f}_x\right)}. \tag{3.60}$$

Indeed, by plugging (3.40) and (3.42) into (3.52), we obtain

$$\bar{\pi}_h = \frac{\bar{r}_h}{\sigma} - \mathrm{f}_d - \theta_{hx}\mathrm{f}_x \tag{3.61}$$

such that $\bar{r}_h = \sigma\left(\bar{\pi}_h + \mathrm{f}_d + \theta_{hx}\mathrm{f}_x\right)$. In addition, it is easy to check that $R_h = \beta L$. At each period, the demand for labor units in the final good sector is given by

$$L_h^Y = M_h^e \mathrm{f}_e + L_{ph}^Y + M_h \mathrm{f}_d + M_{hx}\mathrm{f}_x \tag{3.62}$$

where $M_h^e \mathrm{f}_e$ represents the units of labor used to enter the market (sunk entry costs), L_{ph}^Y is the sum of labor units allocated to production, and $M_h \mathrm{f}_d$ (resp., $M_{hx}\mathrm{f}_x$) is the sum of units of labor to pay the fixed domestic costs (resp., fixed exporting costs). The sum of wages paid by final sector firms is equal to the aggregated revenue minus aggregated profit and total expenditure for the intermediate products, that is

$$L_{ph}^Y + M_h \mathrm{f}_d + M_{hx}\mathrm{f}_x = R_h - \Pi_h - zA_h \tag{3.63}$$

where A_h is the mass of intermediate goods purchased by national firms. Note that $zA_h = wL_h^A = L_h^A$ (no pure profit in the intermediate sector) and $\Pi_h = \bar{\pi}_h M_h = M_h^e \mathrm{f}_e$ (because $\bar{\pi}_h = \delta \mathrm{f}_e/\theta_{hd}$ and $M_h = \theta_{hd} M_h^e/\delta$).

$$R_h = L_{ph}^Y + M_h \mathrm{f}_d + M_{hx}\mathrm{f}_x + M_h^e \mathrm{f}_e + L_h^A = L - L_h^N \tag{3.64}$$

In appendix D.6 we show that[6]

$$L_h^N = N_h = (1-\beta)\, L \tag{3.65}$$

Thus $R_h = \bar{r}_h M_h = \beta L$ and

$$\frac{\mathrm{d}M_h}{\mathrm{d}z} = \frac{-M_h}{\bar{r}_h}\frac{\mathrm{d}\bar{r}_h}{\mathrm{d}z} = \frac{-M_h\left(\frac{\mathrm{d}\bar{\pi}_h}{\mathrm{d}z} + \mathrm{f}_x\frac{\mathrm{d}\theta_{hx}}{\mathrm{d}z}\right)}{\bar{\pi}_h + \mathrm{f}_d + \theta_{hx}\mathrm{f}_x} \tag{3.66}$$

where

$$\frac{\mathrm{d}\theta_{hx}}{\mathrm{d}z} = \frac{-g(\varphi'_{hx})\frac{\mathrm{d}\varphi'_{hx}}{\mathrm{d}z} + \theta_{hx} g(\varphi'_{hd})\frac{\mathrm{d}\varphi'_{hd}}{\mathrm{d}z}}{\theta_{hd}} \tag{3.67}$$

Except in the case of very low fixed export costs, a fall in intermediate good

[6] As countries are perfectly symmetric there is no international trade in numeraire.

price reduces the number of domestic varieties ($\mathrm{d}M_h/\mathrm{d}z > 0$).

From a consumer's point of view, if export fixed costs are high enough, a fall in intermediate good price results in a fall in the export threshold and to an increase in the number of imported varieties. Thus, the number of imported varieties may lead to an increase in the number of varieties available for consumers.

Aggregated production

Like in a closed economy, both an increase in the domestic threshold and reallocation results in better allocation of resources and an increase in the level of production.

In addition, we know that a fall in intermediate good price causes reallocation from low productivity firms to high productivity ones, and that more productive firms export. Thus, reallocation leads to a higher market share for exporting firms. Indeed, even if some exporting firms reduce their market share, market share losses of domestic and exporting firms favor more productive exporting firms. Thus, when input prices decrease, aggregated exports and the share of the final good sold overseas increases in both countries.

Price index

The effect of the intermediate good price on the price of the variety sold by the less productive domestic firm is still given by:

$$\frac{\mathrm{d}p_{hd}\left(\varphi'_{hd}\right)}{\mathrm{d}z} = \alpha + \frac{\partial p_{hd}\left(\varphi\right)}{\partial \varphi}\frac{\partial \varphi'_{hd}}{\partial z} = \alpha - \frac{1}{\varphi'^{2}_{hd}}\underbrace{\frac{\partial \varphi'_{hd}}{\partial z}}_{<0} > 0 \tag{3.68}$$

Because $r_{hd}(\varphi'_{hd}) = \sigma \mathrm{f}_d$ and $r_{dh}(\varphi) = \beta L \left[\frac{P'_h}{p_{hd}(\varphi)}\right]^{\sigma-1}$, we can write

$$P'_h = \left(\sigma \mathrm{f}_d/\beta L\right)^{\frac{1}{\sigma-1}} p_{hd}(\varphi'_{hd}).$$

Knowing that $\mathrm{d}p_{hd}\left(\varphi'_{hd}\right)/\mathrm{d}z > 0$ a fall in intermediate good price decreases the price index ($\mathrm{d}P'_h/\mathrm{d}z > 0$).

Thus, as previously, a fall in intermediate good prices increases consumer welfare ($\mathrm{d}W'_h/\mathrm{d}z < 0$) and the effect of the fall in prices is greater than the possible decrease in the number of varieties available for consumers.

Proposition 6 *A simultaneous and identical decline in prices of intermediate goods increases consumer welfare in both countries even if the mass of firms producing on domestic markets decreases.*

4.4 The impact of intermediate good prices on market entry/exit when the countries are asymmetric

Like in section 3, we assume that the price of intermediate goods is higher in the home country, while other variables remain constant.

$$z_h > z_f \tag{3.69}$$

However, in this section, we assume that importing costs τ_A or f_M are prohibitive so that all firms use locally produced intermediate goods. The threshold values of labor productivity and endogenous variables with asymmetric countries without input trade are denoted with the superscript *.

In addition, we assume that z_h and z_f are not too different in order to have $\mathrm{f}_x > \mathrm{f}_d(\tau P_h/P_f)^{1-\sigma}$ and $\mathrm{f}_x > \mathrm{f}_d(\tau P_f/P_h)^{1-\sigma}$ enabling the coexistence of domestic and exporting firms in both countries.

4.4.1 International differences in entry/exit conditions

At equilibrium, given the free entry condition, we have $\theta_{hd}\bar{\pi}_h = \delta \mathrm{f}_e$ where the average profit in country h is now given by:

$$\begin{aligned}\bar{\pi}_h &= \mathrm{f}_d\left(\frac{1}{\varphi'^*_{hd}} + \alpha z_h\right)^{\sigma-1}\int_{\varphi'^*_{hd}}^{\infty}\left(\frac{1}{\varphi} + \alpha z_h\right)^{1-\sigma}\mu_h(\varphi)\,\mathrm{d}\varphi - \mathrm{f}_d \\ &\quad + \mathrm{f}_x\left(\frac{1}{\varphi'^*_{hx}} + \alpha z_h\right)^{\sigma-1}\int_{\varphi'^*_{hx}}^{\infty}\left(\frac{1}{\varphi} + \alpha z_h\right)^{1-\sigma}\mu_h(\varphi)\,\mathrm{d}\varphi - \theta_{hx} n \mathrm{f}_x\end{aligned} \tag{3.70}$$

When $z_h > z_f$, φ'^*_{hd} (resp. φ'^*_{fd}) exists, it is positive and unique, as shown in Appendix D.3. Indeed, as shown in Appendix D.2, the relationship between φ'^*_{hd} and φ'^*_{hx} (resp. φ'^*_{fd} and φ'^*_{fx}) remains positive when $z_h > z_f$ because

$$\frac{\mathrm{d}p_{hd}(\varphi'^*_{hd})}{\mathrm{d}p_{hx}(\varphi'^*_{hx})} = \left(\frac{\mathrm{f}_x}{\mathrm{f}_d}\right)^{\frac{1}{\sigma-1}}\frac{P'_f}{P'_h}\left(\frac{\partial P'_h}{\partial P'_f}\right)^2 > 0 \tag{3.71}$$

As $p_{hd}(\varphi'^*_{hd})$ and $p_{hx}(\varphi'^*_{hx})$ are decreasing functions of φ'^*_{hd} and φ'^*_{hx} respectively, φ'^*_{hx} is an increasing function of $\varphi'^*_{hd.}$. Thus, $\mathrm{d}\theta_{hd}\bar{\pi}_h/\mathrm{d}\varphi'_{hd} < 0$, $\lim \theta_{hd}\bar{\pi}_h = \infty$ when $\varphi'_{hd} \to 0$ and $\lim \theta_{hd}\bar{\pi}_h = 0$ when $\varphi'_{hd} \to \infty$ so that φ'^*_{hd} (resp. φ'^*_{fd}) exists, is positive and unique.

In addition, the profit at threshold values is equal to 0, $\pi_{hd}(\varphi'^*_{hd}) = \pi_{fd}(\varphi'^*_{fd}) = 0$ and $\pi_{hx}(\varphi'^*_{hx}) = \pi_{fx}(\varphi'^*_{fx}) = 0$ (or equivalently, $r_{hd}(\varphi'^*_{hd}) = r_{fd}(\varphi'^*_{fd}) = \sigma \mathrm{f}_d$ and

$r_{hx}(\varphi'^{*}_{hx}) = r_{fx}(\varphi'^{*}_{fx}) = \sigma \mathrm{f}_x)$, now implying that

$$\frac{P'_h}{P'_f} = \frac{p_{hd}(\varphi'^{*}_{hd})}{p_{fd}(\varphi'^{*}_{fd})} = \frac{p_{fx}(\varphi'^{*}_{fx})}{p_{hx}(\varphi'^{*}_{hx})} \neq 1 \tag{3.72}$$

and

$$\frac{p_{hx}(\varphi'^{*}_{hx})}{p_{fd}(\varphi'^{*}_{fd})} = \frac{p_{fx}(\varphi'^{*}_{fx})}{p_{hd}(\varphi'^{*}_{hd})} = \left(\frac{\mathrm{f}_x}{\mathrm{f}_d}\right)^{\frac{1}{1-\sigma}} \tag{3.73}$$

The ratio of variety prices at threshold values is given by the ratio of price indexes, and on a given market, the ratio between prices of the most expensive domestic variety ($p_{hd}(\varphi'^{*}_{hd})$) and the most expensive imported variety ($p_{fx}(\varphi'^{*}_{fx})$) is given by the ratio of fixed costs and by the elasticity of substitution σ. Thus, for both countries, we can write the export threshold in a given country as a function of the domestic threshold in the other country:

$$\varphi'^{*}_{hx} = \left[\frac{1}{\tau}\left(\frac{\mathrm{f}_x}{\mathrm{f}_d}\right)^{\frac{1}{1-\sigma}} \frac{1}{\varphi'^{*}_{fd}} + \frac{1}{\tau}\left(\frac{\mathrm{f}_x}{\mathrm{f}_d}\right)^{\frac{1}{1-\sigma}} \alpha z_f - \alpha z_h\right]^{-1} \tag{3.74}$$

$$\varphi'^{*}_{fx} = \left[\frac{1}{\tau}\left(\frac{\mathrm{f}_x}{\mathrm{f}_d}\right)^{\frac{1}{1-\sigma}} \frac{1}{\varphi'^{*}_{hd}} + \frac{1}{\tau}\left(\frac{\mathrm{f}_x}{\mathrm{f}_d}\right)^{\frac{1}{1-\sigma}} \alpha z_h - \alpha z_f\right]^{-1} \tag{3.75}$$

As $z_h > z_f$, we show in Appendix D.4 that, knowing (3.58),

$$\frac{\mathrm{d}\varphi'^{*}_{hd}}{\mathrm{d}z_h} = \frac{\mathrm{d}\bar{\pi}_h}{\mathrm{d}z_h} \frac{\theta^2_{hd}}{\delta \mathrm{f}_e g(\varphi'^{*}_{hd})} < 0. \tag{3.76}$$

so that the domestic threshold is lower in the country in which the price of the intermediate good is higher ($\varphi'^{*}_{hd} < \varphi'^{*}_{fd}$). In other words, due to reallocation, the probability of entering the domestic market is higher in the country with higher prices for intermediate goods. Thus, as the domestic productivity threshold is lower in country h and the input price is higher, the price of the variety sold by the less productive firm is higher in country h ($p_{hd}\left(\varphi'^{*}_{hd}\right) > p_{fd}\left(\varphi'^{*}_{fd}\right)$), such as the price of the more expensive imported variety ($p_{hx}\left(\varphi'^{*}_{hx}\right) < p_{fx}\left(\varphi'^{*}_{fx}\right)$, see eq. 3.73). Given that the price at the export threshold is lower for firms in country h, it is easy to show that $\varphi'^{*}_{hx} > \varphi'^{*}_{fx}$: the labor productivity threshold above which a firm is able to enter the foreign market is higher in country h. Moreover, plugging these inequalities in equation 3.72 shows that the price index is higher in country h $\left(P'_h > P'_f\right)$, thus consumer welfare is lower in the country with the higher intermediate good price $\left(W'_h < W'_f\right)$.

To sum up, more expensive intermediate goods lead to a larger share of firms able to produce, but a smaller share of firms able to export, a higher price index

and lower consumer welfare.

The probability of entering the domestic market is higher in country h ($\theta_{hd} > \theta_{fd}$) as is the probability of exporting from country f to country h ($\theta_{fx} > \theta_{hx}$):

Proposition 7 *Assuming no input trade, the probability of entry is lower in the country with lower intermediate good prices, and the probability of exporting is lower for firms producing in the country with higher intermediate good prices.*

From equation 3.41, 3.43 and 3.73, the ratio between domestic (resp. exporting) prices at the domestic (resp. export) threshold and the price index in each country is given by

$$\frac{p_{fd}(\varphi'^{*}_{fd})}{P'_f} = \frac{p_{hd}(\varphi'^{*}_{hd})}{P'_h} = \left(\frac{\sigma \mathrm{f}_d}{\beta L}\right)^{\frac{1}{1-\sigma}} \tag{3.77}$$

$$\frac{p'_{hx}(\varphi^{*}_{hx})}{P'_f} = \frac{p_{fx}(\varphi'^{*}_{fx})}{P'_h} = \left(\frac{\sigma \mathrm{f}_x}{\beta L}\right)^{\frac{1}{1-\sigma}} \tag{3.78}$$

Thus, a change in the price index will lead to the same variation in the prices above which firms are able to access the market, both domestic firms and firms that export to this market.

4.4.2 A unilateral fall in the price of intermediate goods

The aim of this section is to highlight the mechanisms by which firms in a country (here country h) are impacted by a fall in the price of intermediate goods, depending on whether the fall in price occurs in the home country (h) or in the foreign one (f).

Impact of $\mathbf{z}_h$ and $\mathbf{z}_f$ on entry in/exit from the domestic market

We first consider that z_h varies unilaterally whereas z_f remains constant but is lower than z_h (so that we still have $z_h > z_f$). We know from equation 3.76 that φ'^{*}_{hd} increases when z_h decreases.

In Appendix A.4 we show that, knowing (3.58),

$$\frac{\mathrm{d}\varphi'^{*}_{hd}}{\mathrm{d}z_h} = \frac{\mathrm{d}\bar{\pi}_h}{\mathrm{d}z_h} \frac{\theta^2_{hd}}{\delta \mathrm{f}_e g(\varphi'^{*}_{hd})} < 0. \tag{3.79}$$

Like in previous sections, the share of intermediate products in total costs ($\alpha z_h/(\alpha z_h + w/\varphi)$) increases with labor productivity so that falling prices for intermediate goods lead to a bigger decrease in the price of the final good of high productivity firms and, in turn, to reallocation of market shares from low productivity firms to high productivity ones. Thus, a fall in the price of intermediate goods in the home country decreases the probability of entering the domestic market (φ'^{*}_{hd} increases).

We now analyze the effect of a fall in the price of intermediate goods in country f on the probability of serving the domestic market for firms in country h. Standard calculations reveal that

$$\frac{\mathrm{d}\varphi'^{*}_{hd}}{\mathrm{d}z_f} = \underbrace{\frac{\partial \varphi'^{*}_{hd}}{\partial z_f}}_{<0} + \underbrace{\frac{\partial \varphi'^{*}_{hd}}{\partial \varphi'^{*}_{fd}}}_{<0} \frac{\partial \varphi'^{*}_{fd}}{\partial z_f} < 0 \tag{3.80}$$

with

$$\frac{\mathrm{d}\varphi'^{*}_{hd}}{\mathrm{d}z_f} < \frac{\mathrm{d}\varphi'^{*}_{fd}}{\mathrm{d}z_f} < 0 \tag{3.81}$$

The fall in prices of intermediate goods in country f leads to a fall in prices of imported varieties from the same country. As imported varieties from country f become relatively more competitive in country h, their market shares increase at the expense of domestic varieties. This leads to a decrease in the probability of entering the domestic market in country h (φ'^{*}_{hd} increases).

