

The Interaction between Firms and Governments in Climate Change and International Trade

Thesis submitted for the degree of
Doctor of Philosophy (Ph.D) in Economics

by

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November 2007

Abstract

This thesis analyses interactions between firms and governments in climate change and international trade.

First, a theory of international agreements on climate change is presented in which governments negotiate targets and firms bear the cost of emission reductions. It analyses the effect on negotiations of investment, on R&D for instance. The public good nature of the problem implies that investment improves the government's bargaining position. Anticipating this effect on the Nash-bargained outcome will induce firms, surprisingly, to over-invest with respect to the second best.

The second chapter explores a different area in which firms and governments interact: trade policy. This chapter analyses the incentives for trade protection in an electoral college setting by constructing a new multi-jurisdictional political agency model. The introduction of a spatial factor shows how the distribution of swing voters across decisive, swing states affects trade policy incentives. The empirical analysis introduces a measure of how industries specialise geographically in swing and decisive states by augmenting a benchmark test of the "Protection for Sale" mechanism. The evidence provides support for the theory.

A newly-available firm-level panel dataset for Belgium is described in the third chapter, in a bid to understand the patterns in the trade transaction data. The final chapter considers the determinants of firm exporting behaviour, in particular liquidity constraints. A heterogeneous firms trade model shows how exporters in general, firms exporting to more destinations and to smaller markets, weighted by distance, are less likely to be credit-constrained. Finally, in the presence of liquidity constraints, the impact of exchange rates on trade flows is decomposed. These equilibrium relations hold in the Belgian data, measuring credit constraints with firm-year-level credit scores. This highlights the potential role of governments in determining, through their policies on credit constraints, the patterns of trade and hence productivity levels and overall welfare.

Acknowledgments

I would like to thank my thesis advisors, Dr. Stephen Redding and Professor Tony Venables, not only for their academic advice and guidance but also for their encouragements throughout the course of writing this thesis.

I would also like to thank Holger Breinlich Alejandro Cunat, Alberto Galasso, Keith Head, Rafael Hortalla-Vallve, Henry Overman, Mauro Pisu, Daniel Sturm and Alessandra Tucci for their helpful comments and suggestions on my work throughout these years. Also, I am extremely grateful to Professor Peter Praet and George Van Gastel, the Microeconomic Analysis team at the National Bank of Belgium and Coface Belgium for supporting me in my project.

Two persons were very important in encouraging me to engage in academic research. I would like to take this opportunity to thank Professor Claude d'Aspremont and Professor Henry Tulkens for their encouragements and advice in the early stages of my academic career and throughout my PhD. Professor Maurice Marchand also provided huge help within the European Doctoral Program.

Financial support from the Economic and Social Research Council is gratefully acknowledged.

I wish to thank all my friends and LSE and CEP colleagues for the fun and support during the PhD. I am especially grateful to Bianca, Ale, Florence, Dimitra, Sabine, Chiara and Ralf.

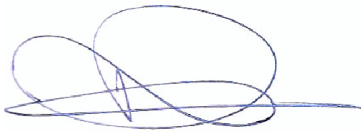
Finally, all this would not have been possible if it wasn't for the support of my family. For this reason I would like to dedicate this thesis to my brothers, Mammy, Daddy, and of course, Fleur, her little brother, and Vincent.

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I declare that the work presented in this thesis is my own except where the collaboration with coauthors is explicitly acknowledged.

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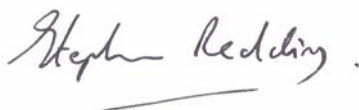
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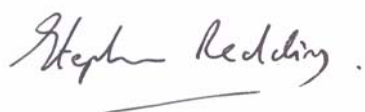
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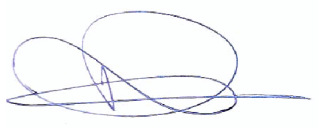
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I certify that chapter 2 of this thesis, "A Swing-State Theory of Trade Protection in the Electoral College.", was written in conjunction with Dimitra Petropoulou. Mirabelle Muûls was involved as full-coauthor, contributing to the genesis of the project (50%), the theoretical modelling (50%), the empirical research (50%), and the writing up of the research findings (50%).

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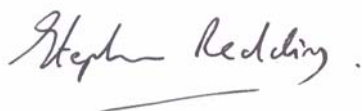
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I have worked with Mirabelle Muûls on the paper "Imports and Exports at the Level of the Firm: Evidence from Belgium", published as Working Paper No 114 of the National Bank of Belgium Working Paper Research series. It forms Chapter 3 of her thesis. I declare that Mirabelle Muûls was responsible for approximately 50% of the work involved in the paper. We worked together on the paper from the beginning to the end, including the development of the idea, the empirical work on the data, the writing of the text and the completion and correction stages.

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I agree with the above statement

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Introduction

This thesis analyses aspects of the interactions between firms and governments in climate change and international trade.

The first chapter presents a theory of international agreements in which investment in R&D by firms in each country affects negotiations between countries on climate change. It seeks in particular to analyse the effects of investment on the bargaining position of states in international negotiations on a global public good, namely greenhouse gas emission reductions. Governments negotiate targets and firms bear the cost of emission reductions. Ex-ante investment by firms cuts the cost of future emission reductions. The public good nature of the problem implies that investment improves the government's bargaining position. The anticipation of Nash bargaining, and of the transfers needed to ensure participation in the agreement, will therefore induce firms to over-invest relative to the second-best.

The second chapter of the thesis explores a different area in which firms and governments interact, namely trade policy. How does the distribution of firms and industry across political districts influence trade policy choice in the presence of electoral incentives? The electoral incentives for trade protection in an electoral college setting are analysed by constructing a new multi-jurisdictional political agency model. In the unique equilibrium, it is shown that political incumbents in their first term of office build a reputation for protectionism. The introduction of a spatial factor shows how the distribution of swing voters across decisive, swing states affects trade policy incentives. The empirical analysis introduces a measure of how industries specialise geographically in swing and decisive states by augmenting a benchmark test of the "Protection for Sale" mechanism. The condensed evidence provides support for the theory and highlights a previously overlooked and important determinant of trade protection.

The third and fourth chapters go further in the analysis of international trade. A newly-available firm-level panel dataset, merging balance sheet and international trade transaction data for Belgium, is described in the third chapter. Both imports and exports appear to be highly concentrated in the hands of a few firms and seem to have become more so over time.

Focusing on manufacturing, facts previously reported in the literature for exports only are shown to actually apply to imports too. Around 80 per cent of exporters are actually two-way traders. The number of trading firms falls as the number of export destinations or import origins rises. The same is true when considering the number of products traded. With regard to productivity differentials, firms that both import and export appear to be the most productive, followed, in descending order, by importers only, exporters only and non-traders. This chapter tries to understand the patterns in the trade transaction data. It provides novel stylised facts and confirms previous findings for other countries also apply to a small, open and European economy.

The final chapter considers the determinants of firm exporting behaviour, in particular liquidity constraints. A heterogeneous firms trade model is presented in which liquidity comprises both an exogenous and an endogenous component. Some firms that are productive enough to export profitably might be prevented to do so due to a lack of liquidity. Exporters in general and firms exporting to more destinations are then less likely to be credit-constrained. This leads to a pecking order in which firms add countries to their portfolio of destinations served in a decreasing order of the size of the importing country, weighted by trade costs. Hence, firms exporting to smaller markets, weighted by distance, are less likely to be credit-constrained. Finally, in the presence of liquidity constraints, the impact of exchange rates on trade flows is decomposed, identifying different variations in the extensive and intensive trade margins at the destination level. These equilibrium relations hold in the Belgian data, measuring credit constraints with firm-year-level credit scores, provided by a private credit insurance company. This highlights the potential role of governments in determining, through their policies on credit constraints, the patterns of trade and hence productivity levels and overall welfare.

Chapter 1

The effect of investment on bargaining positions. Over-investment in the case of international agreements on climate change.

Introduction

This chapter presents a theory of international agreements in which the investment in R&D by firms in each country affects the negotiations between countries. It seeks in particular to analyse the effects of investment on the bargaining position of states in international negotiations on a global public good and shows that the anticipation of Nash bargaining will cause firms to over-invest relative to the second-best solution. The example of global public good used throughout this chapter is that of greenhouse gas (GHG) emissions reductions in order to mitigate climate change. Investment in R&D by decentralised firms is non-reversible and is likely to strongly affect the cost of reducing (abating) GHG emissions in the future.

GHGs, such as carbon dioxide, accumulate in the atmosphere, thus capturing more heat from the sun, hence the term "greenhouse". The growth of man-made emissions throughout the industrial era is thought to be exacerbating this phenomenon, causing climate change at a global scale, now and in the decades and centuries to come. The global nature of the problem has led politicians to seek a global response in reducing emissions. International talks on this issue within the framework of the United Nations Framework Convention on Climate Change (UNFCCC) have agreed that greenhouse gas abatement targets are to be negotiated periodically at global level. The first negotiating round yielded the Kyoto Protocol in 1997 and targets for its signatories to be reached by 2008-2012; negotiations have now started on the post-Kyoto era. The outcome of these re-negotiations is clearly uncertain. However, when investments in R&D are made by firms to reduce the cost of

emission cuts, they have a long-term effect, well beyond the commitment period of an agreement.

The aim of this chapter is to understand the impact of these investments on future negotiations towards emissions reduction targets, and more specifically on the bargaining position of countries. The main finding of this chapter is that the anticipation of bargained agreements between governments will affect the investment decision of firms. A two period-two country model is therefore presented in which firms invest in R&D to reduce with certainty the cost of future emission cuts. The rest of the economic activity of these firms within each country, any possible trade in goods and their effects on social welfare are abstracted from, as I focus on a partial equilibrium, concentrating solely on the emissions reduction problem. The first-best social-planner's choice of investment and abatement cannot be reached due to the inefficiencies introduced by the timing of the game: firms would choose not to invest, and it would then be too costly for the government to implement and emission reductions target. The first-best can however be approached by introducing emission permit markets when there is a large number of firms. This is considered as the second-best case and would be possible to reach if investment were verifiable and firms and governments could sit at the same negotiating table. However, the investment being non-contractible and sunk at the time of the international negotiations, governments set their abatement targets through a Nash bargaining procedure. If necessary, a transfer between the two countries will be devised to ensure participation in the agreement. Regulation is ruled out, as it would lead to a certain type of hold-up problem, as discussed further on in the chapter. Governments could also choose to implement either national or international emissions permit markets. I will also argue that, in the context of this model, international permit markets do not yield any additional welfare gain, and will therefore focus on national permits. Once the emission targets and possible transfers have been decided upon, firms must meet their assigned targets by reducing emissions or buying permits, with their cost of doing so determined by the investment they have made in the past. The positive effect of investment is greater on the social welfare in the outside option case of non-cooperation than in the cooperative case in which some of the benefits of investment are reaped by the other country. The re-

sults thus show that investment improves the bargaining position of governments because emissions reductions are a global public good shared by the two parties to the contract. Anticipating the effect of their investment on the negotiations will induce firms, surprisingly, to over-invest with respect to the first best.

The existing literature has considered how the anticipation of international agreements affects firms' investment *ex ante*. In the case of non-public goods, it has identified the presence of a hold-up problem in international agreements. The hold-up problem has been described at length in the literature on the theory of the firm (Williamson 1985, Grossman and Hart 1986, Hart and Moore, 1988). McLaren (1997) analyses international trade agreements as incomplete contracts: firms in a country might anticipate future negotiations in favour of free trade and invest accordingly, e.g. by making irreversible investments in the export industry. Firms in this context act as decentralised agents and will reduce the bargaining power of the country when it later needs to negotiate. By having a modified outside option, the country is shown to be put at a strategic disadvantage by its firms' previous investments. For this reason, a country's government would benefit from never committing itself to negotiate on free trade in order to solve the hold-up problem. A similar type of argument is derived by Wallner (2003) for EU enlargement and allows one to revalue the welfare effects of EU membership. Because of the incompleteness of contracts, the surplus enhancement made by a country's corporate investments will be shared through a transfer, reducing the benefit to the investing country. Harstad (2005) studies how majority rules can affect incentives for decentralised agents to invest in anticipation of public projects, and how multilateral hold-up problems may arise in the context of the EU Constitution. This chapter contributes to this literature by considering the case of international negotiations on a global public good in which decentralised agents in the two parties to the bargaining procedure make specific investments. The anticipation of Nash bargaining leads firms to over-invest relative to the second-best.

There is also a large body of literature on how various policies might affect investment and innovation in environmentally-friendly technologies. Jaffe et al. (2003) provide an overview of both theoretical and empirical contributions to these questions. Empirically,

the impact of regulation and price changes on innovation has found support for both autonomous progress and induced innovation (Newell et al., 1999 and Popp, 2002). On the theory side, the focus has been on comparing the effects of prescriptive regulation and different market-based policies on efficient innovation (e.g. Downing and White, 1986, Jung et al., 1996). This area of research has focused on the effects on investment *after* the agreement or policy has been implemented. However, Gersbach and Glazer (1999) invert the timing and study how investment levels by firms *ex ante* affect the choice of policy instruments for reducing emissions at the national level. This is the timing we adopt in the present chapter. Gersbach and Glazer identify a hold-up problem for a government seeking to reduce emissions through regulation within the boundaries of its country. Marketable emission permits are shown to solve the hold-up problem and induce firms to invest in a Pareto efficient manner. By considering continuous rather than binary investment decisions, I do not exactly replicate their result, except in the limit when the number of firms is infinite. I also extend their approach by considering firms' investments in the context of international negotiations on emissions reductions and find the result of over-investment thus improving on the existing literature.

In the next section, I present the two period-two country model set up. It is then solved by backward induction under different scenarios. Starting in section 1.2 with the first-best case, I show how it can only be approached by the second-best global welfare maximisation cooperative outcome with emission permits. This is taken as my benchmark. Section 1.3 then demonstrates that with firms anticipating Nash bargaining, they will over-invest. Section 1.4 concludes.

1.1 Set-up

The setting is that of two countries, Home and Foreign, which share a public good: greenhouse gas abatement, where World, Home and Foreign reductions are respectively noted M^W , M , and M^* and $M^W = M + M^*$. ($M \geq 0$, $M^* \geq 0$).

Reducing GHG emissions, reduces climate change and increases social welfare by $a(M + M^*)$ at Home and $a^*(M + M^*)$ in Foreign. Apart from their different preferences for the public good when $a \neq a^*$, the two countries are symmetric. Firms in each country bear the cost of reducing emissions.

There are n identical firms in each country. For simplicity, the number of firms is assumed to be fixed, and there is no entry and exit. Even if the firm makes negative profits on the emissions side of its activities in my setting, it does not exit: the model only considers the abatement part of a firm's behaviour, and does not take into account its main production activity. More than one firm is needed in each country in order to model emissions permits markets. At time 0, each firm can choose to invest such as to reduce the long-term marginal cost of abatement. This investment is denoted by k_i and costs $m(k_i)$ to each firm i . Because it does not reduce emissions at the time it is made, a good example of such an investment would be R&D in ways to reduce a firm's emissions in the future. I do not consider investments whose effect on reductions is immediate, such as the building of a wind-turbine. It is assumed that the investment is irreversible, and therefore sunk. At time 1, each country decides on the level of emissions reductions M or M^* it wants to achieve. It divides the burden equally among all firms. At that point, the country can either enter into an international agreement, or act on its own accord, i.e. selfishly. It may also decide to implement an emissions permit trading system within its borders, or even internationally. However, given the assumptions made in this setting, national and international markets yield equivalent solutions, as shown in Appendix 1.A. There are no additional welfare gains of implementing an international market given that under cooperation, governments already internalise the inter-country externality in their decisions on the national permits scenario. Alternatively, a country may simply choose to impose a regulation or a tax. In this chapter, regulation is ruled out, as it would lead firms to hold up their investment, as shown in Appendix 1.B. This is a replication of the result by Gersbach and Glazer (1999). I also abstract from the free-riding problem by assuming that a third party can verify and implement internationally agreed abatement targets.