To summarize,

Proposition 8 *Assuming output trade but no input trade, the probability of entering the domestic market decreases with a fall in the price of intermediate goods in the home country or with a fall in the price of intermediate goods in the partner country.*

Thus, even if the intermediate good is not internationally traded, its price in the foreign country has an impact on the share of firms able to produce in the home country. Indeed, prices of intermediate goods in the foreign country impact the price of varieties produced in the same country, including varieties exported to the other country. Thus, a fall in intermediate good prices in the foreign country reduces the price of imported varieties, strengthens competition on the domestic market and forces less productive firms to exit the market. This proposition highlights the existence of international externalities in the prices of intermediate goods, even if only final goods are internationally traded.

Impact of $\mathbf{z}_h$ and $\mathbf{z}_f$ on entry in/exit from the export market

We are also equipped to determine the impact of the price of domestic and foreign intermediate goods on the probability of exporting.

We first investigate the impact of prices of domestic intermediate goods on the probability of exporting, which is given by

$$\frac{\mathrm{d}\varphi'^{*}_{hx}}{\mathrm{d}z_h} = \underbrace{\frac{\partial \varphi'^{*}_{hx}}{\partial z_h}}_{>0} + \underbrace{\frac{\partial \varphi'^{*}_{hx}}{\partial \varphi'^{*}_{hd}}}_{>0} \underbrace{\frac{\mathrm{d}\varphi^{*}_{hd}}{\mathrm{d}z_h}}_{<0} = \alpha(1-B)\varphi'^{*2}_{hx} + \frac{B}{\varphi'^{*2}_{hd}} \varphi'^{*2}_{hx} \frac{\mathrm{d}\varphi'^{*}_{hd}}{\mathrm{d}z_h}. \tag{3.82}$$

Like in the previous section, a fall in intermediate good prices in country h may

increase or decrease the labor productivity threshold above which a firm is able to export to country f depending on the level of fixed export costs.

However, the convergence of prices leads to convergence of all variables, including export thresholds. Remember that when $z_h > z_f$, $\varphi'^*_{hx} > \varphi'^*_{fx}$.

When fixed export costs are high enough, a fall in the price of domestic intermediate goods lowers the export threshold, because the prices of all exported varieties decrease more than the fall in the price index in the foreign country. In addition, the fall in intermediate good prices in country h reduces the price index in country h, so that the export threshold in country f increases. In this case, as the export threshold increases in country f and decreases in country h, the convergence of export thresholds is obvious.

When fixed export costs are low enough, a fall in the price of domestic intermediate goods leads to an increase in the export threshold, because the less productive exporting firm decreases their variety prices less than the fall in the foreign price index. In addition, the fall in intermediate good price in country h reduces the price index in country h, so that the export threshold in country f increases (as the less productive exporting firm does not decrease its variety price). In this case, export thresholds increase in both countries, but they still converge. Indeed, as the share of firms that decrease their price is higher in the country where there is a fall in the intermediate good price, the price index decreases more in country h than in country f. Given the equation 3.78, the fall in the export threshold price is higher in country f than in country h, so that the increase in the export threshold is higher in country f than in country h, leading to convergence of φ'^*_{hx} and φ'^*_{fx}.

By the same token, if the intermediate good price decreases in the foreign country (country f), this leads to a fall in the price index in both countries, reducing the probability of entering domestic markets and the probability of exporting from country h. Indeed, it appears that

$$\frac{\mathrm{d}\varphi'^*_{hx}}{\mathrm{d}z_f} = \underbrace{\frac{\partial \varphi'^*_{hx}}{\partial z_f}}_{<0} + \underbrace{\frac{\partial \varphi'^*_{hx}}{\partial \varphi'^*_{fd}}}_{<0} \frac{\mathrm{d}\varphi'^*_{fd}}{\mathrm{d}z_f} = \frac{-\alpha B}{\varphi'^{*2}_{hx}} + \frac{B}{\varphi'^{*2}_{hd}\varphi'^{*2}_{hx}} \frac{\mathrm{d}\varphi'^*_{fd}}{\mathrm{d}z_f} < 0 \tag{3.83}$$

Because exporting firms in country h are not able to decrease their variety price while the price index is decreasing in country f, they lose export market shares in favor of firms producing in country f. In addition, the probability of exporting from country f increases when fixed export costs are high enough, and decreases when fixed export costs are low enough. In this case, the divergence between intermediate good prices increases the differences between aggregated variables and labor productivity thresholds.

To summarize

Proposition 9 *Assuming no input trade, the threshold above which a firm can enter the export market increases with a fall in the price of intermediate goods in the partner country regardless of fixed export costs and with a fall in the price of domestic intermediate goods provided fixed export costs are low enough.*

The effect of the price of domestic intermediate goods on the probability of exporting is the same as in proposition 5 as the effect also depends on fixed export costs. However, as firms in the foreign country do not change their variety prices, the price index in the foreign country is less affected than when the price of intermediate goods falls in both countries and reallocation is less likely to occur. Thus, for the export threshold in the domestic country to go up, fixed export costs need to be even lower than when the countries are symmetric.

However, even if the mechanisms are the same as in the case of symmetric countries for exporting firms in the country with falling input prices, the effect on exporting firms in the other country is no longer ambiguous. Indeed, the fall in prices in the other country always leads to a decrease in the relative competitiveness of firms, forcing less productive firms to leave the export market.

4.4.3 Welfare

A fall in the price of intermediate goods in one country decreases the price indexes in both countries, and hence increases consumer welfare in both countries. A fall in the price of intermediate goods improves consumer welfare even if it reduces the probability of exporting to the other country, and in both countries if fixed export costs are low enough. However, the increase in consumer welfare is greater in the country that reduces the price of its intermediate goods. Conversely, an increase in the price of intermediate goods reduces consumer welfare in both countries.

Thus, because a fall in the price of intermediate goods in one country also increases consumer welfare in the other country, positive international externalities exist. Actually, two effects increase consumer welfare in the other country. First, the fall in prices of varieties imported from the country with the lower price of intermediate goods increases consumer welfare because prices are lower, at least for the imported varieties. Second, as imported varieties are less expensive, their market share increases at the expense of firms producing locally, and this forces less productive domestic firms to exit the market. Thus, the average productivity of firms in this country increases, leading to better allocation of resources and to a rise in production, and the price index decreases even more.

4.5 International trade in final and intermediate goods

We now analyze the effect of input trade when final goods are internationally traded. The input price is higher in country h and firms located in country h can import intermediate goods from country f. Importing firms incur the same import costs as in section 3.

$$\tau_A z_f \alpha y(\varphi, z_f) + \mathrm{f}_M. \tag{3.84}$$

As previously, firms producing final goods in country f do not import inputs. In other words, input trade (if any) is unilateral from country f to country h, contrary to final good trade which is bilateral (two-way trade). It is worth stressing that the case studied in section 4.4 corresponds to the configuration where $\tau_A z_f \geq z_h$ or where $\mathrm{f}_M \to \infty$ (such that no firms import).

In what follows, we first investigate the effects of free input trade ($\tau_A = 1$ and $\mathrm{f}_M = 0$). Next we introduce only a positive variable cost ($\tau_A > 1$ and $\mathrm{f}_M = 0$). Finally, we only include a positive import fixed cost ($\tau_A = 1$ and $\mathrm{f}_M > 0$).

4.5.1 Intermediate good prices and entry/exit with free trade in inputs

We first assume that all firms can import intermediate goods without any costs. Thus, all firms producing final goods in country h import the intermediate product and firms producing in the foreign country purchase their intermediate goods in their own country. From a situation where the price of the intermediate good is higher in country h ($z_h > z_f$), the openness to trade in the intermediate good sector leads to imports of this good from country f to country h. As all firms in country h are importers, the intermediate good is only produced in country f. From here, we now focus on equilibrium when total exports of intermediate goods from country f equal total exports of numeraire from country h (see section 3).

With input trade in inputs, if total exports of intermediate goods from country f to country h equal total exports of numeraire from country h to country f, the amount of labor available for the final good sector is the same in both countries. In addition, these imports of intermediate goods do not imply additional costs, firms in both countries purchase intermediate goods at the same price and marginal costs for a given level of labor productivity are the same in both countries. Thus, all variables referring to the final good sector are equal (same costs, same distribution of labor productivity, same demand, etc.), which means that labor productivity thresholds are also the same.

Labor productivity thresholds and endogenous variables related to free trade in inputs are denoted with the superscript FT, and an apostrophe indicates that final goods are also traded internationally.

From a situation with no trade in intermediate goods, the fall in marginal costs in country h reduces the price index in country h and the probability of entering the domestic market (see eq.3.79). In addition, the price index in country f decreases due to imports of less expensive final goods from country h. But as the distribution of labor productivity, the cost structure, the consumer revenues and the substitution between varieties are the same in both countries, price indexes, productivity thresholds and other variables in the final good sector are also the same:

$$\begin{aligned} P_h'^{FT} &= P_f'^{FT} \\ \varphi_{hd}'^{FT} &= \varphi_{fd}'^{FT} \\ \varphi_{fx}'^{FT} &= \varphi_{hx}'^{FT} \end{aligned} \tag{3.85}$$

Remember that before the intermediate good sector was open to trade, the price index was higher in country h $\left(P_f'^* < P_h'^*\right)$, as were the probability of entering the domestic market $\left(\varphi_{fd}'^* > \varphi_{hd}'^*\right)$ and the export threshold $\left(\varphi_{fx}'^* < \varphi_{hx}'^*\right)$.

We know that due to lower marginal costs and imports of less expensive varieties, P_h and P_f decrease in openness to trade,

$$P_h'^{FT} = P_f'^{FT} < P_f'^* < P_h'^* \tag{3.86}$$

Given the relationship in equation 3.77, the same relation exists between prices of more expensive varieties and domestic thresholds increase in both countries.

$$\begin{aligned} & p_{hd}\left(\varphi_{hd}'^{FT}\right) = p_{fd}\left(\varphi_{fd}'^{FT}\right) < p_{fd}\left(\varphi_{fd}'^*\right) < p_{hd}\left(\varphi_{hd}'^*\right) \\ \Longleftrightarrow \quad & \varphi_{hd}'^{FT} = \varphi_{fd}'^{FT} > \varphi_{fd}'^* > \varphi_{hd}'^* \end{aligned} \tag{3.87}$$

By the same token, using 3.78 we can write

$$p_{fx}\left(\varphi_{fx}'^{FT}\right) = p_{hx}\left(\varphi_{hx}'^{FT}\right) < p_{hx}\left(\varphi_{hx}'^*\right) < p_{fx}\left(\varphi_{fx}'^*\right) \tag{3.88}$$

$$\begin{aligned} \varphi_{fx}'^{FT} &> \varphi_{fx}'^* \\ \varphi_{hx}'^{FT} &\lessgtr \varphi_{hx}'^* \text{ depending on fixed export costs} \end{aligned}$$

To sum up, due to reallocation in country h and less expensive imported varieties in country f, the threshold values of labor productivity above which firms can produce final goods increase in both countries when the economy shifts from no trade in inputs to trade in inputs ($\varphi_{hd}'^{FT} > \varphi_{hd}'^*$ and $\varphi_{fd}'^{FT} > \varphi_{fd}'^*$). The fall in input prices in country h leads to an increase in φ_{hd}' and φ_{fd}' (see proposition 8). In other

words, *input trade openness reduces the probability of entering the domestic market in the country that imports inputs as well as in the country that exports inputs.*

Moreover, a shift from no input trade to free input trade leads to a fall in the price index in both countries and increases consumer welfare in the country that imports inputs as well as in the country that exports inputs.

In addition, the labor productivity thresholds above which firms are able to export are the same in both countries ($\varphi_{hx}^{\prime FT} = \varphi_{fx}^{\prime FT}$). Given that the price index decreases in country h and that marginal costs remain stable in country f, the labor productivity needed to export from country f increases Hence, *input trade openness increases the labor productivity needed to export for downstream firms located in the country that exports inputs* (country f) *regardless of the fixed costs of exports.*

The effect of input trade on the probability of exporting in the country that imports inputs (country h) depends on the fixed costs of exports. Input trade openness decreases (resp., increases) the probability of exporting for downstream firms located in the country that imports inputs if fixed exports costs are low (resp., high) enough. This result is in line with proposition 9, as openness to input trade leads to a fall in input prices in the country that imports inputs.

Thus, when fixed exports costs are low enough, we have $\varphi_{hx}^{\prime *} > \varphi_{fx}^{\prime *}$ with no trade in inputs and $\varphi_{hx}^{\prime FT} = \varphi_{fx}^{\prime FT}$ with free trade in inputs, with $\varphi_{fx}^{\prime FT} = \varphi_{hx}^{\prime FT} > \varphi_{hx}^{\prime *} > \varphi_{fx}^{\prime *}$. Export thresholds increase in both countries.

In contrast, when fixed export costs are high enough, we have $\varphi_{hx}^{\prime *} > \varphi_{fx}^{\prime *}$ with $\varphi_{hx}^{\prime *} > \varphi_{hx}^{\prime FT} = \varphi_{fx}^{\prime FT} > \varphi_{fx}^{\prime *}$, export threshold increases in the country that exports inputs and decreases in the country that imports inputs.

These results are in line with the results in chapter 1. However, in chapter 1 the mass of firms is exogenously given and firms are not able to import. In this chapter, we generalize the previous results when both intermediate goods and final goods are internationally traded and introduce entry in and exit from domestic markets.

To summarize, the effect of a switch from no trade in inputs to free trade in inputs has the same effects as a unilateral fall in input prices in the country that imports inputs, except that it leads to unilateral trade in numeraire and in intermediate goods.

Thus, proposition 8 and 9 hold when the intermediate good price decreases due to imports of less expensive intermediate goods: the probability of entering domestic markets decreases in both countries; the threshold above which a firm can enter the export market increases in the country that exports inputs regardless of fixed export costs, and in the country that imports inputs provided that fixed export costs are low enough.

4.5.2 Intermediate good prices and entry/exit with variable import costs

In this section, we introduce variable import costs $\tau_A > 1$ so that firms located in country h import intermediate goods from country f if and only if $\tau_A \leq z_h/z_f$. Labor productivity thresholds and endogenous variables related to trade in inputs with variable import costs are denoted with the superscript V and an apostrophe indicates that final goods are also traded internationally.

As in previous section, we focus on the equilibrium at which total exports of numeraire from country h equal total imports of intermediate goods from country f. Assuming that $\tau_A \leq z_h/z_f$, all firms in country h import intermediate goods from country f and produce final goods with an intermediate good price equal to $\tau_A z_f$. Thus, the production cost structure is the same as in section 4.4.

Because the fall in marginal costs in the country that imports inputs is lower than with free trade in inputs, its impact on price indexes is also lower and the situation is intermediate between the one with no trade in inputs and the one with free trade in inputs.

Thus, it appears that

$$\varphi'^{*}_{hd} < \varphi'^{V}_{hd} < \varphi'^{FT}_{hd} \qquad \varphi'^{*}_{fd} < \varphi'^{V}_{fd} < \varphi'^{FT}_{fd} \tag{3.89}$$

The fall in prices of intermediate goods purchased by firms in country h leads to a decrease in the price index in country h, as in country f, through imports of less expensive varieties. As the marginal costs of firms producing final goods in country f remain unchanged, the fall in the price index in country h raises the labor productivity threshold above which firms are able to export to this country. In addition, as the fall in prices is lower than with free trade in inputs we have

$$\varphi'^{*}_{fx} < \varphi'^{V}_{fx} < \varphi'^{FT}_{fx}$$

The effect of the change in marginal costs for exporting firms in country h depends on how their marginal costs is affected in relation to the change in the price index in country f.

If exports fixed costs are low enough, reallocation leads to an increase in φ'_{hx} so that $\varphi'^{V}_{hx} > \varphi'^{*}_{hx}$, and we have $\varphi'^{V}_{hx} < \varphi'^{V}_{fx}$.

If fixed export costs are high enough, the fall in intermediate good prices in country h leads to a decrease in φ_{hx} so that $\varphi'^{V}_{hx} < \varphi'^{*}_{hx}$ and we have $\varphi'^{V}_{fx} < \varphi'^{V}_{hx}$. It appears that as long as $\tau_A > 1$, a fall in τ_A leads to convergence of the threshold values of labor productivity in both countries, without leading to the equality obtained with free trade in inputs.

4.5.3 Prices of intermediate goods and entry/exit with fixed import costs

In this section, we introduce a fixed import cost $\mathrm{f}_M > 0$ only, while $\tau_A = 1$ and the intermediate good price remains higher in country h ($z_h > z_f$). Remember that $\mathrm{f}_M = 0$ corresponds to free trade in inputs (see section 4.5.1) and that $\mathrm{f}_M \to \infty$ corresponds to the configuration where there is no input trade (see section 4.4).

The labor productivity thresholds and endogenous variables related to trade with fixed import costs are denoted with the superscript F and an apostrophe indicates that final goods are also traded internationally. As in section 3.4, a firm decides to import the intermediate good as long as its profit is higher with imported intermediate goods

$$\pi\left(\varphi, z_f\right) - \mathrm{f}_M \geq \pi\left(\varphi, z_h\right) \tag{3.90}$$

and φ'_M is the labor productivity threshold at which a firm located in the input importing country is indifferent between importing and purchasing the intermediate good on the home market.

The effect of input trade with fixed import costs on the probability of entering domestic markets

Regardless of the value of φ'_M and as long as $f_M \in]0;\infty[$, the probability of entering the domestic market decreases when input trade is allowed with a fixed import cost. Indeed, the openness to input trade induces a higher fall in price index in both countries than the fall in the variety price of the less productive domestic firm, which is forced to exit the domestic market. In each country, entry in and exit from domestic markets are driven by changes in price indexes.

If fixed import costs are extremely high, at least the most productive firm is able to import less expensive intermediate goods from country f and its marginal costs and variety price decrease. As this firm is the most productive one in country h, it produces both for its domestic market and for country f. Thus, the fall in its variety price will decrease the price index in both countries thereby raising domestic labor productivity thresholds.

The fall in the price index in country h increases when fixed import costs decrease, as the share of firms reducing their variety price increases. In other words, the rise in the domestic threshold due to a switch from no trade in inputs to trade in inputs with fixed costs is lower when fixed import costs are high.

When fixed import costs are low enough such that $\varphi'_M \leq \varphi'^F_{hd}$, all firms producing in country h import, and the openness to input trade has the same effect as free trade in inputs, decreasing the probability of entering the domestic market. However,

domestic labor productivity thresholds are not the same in both countries because of higher fixed costs in country h. Indeed, in addition to fixed domestic costs, firms have to pay fixed import costs. In this case, the domestic profit of a firm in country h is given by

$$\pi_{hd}^{\prime F} = \frac{r_{hd}\left(\varphi, z_f\right)}{\sigma} - \mathrm{f}_d - \mathrm{f}_M \tag{3.91}$$

while in country f we still have

$$\pi_{fd}^{\prime F} = \frac{r_{hd}\left(\varphi, z_f\right)}{\sigma} - \mathrm{f}_d \tag{3.92}$$

Thus, the domestic labor productivity threshold is higher in the country that imports inputs. Note that if all firms in country h are able to import, a fall in fixed import costs lowers the labor productivity threshold above which firms enter the domestic market.

In country f, the price index decreases when fixed import costs decrease because the share of less expensive imported varieties increases, which reduces the price index. However, if all exporting firms in country h are already importing firms ($\varphi_M^{\prime} \leq \varphi_{hx}^{\prime F}$), the price index in country h is no longer affected by a fall in fixed import costs (new importing firms are not able to export to country f.)

To summarize, a move from no trade in inputs to trade in inputs with fixed import costs increases $\varphi_{hd}^{\prime}$ and $\varphi_{fd}^{\prime}$ such that $\varphi_{hd}^{\prime F} > \varphi_{hd}^{\prime *}$ and $\varphi_{fd}^{\prime F} > \varphi_{fd}^{\prime *}$, and the effects of input trade openness decrease with fixed import costs.

Proposition 10 *When the final good is internationally traded, a shift from no trade in inputs to trade in inputs with fixed import costs favors exit from domestic markets in both countries.*

Proposition 11 *Starting from high fixed import costs, the probability of entering the domestic market in the input importing country decreases with falling fixed import costs as long as $\varphi_M^{\prime} > \varphi_{hd}^{\prime F}$ and increases once $\varphi_M^{\prime} < \varphi_{hd}^{\prime F}$.*

The gain in consumer welfare resulting from the switch from no trade in inputs to trade in inputs with import fixed costs depends on the fall in the price index. Thus, openness to trade in inputs increases consumer welfare in both countries, but the gain in welfare decreases with fixed import costs.

The effect of fixed import cost on firms' revenues and on the probability of exporting.

Table 3.1: Effects of openness to input trade and decreasing fixed import costs on export productivity threshold depending on fixed costs level.

	$\varphi_{hx}^{\prime F} < \varphi_M^{\prime}$		
	f_x and f_M low	f_x low and f_M high	f_x and f_M high
	$\varphi_{hx}^{\prime F} < \varphi_M^{\prime} < \hat{\varphi}^{\prime}$	$\varphi_{hx}^{\prime F} < \hat{\varphi}^{\prime} < \varphi_M^{\prime}$	$\hat{\varphi}^{\prime} < \varphi_{hx}^{\prime F} < \varphi_M^{\prime}$
	fig.3.9	fig.3.10	fig.3.10
openness to input trade	$\varphi_{hx}^{\prime F}$ ↗	$\varphi_{hx}^{\prime F}$ ↗	$\varphi_{hx}^{\prime F}$ ↗
f_M ↘	$\varphi_{hx}^{\prime F}$ ↗	$\varphi_{hx}^{\prime F}$ ↗	$\varphi_{hx}^{\prime F}$ ↗
	$\varphi_M < \varphi_{hx}^{\prime F}$		
	f_M and f_x low	f_M low and f_x high	f_M and f_x high
	$\varphi_M^{\prime} < \varphi_{hx}^{\prime F} < \hat{\varphi}^{\prime}$	$\varphi_M^{\prime} < \hat{\varphi}^{\prime} < \varphi_{hx}^{\prime F}$	$\hat{\varphi}^{\prime} < \varphi_M^{\prime} < \varphi_{hx}^{\prime F}$
	fig.3.11	fig.3.12	fig.3.13
openness to input trade	$\varphi_{hx}^{\prime F}$ ↗	$\varphi_{hx}^{\prime F}$ ↘	$\varphi_{hx}^{\prime F}$ ↘
f_M ↘	$\varphi_{hx}^{\prime F}$ →	$\varphi_{hx}^{\prime F}$ →	$\varphi_{hx}^{\prime F}$ →

As previously, the impact of input trade on firms' revenues and on the probability of exporting depends on how much firms decrease their variety price in relation to the fall in the price index in the destination market.

In country f, the price index decreases because of less expensive imported varieties, but domestic firms do not decrease their variety price. As a result, the domestic revenues of firms producing in country f decrease in favor of imported varieties from country h. In addition, exporting firms do not decrease their variety prices although the price index decreases in country h if at least one firm in this country is able to import. Thus, like domestic firms, all exporting firms in country f lose export market shares, and the labor productivity threshold above which firms are able to export rises ($\varphi_{fx}^{\prime F} > \varphi_{fx}^{\prime *}$).

The switch from no trade in inputs to trade in inputs with fixed import costs hurts all firms that produce in the country that exports inputs, even if consumer welfare increases. Domestic revenues of firms in country f decrease with a fall in import fixed costs as long as the share of less expensive imported varieties increases, or, in other words, as long as some exporting firms located in country h are not able to import ($\varphi_M^{\prime} > \varphi_{hx}^{\prime *}$). Similarly, export revenues of firms in country f decrease with a fall in import fixed costs as long as some domestic firms in country h are not able to import ($\varphi_M^{\prime} > \varphi_{hd}^{\prime *}$).

In country h, importing firms decrease their variety price while non-importing firms keep the same variety price. Thus, whatever their destination market, non-importing firms lose market shares with openness to input trade.

On the domestic market, when some firms cannot import ($\varphi_M^{\prime} > \varphi_{hd}^{\prime F}$), they lose market shares in favor to importing ones. Moreover, a reallocation process between importing firms may occur if fixed import costs are low enough that a large share

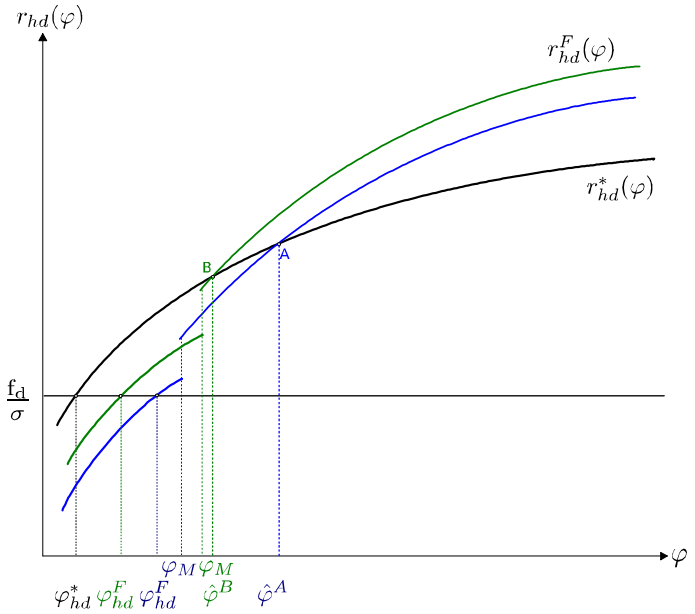
of domestic firms is able to import. Indeed, the higher the share of importing firms, the bigger the fall in the price index. Thus, as the fall in variety price is higher for more productive firms, less productive firms ones may decrease their variety price less than the fall in the price index and lose market shares.

When fixed import costs are low enough, reallocation occurs between importing firms ($\varphi'_M < \hat{\varphi}'$). However, the higher the fixed import costs, the smaller the share of firms able to import and the higher the price index. Thus, an increase in fixed import costs reduces reallocation between importing firms, and increases the share of firms that benefit from openness to input trade.

Alternatively, if fixed import costs are high enough, reallocation between importing firms no longer occurs, and all importing firms gain from input trade openness at the expense of non-importing firms Thus, the share of firms that benefit from openness to input trade decreases with increasing import fixed costs.

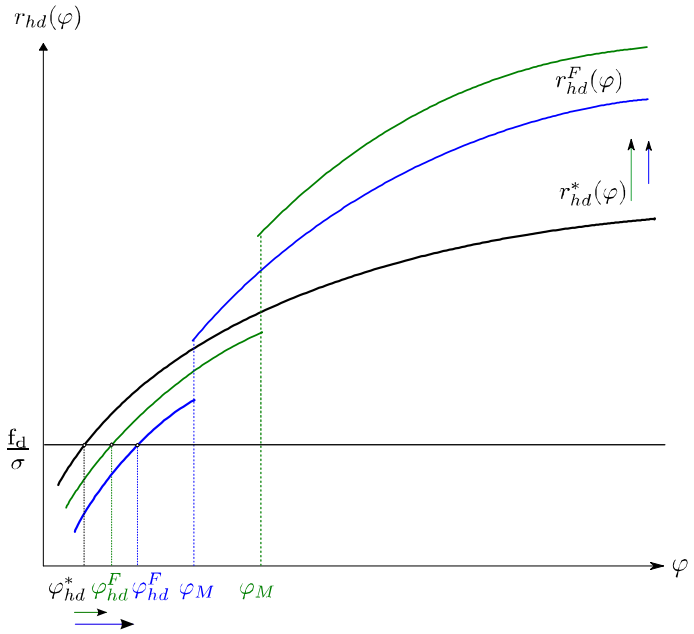
Figures 3.7 and 3.8 show the effect of increasing import fixed costs with and without reallocation.

Figure 3.7: Impact of fixed import cost level on domestic revenue. Low import fixed costs ($\varphi^*_{hd} < \varphi_M < \hat{\varphi}$)



Note that reallocation is highest when $\varphi'_M = \hat{\varphi}'$. In this case, all importing firms increase their market shares at the expense of all non-exporting firms. A firm with a labor productivity threshold $\varphi'_M = \hat{\varphi}'$ is indifferent between importing or not, and is not affected by openness to input trade. In this case, a change in fixed import costs reduces the share of firms that gain from input trade. If fixed import costs increase, the least productive importing firm is no longer able to import, its variety price increases and it loses market shares. If fixed import costs decrease, the share

Figure 3.8: Impact of fixed import cost level on domestic revenue. High import fixed costs ($\varphi^*_{hd} < \hat{\varphi} < \varphi_M$)



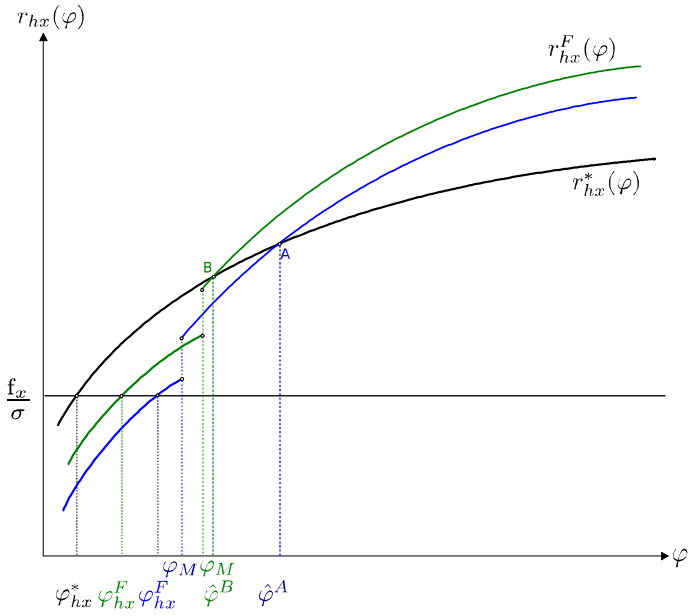
of firms able to import increases, and the price index decreases. Thus, in order to benefit from openness to trade in inputs, firms must decrease their variety price even more, $\hat{\varphi}$ increases and the share of firms that gain from openness to trade in inputs decreases due to reallocation between importing firms.

The impact on exporting firms in country h depends on both fixed import costs and fixed export costs.

When fixed import costs are high enough that some exporting firms are not able to import intermediate goods from country f ($\varphi'_M > \varphi'^F_{hx}$, see fig. 3.9 and 3.10), all non-importing firms lose market shares to the benefit of importing ones. As less productive exporting firms are not able to import, they loses market share and the labor productivity threshold above which firms are able to export rises. Here, the labor productivity threshold φ'^F_{hx} rises when import fixed costs decrease. Indeed, as the share of exporting firms able to import increases, the fall in price index in country f is higher, and the fall in export revenue of non-importing exporting firms is higher. As shown in figures 3.9 and 3.10, the labor productivity threshold above which firms are able to export rises whatever the fixed export costs, as long as $\varphi'^F_{hx} < \varphi'_M$. However, if fixed export costs and fixed import costs are low enough (fig. 3.9), reallocation occurs among firms that are both importers and exporters, so that some exporting firms lose export market shares even if they are able to import. In this case, a fall in fixed import costs increases the share of importing firms suffering from reallocation, because the fall in the price index in the foreign country is higher

due to the bigger share of firms that reduce their variety price.

Figure 3.9: Impact of fixed import cost level on export revenues. Low fixed export and import costs ($\varphi_x < \varphi_M < \hat{\varphi}$).



Now let us assume that fixed import costs are lower, so that all exporting firms are able to import ($\varphi'_M < \varphi'^F_{hx}$). The impact of fixed import costs on the export performance of firms in country h still depends on the variation in variety prices linked to the variation in the price index in country f. As all exporting firms are able to import, variations in fixed import costs do not impact either the price index in country f or the variety price of exporting firms. Thus, as long as $\varphi'_M < \varphi'^F_{hx}$, reallocation on the export market only depends on fixed export costs. As in previous sections, all firms exporting to country f increase their export market shares if and only if fixed export costs are high enough (fig. 3.12 and 3.13).

If fixed import costs are so low that all firms in country h are able to import ($\varphi_M < \varphi^F_{hd}$), all firms in this country decrease their marginal costs and their variety price. The mechanism is the same as with free input trade: on the domestic market, more productive firms increase their market share at the expense of less productive ones. If fixed export costs are low enough, reallocation also occurs on the export market and the probability of exporting decreases in country h. If fixed export costs are high enough, all firms exporting to country f increase their export market share and export profit, and the probability of exporting increases.