At time 2, the firms need to fill the emissions permits quota they were allocated given the agreed target, $\frac{M}{n}$. They can either reduce the emissions themselves and/or trade permits with other firms. I denote by v_i the amount of reductions firm i decides to do itself at a cost $C(v_i, k_i)$. It is a function of k_i , the investment made at time 0 to reduce the cost of abatement. The more it invested in R&D in the past, the cheaper it is to abate. Payoffs are then realised. There is no discounting. The timeline is represented in Figure (1.1).

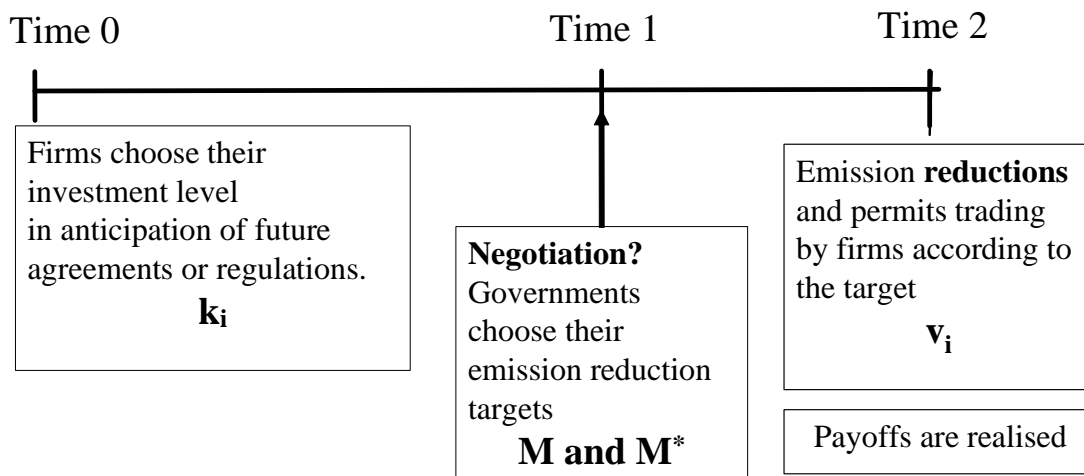


Fig. 1.1. Timeline

If investments were verifiable and contractible, there could be an agreement between countries and firms specifying ex-ante the optimal level of R&D investment to be made in each country. However, in an international context it is hard to imagine that a third party be able to verify the amount of R&D made by firms in each country. Therefore, given investments are irreversible, it is only once they have been made that countries negotiate and choose together their respective level of emissions reductions. With Nash bargaining, transfers can be made between countries to encourage them to cooperate. These transfers could in practice also be replaced by the choice of international permit quotas. Ex ante, each firm will choose investment to maximise its profit by anticipating which scenario will occur: full cooperation or a Nash bargained agreement. I restrict my analysis to pure strategies.

Social welfare depends positively on total world abatement, and negatively on the cost of emission reductions and of investment by domestic firms. The rest of the economic activity within each country is abstracted from and not included in the model. At Home social welfare is defined by W , where a is the preference parameter for reductions:

$$W = a(M + M^*) - \sum_{i=1}^n C(v_i, k_i) - \sum_{i=1}^n m(k_i) \quad (1.1)$$

In Foreign, a^* is the preference parameter for world abatement:

$$W^* = a^*(M + M^*) - \sum_{i=1}^n C(v_i^*, k_i^*) - \sum_{i=1}^n m(k_i^*) \quad (1.2)$$

The cost of reducing emissions is symmetric across all firms in both countries. It is increasing in the level of reductions and I make the hypothesis of an increasing marginal cost of reduction ($\frac{\partial C(v_i, k_i)}{\partial v_i} > 0, \frac{\partial^2 C(v_i, k_i)}{\partial v_i^2} > 0$). The cost of reducing emissions is decreasing in the level of prior investment, but at a decreasing rate ($\frac{\partial C(v_i, k_i)}{\partial k_i} < 0, \frac{\partial^2 C(v_i, k_i)}{\partial k_i^2} > 0$). There is no uncertainty as to how R&D investment will affect the cost of abatement. The following functional form is chosen:

- $C(v_i, k_i) = \frac{v_i^2}{2k_i}$

Finally, the cost of the investment is assumed to be quadratic.

- $m(k_i) = k_i^2$

This multistage game can therefore defined as follows. There are $2n + 2$ *players*: the Governments in Home and Foreign, and n firms in each country. The Governments' *strategy spaces* consist of the emissions targets, respectively $M \geq 0$ and $M^* \geq 0$, and their decision to implement emission permits market (international or national), regulate the firms or none of these. The strategy of a firm at Home is defined by the pair (v_i, k_i) with emission reductions $v_i \geq 0$ and investment $k_i \geq 0$; for firms in Foreign, (v_i^*, k_i^*) with emission reductions $v_i^* \geq 0$ and investment $k_i^* \geq 0$. The Governments' *payoffs* are respectively Home and Foreign welfare: $W = a(M + M^*) - \sum_{i=1}^n \frac{v_i^2}{2k_i} - \sum_{i=1}^n k_i^2$ and

$W^* = a^*(M + M^*) - \sum_{i=1}^n \frac{v_i^{*2}}{2k_i^*} - \sum_{i=1}^n k_i^{*2}$, while the firms' payoffs are negative and equal to the cost of abatement plus the cost of investment: $\Pi = -C(v_i, k_i) - m(k_i) = -\frac{v_i^2}{2k_i} - k_i^2$ and $\Pi^* = -C(v_i^*, k_i^*) - m(k_i^*) = -\frac{v_i^{*2}}{2k_i^*} - k_i^{*2}$. Finally, the timing of the game consists of three stages. At time 0, Firms in Home and Foreign choose their investment level k_i and k_i^* . At time 1, Governments in Home and Foreign choose their emission reduction targets, M and M^* and finally at time 2, firms in Home and Foreign reduce their emissions by v_i and v_i^* .

The model is solved by backward induction for the cases of the first-best social planner choice, cooperative outcome and Nash bargaining. In each of these last two possibilities, I focus on national permit trading schemes (Appendices 1.A and 1.B show how international permits give equivalent results and regulation can be ruled out). This allows me to solve the hold-up problem that would occur under regulation, and concentrate rather on the effect of international bargaining on investment choices.

1.2 Cooperative outcome and first-best

This section derives the first-best emissions reductions and investment levels and then shows how they can be approached using as policy instrument an emission permits market when n , the number of firms increases.

1.2.1 First-best

The socially optimal solution is characterised by two elements the investment levels and emission reductions by each firm in each country. By maximising $W + W^*$ given by equations 1.1 and 1.2, the first-best levels of investment that would be chosen by a social planner are:

$$k_i^{FB} = k_i^{FB*} = \frac{(a + a^*)^2}{4} \quad (1.3)$$

and the optimal level of abatement by each firm is:

$$v_i^{FB} = v_i^{FB*} = \frac{(a + a^*)^3}{4} \quad (1.4)$$

These first-best reductions and investments would not be affected by the timing. However, the timing of the game introduces some inefficiencies in the game: firms, maximising their pay-off, and therefore minimising their cost, will have an incentive not to invest at time 0, such that the optimal choice of governments will be to choose a zero target (at time 1, once the investment is sunk, the first-best abatement as a function of investment, is $v_i^{FB} = (a + a^*) k_i$). This is equivalent at the international level to the hold-up problem identified by Gersbach and Glazer (1999) at the national level, described in appendix 1.A. As shown in the following sub-section, the first-best can be approached (and reached if $n \rightarrow \infty$) by using as an instrument emission permits.

1.2.2 Emission permit markets

This sub-section shows how national emission permit markets allow to overcome the hold-up problem when n tends to infinity. An international emission permit market is shown to have the same property in appendix 1.B. With emission permits markets, the decisions of firms at time 2 and time 0 will differ.