Proposition 12 *A shift from no trade in inputs to trade in inputs with fixed import costs favors the entry in export markets of firms located in the country that imports inputs if and only if* f_x *is high enough and* f_M *is low enough.*

Figure 3.10: Impact of fixed import cost level on export revenues. High fixed import costs ($\varphi_x < \hat{\varphi} < \varphi_M$ or $\hat{\varphi} < \varphi_x < \varphi_M$)

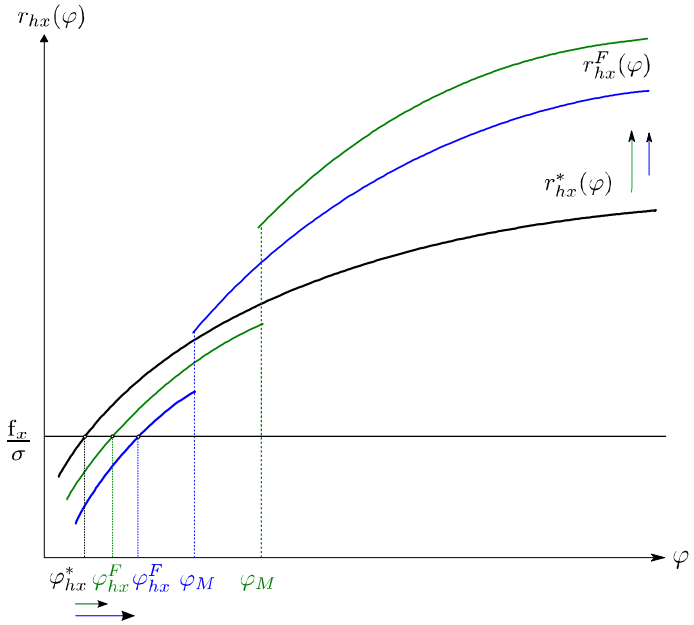


Figure 3.11: Impact of fixed import cost level on export revenues. Low fixed import and export costs $\varphi_M < \varphi_x < \hat{\varphi}$

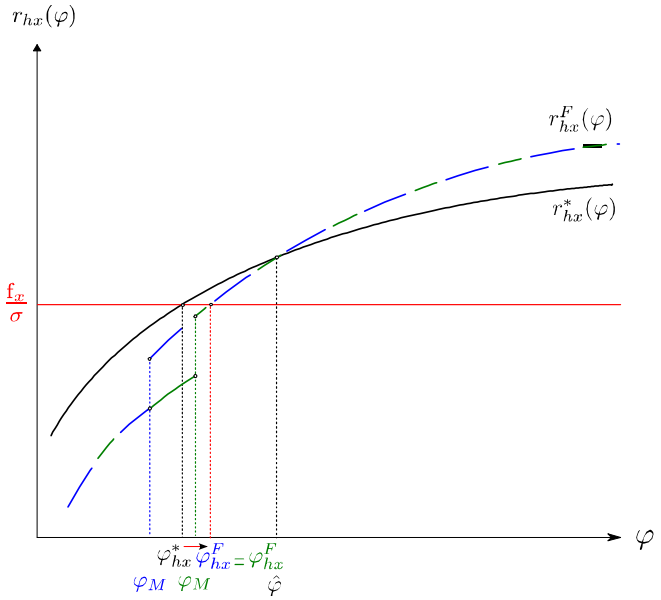


Figure 3.12: Impact of fixed import cost level on export revenues. Low fixed import and high fixed export costs ($\varphi_M < \hat{\varphi} < \varphi_x$)

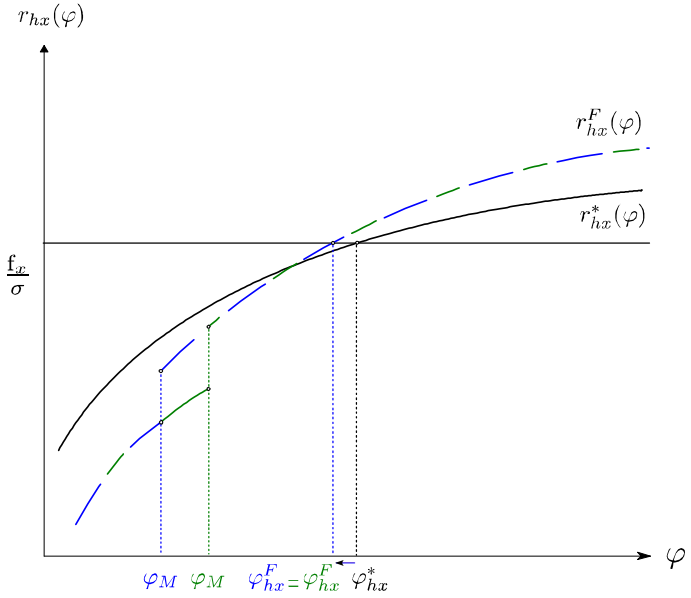
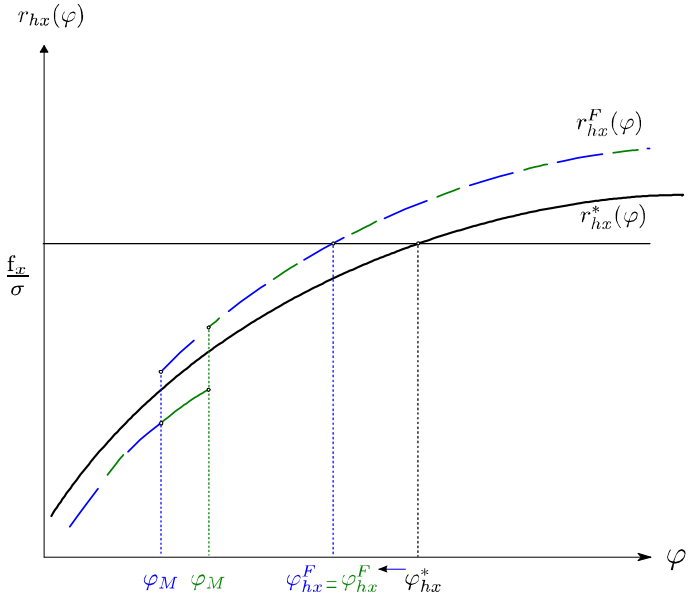


Figure 3.13: Impact of fixed import cost level on export revenues. High fixed export and import costs $\hat{\varphi} < \varphi_M < \varphi_x$



In all cases, less productive firms suffer from the reallocation process that results from less expensive inputs, but their losses are even higher if they are not able to import due to high fixed import costs. However, when fixed import costs increase, both non-importing firms and high productive importing firms benefit. In fact, the share of importing firms decreases thereby causing an increase in the price index. Thus, all firms whose variety prices are not affected by this change increase their market share (namely firms that are still able to import and firms that were previously unable to import), at the expense of firms forced to exit the import market because of higher import costs $\left(\varphi \in \left[\varphi'_{M_{low}}, \varphi'_{M_{high}}\right[\right)$.

5 Conclusion

In this chapter, we developed a theoretical model to highlight the impact of the liberalization of trade in intermediate goods in a global economy. While aggregated results are in line with the international trade literature, namely input trade liberalization or a fall in intermediate good prices in a country leads to an increase in aggregated production and exports for firms located in this country, these results need to be relativized.

In fact, all firms do not always benefit from openness to trade in inputs, even if they decrease their marginal costs. This is particularly the case if some firms are excluded from import markets due to fixed import costs, because these firms are then less competitive than importing firms. However, because openness to trade in inputs also affects the structure of the market in the final good sector, even importing firms may be affected negatively. As some firms are more impacted than others depending on the proportion of intermediate goods in their production costs, relative prices of varieties are modified. Due to the larger share of intermediate goods in their marginal costs, more productive firms are able to reduce their prices to a greater extent than less productive firms. This leads to reallocation of market shares from low productivity firms to high productivity firms. This forces less productive firms to exit the domestic market whatever the structure of trade costs, and results in the concentration of market shares among more productive firms. Thus, the number of varieties produced locally always decreases, as does the number of imported varieties. As the prices of imported varieties do not change, they become less competitive than locally produced varieties.

However, from a consumer's point of view, the effect of trade liberalization of intermediate goods is not ambiguous. Indeed, the fall in variety prices and the exit of more expensive varieties always outrates the reduction in the number of available varieties. It is also important to note that even if consumers gain more in the

country that imports inputs, consumer welfare also increases in the country that exports inputs, as imported varieties become less expensive, leading to a fall in the price index.

This chapter allows us to generalize the results obtained in chapter 1. Indeed, we go deeper in our analysis of the mechanisms via which firms in the final good sector can be affected by input trade liberalization. While in the first chapter, we assumed that the price in the home country was given by the world price plus a border tariff, in this chapter, we generalize these results taking the effect of input trade liberalization on domestic markets into account and introducing an endogenous share of firms able to import intermediate goods. We show that the case where all exporting firms gain from input trade liberalization is even narrower than in chapter 1. Remember that in the theoretical model presented in chapter 1, all exporting firms gain from input trade liberalization if fixed export costs are high enough. In this chapter, all exporting firms gain from a change from no trade in inputs to trade in inputs, or from a fall in import trade costs only if fixed export costs are high enough and if fixed import costs are low enough so that all exporting firms are already able to import ($\varphi_M < \varphi_x$). Thus, this model gives a new interpretation of the empirical part of the first chapter. We show that the fall in input tariffs decreases the probability of firms to export. Thus, according to theoretical models in both chapter 1 and 2, fixed export costs can be low. According to this chapter, they also can be high, but if they are, import fixed costs must be even higher so that some exporting French agrifood firms are excluded from import markets.

Appendix

A Additional stylized facts on the French agrifood sector[7]

When we compared some stylized facts with the international trade literature, we noted that some can be easily explained, while other remain outside the theoretical international trade literature. In this section we present some stylized facts about French agrifood firms, and compare them with the international trade literature.

A.1 French agrifood sector today

Based on agricultural production in 2009, which amounted to €61 billion, France is the first agricultural producer in Europe, as agriculture represents 18% of its production. France is the second European producer of agrifood goods, with a total of €125 bn. It also plays an important role in the world economy, as it is the fourth exporter of agrifood and agricultural products with a total of €47.2 bn, which represents more than 6% of the world export market share.

France plays an important role in the European and world agricultural and agrifood sectors, and these sectors also play an important role in the French economy. The food and agriculture industries generate a little over 13% of the value added of French industry as a whole. The agrifood sector accounts for 1.7% of the French gross domestic product and 7.1% of French exports. In 2008, despite the slowdown in global trade in the second half of the year, the agrifood sector generated one of the biggest surpluses in the overall French trade balance with an annual surplus of €6 bn.

French agrifood firms are responsible for more than 12% of the value added of the French industry, and provide jobs for 412 500 people. But the distribution of employees among firms is not homogeneous, and most of the 10 500 French agrifood firms are small or even very small (90% have fewer than 250 employees, 70% than 20).

In the French agrifood sectors, as in other sectors, aggregated characteristics hide a huge heterogeneity. This heterogeneity appears between sub sectors, and between firms within each sub sectors (see Chevassus-Lozza and Latouche, 2011).

Firm level data used in this section come from INSEE-EAE database, which includes only firms with more than 20 employees or with total sales of over 5 million €. They show that the number of firms, the share of exporting firms, the number of employees per firm, the value added, the total sales, the domestic sales, the export

[7]Main sources : French agricultural ministery: http://agriculture.gouv.fr/alim-agri-chiffres-cles-2011, EU Commission: http://ec.europa.eu/enterprise/sectors/food

sales and the share of exports in firms' total sales differ greatly between sectors, and among the firms in each sector, as shown by firm level variables.

Tables 3.2 to 3.10 give an idea of the range of values at sectoral level. In 2007, the largest sector was the meat sector, with 910 firms, while the smallest was vegetable and animal oils and fats with only 28 firms. The meat sector was also the sector in which firms were the least internationalized, with, on average, 5% of export sales, while the oil and fat sector was the one where firms are the most internationalized with 29% of export sales and 89% of firms that export.

Table 3.2: 151 - Production, processing and preserving of meat and meat products

variable	mean	median	min	max	sd	p5	p95
N	910						
EXP	0,5648						
employees	132,057	45	0	4501	322,651	15	498
va	5219,168	1796,5	-6880	153414	12960,98	586	18811
total sales	35145,11	10079,5	100	1264890	98483,44	1959	136220
dom. sales	31643,36	9526,5	0	1148801	86505,38	1826	127515
exp. sales	3501,753	19,5	0	268943	16728,46	0	13815
exp. rate	0,0532	0,0018	0	1	0,1174	0	0,284

Table 3.3: 152 - Processing and preserving of fish and fish products

variable	mean	median	min	max	sd	p5	p95
N	138						
EXP	0,7101						
employees	98,014	41	11	1403	157,847	19	339
va	4259,87	1772,5	-1836	66968	7695,816	644	14666
total sales	25129,04	10021,5	578	289201	45008,3	2447	119323
dom. sales	22516,24	8889	578	264602	39943,14	2344	106552
exp. sales	2612,819	210	0	54766	6795,125	0	16028
exp. rate	0,0771	0,0190	0	0,7161	0,1292	0	0,3664

The heterogeneity among agrifood sectors is also apparent within each sector. There are many small firms that produce very little, but only a few very big firms that account for a large share of each sector in terms of employees, sales and exports (Chevassus-Lozza and Latouche, 2011).

Table 3.4: 153 - Processing and preserving of fruit and vegetables

variable	mean	median	min	max	sd	p5	p95
N	168						
EXP	0,7917						
employees	151,030	56	0	1949	235,497	19	565
va	7946,768	3275,5	-2947	112109	13877,91	589	32807
total sales	45675,64	15213,5	1648	538687	80067,51	3356	167786
dom. sales	37862,68	10711	3	415314	66025,94	2043	147041
exp. sales	7812,964	870	0	150139	19493,69	0	36008
exp. rate	0,1665	0,0530	0	0,9992	0,2369	0	0,7402

Table 3.5: 154 - Manufacture of vegetable and animal oils and fats

variable	mean	median	min	max	sd	p5	p95
N	28						
EXP	0,8929						
employees	76	35	0	570	126,045	8	424
va	10313,39	2570,5	-408	82326	20374,43	655	67368
total sales	86091,14	14560,5	2886	1089193	232568,5	5992	665412
dom. sales	68663,54	11455,5	2565	868001	188671,2	2878	556861
exp. sales	17427,57	3384,5	0	221192	45057,67	0	108551
exp. rate	0,2870	0,1974	0	0,7201	0,2656	0	0,6993

Table 3.6: 155 - Manufacture of dairy products

variable	mean	median	min	max	sd	p5	p95
N	294						
EXP	0,7143						
employees	181,238	76,5	0	2394	321,312	14	710
va	11459,58	3643,5	-2519	336679	27441,92	670	43044
total sales	87030,65	29976,5	1453	1931641	192583,6	3494	310108
dom. sales	72393,08	28276	1256	1751463	157122,4	3114	259154
exp. sales	14637,56	479	0	536267	48833,23	0	78632
exp. rate	0,1033	0,0267	0	0,9656	0,1645	0	0,4467

Table 3.7: 156 - Manufacture of grain mill products, starches and starch products

variable	mean	median	min	max	sd	p5	p95
N	105						
EXP	0,6571						
employees	113,438	42	8	3383	347,167	13	420
va	11056,91	2632	-990	497948	49590,14	508	30536
total sales	54191,47	15902	3019	1723378	178662	4397	237916
dom. sales	30051,63	11793	1036	415373	57730,56	3543	93760
exp. sales	24139,84	170	0	1308005	131058,5	0	69799
exp. rate	0,1570	0,0106	0	0,8955	0,2487	0	0,7172

Table 3.8: 157 - Manufacture of prepared animal feeds

variable	mean	median	min	max	sd	p5	p95
N	197						
EXP	0,4670						
employees	88,995	40	0	1544	170,987	9	377
va	6512,294	2074	-982	190963	19095,32	428	24448
total sales	51329,89	20540	1139	835724	102471,7	5423	214242
dom. sales	44300,84	19274	1139	594284	80653,76	5028	156388
exp. sales	7029,051	0	0	303977	33432,46	0	25200
exp. rate	0,0683	0	0	0,7287	0,1447	0	0,4168

Table 3.9: 158 - Manufacture of other food products

variable	mean	median	min	max	sd	p5	p95
N	722						
EXP	0,6524						
employees	127,359	53	0	3358	249,870	20	427
va	8678,161	2440	-14593	446618	28666,53	648	26146
total sales	40487,5	9763	765	2111805	140757,1	1822	135344
dom. sales	33263,42	8095	27	1719202	121203,2	1526	98863
exp. sales	7224,08	141,5	0	545512	34402,23	0	26613
exp. rate	0,1170	0,0177	0	0,9999	0,2017	0	0,6059

Table 3.10: 159 - Manufacture of beverages

variable	mean	median	min	max	sd	p5	p95
N	378						
EXP	0,8175						
employees	96,445	30	0	2324	251,98	7	329
va	12636,45	2503,5	-869	364850	40032,52	584	52084
total sales	56863,62	13289	1539	1795582	168225,3	3951	231846
dom. sales	39256,43	10200,5	44	1740159	133438,1	1969	148695
exp. sales	17607,2	1213,5	0	694804	71470,36	0	52193
exp. rate	0,2219	0,0994	0	0,9962	0,2710	0	0,8815346

There is a huge international trade literature with heterogeneous firms, and we have not attempted to present a review of this literature. However, most of the mechanisms are common to all the papers. Firms can produce with different marginal costs, and variety prices are thus not equal across firms. The most productive firms sell their variety at a lower price, so they can sell more and enjoy higher revenues. The existence of fixed costs to access domestic or foreign markets leads to segmentation of the market and only the most productive firms have sufficient revenue to pay these costs.

Thus, in the French agrifood sector, the coexistence of domestic and exporting firms is explained by the existence of export fixed costs. In addition, we will see that some agrifood sectors have fewer firms, or a smaller percentage of exporting firms. Again, this is explained by the level of fixed costs. Indeed, if fixed domestic costs are high, the number of firms able to produce is low. Thus, if the vegetable and animal oils and fats sector has fewer producing firms than the meat products sector, it could be because domestic fixed costs are higher in this sector.

By the same token, differences in the share of exporting firms can be explained by the level of fixed export costs relative to fixed domestic costs. Indeed, if fixed export costs are much higher than fixed domestic costs, the share of exporting firms will be low. Conversely, if fixed export costs are similar to fixed domestic costs, firms that are able to pay domestic fixed costs will also be able to pay export fixed costs, and the share of exporting firms will be close to one.

Thus, the heterogeneity between and within sectors can be explained by the presence of fixed costs and the differences in their levels.

A.2 Changes in the French agrifood sector

Our dataset covers the period between 1996 and 2007. In this period, in order to comply with the Uruguay Round Agreement on Agriculture (URAA), several reforms of the European agricultural policies were undertaken in both the agricultural and the agrifood sector. This agreement on agriculture included agrifood goods and introduced common rules in three areas of agricultural policy; market access; export subsidies and domestic subsidies (these pillars remain central to the debate on further reform of agricultural trade in the ongoing Doha Round negotiations). One of the aims of this agreement was to reduce agricultural and agrifood tariffs (including those resulting from tariffication) on a simple average basis by 36%, with a minimum reduction of 15% per tariff line to be implemented in equal annual installments (two-thirds of these rates for developing countries, and no reduction for the least-developed countries). Its implementation was spread over a period of six years from 1995 to 2000 for developed countries, and for ten years (ending in 2004)

for developing countries.

Over this period, French agrifood firms improved their performance: they became larger, produced more, exported a larger share of their production, and generated more value added.

These changes can be explained by theories on output trade liberalization. In models with heterogeneous firms, output trade liberalization leads to the exit of smaller and less productive firms. Thus, agrifood trade liberalization, which took place at the time of the Marrakesh agreement and European enlargement, led to a reduction in trade protection at European borders, so that foreign agrifood competitors had easier access to the European market, and to the French market. This fiercer competition on the French agrifood market may have forced less productive French agrifood firms to exit, and others to improve their productivity level in order to survive. These two mechanisms led to better allocation of resources and can explain the observed rise in the average production level.

The Marrakesh agreement also concerned some non-European developed countries. Thus, French firms saw their access to non-European markets become easier, which can explain the increase in export sales and in the share of production destined for foreign markets. In addition, European enlargement and the creation of a common currency certainly facilitated access to foreign European markets, increasing the export performance of European firms, including French agrifood firms.

Finally, the performance of agrifood French firms may also have been affected by the liberalization of agricultural trade. Agrifood firms use agricultural goods as inputs, and for some sectors, the share of agricultural goods can be very large (on average, the consumption of intermediate goods accounts for 84.5% of the production costs of French agrifood firms).

Trade liberalization in the agricultural sector may have had the same effects as in agrifood sectors: fiercer competition, better allocation of resources, and finally a fall in agricultural prices. This fall in agricultural prices may also be due to the end of guaranteed prices and the decoupling of subsidies.

With this fall of input prices, French agrifood firms saw their production costs decrease, increasing their competitiveness on export markets.

Considering an earlier period, Gopinath (1996) showed empirically that improvements in productivity in the US agrifood sector were mainly due to a drop in prices and to improved productivity in the agricultural sector.

Like figure 3.2 in the introduction, tables 3.11 and 3.12 show that the market structure has also evolved, with an increase in the concentration of market shares in the French agrifood market. The number of firms with more than 20 employees

decreased and the difference between larger and smaller firms (in terms of their level of production and number of employees) increased. This concentration happened on both the export and on the domestic market.

Table 3.11: Market structure 1996

variable	mean	median	min	max	sd	p5	p95	p95/p5
N	3224							
EXP	0,6290							
employees	112,319	43	0	6553	264,7611	17	1293	76.1
va	5798,463	1598	-3331	587952	21779,92	431	75617	175.5
total sales	31389,52	8592	208	2281779	90988,23	1430	414980	290.2
dom. sales	25926,14	7643	61	1734794	72339,5	1285	332100	258.4
exp. sales	5463,381	99	0	814737	30858,38	0	85425	
exp. rate	0,0966	0,0113	0	0,9918	0,1749	0	0,8491	

Table 3.12: Market structure 2007

variable	mean	median	min	max	sd	p5	p95	p95/p5
N	2940							
EXP	0,6534							
employees	126,645	45	0	4501	277,9354	13	1442	110.9
va	8100,803	2253,5	-14593	497948	25898,05	605	121701	201.2
total sales	46819,54	12617,5	100	2111805	135056,3	2342	657384	280.7
dom. sales	38165,84	10670	0	1751463	109663,2	1917,5	522458	272.5
exp. sales	8653,697	177	0	1308005	45038,29	0	166770	
exp. rate	0,1101	0,0153	0	1	0,1947	0	0,9108	

In international trade models with heterogeneous firms, output trade liberalization leads to fiercer competition from foreign firms, and all firms selling on the domestic market are affected by the entry of new competitors. Thus, with output trade liberalization, all French agrifood firms may have lost domestic market shares, so the structure of the distribution of domestic market shares was probably not modified by agrifood trade liberalization.

However, trade liberalization also occurred in the European agricultural sector. Thus, French agrifood firms saw their input costs decreasing thanks to easier import of less expensive foreign inputs, and to agricultural productivity gains in French agriculture.

Agricultural productivity gains benefit agrifood firms producing in France, so that the price effect of input trade liberalization should not, a priori, change the structure of the French agrifood sector. But given fixed import costs, agricultural trade liberalization may explain the concentration of domestic market shares. Indeed, in this case, only some highly productive firms are able to import and to increase their productivity due to the use of new foreign inputs. If this is the case,

importing firms gain market shares at the expense of non-importing firms. But this explanation only holds if fixed import costs are high enough to exclude some French agrifood firms from the import market.

In this chapter, we investigated the role of input trade liberalization on firms in the output sector and show that it can explain the changes that have occurred in the French agrifood sector, even if all firms are able to access less expensive inputs.

B Model in a closed economy

B.1 Zero profit condition

Let

$$\tilde{\psi}_{hd} \equiv \frac{1}{\theta_{hd}} \left[\int_{\varphi_{hd}}^{\infty} \left(\frac{1}{1/\varphi + z_h \alpha} \right)^{\sigma-1} g(\varphi) \, \mathrm{d}\varphi \right]^{\frac{1}{\sigma-1}} \tag{3.93}$$

be the productivity of the firm with average revenues on the domestic market. By using (3.6) and then by introducing (3.9) and $r_{hd}(\varphi^*_{hd}) = \sigma \mathrm{f}_d$, we can write:

$$\begin{aligned} \pi_{hd}(\tilde{\psi}_{hd}) &= \frac{r_{hd}(\tilde{\psi}_{hd})}{\sigma} - \mathrm{f}_d = \frac{r_{hd}(\tilde{\psi}_{hd})}{r_{hd}(\varphi^*_{hd})} \frac{r_{hd}(\varphi^*_{hd})}{\sigma} - \mathrm{f}_d \\ &= \left[\tilde{\psi}_{hd} \left(\frac{1}{\varphi^*_{hd}} + z_h \alpha \right) \right]^{\sigma-1} \frac{r_{hd}(\varphi^*_{hd})}{\sigma} - \mathrm{f}_d \\ &= \mathrm{f}_d \left\{ \left[\tilde{\psi}_{hd} \left(\frac{1}{\varphi^*_{hd}} + z_h \alpha \right) \right]^{\sigma-1} - 1 \right\} \end{aligned} \tag{3.94}$$

Because $\bar{\pi}_h = \pi_{hd}\left(\tilde{\psi}_{hd}\right)$, we obtain:

$$\bar{\pi}_h = \mathrm{f}_d \left\{ \left[\tilde{\psi}_{hd} \left(\frac{1}{\varphi^*_{hd}} + z_h \alpha \right) \right]^{\sigma-1} - 1 \right\} \tag{3.95}$$

B.2 Existence and uniqueness of φ^*_{hd}.

We use the zero profit condition $\bar{\pi}_h = \mathrm{f}_d k(\varphi^*_{hd})$ where

$$k(\varphi^*_{hd}) \equiv \left(\frac{1}{\varphi^*_{hd}} + \alpha z_h \right)^{\sigma-1} \left[\int_0^{\infty} \left(\varphi^{-1} + \alpha z_h \right)^{1-\sigma} \mu_h(\varphi) \, \mathrm{d}\varphi \right] - 1 \tag{3.96}$$

and the free entry condition $\bar{\pi}_i = \delta \mathrm{f}_e / \theta_{hd}$. Then, φ^*_{hd} is implicitly defined by:

$$\delta \mathrm{f}_e = \theta_{hd} f k(\varphi^*_{hd}) \tag{3.97}$$

or, equivalently,

$$\delta \mathrm{f}_e = (1 - G(\varphi^*_{hd}))\, \mathrm{f}_d k(\varphi^*_{hd}) \tag{3.98}$$

Let $K(\varphi) \equiv k(\varphi)[1 - G(\varphi)]$ such that:

$$\delta \mathrm{f}_e = \mathrm{f}_d K(\varphi^*_{hd})$$

As in Melitz (2003), we have $\mathrm{d}K(\varphi)/\mathrm{d}\varphi < 0$ when $\varphi > 0$ (see Melitz, 2003, p. 1720).

Moreover, given the structure of costs, we have:

$$\lim_{\varphi \to +\infty} \mathrm{f}_d K(\varphi^*_{hd}) = 0 \quad \text{and} \quad \lim_{\varphi \to 0} \mathrm{f}_d K(\varphi^*_{hd}) = +\infty \tag{3.99}$$

Then the curve $\mathrm{f}_d K(\varphi^*_{hd})$ only intersects with the curve $\delta \mathrm{f}_e$ once when $\varphi > 0$ which ensures the existence and uniqueness of the equilibrium cut off $\varphi^*_{hd} > 0$.

B.3 Proof that $\partial \varphi^*_{hd}/\partial z_h < 0$

Let $\Psi_h \equiv \theta_{hd}\overline{\pi}_h = \mathrm{f}_d K(\varphi^*_{hd})$ such that:

$$\Psi_h = \mathrm{f}_d \left(\frac{1}{\varphi^*_{hd}} + \alpha z_h\right)^{\sigma-1} \left[\int_{\varphi^*_{hd}}^{\infty} \left(\varphi^{-1} + \alpha z_h\right)^{1-\sigma} g(\varphi)\, \mathrm{d}\varphi\right] - \theta_{hd}\mathrm{f}_d \tag{3.100}$$

where $\mathrm{d}\varphi^*_{hx}/\mathrm{d}\varphi^*_{hd} > 0$ and we must have $\Psi_h = \delta \mathrm{f}_e$ at equilibrium. The impact of intermediate goods price is as follows:

$$\frac{\partial \varphi^*_{hd}}{\partial z_h} = -\frac{\partial \Psi_h}{\partial z_h}\left(\frac{\partial \Psi_h}{\partial \varphi}\right)^{-1} \tag{3.101}$$

where $\partial \Psi_h/\partial \varphi < 0$ (see Appendix A.3) whereas $\partial \Psi_h/\partial z_h = \theta_{hd}\partial \overline{\pi}_h/\partial z_h$

$$\begin{aligned} \frac{\partial \overline{\pi}_h}{\partial z_h} &= \mathrm{f}_d(\sigma - 1)\alpha \left(\frac{1}{\varphi^*_{hd}} + \alpha z_h\right)^{\sigma-1} \\ &\times \left[\int_{\varphi^*_{hd}}^{\infty} \frac{\left(\varphi^{-1} + \alpha z_h\right)^{1-\sigma}}{\frac{1}{\varphi^*_{hd}} + \alpha z_h} \mu_h(\varphi)\, \mathrm{d}\varphi - \int_{\varphi^*_{hd}}^{\infty} \frac{\left(\varphi^{-1} + \alpha z_h\right)^{1-\sigma}}{\varphi^{-1} + \alpha z_h} \mu_h(\varphi)\, \mathrm{d}\varphi\right] < 0 \end{aligned} \tag{3.102}$$

Consequently, $\partial \varphi^*_{hd}/\partial z_h < 0$.

B.4 Proof that $L^N_h = (1 - \beta) L$

The total expenditure of a representative consumer is given by the size of the country:

$$\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\, \mu_h(\varphi)\, d\varphi\right] M_h + N_h = L \tag{3.103}$$

For all firms, revenue minus expenditure is equal to profit.

$$\begin{aligned} & \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\, \mu_h(\varphi)\, d\varphi\right] M_h - \left[\rho \int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\, \mu_h(\varphi)\, d\varphi + \mathrm{f}_d\right] M_h \\ = \;& \Pi_h \end{aligned} \tag{3.104}$$

$$\Leftrightarrow \quad M_h(1-\rho)\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\, \mu_h(\varphi)\, d\varphi\right] - \mathrm{f}_d M_h = \Pi_h \tag{3.105}$$

The labor used in each country is given by:

$$\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\left(1/\varphi + z_h\alpha\right)\mu_h(\varphi)\, d\varphi + \mathrm{f}_d\right] M_h + \Pi_h + L_h^N = L \tag{3.106}$$

Plugging 3.152 and 3.155, we have:

$$\begin{aligned} & \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\left(1/\varphi + z_h\alpha\right) + \mathrm{f}_d\right] M_h + \Pi_h + L_h^N \\ = \;& \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\right] M_h + N_h \\ \Longleftrightarrow \;& \rho \int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\, M_h + \mathrm{f}_d M_h + \Pi_h + L_h^N \\ = \;& \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\right] M_h + N_h \\ \Longleftrightarrow \;& (\rho-1)\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\right] M_h + \mathrm{f}_d M_h + \Pi_h + L_h^N = N_h \\ \Longleftrightarrow \;& \Pi_h = (1-\rho)\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\right] M_h - \mathrm{f}_d M_h + N_h - L_h^N \end{aligned} \tag{3.107}$$

Plugging this equation into 3.154:

$$\begin{aligned} \Pi_h &= (1-\rho)\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\right] M_h - \mathrm{f}_d M_h + N_h - L_h^N \\ \Pi_h &= M_h(1-\rho)\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\right] - \mathrm{f}_d M_h \\ &\Longrightarrow \quad N_h = L_h^N = (1-\beta)\, L \end{aligned} \tag{3.108}$$

The homogenous good supply is equal to the demand and $L_h^N = (1-\beta)\, L$

C Model with input trade only

C.1 Proof that imports of inputs equal exports of numeraire

The total expenditure of a representative consumer is given by the size of the country.