At time 2, firms take as given the investment they made at time 0 and the target that was set at the intergovernmental negotiation at time 1. The possibility of a firm deciding to exit and not abate is ruled out by assuming it makes sufficient profits in its main activity to remain active, and compensate for the negative profit it makes on the emissions reductions. It is assumed that the governments distribute M equally across firms: each firm receives a fraction n of the total abatement target M fixed by the government in time 1. This target can be reached in two ways. Either the firm reduces its emissions, by v_i , at a cost $C(v_i, k_i)$ dependent of its investment. Or it buys permits on the national market at price p . The firm maximises its profit, which is composed of the revenue of sales of permits minus the cost of reducing emissions, $C(v_i, k_i)$. A firm may sell at price p any abatement it has made in excess of its quota $\frac{M}{n}$, which is $[v_i - \frac{M}{n}]$. If it reduces below its quota ($v_i < \frac{M}{n}$), it will have

to buy permits at price p and this will negatively affect its profits. Hence, the maximisation problem for firm i at Home at time 2 is:

$$\text{Max}_{v_i} \pi_i = p[v_i - \frac{M}{n}] - \frac{v_i^2}{2k_i} \quad (1.5)$$

The cost $m(k_i)$ of the investment k_i is not taken into account at this stage, as it is paid at time 0 and therefore sunk at time 2. The first-order condition of this maximisation problem is:

$$v_i = pk_i \quad (1.6)$$

The higher the price of permits, the more a firm will reduce its own emissions. Investment at time 1 reduces the cost of abatement, and therefore increases emission reductions. As the emission permit market is national, the market clearing condition dictates that total emission reductions within the country must be equal to the total amount of quotas M^F (F for first-best), the target chosen by government at time 1.

$$\sum_{i=1}^n v_i = M^F \quad (1.7)$$

This allows us to derive the equilibrium price:

$$p^{FN} = \frac{M^F}{\sum_{i=1}^n k_i} \quad (1.8)$$

The price is increasing in the target set by the government, as this boosts the supply of permits. It is decreasing in total investment by national firms, as by reducing the cost of self-abatement, investment reduces demand for permits.

Given the price and the profit function, total profits for firm i at time 2 are:

$$\pi_i = \frac{M^{F^2} k_i}{2(\sum_{i=1}^n k_i)^2} - \frac{M^{F^2}}{n \sum_{i=1}^n k_i} \quad (1.9)$$

The profit is increasing in the number of firms, as this reduces the quota $\frac{M}{n}$ assigned to the firm by the government and therefore increases, for a given realised reduction v_i , the amount of permits it has in surplus and can sell. The effect of M^F on firm-level profit is negative, as it is imposed by government as an extra cost on top of the company's usual

operations ($\frac{\partial \pi_i^F}{\partial M^F} < 0$ as in equilibrium, all firms within the country will act symmetrically and $k_i = k_j$). The effect of investment k_i on profits at time 2 is positive, as the cost of investment is sunk and it reduces the cost of meeting the target, both through a lower price of permits and a smaller cost of abatement.

In the aggregate, the revenue from permits sales and costs of permit purchases will cancel out, so that the total cost for all n firms in Home to meet the government's target M^F is:

$$\sum_{i=1}^n C(v_i, k_i) = \frac{M^{F^2}}{2(\sum_{i=1}^n k_i)} \quad (1.10)$$

The higher the national target, the higher the cost of reaching it. The cost is decreasing in aggregate investment. The same expression applies in the other country, so that the total cost for all n firms in Foreign to meet the government's target M^{F*} is:

$$\sum_{i=1}^n C(v_i^*, k_i^*) = \frac{M^{F*^2}}{2(\sum_{i=1}^n k_i^*)} \quad (1.11)$$

At time 1, anticipating the firms' reactions at time 2 and therefore the aggregate cost equations in each country, governments decide on the targets M^F and M^{F*} they wish to set. In the first-best complete contract with full cooperation, the two countries act as one, internalising the effect of their emissions on the other country. They choose the first-best targets by maximising joint total social welfare:

$$Max_{M^F, M^{F*}} (a + a^*)(M^F + M^{F*}) - \frac{(M^F)^2}{2(\sum_{i=1}^n k_i)} - \frac{(M^{F*})^2}{2(\sum_{i=1}^n k_i^*)} \quad (1.12)$$

The first-order conditions confirm that each country takes into account the externality of its emissions reductions on the other country's welfare. Each target is thus increasing in both preference parameters a and a^* and in the aggregate investment of firms at time 0. Governments, at time 1, act according to the first-best. They will equate the marginal benefit of total reductions with the marginal cost of the reduction in each country. This result is an application of the Coase theorem, leading to an efficient outcome. With the specified functional forms, the first-best national permits targets will thus be, as above:

$$M^F = (a + a^*) \left(\sum_{i=1}^n k_i \right) \text{ and } M^{F*} = (a + a^*) \left(\sum_{i=1}^n k_i^* \right) \quad (1.13)$$

The presence of a third party able to enforce the agreement allows the optimal provision of the public good to be reached. The implied welfare levels, taking the investment as sunk, are the following:

$$V^F = a(a + a^*) \sum_{i=1}^n k_i^* + \left(\frac{a^2 - a^{*2}}{2} \right) \sum_{i=1}^n k_i \quad (1.14)$$

$$V^{F*} = a^*(a + a^*) \sum_{i=1}^n k_i + \left(\frac{a^{*2} - a^2}{2} \right) \sum_{i=1}^n k_i^* \quad (1.15)$$

Welfare is increasing in the aggregate investment of the other country, as it will allow a higher target to be set at no extra cost. However, if Home's preference for abatement a is lower than Foreign's, a^* , Home's social welfare will be decreasing in its own aggregate investment. This is because, in a cooperative setting, the marginal cost of reductions is equated to the marginal benefit of reductions for both countries, and not the marginal benefit of Home which in this case would be lower. This is an important element for explaining my results below.

In a full cooperative setting in which firms' investments can be verified and government targets enforced, and with national emission permit markets, I compute firm-level investment. At time 0, firm i will maximise profits by anticipating that negotiations between governments at time 1 will yield the target set out in equations (1.13) and that its revenue at time 2, π_i , will be as in equation (1.9). It then solves the following maximisation problem:

$$\text{Max}_{k_i} \pi_i - k_i^2 \quad (1.16)$$

The first-order conditions yield an efficient level of investment by equating the marginal cost of investment at time 0 with its anticipated marginal benefit. Given time 1's target choice, this marginal benefit is the decrease in C_i , the cost of reducing emissions, given the expectation of the target. Firms at Home would therefore invest at time 0 an amount k_i^{SB} while those in Foreign will invest k_i^{SB*} .

$$k^{SB} = \frac{(n-2)(a+a^*)^2}{4n} \text{ and } k_i^{SB*} = \frac{(n-2)(a+a^*)^2}{4n} \quad (1.17)$$

These investment levels show that the first-best investment levels can only be reached using as an instrument emission permits markets when n is infinite. This differs slightly from the Gersbach and Glazer (1999) result in which the investment and therefore abatement decisions are binary and where the first-best is therefore reached through permits for an n above a certain finite threshold. In this model, investment by each firm is a continuous choice. The incentive to invest when emission permits exist comes from the potential profits from deviating from a non-investment situation and becoming a permit seller in the future. The higher the number of firms, the higher the profits (as seen in equation 1.7), and hence the higher the return on investment. In other words, the larger the number of firms, the higher the costs of choosing to invest less and being a permit buyer from other firms relative to being a permit seller. We also notice here that firms anticipate that, when there is full cooperation, there will be no free riding. Countries will choose their targets by taking into account the effect of their emissions on the other country's welfare (which explains why both a and a^* are in equation (1.17)). Governments will choose higher targets, which in turn imposes a greater responsibility on firms. This gives firms an incentive to invest more than when countries do not cooperate as shown in section 1.3.1.

Given the symmetry of both countries and the fact that they act jointly, their firms in aggregate will invest the same amount.