In country h

$$\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\, \mu_h(\varphi)\, d\varphi\right] M_h + N_h = L \tag{3.109}$$

in country f

$$\left[\int_{\varphi_{fd}}^{\infty} y_{fd}(\varphi)\, p_{fd}(\varphi)\, \mu_f(\varphi)\, d\varphi\right] M_f + N_f = L \tag{3.110}$$

The labor used in each country is given by:

in country h

$$\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\,(1/\varphi)\, \mu_h(\varphi)\, d\varphi + \mathrm{f}_d\right] M_h + \Pi_h + L_h^N = L \tag{3.111}$$

in country f

$$\left[\int_{\varphi_{fd}}^{\infty} y_{fd}(\varphi)\,(1/\varphi + z_f\alpha)\, \mu_f(\varphi)\, d\varphi + \mathrm{f}_d\right] M_f + \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\,(z_f\alpha)\, \mu_h(\varphi)\, d\varphi\right] M_h$$
$$+\Pi_f + L_f^N = L \tag{3.112}$$

Plugging total consumer expenditure with labor used we have:

in country h

$$\begin{aligned} & \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\,(1/\varphi)\, \mu_h(\varphi)\, d\varphi + \mathrm{f}_d\right] M_h + \Pi_h + L_h^N \\ = \; & \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\, \mu_h(\varphi)\, d\varphi\right] M_h + N_h \end{aligned} \tag{3.113}$$

$$\begin{aligned} \Pi_h \;=\; & \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\, \mu_h(\varphi)\, d\varphi\right] M_h - \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\,(1/\varphi)\, \mu_h(\varphi)\, d\varphi\right] M_h \\ & -M_h\mathrm{f}_d + N_h - L_h^N \end{aligned} \tag{3.114}$$

in country f

$$\begin{aligned} & \left[\int_{\varphi_{fd}}^{\infty} y_{fd}(\varphi)\left(1/\varphi + z_f\alpha\right)\mu_f(\varphi)\,d\varphi + \mathrm{f}_d\right] M_f \\ & + \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\left(z_f\alpha\right)\mu_h(\varphi)\,d\varphi\right] M_h + \Pi_f + L_f^N \\ = & \left[\int_{\varphi_{fd}}^{\infty} y_{fd}(\varphi)\, p_{fd}(\varphi)\,\mu_f(\varphi)\,d\varphi\right] M_f + N_f \end{aligned} \tag{3.115}$$

$$\begin{aligned} \Pi_f = & (1-\rho)\left[\int_{\varphi_{fd}}^{\infty} y_{fd}(\varphi)\, p_{fd}(\varphi)\,\mu_f(\varphi)\,d\varphi\right] M_f + N_f \\ & - \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\left(z_f\alpha\right)\mu_h(\varphi)\,d\varphi\right] M_h - M_f\mathrm{f}_d - L_f^N \end{aligned} \tag{3.116}$$

In addition, for all firms, revenue minus expenditure equals profit. Thus at the aggregated level we have:

in country h

$$\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\,\mu_h(\varphi)\,d\varphi\right] M_h - \left[\rho\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\,\mu_h(\varphi)\,d\varphi + \mathrm{f}_d\right] M_h = \Pi_h$$

$$\Leftrightarrow M_h(1-\rho)\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\,\mu_h(\varphi)\,d\varphi\right] - \mathrm{f}_d M_h = \Pi_h \tag{3.117}$$

in country f

$$\left[\int_{\varphi_{fd}}^{\infty} y_{fd}(\varphi)\, p_{fd}(\varphi)\,\mu_f(\varphi)\,d\varphi\right] M_f - \left[\rho\int_{\varphi_{fd}}^{\infty} y_{fd}(\varphi)\, p_{fd}(\varphi)\,\mu_f(\varphi)\,d\varphi + \mathrm{f}_d\right] M_f = \Pi_f$$

$$\Leftrightarrow M_f(1-\rho)\left[\int_{\varphi_{fd}}^{\infty} y_{fd}(\varphi)\, p_{fd}(\varphi)\,\mu_f(\varphi)\,d\varphi\right] - \mathrm{f}_d M_f = \Pi_f \tag{3.118}$$

Plugging equations 3.114 into 3.117, in country h we have:

$$\begin{aligned} \Pi_h = & \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\,\mu_h(\varphi)\,d\varphi\right] M_h - \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\left(1/\varphi\right)\mu_h(\varphi)\,d\varphi\right] M_h \\ & - M_h\mathrm{f}_d + N_h - L_h^N \\ \Pi_h = & M_h(1-\rho)\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\,\mu_h(\varphi)\,d\varphi\right] - \mathrm{f}_d M_h \end{aligned}$$

$$\begin{aligned}
& \rho\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\, \mu_h(\varphi)\, d\varphi\right] M_h - \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\,(1/\varphi)\, \mu_h(\varphi)\, d\varphi\right] M_h \\
= \;& L_h^N - N_h \\
\Leftrightarrow \;& \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\,(1/\varphi + z_f\alpha)\, \mu_h(\varphi)\, d\varphi\right] M_h - \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\,(1/\varphi)\, \mu_h(\varphi)\, d\varphi\right] M_h \\
= \;& L_h^N - N_h
\end{aligned}$$

$$\begin{aligned}
& \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\,(1/\varphi)\, \mu_h(\varphi)\, d\varphi\right] M_h + \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\,(z_f\alpha)\, \mu_h(\varphi)\, d\varphi\right] M_h \\
- \;& \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\,(1/\varphi)\, \mu_h(\varphi)\, d\varphi\right] M_h = L_h^N - N_h
\end{aligned}$$

$$\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\,(z_f\alpha)\, \mu_h(\varphi)\, d\varphi\right] M_h = L_h^N - N_h$$

The amount of intermediate good used by firms in country h equals the production of numeraire minus the amount of numeraire consumed in country h. In other words, imports of intermediate goods from country f equal exports of numeraire to country f.

Plugging equations 3.116 into 3.118, in country f we have:

$$\begin{aligned}
\Pi_f &= (1-\rho)\left[\int_{\varphi_{fd}}^{\infty} y_{fd}(\varphi)\, p_{fd}(\varphi)\, \mu_f(\varphi)\, d\varphi\right] M_f + N_f \\
&\quad - \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\,(z_f\alpha)\, \mu_h(\varphi)\, d\varphi\right] M_h - M_f \mathrm{f}_d - L_f^N \\
\Pi_f &= (1-\rho)\left[\int_{\varphi_{fd}}^{\infty} y_{fd}(\varphi)\, p_{fd}(\varphi)\, \mu_f(\varphi)\, d\varphi\right] M_f - \mathrm{f}_d M_f
\end{aligned}$$

$$\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\,(z_f\alpha)\, \mu_h(\varphi)\, d\varphi\right] M_h = N_f - L_f^N$$

The amount of intermediate goods produced in country f destined for firms in country h equals the demand for numeraire minus the production of numeraire in country f. In other words, exports of intermediate goods to country h equal imports of numeraire from country h.

This also implies that the amount of labor used to produce numeraire for export from country h equals the amount of labor used to produce intermediate goods

exported from country h.

Thus, in both countries, the amount of labor available to produce final goods is the same.

D Model with output trade only

D.1 Zero profit condition

Let

$$\tilde{\psi}_{hd} \equiv \frac{1}{\theta_{hd}} \left[\int_{\varphi_{hd}}^{\infty} \left(\frac{1}{1/\varphi + z_h \alpha} \right)^{\sigma-1} g(\varphi) \, \mathrm{d}\varphi \right]^{\frac{1}{\sigma-1}} \tag{3.119}$$

be the productivity of the firm with average revenue on domestic market and

$$\tilde{\psi}_{hx} \equiv \frac{1}{\theta_{hd}\theta_{hx}} \left[\int_{\varphi_{hd}}^{\infty} \left(\frac{1}{1/\varphi + z_h \alpha} \right)^{\sigma-1} g(\varphi) \, \mathrm{d}\varphi \right]^{\frac{1}{\sigma-1}} \tag{3.120}$$

be the productivity of the firm with average revenue on a foreign market. By using (3.6) and then by introducing (3.9) and $r_{hd}(\varphi^*_{hd}) = \sigma \mathrm{f}_d$, we can write:

$$\begin{aligned} \pi_{hd}(\tilde{\psi}_{hd}) &= \frac{r_{hd}(\tilde{\psi}_{hd})}{\sigma} - \mathrm{f}_d = \frac{r_{hd}(\tilde{\psi}_{hd})}{r_{hd}(\varphi^*_{hd})} \frac{r_{hd}(\varphi^*_{hd})}{\sigma} - \mathrm{f}_d \\ &= \left[\tilde{\psi}_{hd} \left(\frac{1}{\varphi^*_{hd}} + z_h \alpha \right) \right]^{\sigma-1} \frac{r_{hd}(\varphi^*_{hd})}{\sigma} - \mathrm{f}_d \\ &= \mathrm{f}_d \left\{ \left[\tilde{\psi}_{hd} \left(\frac{1}{\varphi^*_{hd}} + z_h \alpha \right) \right]^{\sigma-1} - 1 \right\} \end{aligned} \tag{3.121}$$

Similarly, we have:

$$\pi_{hx}(\tilde{\psi}_{hx}) = \mathrm{f}_x \left\{ \left[\tilde{\psi}_{hx} \left(\frac{1}{\varphi^*_{hx}} + z_h \alpha \right) \right]^{\sigma-1} - 1 \right\} \tag{3.122}$$

Because $\bar{\pi}_h = \pi_{hd}\left(\tilde{\psi}_{hd}\right) + \theta_{hx}\pi_{hx}\left(\tilde{\psi}_{hx}\right)$, we obtain:

$$\bar{\pi}_h = \mathrm{f}_d \left\{ \left[\tilde{\psi}_{hd} \left(\frac{1}{\varphi^*_{hd}} + z_h \alpha \right) \right]^{\sigma-1} - 1 \right\} + \theta_{hx} \mathrm{f}_x \left\{ \left[\tilde{\psi}_{hx} \left(\frac{1}{\varphi^*_{hx}} + z_h \alpha \right) \right]^{\sigma-1} - 1 \right\} \tag{3.123}$$

D.2 Threshold values of labor productivity

By using (3.9), $r_{hd}\left(\varphi_{hd}^{*}\right)=r_{fd}\left(\varphi_{fd}^{*}\right)=\sigma \mathrm{f}_{d}$, we have:

$$\frac{P_{h}}{P_{f}}=\frac{p(\varphi_{hd}^{*})}{p(\varphi_{fd}^{*})} \tag{3.124}$$

and $r_{hx}\left(\varphi_{hx}^{*}\right)=r_{fx}\left(\varphi_{fx}^{*}\right)=\sigma \mathrm{f}_{x}$ we have:

$$\frac{P_{h}}{P_{f}}=\frac{p(\varphi_{fx}^{*})}{p(\varphi_{hx}^{*})} \tag{3.125}$$

leading to:

$$\frac{P_{h}}{P_{f}}=\frac{p(\varphi_{hd}^{*})}{p(\varphi_{fd}^{*})}=\frac{p(\varphi_{fx}^{*})}{p(\varphi_{hx}^{*})} \tag{3.126}$$

In addition, we have $r_{fx}\left(\varphi_{fx}^{*}\right)=r_{fx}\left(\varphi_{fx}^{*}\right)=\sigma \mathrm{f}_{x}$ and $r_{hd}\left(\varphi_{hd}^{*}\right)=r_{fd}\left(\varphi_{fd}^{*}\right)=\sigma \mathrm{f}_{d}$.

$$\frac{r_{fx}\left(\varphi_{fx}^{*}\right)}{r_{hd}\left(\varphi_{hd}^{*}\right)}=\frac{r_{hx}\left(\varphi_{hx}^{*}\right)}{r_{fd}\left(\varphi_{fd}^{*}\right)}=\frac{r_{fx}\left(\varphi_{fx}^{*}\right)}{r_{fd}\left(\varphi_{fd}^{*}\right)}=\frac{r_{hx}\left(\varphi_{fx}^{*}\right)}{r_{hd}\left(\varphi_{hd}^{*}\right)}=\frac{\mathrm{f}_{x}}{\mathrm{f}_{d}} \tag{3.127}$$

$$\Longrightarrow \frac{p_{hx}(\varphi_{hx}^{*})}{p_{fd}(\varphi_{fd}^{*})}=\frac{p_{fx}(\varphi_{fx}^{*})}{p_{hd}(\varphi_{hd}^{*})}=\left(\frac{\mathrm{f}_{x}}{\mathrm{f}_{d}}\right)^{\frac{1}{1-\sigma}} \tag{3.128}$$

$$\frac{P_{h}}{P_{f}}=\frac{p(\varphi_{hd}^{*})}{p(\varphi_{fd}^{*})} \Leftrightarrow \frac{p(\varphi_{fd}^{*})}{P_{f}}=\frac{p(\varphi_{hd}^{*})}{P_{h}} \tag{3.129}$$

$$\Longrightarrow \quad \frac{p_{fd}(\varphi_{fd}^{*})}{P_{f}}=\frac{p_{hd}(\varphi_{hd}^{*})}{P_{h}}=\left(\frac{\sigma \mathrm{f}_{d}}{L}\right)^{\frac{1}{1-\sigma}} \tag{3.130}$$

$$\Longrightarrow \quad \frac{p_{hx}(\varphi_{hx}^{*})}{P_{f}}=\frac{p_{fx}(\varphi_{fx}^{*})}{P_{h}}=\left(\frac{\sigma \mathrm{f}_{x}}{L}\right)^{\frac{1}{1-\sigma}} \tag{3.131}$$

Relation between domestic and export thresholds

We know that $r_{hx}\left(\varphi_{hx}^{*}\right)/r_{hd}\left(\varphi_{hd}^{*}\right)=\mathrm{f}_{x}/\mathrm{f}_{d}$ or, equivalently,

$$\frac{P_{f}}{P_{h}}\frac{p_{hd}\left(\varphi_{hd}^{*}\right)}{p_{hx}\left(\varphi_{hx}^{*}\right)}=\left(\frac{\mathrm{f}_{x}}{\mathrm{f}_{d}}\right)^{\frac{1}{\sigma-1}} \tag{3.132}$$

such that

$$F \equiv p_{hd}\left(\varphi_{hd}^{*}\right)-\left(\frac{\mathrm{f}_{x}}{\mathrm{f}_{d}}\right)^{\frac{1}{\sigma-1}}\frac{P_{h}}{P_{f}}p_{hx}\left(\varphi_{hx}^{*}\right)=0 \tag{3.133}$$

Thus,

$$\frac{\partial F}{\partial p_{hx}\left(\varphi_{hx}^{*}\right)}+\frac{\partial F}{\partial p_{hd}\left(\varphi_{hd}^{*}\right)}\frac{\partial p_{hd}\left(\varphi_{hd}^{*}\right)}{\partial p_{hx}\left(\varphi_{hx}^{*}\right)}=0\Leftrightarrow\frac{\partial p_{hd}\left(\varphi_{hd}^{*}\right)}{\partial p_{hx}\left(\varphi_{hx}^{*}\right)}=\frac{-\frac{\partial F}{\partial p_{hx}\left(\varphi_{hx}^{*}\right)}}{\frac{\partial F}{\partial p_{hd}\left(\varphi_{hd}^{*}\right)}} \tag{3.134}$$

We have:

$$\begin{aligned}\frac{\partial F}{\partial p_{hx}\left(\varphi_{hx}^{*}\right)} &= -\left(\frac{\mathrm{f}_x}{\mathrm{f}_d}\right)^{\frac{1}{\sigma-1}}\left[\frac{P_h}{P_f}-p_{hx}\left(\varphi_{hx}^{*}\right)\frac{P_h}{P_f^2}\frac{\partial P_j}{\partial p_{hx}\left(\varphi_{hx}^{*}\right)}\right.\\ &\quad\left.+\frac{p_{hx}\left(\varphi_{hx}^{*}\right)}{P_f}\frac{\partial P_h}{\partial P_f}\frac{\partial P_f}{\partial p_{hx}\left(\varphi_{hx}^{*}\right)}\right]\\ \frac{\partial F}{\partial p_{hx}\left(\varphi_{hx}^{*}\right)} &= -\left(\frac{\mathrm{f}_x}{\mathrm{f}_d}\right)^{\frac{1}{\sigma-1}}\left[\frac{P_h}{P_f}-\frac{P_h}{P_f}\frac{p_{hx}\left(\varphi_{hx}^{*}\right)}{P_f}\frac{\partial P_f}{\partial p_{hx}\left(\varphi_{hx}^{*}\right)}\right.\\ &\quad\left.+\frac{p_{hx}\left(\varphi_{hx}^{*}\right)}{P_f}\frac{\partial P_f}{\partial p_{hx}\left(\varphi_{hx}^{*}\right)}\frac{\partial P_h}{\partial P_f}\right]\end{aligned} \tag{3.135}$$

We know that $r_{hx}=\mathrm{f}_x$ or, equivalently, $P_f=\mathrm{f}_x^{\frac{1}{\sigma-1}}p_{hx}$ such that

$$\frac{p_{hx}\left(\varphi_{hx}^{*}\right)}{P_f}\frac{\partial P_f}{\partial p_{hx}\left(\varphi_{hx}^{*}\right)}=1 \tag{3.136}$$

Thus,

$$\frac{\partial F}{\partial p_{hx}\left(\varphi_{hx}^{*}\right)}=-\left(\frac{\mathrm{f}_x}{\mathrm{f}_d}\right)^{\frac{1}{\sigma-1}}\frac{\partial P_h}{\partial P_f} \tag{3.137}$$