In this section, I have shown how the timing of the game modifies the incentives of firms and hence prevents the first-best investments and reductions to be attained with no instrument. It is then shown how they can be approached by cooperation, using emission permit markets as instruments when the number of firms is infinite. The levels reached with the permits will be considered as our second-best cooperative benchmark for the remainder of this chapter. I now consider the case of a Nash bargained agreement.

Having set-out the baseline case of full cooperation with national permits in which the first best investment and reductions are obtained, I now consider the case of a Nash bargained agreement.

1.3 Nash Bargaining

This section shows how firms anticipating a Nash bargained agreement will over-invest. Targets in this setting cannot be set in advance nor be made contingent on investment levels. Given that investments are assumed to be non-verifiable, countries are bound to negotiate at time 1 taking the investment levels of their firms as given. The investments are assumed to be irreversible. If they were reversible, there would be no benefit of negotiation. Given the sunk investments, the surplus of cooperation over non-cooperation will be shared according to a Nash bargaining process. The behaviour of firms at time 2, given the agreed target and/or transfer will be similar to the second-best case. The difference between the two types of solutions stems from the way in which governments bargain at time 1. In view of the public nature of the emission reductions, cooperation in fixing the targets is Pareto superior to non-cooperation. Given the results of the previous section, it is assumed that there are national permits markets in place. It is also assumed that social welfare is transferable in so far as the negotiation, based on the bargaining power of each country, will devise a transfer which ensures that both countries participate in the agreement. In the case of an international permits market, the transfer would not be made in this way, but through a different allocation of national emission allowances, which is closer to reality. The two cases are shown to be equivalent in Appendix 1.A. First, I present the non-cooperation case, in order to measure thereafter the surplus of cooperation over non-cooperation.

1.3.1 Non-cooperation

Anticipating the revenue functions of firms at time 2 as in the full cooperation case, one can compute the social welfare in the event that the government fixes the national emissions reduction target without taking into account the externality on the other country. This is called the non-cooperative case. As proved in Appendix 1.B, the government will not use regulation but national permits. At Home, the government maximises social welfare. Investments of time 0 are sunk and irreversible. The government maximises welfare achieved

from the target, anticipating the cost of reaching that target, with national permits trading at time 2 will be such as derived in equation (1.10). The maximisation problem is therefore:

$$Max_{Ma} (M + M^*) - \frac{M^2}{2(\sum_{i=1}^n k_i)} \quad (1.18)$$

at Home and a parallel equation holds in Foreign. The first-order condition thus dictates the optimum choice of targets for the non-cooperative governments to be:

$$M^{NC} = a \sum_{i=1}^n k_i \text{ and } M^{NC*} = a^* \sum_{i=1}^n k_i^* \quad (1.19)$$

Unlike the second-best case, each government only integrates its own preference parameter, respectively a and a^* , in its choice of target. The more social welfare benefits from abatement, the higher the target. Aggregate investment positively affects the target, as it reduces the cost of emission reductions. Given these targets, the social welfare levels for each country implied by a non-cooperative outcome at time 1 are computed in equations (1.20). The cost of investment at time 0 is not accounted for, given that it is sunk.

$$V^{NC} = \frac{a \sum_{i=1}^n k_i}{2} + aa^* \left(\sum_{i=1}^n k_i^* \right) \text{ and } V^{NC*} = \frac{a^* \sum_{i=1}^n k_i^*}{2} + aa^* \left(\sum_{i=1}^n k_i \right) \quad (1.20)$$

The Home social welfare functions in the non-cooperative case is increasing in Home investment, as this will reduce the cost of abatement and increase the agreed reductions. It is also increasing in Foreign firms' aggregate investment and in a^* as these will raise the target chosen non-cooperatively by the foreign government, and hence the reductions. Given these are a positive externality on Home, social welfare will be improved. The same applies to Foreign. These levels of social welfare are used in the following two parts to compute the surplus of the agreement.

At time 0, anticipating the target that would be imposed by governments in an non-cooperative behaviour, firms in Home and Foreign will invest such as to maximise their payoff at time 2:

$$k_i^{NC} = \frac{(n-2)a^2}{4n} \text{ and } k_i^{NC*} = \frac{(n-2)a^2}{4n} \quad (1.21)$$

This leads to the following proposition.

Proposition 1.1 *Firms anticipating their country will act non-cooperatively in setting the target for emission reductions will invest less than in the first-best and second best, $k_i^{NC} \leq k_i^{SB} \leq k_i^{FB}$. This level of investment is efficient when governments decide not to cooperate and n is infinite. **Proof.** Firms anticipate that the abatement targets will be lower in the non-cooperative case, given that governments do not take into account the externality caused by the country's emissions. Therefore, firms invest less as the marginal return to their investment is lower. This can be seen by comparing equations 1.17 and 1.21. Given the governments choose not to cooperate, the investment by firms is equal to the levels chosen by the social planner, if the number of firms is infinite. As in the cooperative outcome, the permits markets can be used as an instrument to solve the inefficiency introduced by the timing. The efficient level of investment under non-cooperation is indeed given by:*

$$k_i = \frac{a^2}{4}$$

■

This proposition also confirms the results by Gersbach and Glazer (1999). As shown in Appendix 1.B, this efficient level of investment would not be chosen in the case governments were to choose regulation rather than permits.

1.3.1 Nash-bargained agreement

In the case of national emissions permits markets, a Nash bargaining process allows for the allocation of the surplus of cooperation over non-cooperation through a transfer. The transfer must be agreed upon in order to make each country at least as well off in the agreement as in its outside option where it would act non-cooperatively and freeride. It gives governments the incentives to participate in the agreement. The agreed targets, functions of aggregate investment levels, will be similar to the Pareto efficient reductions agreed to in the first-best, given in equations (1.13).

For Home, I subtract social welfare under non-cooperation, given in equation (1.20), from social welfare with cooperation and national permits (equation (1.14)) and obtain the surplus:

$$S = a^2 \sum_{i=1}^n k_i^* - \frac{a^{*2}}{2} \sum_{i=1}^n k_i \quad (1.22)$$

The effect of Home firms' investment on Home's social welfare is smaller under cooperation than under non-cooperation due to the public good nature of abatement. This is a key element of the model, and the results detailed below crucially depend on it. Part of the benefits from investment are captured by Foreign when there is full cooperation as reductions are higher when the Home government takes into account the positive effect of its abatement on Foreign. For example, one can take the case in which investment is given and Home does not benefit from reductions ($a = 0$). In the non-cooperative case, its social welfare is zero and it does not abate. In the cooperative case, it takes into account the fact that its reductions positively affect Foreign, assuming Foreign does benefit from global reductions ($a^* > 0$). It would then decide to reduce its emissions, and the higher the exogenous investment, the higher the abatement, as it equates the global marginal benefit of reductions to the national marginal cost which is increasing in investment. In this extreme case, the cooperative social welfare for Home is negative, and therefore so is the surplus of cooperation over non-cooperation. This explains why Home's surplus depends negatively on Home's investment. Similarly, the surplus for Foreign is:

$$S^* = a^{*2} \sum_{i=1}^n k_i - \frac{a^2}{2} \sum_{i=1}^n k_i^* \quad (1.23)$$

Adding up equations (1.22) and (1.23) confirms that the total surplus is always positive or zero, as shown in equation (1.24). In my example above with $a = 0$ and $a^* > 0$, although Home's social welfare under cooperation and surplus would have both been negative, the counterparts in Foreign would have been positive and higher in absolute value, so that the total surplus is positive. This ensures there will always be gains from negotiation.

$$S^T = \frac{a^{*2}}{2} \sum_{i=1}^n k_i + \frac{a^2}{2} \sum_{i=1}^n k_i^* \geq 0 \quad (1.24)$$

It reflects the public good nature of emissions abatement. Home aggregate investment will only have a positive effect on total surplus if Foreign cares about reductions and $a^* > 0$,

because in that case, there will be a positive effect on Foreign's surplus of Home internalising the externality of its emissions. The negative effect of a country's investment on its own surplus that was explained above is smaller than the positive effect it has on the other country's benefit of cooperating.