In addition, we have:

$$\begin{aligned}\frac{\partial F}{\partial p_{hd}\left(\varphi_{hd}^{*}\right)} &= 1-p_{hx}\left(\varphi_{hx}^{*}\right)\left(\frac{\mathrm{f}_x}{\mathrm{f}_d}\right)^{\frac{1}{\sigma-1}}\left[\frac{1}{P_f}\frac{\partial P_h}{\partial p_{hd}\left(\varphi_{hd}^{*}\right)}-\frac{P_h}{P_f^2}\frac{\partial P_f}{\partial P_h}\frac{\partial P_h}{\partial p_{hd}\left(\varphi_{hd}^{*}\right)}\right]\\ \frac{\partial F}{\partial p_{hd}\left(\varphi_{hd}^{*}\right)} &= 1-\left(\frac{\mathrm{f}_x}{\mathrm{f}_d}\right)^{\frac{1}{\sigma-1}}\left[\frac{p_{hx}\left(\varphi_{hx}^{*}\right)}{P_f}\frac{\partial P_h}{\partial p_{hd}\left(\varphi_{hd}^{*}\right)}\right]\\ &\quad+\left(\frac{\mathrm{f}_x}{\mathrm{f}_d}\right)^{\frac{1}{\sigma-1}}\left[\frac{p_{hx}\left(\varphi_{hx}^{*}\right)}{P_f}\frac{P_h}{P_f}\frac{\partial P_f}{\partial P_h}\frac{\partial P_h}{\partial p_{hd}\left(\varphi_{hd}^{*}\right)}\right]\end{aligned} \tag{3.138}$$

Knowing that $P_f=\mathrm{f}_x^{\frac{1}{\sigma-1}}p_{hx}$ and $P_h=\mathrm{f}_d^{\frac{1}{\sigma-1}}p_{hd}$, we get

$$\begin{aligned}\frac{\partial F}{\partial p_{hd}\left(\varphi_{hd}^{*}\right)} &= \left(\frac{\mathrm{f}_x}{\mathrm{f}_d}\right)^{\frac{1}{\sigma-1}}\left[\frac{p_{hx}\left(\varphi_{hx}^{*}\right)}{P_f}\frac{P_h}{P_f}\frac{\partial P_f}{\partial P_h}\frac{\partial P_h}{\partial p_{hd}\left(\varphi_{hd}^{*}\right)}\right]\\ &= \frac{P_h}{P_f}\frac{\partial P_f}{\partial P_h}\end{aligned} \tag{3.139}$$

Thus,

$$\frac{\mathrm{d}p_{hd}\left(\varphi_{hd}^{*}\right)}{\mathrm{d}p_{hx}\left(\varphi_{hx}^{*}\right)}=\frac{\left(\frac{\mathrm{f}_x}{\mathrm{f}_d}\right)^{\frac{1}{\sigma-1}}\frac{\partial P_{hi}}{\partial P_f}}{\frac{P_h}{P_f}\frac{\partial P_f}{\partial P_h}}=\left(\frac{\mathrm{f}_x}{\mathrm{f}_d}\right)^{\frac{1}{\sigma-1}}\frac{P_f}{P_h}\left(\frac{\partial P_h}{\partial P_f}\right)^{2}>0 \tag{3.140}$$

As $p_{hd}\left(\varphi_{hd}^{*}\right)$ and $p_{hx}\left(\varphi_{hx}^{*}\right)$ are decreasing functions of φ_{hd}^{*} and φ_{hx}^{*} respectively, φ_{hx}^{*} is an increasing function of φ_{hd}^{*}.

Note that under symmetry, we have $P_h=P_f$ and, in turn, $\mathrm{d}p_{hd}\left(\varphi_{hd}^{*}\right)/\mathrm{d}p_{hx}\left(\varphi_{hx}^{*}\right)=\left(\mathrm{f}_x/\mathrm{f}_d\right)^{\frac{1}{\sigma-1}}$ as in Melitz (2003).

D.3 Existence and uniqueness of φ_{hd}^{*} and φ_{hx}^{*}.

We use the zero profit condition $\bar{\pi}_h=\mathrm{f}_d k\left(\varphi_{hd}^{*}\right)+\theta_{hx}\mathrm{f}_x k\left(\varphi_{hx}^{*}\right)$ where

$$k\left(\varphi_{hd}^{*}\right)\equiv\left(\frac{1}{\varphi_{hd}^{*}}+\alpha z_h\right)^{\sigma-1}\left[\int_0^{\infty}\left(\varphi^{-1}+\alpha z_h\right)^{1-\sigma}\mu_h\left(\varphi\right)\mathrm{d}\varphi\right]-1 \tag{3.141}$$

$$k\left(\varphi_{hx}^{*}\right)\equiv\left(\frac{1}{\varphi_{hx}^{*}}+\alpha z_h\right)^{\sigma-1}\left[\int_0^{\infty}\left(\varphi^{-1}+\alpha z_h\right)^{1-\sigma}\eta_{hx}\left(\varphi\right)\mathrm{d}\varphi\right]-1 \tag{3.142}$$

and the free entry condition $\bar{\pi}_i=\delta\mathrm{f}_e/\theta_{hd}$. Then, φ_{hd}^{*} is implicitly defined by:

$$\delta\mathrm{f}_e=\theta_{hd}fk\left(\varphi_{hd}^{*}\right)+\theta_{hd}\theta_{hx}\mathrm{f}_x k\left(\varphi_{hx}^{*}\right) \tag{3.143}$$

or, equivalently,

$$\delta\mathrm{f}_e=\left(1-G\left(\varphi_{hd}^{*}\right)\right)\mathrm{f}_d k\left(\varphi_{hd}^{*}\right)+\left(1-G\left(\varphi_{hx}^{*}\right)\right)\mathrm{f}_x k\left(\varphi_{hx}^{*}\right) \tag{3.144}$$

Let $K\left(\varphi\right)\equiv k\left(\varphi\right)\left[1-G\left(\varphi\right)\right]$ such that

$$\delta\mathrm{f}_e=\mathrm{f}_d K\left(\varphi_{hd}^{*}\right)+\mathrm{f}_x K\left(\varphi_{hx}^{*}\right) \tag{3.145}$$

As in Melitz (2003), we have $\mathrm{d}K\left(\varphi\right)/\mathrm{d}\varphi<0$ when $\varphi>0$ (see Melitz, 2003, p. 1720). In addition, we have

$$\frac{\mathrm{d}\varphi_{hx}^{*}}{\mathrm{d}\varphi_{hd}^{*}}>0 \tag{3.146}$$

then $\mathrm{d}K\left(\varphi_{hx}^{*}\right)/\mathrm{d}\varphi_{hd}^{*}<0$. As a result, $\mathrm{f}_d K\left(\varphi_{hd}^{*}\right)+\mathrm{f}_x K\left(\varphi_{hx}^{*}\right)$ decrease with φ. Moreover, given the cost structure, we have:

$$\lim_{\varphi\to+\infty}\mathrm{f}_d K\left(\varphi_{hd}^{*}\right)+\mathrm{f}_x K\left(\varphi_{hx}^{*}\right)=0\quad\text{and}\quad\lim_{\varphi\to 0}\mathrm{f}_d K\left(\varphi_{hd}^{*}\right)+\mathrm{f}_x K\left(\varphi_{hx}^{*}\right)=+\infty \tag{3.147}$$

Then the curve $\mathrm{f}_d K\left(\varphi_{hd}^{*}\right)+\mathrm{f}_x K\left(\varphi_{hx}^{*}\right)$ only intersects with the curve $\delta\mathrm{f}_e$ once when $\varphi>0$ which ensures the existence and uniqueness of the equilibrium cut off $\varphi_{hd}^{*}>0$.

D.4 Proof that $\partial\varphi_{hd}^{*}/\partial z_h < 0$

Let $\Psi_h \equiv \theta_{hd}\overline{\pi}_h = \mathrm{f}_d K\left(\varphi_{hd}^{*}\right) + \mathrm{f}_x K\left(\varphi_{hx}^{*}\right)$ such that

$$\begin{aligned}\Psi_h &= \mathrm{f}_d\left(\frac{1}{\varphi_{hd}^{*}}+\alpha z_h\right)^{\sigma-1}\left[\int_{\varphi_{hd}^{*}}^{\infty}\left(\varphi^{-1}+\alpha z_h\right)^{1-\sigma} g\left(\varphi\right)\mathrm{d}\varphi\right]-\theta_{hd}\mathrm{f}_d \\ &+\left(\mathrm{f}_x\left(\frac{1}{\varphi_{hx}^{*}}+\alpha z_h\right)^{\sigma-1}\left[\int_{\varphi_{hx}^{*}}^{\infty}\left(\varphi^{-1}+\alpha z_h\right)^{1-\sigma} g\left(\varphi\right)\mathrm{d}\varphi\right]\right)-(1-G(\varphi_{hx}^{*}))\mathrm{f}_x\end{aligned} \tag{3.148}$$

where $\mathrm{d}\varphi_{hx}^{*}/\mathrm{d}\varphi_{hd}^{*} > 0$ and we must have $\Psi_h = \delta \mathrm{f}_e$ at equilibrium. The impact of the price of the intermediate goods price is as follows:

$$\frac{\partial\varphi_{hd}^{*}}{\partial z_h} = -\frac{\partial\Psi_h}{\partial z_h}\left(\frac{\partial\Psi_h}{\partial\varphi}+\frac{\partial\Psi_h}{\partial\varphi}\frac{\mathrm{d}\varphi_{hx}^{*}}{\mathrm{d}\varphi_{hd}^{*}}\right)^{-1} \tag{3.149}$$

where $\partial\Psi_h/\partial\varphi < 0$ (see Appendix A.3) and $\mathrm{d}\varphi_{hx}^{*}/\mathrm{d}\varphi_{hd}^{*} > 0$ whereas $\partial\Psi_h/\partial z_h = \theta_{hd}\partial\overline{\pi}_h/\partial z_h$

$$\begin{aligned}\frac{\partial\overline{\pi}_h}{\partial z_h} &= \mathrm{f}_d\left(\sigma-1\right)\alpha\left(\frac{1}{\varphi_{hd}^{*}}+\alpha z_h\right)^{\sigma-1} \\ &\left[\int_{\varphi_{hd}^{*}}^{\infty}\frac{\left(\varphi^{-1}+\alpha z_h\right)^{1-\sigma}}{\frac{1}{\varphi_{hd}^{*}}+\alpha z_h}\mu_h\left(\varphi\right)\mathrm{d}\varphi-\int_{\varphi_{hd}^{*}}^{\infty}\frac{\left(\varphi^{-1}+\alpha z_h\right)^{1-\sigma}}{\varphi^{-1}+\alpha z_h}\mu_h\left(\varphi\right)\mathrm{d}\varphi\right]<0 \\ &+\mathrm{f}_x\left(\sigma-1\right)\alpha\left(\frac{1}{\varphi_{hx}^{*}}+\alpha z_h\right)^{\sigma-1} \\ &\left[\int_{\varphi_{hx}^{*}}^{\infty}\frac{\left(\varphi^{-1}+\alpha z_h\right)^{1-\sigma}}{\frac{1}{\varphi_{hx}^{*}}+\alpha z_h}\eta_{hx}\left(\varphi\right)\mathrm{d}\varphi-\int_{\varphi_{hx}^{*}}^{\infty}\frac{\left(\varphi^{-1}+\alpha z_h\right)^{1-\sigma}}{\varphi^{-1}+\alpha z_h}\eta_{hx}\left(\varphi\right)\mathrm{d}\varphi\right]<0\end{aligned} \tag{3.150}$$

Consequently, $\partial\varphi_{hd}^{*}/\partial z_h < 0$.

D.5 Sign of $\partial\pi_{hx}\left(\varphi\right)/\partial z_h$

Let $r_{hx}(\omega)$ be the export sales of variety ω produced in country h. By using (3.42), $r_{hx}(\omega) = \tau^{1-\sigma} r_{hd}\left(\omega\right)$ (because $P_h = P_f$ when countries are symmetric), and (3.7) we have

$$\begin{aligned}\pi_{hx}\left(\omega\right) &= \tau^{1-\sigma} r_{hd}\left(\omega\right)/\sigma - \mathrm{f}_x \\ &= \tau^{1-\sigma} R_h p_{hd}(\omega)^{1-\sigma} P_h^{\sigma-1}/\sigma - \mathrm{f}_x \\ &= \frac{\tau^{1-\sigma} R_h p_{hd}(\omega)^{1-\sigma}}{\sigma}\left[\int_{\varphi_{hd}^{*}}^{\infty} p_{hd}\left(\varphi\right)^{1-\sigma} g(\varphi)\mathrm{d}\varphi\right. \\ &\left.+\tau^{1-\sigma}\int_{\varphi_{hx}^{*}}^{\infty} p_{hd}\left(\varphi\right)^{1-\sigma} g(\varphi)\mathrm{d}\varphi\right]^{-1}\theta_{hd}-\mathrm{f}_x\end{aligned}$$

Some standard calculations reveal that

$$\begin{aligned}\operatorname{sign}\left\{\frac{\partial \pi_{hx}(\omega)}{\partial z_h}\right\} &= \operatorname{sign}\left\{\int_{\varphi_{hd}^*}^{\infty}\frac{p(\varphi)^{1-\sigma}}{p(\varphi)}g(\varphi)\mathrm{d}\varphi+\tau^{1-\sigma}\int_{\varphi_{hx}^*}^{\infty}\frac{p(\varphi)^{1-\sigma}}{p(\varphi)}g(\varphi)\mathrm{d}\varphi\right.\\ &\left.-\int_{\varphi_{hd}^*}^{\infty}\frac{p(\varphi)^{1-\sigma}}{p(\omega)}g(\varphi)\mathrm{d}\varphi-\tau^{1-\sigma}\int_{\varphi_{hx}^*}^{\infty}\frac{p(\varphi)^{1-\sigma}}{p(\omega)}g(\varphi)\mathrm{d}\varphi\right\} \quad (3.151)\end{aligned}$$

Thus $\partial \pi_{hx}(\varphi)/\partial z_f > 0$ (resp., < 0) when $p(\varphi)$ is high (resp., low) and thus, when φ is low (resp., high).

D.6 Homogeneous good consumption and labor use without trade in inputs

The total expenditure of a representative consumer is given by the size of the country

$$\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\, \mu_h(\varphi)\, d\varphi\right] M_h + \left[\int_{\varphi_{fx}}^{\infty} y_{fx}(\varphi)\, p_{fx}(\varphi)\, \eta_h(\varphi)\, d\varphi\right] M_{fx} + N_h = L \quad (3.152)$$

For all firms, revenue minus expenditure equals profit.

$$\begin{aligned}&\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\, \mu_h(\varphi)\, d\varphi\right] M_h\\ +\ &\left[\int_{\varphi_{fx}}^{\infty} y_{hx}(\varphi)\, p_{hx}(\varphi)\, \eta_h(\varphi)\, d\varphi\right] M_{hx}\\ -\ &\left[\rho\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\, \mu_h(\varphi)\, d\varphi + \mathrm{f}_d\right] M_h\\ -\ &\left[\rho\int_{\varphi_{fx}}^{\infty} y_{hx}(\varphi)\, p(\varphi)\, \eta_h(\varphi)\, d\varphi + \mathrm{f}_x\right] M_{hx}\\ =\ &\Pi_h \quad (3.153)\end{aligned}$$

$$\begin{aligned}\Leftrightarrow\ & M_h(1-\rho)\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\, \mu_h(\varphi)\, d\varphi\right]\\ +\ &(1-\rho)\left[\int_{\varphi_{fx}}^{\infty} y_{hx}(\varphi)\, p_{hx}(\varphi)\, \eta_h(\varphi)\, d\varphi\right] - \mathrm{f}_d M_h - \mathrm{f}_x M_{hx} = \Pi_h \quad (3.154)\end{aligned}$$

The labor used in each country is given by:

$$\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\left(1/\varphi + z_h\alpha\right)\mu_h(\varphi)\,d\varphi\right] M_h + \left[\int_{\varphi_{hx}}^{\infty} y_{hx}(\varphi)\,\tau\left(1/\varphi + z_h\alpha\right)\mu_h(\varphi)\,d\varphi\right] M_{hx} + \mathrm{f}_d M_h + \mathrm{f}_x M_{hx} + \Pi_h + L_h^N = L \tag{3.155}$$

Plugging 3.152 into 3.155 we have:

$$\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\left(1/\varphi + z_h\alpha\right) + \mathrm{f}_d\right] M_h + \left[\int_{\varphi_{hx}}^{\infty} \tau y_{hx}(\varphi)\left(1/\varphi + z_h\alpha\right) + \mathrm{f}_x\right] M_{hx} + \Pi_h + L_h^N \tag{3.156}$$

$$= \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\,p_{hd}(\varphi)\right] M_h + \left[\int_{\varphi_{fx}}^{\infty} y_{fx}(\varphi)\,p_{fx}(\varphi)\right] M_{fx} + N_h$$

$$\iff \rho\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\,p_{hd}(\varphi)\,M_h + \mathrm{f}_d M_h + \rho\int_{\varphi_{hx}}^{\infty} y_{hx}(\varphi)\,p_{hx}(\varphi)\,M_{hx} + \mathrm{f}_x M_{hx} + \Pi_h + L_h^N \tag{3.157}$$

$$= \left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\,p_{hd}(\varphi)\right] M_h + \left[\int_{\varphi_{fx}}^{\infty} y_{fx}(\varphi)\,p_{fx}(\varphi)\right] M_{fx} + N_h$$

$$\iff (\rho-1)\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\,p_{hd}(\varphi)\right] M_h + \mathrm{f}_d M_h + (\rho-1)\left[\int_{\varphi_{fx}}^{\infty} y_{fx}(\varphi)\,p_{fx}(\varphi)\right] M_{fx} + \mathrm{f}_x M_{hx} + \Pi_h + L_h^N = N_h \tag{3.158}$$

$$\iff \Pi_h = (1-\rho)\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\,p_{hd}(\varphi)\right] M_h - \mathrm{f}_d M_h + (1-\rho)\left[\int_{\varphi_{fx}}^{\infty} y_{fx}(\varphi)\,p_{fx}(\varphi)\right] M_{fx} - \mathrm{f}_x M_{hx} \tag{3.159}$$

$$+ N_h - L_h^N \tag{3.160}$$

Plugging this equation into 3.154 gives

$$\begin{aligned}
\Pi_h &= (1-\rho)\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\right] M_h - \mathrm{f}_d M_h + (1-\rho)\left[\int_{\varphi_{fx}}^{\infty} y_{fx}(\varphi)\, p_{fx}(\varphi)\right] M_{fx} \\
&\quad -\mathrm{f}_x M_{hx} + N_h - L_h^N \\
\Pi_h &= M_h (1-\rho)\left[\int_{\varphi_{hd}}^{\infty} y_{hd}(\varphi)\, p_{hd}(\varphi)\right] + (1-\rho)\left[\int_{\varphi_{hx}}^{\infty} y_{hx}(\varphi)\, p_{hx}(\varphi)\right] \\
&\quad -\mathrm{f}_d M_h - \mathrm{f}_x M_{hx} \qquad (3.161) \\
\Longrightarrow\ & N_h = L_h^N = (1-\beta)\, L \qquad (3.162)
\end{aligned}$$

The supply of numeraire is equal to the demand, thus there is no international trade in numeraire. This result holds when $z_h \neq z_f$ as long as there is no trade in intermediate goods.

Conclusion

The impact of input trade liberalization has received much less attention than the impact of output trade liberalization in the international trade literature. The present thesis highlights some new mechanisms through which final sector firms may be affected by changes in intermediate good sectors. Even if input trade liberalization has the expected aggregated results at sectorial level, i.e. it improves the performance of the final good sector and increases exports, different mechanisms may affect downstream firms and the structure of the downstream sector.

We developed a theoretical framework based on the "new new trade literature", with both heterogeneous firms and an intermediate good sector. This theoretical framework was used to investigate three important issues cited in the international trade literature: the impact of input tariffs on the export performance of downstream firms (Chap.1), the impact of input prices on the trade-off between exports and foreign direct investment (Chap.2), and finally the impact of input trade liberalization on the structure of final good sectors, including the domestic market and export and import behaviors (Chap.3).

In the first chapter, we focused on the impact of input tariffs on the export performance of firms in the final good sector. While in the standard literature, a fall in input tariffs may lead to an increase in export performance, we show that even if this effect holds at sectorial level, some firms may be forced to exit foreign markets. Indeed, the heterogeneity of firms results in heterogeneity in the fall in marginal costs, and thus in a change in relative prices and in the distribution of market shares. If reallocation of market share is large enough, i.e. if fixed export costs are low enough so that a large proportion of firms is able to export, less productive exporting firms are no longer able to produce. The model developed in this thesis introduces heterogeneity of firms following the seminal Melitz model (2003), along with a homogenous intermediate good used in fixed proportions. However, we show that the results hold for less restrictive assumptions on the production function of firms in the final sector and on the use and characteristics of the intermediate good. In addition, as the focus is on export performance, the mass of domestic firms is exogenous so that the effect on the domestic market structure is not taken into

account.

In chapter 1, we compare this result with firm level data on the French agrifood sector, and show that, indeed, the fall in input tariffs leads to reallocation from less productive exporting firms to more productive ones, decreasing the probability of exporting in this sector. These results are consistent with low fixed export costs.

The validation of these theoretical results using a large set of firm level data enabled us to validate the main assumptions of this framework, and to extend it to investigate other issues.

Using the same simple framework, the same symmetry of countries and mass of domestic firms, in the second chapter, we investigated the effect of input prices on the trade-off between exports and horizontal FDI in the final good sector. To do so, we followed the model of Helpman, Melitz and Yeaple (2004) to include the possibility for firms to serve foreign markets through FDI. We used the model presented and tested in the first chapter to introduce the intermediate good sector. In chapter 2, we show that a fall in input price leads to a reallocation process that does not depend on a firm's status. Indeed, whatever the destination market and the way firms serve it, the loss or gain in market shares only depends on the firms labor productivity. However, as in chapter 1, the level of fixed costs to access foreign markets via exports or FDI determines the status of the firms that gain or lose.

In chapter 2, we also show that the lower the intermediate good price, the higher the "observed" heterogeneity among firms (i.e. differences in levels of production and in revenues). The fall in input price also leads to a higher share of FDI sales than of export sales. This result is in line with the core result of the Helpman, Melitz and Yeaple model (2004): the higher the heterogeneity of a sector (in terms of productivity or elasticity of substitution), the higher the share of FDI sales relative to export sales.

While the heterogeneity of firms and products may not be impacted by policy makers, intermediate good prices can. For this reason, we also investigated the impact of two policies on the trade-off between exports and FDI: a subsidy on the cost of intermediate goods, and a subsidy on wages. We show that while the intermediate good subsidy leads to reallocation from less productive firms to more productive ones, the subsidy on wages leads to reallocation from more productive firms to less productive ones. In other words, a subsidy on wages benefits small domestic firms, while a subsidy on the intermediate good price benefits large multinational firms.

In addition, we show that both subsidies support incoming FDI, but that only a subsidy on wages always supports exports, irrespective of fixed costs.

This chapter provides a new determinant of FDI with symmetric countries. Indeed, the relative share of production factors among production costs influences the

heterogeneity of firms, which impacts both the distribution of market shares and the share of FDI sales relative to exports.

In chapter 3, we took a different perspective. The two first chapters were about the trade liberalization in intermediate goods and the prices of intermediate goods as determinants of international output trade. In the last chapter, we investigated the impact of international trade liberalization on domestic markets, and since less attention has been paid to the impact of intermediate good liberalization than to output trade liberalization, we focused on the former.

To the end, we used the same framework as in chapters 1 and 2, but we relaxed the assumption on the exogeneity of the mass of domestic firms. Following Melitz (2003), the endogenous mass of domestic firms was allowed introducing fixed domestic costs. The main results of this chapter can be summarized as follows:

First, in a closed economy, a fall in intermediate good price favors exit from the market. Indeed, reallocation (also described in the first two chapters) leads to a fall in market shares for less productive firms, and consequently, if fixed domestic costs exist, some less productive firms will no longer be able to pay them.

Next, we introduced a foreign country in the model. Unlike the two first chapters, countries are not symmetric: the intermediate good price is lower in the foreign country. In the final sections, we investigated the impact of input trade liberalization on domestic markets. We took different modalities of input trade into account, namely free input trade, input trade with variable trade costs, and input trade with fixed import costs.

We show that openness to input trade or its liberalization always reduces the probability of entering the domestic market in the input importing country. In other words, less productive domestic firms always lose market shares even if they are able to import less expensive inputs, but even more so if they are excluded from the import market due to fixed import costs.

Finally, in the last section, we introduced both input and output trade. We show that openness to input trade or its liberalization when the final good is internationally traded reduces the probability of entering the domestic market in both the input importing country and the input exporting country.

However, even if the fall in input prices or the liberalization of input trade reduce the number of firms able to produce, the effect of the fall in variety prices is always greater, so that consumer welfare is improved. In addition, the exit of less productive firms improves average productivity and leads to better allocation of resources, so that aggregated outcome also increases. Thus, when both inputs and final goods are internationally traded, input trade liberalization is welfare improving in both countries.

In the framework presented in this thesis, the level of fixed costs is the main determinant of the effect of changes in input prices resulting from an exogenous fall, a subsidy, or trade liberalization. In other words, depending on the structure of fixed costs, input trade liberalization has different effects on firms in the final good sector. A reallocation process is more likely to occur when, on a given market, a large share of firms are impacted by the fall in input price or by the input trade liberalization: low fixed import costs for the reallocation of domestic market shares, and low fixed export costs for reallocation on export markets.

To conclude, in this thesis we show that while a fall in input prices or input trade liberalization is always welfare improving, results in better allocation of resources, and a better aggregated performance on export markets, the effects such a fall has on individual firms are much more complex. The main contribution of this thesis is to highlight the fact that changes in the input market can have significant effects on the structure of the final good sector, and that heterogeneous firms may be affected by changes in their environment in different ways.

In the first chapter, we applied our framework to the French agrifood sector, and show that a fall in input price leads to both reallocation from less productive exporting firms to more productive ones and reduces the probability of entering the export market. Even if chapters 2 and 3 did not include empirical applications, these theoretical results provide more insight into the potential effects of European agricultural trade liberalization on French agrifood firms.

The second chapter focused on the way firms serve foreign markets, i.e., through FDI or exports. According to this chapter, the way French agrifood firms serve foreign markets and foreign firms serve the French market should differ provided that the partner country is a European country or an extra-European country.

Regarding European countries, the fall in agricultural prices caused by agricultural trade liberalization of the European market may lead to a change in the way European firms serve other European markets. Indeed, if the fall in input price occurs in both the home and the foreign country, the share of FDI sales may increase relative to exports. Thus, European agrifood firms may reduce their exports to foreign European countries in favor of horizontal FDI, and both incoming and outgoing FDI may increase in the French agrifood market.

For non-European countries, agricultural trade liberalization may not be as important as it is in the European market. We show that if the price of inputs decreases more in the home country, incoming FDI increases while outgoing FDI decreases. Thus, agricultural trade liberalization should lead to a reduction in imports from non-European countries in favor of incoming FDI, and to a reduction in outgoing FDI to non-European countries in favor of exports.

These two effects increase incoming FDI and reduce imports from both European and non-European countries.

Regarding changes in the structure of the French agrifood sector, input trade liberalization should lead to a concentration of production among more productive firms. Indeed, only the most productive firms gain from input trade liberalization and can increase their market share. If the reallocation process leads to a fall in the price index and to better allocation of resources, taking other effects into account may have an impact on these positive effects.

If reallocation leads to a concentration of production among more productive firms, we can expect that the geographical concentration of activities will also increase. This change in the distribution of agrifood activities in France may have negative effects on employment as well as on the supply of agrifood goods in some regions. The fall in prices may be reduced by transport costs within the country and workers living in regions where agrifood activity decreases will have to chose between moving to another region to find a job in the same sector or staying in the same region and looking for a job in another sector. This trade-off could reduce the amount of labor used in the agrifood sector, and hence reduce the gain in production caused by the better allocation of resources.

This thesis highlights several mechanisms through which agrifood firms can be affected by changes in the input sector, but it also provides the basis for further studies, both in the input sector and in others.

Even though our framework is particularly applicable to the agrifood sector, this sector is obviously not the only one to use intermediate goods. It would be interesting to test our model in other sectors. One possible application would be the linkage between the services and manufacturing sectors. Like in the agricultural sector, international trade liberalization of services is still an important issue in international trade negotiations, and many manufacturing sectors use services as inputs.

This thesis may also have implications for other issues than the linkage between input trade liberalization and the output sector. While some recent empirical studies show that firms react differently to changes in their environment (e.g. Greenaway et al. 2010 on the impact of the exchange rate), there is still no theoretical framework to explain these different reactions. This thesis provides a relatively simple framework showing that firms react differently to a change in their environment. Without major modifications, it could also be used to study the effects of higher energy prices or of increasing minimum wages. Finally, our model provides a theoretical intuition as to why firms may react differently to changes in their environment, giving a motivation for micro econometric studies to test whether different changes affect firms in the

same way or not.

In addition to the potential generalization of our framework, this thesis also provides some ideas for further studies to better understand the agrifood sector.

While we only tested the export side of our framework, it would be interesting to test the other sides of the model, i.e. the export FDI trade-off and the effect of input trade liberalization on the structure of the domestic market. The main difficulty would be to find an exhaustive dataset that includes international financial linkages for the FDI-export trade-off or very small firms (unlike the EAE survey used in chapter 1 of this thesis) that could be used to analyze the effect of input trade liberalization on the structure of the home market.

While the first mentioned empirical study could validate part of the framework, the latter seems to be more interesting. Indeed, the last chapter of this thesis is the most exhaustive, and includes the majority of the mechanisms presented in this thesis. In addition, empirical studies on the effect of international trade on domestic markets have not received as much attention as the determinants of international trade and FDI.

Finally, even if agricultural trade liberalization has resulted in lower agricultural prices, it has also led to an increase in price volatility. Using the framework developed in this thesis, it would be interesting to include the volatility of input prices, and -depending on their characteristics- to determine if some firms are in a better position to deal with this higher volatility. Unlike the application of this model to other sectors, this extension would require major modification, especially by coupling this model of international trade with tools used in the field of economics of uncertainty.

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Titre

Biens intermédiaires et commerce international avec firmes hétérogènes : développements théoriques et application au secteur agroalimentaire français.

Résumé

Dans cette thèse, nous étudions l'impact de la libéralisation des inputs sur les firmes du secteur final, en particulier l'impact de la libéralisation du secteur agricole sur le secteur agroalimentaire français. La contribution de cette thèse est aussi bien théorique qu'empirique. Le cadre théorique développé dans cet ouvrage reprend les concepts clés des nouvelles théories du commerce international, à savoir l'hétérogénéité des firmes et la sélection des firmes sur les différents marchés. Pour prendre en compte le lien entre la libéralisation du secteur intermédiaire et la structure du secteur final nous introduisons un secteur intermédiaire dans un modèle avec firmes hétérogènes. Ce cadre théorique est ensuite utilisé afin d'analyser l'impact de la libéralisation des inputs sur différents aspects du secteur final, que sont les performances des firmes à l'exportation, leurs modalités d'accès aux marchés étrangers (exportations ou investissements directs à l'étranger), et enfin les entrées et sorties du marché domestique. Nous confrontons les résultats obtenus à des données sur les firmes agroalimentaires françaises, ce qui nous permet de valider les propositions faites dans le modèle théorique. Nous montrons que la libéralisation des inputs a conduit à une baisse de la probabilité d'exporter dans le secteur agroalimentaire français et à une concentration des parts de marché sur les firmes les plus productives. Nous montrons également que la libéralisation des inputs pousse les firmes les moins productives à sortir du marché domestique. Enfin, nous montrons que les effets de la libéralisation des inputs dépendent fortement de la structure des coûts fixes.

Mot-clefs

Lien Vertival, Industrie Agroalimentaire, Investissements Directs à l'Etranger, Exportations, Firmes Hétérogènes, Bien Intermédiaires, Libéralisation Agricole

Titre en anglais

Intermediate goods and international trade with heterogeneous firms: theoretical developments and application to the French agrifood sector.

Abstract

In this thesis, we analyze the impact of trade liberalization of intermediate goods on firms in the downstream sector, with a particular focus on the impact of agricultural trade liberalization on French agrifood firms. The contribution of this thesis is both theoretical and empirical. The theoretical framework developed here uses key points of new international trade theories, namely the heterogeneity of firms and the selection of firms in different markets due to the presence of fixed costs. To account for the link between the liberalization of inputs and the structure of the downstream industry, we introduce an intermediate good sector in a model with heterogeneous firms. This theoretical framework is then used to analyze the impact of input trade liberalization on different aspects of the final sector, such as the export performance of firms, the way they serve foreign markets (through exports or direct investment abroad), and finally the entry in and exit from the domestic market. We compare our results with firm level data on French agrifood firms validate the propositions made in the theoretical model. We show that input trade liberalization reduces the probability of in the French agrifood sector, and results in the concentration of market shares in the hands of the most productive firms. We also show that input trade liberalization forces less productive firms to exit the domestic market. Finally, we show that the effects of input trade liberalization depend on the structure of fixed costs to access markets.

Keywords

Vertical Linkage, Agrifood Industry, Foreign Direct Investment, Exports, Heterogeneous Firms, Intermediate Goods, Agricultural Trade Liberalization

Adresse : LEMNA, Chemin de la cencive du Tertre, 44000 Nantes

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