Assuming equal bargaining power, the Nash maximand will be maximised in order to derive the transfer needed from Home to Foreign to ensure participation in the agreement¹.

$$\text{Max}_t (V^F - t - V^{NC})^{\frac{1}{2}} (V^{F*} + t - V^{NC*})^{\frac{1}{2}} \quad (1.25)$$

The first-order condition of this maximisation problem yields the equilibrium transfer.

$$t = \frac{S^2 - S^{*2}}{2(S + S^*)} \quad (1.26)$$

$$= \frac{3}{4}a^2 \sum_{i=1}^n k_i^* - \frac{3}{4}a^{*2} \sum_{i=1}^n k_i \quad (1.27)$$

Notice that if countries had the same preferences and the same amount of aggregate investment, the transfer would be zero. The transfer from Home to Foreign shares the surplus, and ensures that both Home and Foreign agree to the agreement. The transfer from Home to Foreign is increasing in Home's surplus: the more a country relatively benefits from cooperation versus non-cooperation, the more it will need to compensate the other country to ensure it participates in the agreement.

As a result of this transfer, social welfare levels under a Nash bargaining agreement with national permits markets (NB) will be:

$$V^{NB} = V^F - t = \frac{a^2 + 4aa^*}{4} \sum_{i=1}^n k_i^* + \frac{2a^2 + a^{*2}}{4} \sum_{i=1}^n k_i \quad (1.28)$$

$$V^{NB*} = V^{F*} + t = \frac{a^{*2} + 4aa^*}{4} \sum_{i=1}^n k_i + \left[\frac{2a^{*2} + a^2}{4} \right] \sum_{i=1}^n k_i^* \quad (1.29)$$

¹ With equal bargaining power, the transfer is equivalent to sharing equally the surplus of the agreement, such that $V^{NB} = V^{NC} + \frac{1}{2} [(V^{NB} + V^{NB*}) - (V^{NC} + V^{NC*})]$, where V^{NB} is the welfare under Nash-Bargaining. This can be shown, as $V^{NB} = V^F - t$ such that $(V^{NB} + V^{NB*}) = (V^F - t) + (V^{F*} + t)$ and therefore, $t = (V^F - V^{NC}) + \frac{1}{2} [(V^{NB} + V^{NB*}) - (V^{NC} + V^{NC*})]$ and $S^W = [(V^{NB} + V^{NB*}) - (V^{NC} + V^{NC*})]$.

The resultant social welfare functions are increasing in the aggregate investment levels of both countries and in both the preference parameters a and a^* . This is different from the full cooperation case where a country's welfare function could be decreasing in its own investment. In the Nash bargaining case, the transfer ensures participation in the agreement and therefore, in all cases, social welfare will be increasing in aggregate investment.

Given there is no government budget, it is assumed that the firms in each country pay the cost or receive the benefit of the transfer. Firms anticipating that their government will decide on targets at time 2 through Nash bargaining, with equal bargaining power, assume they will have to have to meet an emissions reduction target or buy permits as in the first-best case for $\frac{M^F}{n}$, but also pay a share n of the transfer which is needed to ensure participation in the agreement. Their maximisation problem in determining their investment level at time 0 will therefore be the following:

$$Max_{k_i} \pi_i - \frac{t}{n} - k_i^2 \quad (1.30)$$

in which the revenue at time 2 is defined in equation (1.9) and k_i^2 is the investment cost. A comparable situation occurs in Foreign. This yields the following investment by firms at time 0 in Home and Foreign respectively in the case of Nash bargaining with a national permits market:

$$k_i^{NB} = \frac{(n-2)(a+a^*)^2}{4n} + \frac{3a^{*2}}{8n} \text{ and } k_i^{NB*} = \frac{(n-2)(a+a^*)^2}{4n} + \frac{3a^2}{8n} \quad (1.31)$$

The investment choices yield the following proposition:

Proposition 1.2 *In the case of a global public good, firms anticipate their government will agree on targets under a Nash bargained agreement with a national emission permit market and will over-invest relative to the cooperative level of investment: $k_i^{FB} \geq k_i^{NB} \geq k_i^{SB}$ and $k_i^{FB*} \geq k_i^{NB*} \geq k_i^{SB*}$. Investment is higher than the second-best level. It is lower than the first-best unless the number of firms is infinite. **Proof.** The investment decisions are derived in equations (1.17) in the cooperative outcome and equations (1.31) such that the proposition follows. ■*

Due to the inefficiency introduced by the timing of the game, the first-best cannot be reached per se. Using an emission permits market as policy instrument allows the first-best levels of investment to be approached in the second-best when the number of firms is large. The investment under Nash-bargaining with emission permits markets is higher than this level, and will approach the first-best as the number of firms approaches infinity: $\frac{\partial(k_i^{FB} - k_i^{NB})}{\partial n} \leq 0$ and $\lim_{n \rightarrow \infty} k_i^{NB} = k_i^{FB}$. The over-investment can be explained in the following way. Due to the public good nature of emission reductions, a firm's higher investment reduces the surplus of cooperation over non-cooperation, as detailed above. This improves the government's bargaining position and reduces the transfer paid by its country (or increases the transfer received). In order to participate in the agreement, the government wants its country to be compensated for the higher investment its firms have realised in R&D as it reduces the cost of abating world emissions if cooperative abatement levels are chosen, whatever the preference of that country for reductions. The transfer is negatively related to domestic firms' investment. As each firm pays a share n of the transfer, it will then benefit from a lower transfer. The return to investment differs from the cooperative outcome because of the negative effect of investment on the transfer from Home to Foreign. Therefore, the anticipation of Nash bargaining increases a firm's return on its investment with respect to the second-best. This yields over-investment. Although the transfer would be zero if the countries were symmetric, there would still be over-investment as firms do not integrate the effect of foreign firms on the transfer and only consider the effect of their own investment. The government needs to be compensated for the fact that by cooperating, Foreign benefits from its reductions and therefore from its investment. This is reflected in the over-investment component $\frac{3a^{*2}}{8n}$ depending on a^* , Foreign's preference for world reductions, and not a . Appendix 1.A proves that this result holds equivalently in the case of international permits markets, in which case the transfers are replaced by a different allocation of targets.

Given these investment levels, the equilibrium agreed targets will be higher than the second-best, and the social welfare levels will be greater than the second-best for the country with the lowest preference for emissions reductions (a), and lower for the country with

the highest preference. If countries have an equal preference ($a = a^*$), then the social welfare levels will be equal under the second-best and Nash bargained agreement.

The over-investment result is of a completely different nature to the hold-up identified by Gersbach and Glazer (1999), as it occurs through the bargaining-position effect of investment. It uses however these authors' result by introducing up front permits and not regulation, as justified in Appendix 1.B. By operating in a one-country set-up, their paper does not consider the same type of issue at all. This chapter's focus is rather on how investment by firms affects international bargaining positions and how this feeds back into the level of investment in R&D.

The results in Proposition 1.2 contradicts the results of McLaren (1997) and Wallner (2003) who demonstrated a hold-up problem whereas I here show there is over-investment by firms who anticipate a negotiation. This is due to the global public good nature of the problem. The benefits from emission reductions in one country also affect the welfare of the other country. As a result, at the point of negotiation, the first best welfare, and the outside option non cooperative welfare are both a function of the investment of both countries. So is the surplus of the agreement where k_i and k_i^* are both in equations (1.22) and (1.23). This means that for example, home's investment has an effect on the relative bargaining position of both countries. Most importantly, and in contrast to the mechanism at play in the previous papers of the literature, the surplus is reduced by firms' investment, thus improving the bargaining position. Another important mechanism behind my result, is that firms do not anticipate the fact that firms in the other country are investing. If they would take the other country's investment into account (or if both countries were integrated), they would invest at a second-best level.

The over-investment is caused by the Nash bargaining and is different from a classic freerider problem. If the contract were fully cooperative, the possibility of verifying R&D investment, and thus writing a full contract between firms and governments, would solve the over-investment. In the Nash bargaining, the outcome is better than non cooperative solution, however the unverifiability creates the over-investment.

The result presented above is obtained by isolating the firms' efforts in reducing GHG emissions. Not taking into account their main activity abstracts from other determinants of firms' investment in R&D, such as profitability and competitiveness issues. Also, it concentrates only on the effect of the anticipation of future agreements, while it is certain that past agreements will also be affecting investment choices. The result obtained in this partial equilibrium could therefore be weighted in future research against other effects present in a general equilibrium. However, the model does shed light on a particular mechanism and yields the over-investment result, something that has not been pointed up in the literature so far.

1.4 Conclusion

In the ongoing debate on climate change and how best to deal with it, the importance of R&D into new technologies has often been stressed. Given the global character of the problem, it is bound to be dealt with in international negotiations. How R&D investment affects these negotiations, and how the anticipation of such agreements affects firms' behaviour *ex ante* is therefore a very relevant question.

This chapter has developed a model where international agreements on GHG emissions reductions are viewed as Nash bargained outcomes. It seeks to understand the effect of R&D investment by firms in a given country on the bargaining position of that country at the international level. By considering the case of a global public good, it mainly contributes to the literature that regards international agreements as incomplete contracts. It shows that the end result of under-investment in the case of international negotiations depends on the nature of the problem being negotiated and thus differs from previous results in the literature. The novel finding is that, in the case of global public goods, there will be no hold-up, but rather over-investment by firms that anticipate a Nash bargaining procedure. As their investment reduces the surplus of the agreement by affecting social welfare to a lesser extent under cooperation than under non-cooperation, it improves the bargaining position of their country. The return on their sunk investment is higher and they invest

more. Also, regulation is ruled out in the chapter in order to avoid another type of hold-up problem previously identified in the literature when there are no permits markets. By avoiding this hold-up, the model concentrates on the effect of investment on international bargaining and isolates the novel over-investment result.

1.A National vs. International emissions permits markets

This appendix confirms that in the setting of this chapter, national and international emissions permits markets are equivalent. Considering the case where countries would have agreed at time 1 to allow for cross border permits trading, the maximisation problem for firm i at Home is identical and leads to the same first order condition as in equations (1.5) and (1.6).

The international nature of the emission permits market implies that firms can now trade across borders. The market clearing condition equates total world emission reductions and total world targets by governments as denoted in equation (1.32) where FBI stands for "First-best - International permits market".

$$\sum_{i=1}^n v_i + \sum_{i=1}^n v_i^* = M^{FBI} + M^{FBI*} \quad (1.32)$$

The international price for permits will thus be:

$$p^{FBI} = \frac{(M^{FBI} + M^{FBI*})}{(\sum_{i=1}^n k_i + \sum_{i=1}^n k_i^*)} \quad (1.33)$$

The international price is consequently a function of world total reduction targets and world aggregate investment. In parallel with equation (1.9), the total revenue for firm i at Home at time 2 when there is international permits trading, not accounting for investment at time 1 which is sunk, is then:

$$\pi_i^I = \frac{(M^{FBI} + M^{FBI*})^2 k_i}{2 (\sum_{i=1}^n k_i + \sum_{i=1}^n k_i^*)^2} - \frac{(M^{FBI} + M^{FBI*})^2 m}{n (\sum_{i=1}^n k_i + \sum_{i=1}^n k_i^*)} \quad (1.34)$$

The share of aggregate reductions that is committed to by the Home government is denoted m . It affects firm level profits negatively. The effect of investment k_i on profits at time 2 is

positive, as the cost of investment is sunk and it reduces the cost of meeting the target, both through a lower price of permits and a smaller cost of abatement. The effect of aggregate reductions $(M^{FBI} + M^{FBI*})$ on profits will be determined by relative investment by domestic and foreign firms and the share of abatement m . Contrarily to the national permits case, the revenue of permits sales and costs of permits purchase will not necessarily cancel out, such that the total cost for all n firms in Home to meet the government's target M^{FBI} when there are international permits is:

$$\sum_{i=1}^n C(v_i, k_i) = \frac{(M^{FBI} + M^{FBI*})^2 m}{(\sum_{i=1}^n k_i + \sum_{i=1}^n k_i^*)} - \frac{(M^{FBI} + M^{FBI*})^2 \sum_{i=1}^n k_i}{2 (\sum_{i=1}^n k_i + \sum_{i=1}^n k_i^*)^2} \quad (1.35)$$

The cost is increasing in the share of aggregate reductions agreed to by Home, as this will shift an extra burden to firms in the country. In most cases, aggregate national cost will be increasing in the aggregate international target, unless again m is small and Home firms have invested more than Foreign. This expression is identical to equation (1.10) if the countries are symmetric and $M^{FBI} = M^{FBI*}$.

A similar equation holds in Foreign, such that the total cost for Foreign and Home firms is:

$$\sum_{i=1}^n C(v_i, k_i) + \sum_{i=1}^n C(v_i^*, k_i^*) = \frac{(M^{FBI} + M^{FBI*})^2}{2 (\sum_{i=1}^n k_i + \sum_{i=1}^n k_i^*)} \quad (1.36)$$

which is increasing in the aggregate target fixed and decreasing in aggregate cost. Anticipating this cost function and selecting an international permits market structure, governments will maximize joint social welfare when choosing the first best targets at time 1:

$$Max_{M^{FBI}, M^{FBI*}} (a + a^*) (M^{FBI} + M^{FBI*}) - \frac{(M^{FBI} + M^{FBI*})^2}{2 (\sum_{i=1}^n k_i + \sum_{i=1}^n k_i^*)} \quad (1.37)$$

The first order condition of this maximisation problem is expressed in equation (1.38).

$$(M^{FBI} + M^{FBI*}) = (a + a^*) \left(\sum_{i=1}^n k_i + \sum_{i=1}^n k_i^* \right) \quad (1.38)$$

This equation does not pin down a particular value for each target, but rather an optimal total value of targets. This is due to the presence of international permits implying that

the first best allocation of costs will occur naturally through the market and that only the aggregate level of reductions affects welfare. As governments already internalise the inter-country externality in their decisions on the national permits scenario, there is no additional welfare gain to an international trade in permits. The total emission reductions target needed to reach first best can be allocated to each country indifferently, given that permits will ensure that this target is achieved at least cost by equating marginal costs across countries. The effect on social welfare however is affected by m , the share of total abatement allocated to Home. The allocation of particular targets to each country is assumed to be the result of a bargaining process between the two governments: although the total reductions are chosen optimally, the burden of the cost does vary with this allocation. The solution is thus indeterminate. For simplicity, I assume the outcome of these negotiations will be such that social welfare levels are identical to the case where permits cannot be traded across borders, as given in equations (1.14) and (1.15). This will ensure participation in the agreement:

$$V^{FBI} = V^{FN} \text{ and } V^{FBI*} = V^{FN*} \quad (1.39)$$

Given this assumption, the targets fixed in the international permits market case will be equal to the national case:

$$M^{FBI} = M^{FN} = m \times (a + a^*) \left(\sum_{i=1}^n k_i + \sum_{i=1}^n k_i^* \right) = (a + a^*) \left(\sum_{i=1}^n k_i \right) \quad (1.40)$$

$$\text{or, } m = \frac{(\sum_{i=1}^n k_i)}{(\sum_{i=1}^n k_i + \sum_{i=1}^n k_i^*)}$$

The investment behaviour of firms at time 1 will not vary between the national and the international permits cases, as the Home target, cost functions (equations (1.10) and (1.35)) and revenue function (equations (1.9) and (1.34)) they anticipate for time 2 are identical. With the simplifying assumption on the determination of m , equation (1.41) therefore holds.

$$k_i^{SB} = k_i^{SBI} \text{ and } k_i^{SB*} = k_i^{SBI*} \quad (1.41)$$

These investment levels of firms constitute my benchmark of the second-best, whether with national or international permits markets.

The international emissions permits market gives a more realistic outcome to the case of Nash bargaining, as it will allow for another form of transfer between countries. Rather than assuming a pure monetary transfer it could be envisaged as a different allocation of targets M^{NBI} and M^{NBI*} (NB for Nash Bargaining - International permits market), in which the total reduction of emissions remains at its first best level.

$$M^{NBI} + M^{NBI*} = M^{FBI} + M^{FBI*} = (a + a^*) \left(\sum_{i=1}^n k_i + \sum_{i=1}^n k_i^* \right) \quad (1.42)$$

If the transfer was positive, it corresponds to Home having a higher allocated target M^{NBI} and Foreign a lower target M^{NBI*} and Home firms having to buy permits from Foreign firms. The assumption that welfare levels under national and international permits would not differ, as summarised in equation (1.39), carries over to the Nash bargained agreement. The social welfare levels with international permits must then correspond to equations (1.28) and (1.29) defining the Nash bargaining and national markets outcome. The only difference should be that instead of reaching it through a transfer, a different allocation of the total reductions, m^{NB} will be agreed to.

$$V^{NBI} = a(M^{NBI} + M^{NBI*}) - \frac{(M^{NBI} + M^{NBI*}) m^{NBI}}{\left(\sum_{i=1}^n k_i + \sum_{i=1}^n k_i^* \right)} + \frac{(M^{NBI} + M^{NBI*})^2 \sum_{i=1}^n k_i}{2 \left(\sum_{i=1}^n k_i + \sum_{i=1}^n k_i^* \right)^2} = V^{NB} \quad (1.43)$$

The same applies in Foreign with $V^{NBI*} = V^{NB*}$. As a result, the agreed target for each country can be defined and related to the transfer.

$$\begin{aligned} M^{NBI} &= M^{FI} + \frac{t}{(a + a^*)} \\ &= \left[\frac{4a^2 + 2aa^* + a^{*2}}{4(a + a^*)} \right] \sum_{i=1}^n k_i + \frac{3a^2}{4(a + a^*)} \sum_{i=1}^n k_i^* \end{aligned} \quad (1.44)$$

$$\begin{aligned}
M^{NBI*} &= M^{FI*} - \frac{t}{(a + a^*)} \\
&= \left[\frac{4a^{*2} + 2aa^* + a^2}{4(a + a^*)} \right] \sum_{i=1}^n k_i^* + \frac{3a^{*2}}{4(a + a^*)} \sum_{i=1}^n k_i
\end{aligned} \tag{1.45}$$

The aggregate target corresponds to the first best level ($M^{FI} + M^{FI*}$), and therefore to the Nash bargained case with national permits. However, individual targets differ as they replace the monetary transfer. As in the national markets case, if transfers are zero, the only difference between the first best with permits and the Nash bargained agreement, is in the anticipation that firms make on the effect of their investment on the outcome of negotiations. In the international permits market case, they would receive emission quotas of $\frac{M^{NBI}}{n}$, but no transfer to contribute to . This corresponds to a profit at time 2 of π_i^{NBI} . The profit maximisation problem at time 0 will hence be :

$$Max_{k_i} \pi_i^{NBI} - k_i^2 \tag{1.46}$$

in which π_i^{NBI} , the anticipated revenue at time 2 will incorporate the agreed target M^{NBI} . At time 0, firm i will hence choose an investment level of k_i^{NBI} (Home) or k_i^{NBI*} (Foreign):

$$k_i^{NBI} = \frac{(n-2)(a+a^*)^2}{4n} + \frac{3a^{*2}}{8n} \tag{1.47}$$

$$k_i^{NBI*} = \frac{(n-2)(a+a^*)^2}{4n} + \frac{3a^2}{8n} \tag{1.48}$$

These are similar to the investment levels chosen under a national permits market, k^{NB} and k^{NB*} , given that governments will be shifting the cost of the agreement and of reductions to firms, be it through the transfer or the emissions targets. By comparison with the second-best cooperative outcome with international permits, it follow that:

$$k_i^{NBI} > k_i^{SBI} \text{ and } k_i^{NBI*} > k_i^{SBI*} \tag{1.49}$$

Proposition 1.2 therefore carries over to the case with international permits The intuition behind this surprising result is similar to that of the national permits case. When choosing their investment level, firms equate the marginal cost of investment at time 0 with the

expected marginal benefit of investment on the return or profit at time 2. In the international permits market case, this return is a function of aggregate investment levels, aggregate reductions agreed and the share of reductions negotiated by Home, such that the marginal benefit of investment depends on several elements, as presented in equation 1.50.

$$\frac{d\pi_i^{NBI}}{dk_i} = \frac{\partial\pi_i^{NBI}}{\partial k_i} + \frac{\partial\pi_i^{NBI}}{\partial(M^{NBI} + M^{NBI*})} \frac{\partial(M^{NBI} + M^{NBI*})}{\partial k_i} + \frac{\partial\pi_i^{NBI}}{\partial m^{NBI}} \frac{\partial m^{NBI}}{\partial k_i} \quad (1.50)$$

Comparing to the second-best marginal benefit with international permits, the first two terms of this expression will be identical, given that the aggregate reductions are equal in both cases. The last term comprises two parts. The effect of the share of aggregate reductions for Home on firms' return at time two is equal in both cases too, $\frac{\partial\pi_i^{NBI}}{\partial m^{NBI}} = \frac{\partial\pi_i^{FI}}{\partial m^{FI}} < 0$. It is negative, as a higher share of abatement for the country means more of the cost being borne by firms. The second part, $\frac{\partial m^{NBI}}{\partial k_i}$, is where the over-investment result comes from, as it is the only element that differs between the full cooperative and Nash bargaining cases. In the case of a Nash bargained agreement, firms anticipate their investment will reduce the surplus for Home government of cooperation over non-cooperation, thus improving its bargaining position and decreasing m^{NBI} . This is an effect of investment which does not occur in the full cooperation case, such that $\frac{\partial m^{NBI}}{\partial k_i} < \frac{\partial m^{FI}}{\partial k_i}$. As a consequence, given the negative effect of m^{NBI} on time 2 profits, the return to investment will be higher in the bargained outcome, and hence investment will be greater.

Intuitively, as in the national permits case, the government's bargaining position is improved when firms have invested more in R&D. For example, if it does not care much about climate change, but enters a Nash bargained agreement, its firms investment will reduce the cost of world aggregate reductions. The country will be compensated for its investment and the benefit it brings to the other country, by being allocated a lower share of the total abatement.

1.B Ruling out regulation

In this appendix, the outcome of firms anticipating regulation by government is compared to the national or international permits equilibrium. This justifies why I did not consider the alternative of regulation in this chapter. It replicates in a different set-up the result of Gersbach and Glazer (1999).

If governments do not allow for trading, the problem of the firm at time 2 is different to what has been set out so far. Each firm must abate by the amount it is assigned to by regulation. In this case, the behaviour of firms at time 2 is determined by the target imposed by government at time 1, M^R . It is assumed that as firms are symmetric, the government will assign equal amounts to each firm. Given the specified cost function, the cost for Home firm i to meet the target will be:

$$C(v_i, k_i) = \frac{M^{R2}}{2n^2 k_i} \quad (1.51)$$

The aggregate cost for each country to meet the target it has chosen will thus be increasing in the chosen target and decreasing in the number of firms and the aggregate investment.

$$\sum_{i=1}^n C(v_i, k_i) = \frac{M^{R2}}{2n^2} \sum_{i=1}^n \frac{1}{k_i} \quad (1.52)$$

A similar cost function can be derived for Foreign. If all firms are symmetric and invest the same amount, this is equal to the total cost of reducing emissions as in the national permits case, given in equation (1.10). Given the anticipation of costs in equation (1.52), the government maximises social welfare, considering the cost of investment by firms at time 0 as sunk:

$$Max_M a(M + M^*) - \frac{M^2}{2n^2} \sum_{i=1}^n \frac{1}{k_i} \quad (1.53)$$

The resultant first-order conditions and the choice of target in the event of no cooperation and regulation (NCR) will lead to the following targets for each country:

$$M^{NCR} = an^2 \sum_{i=1}^n k_i \text{ and } M^{NCR*} = a^* n^2 \sum_{i=1}^n k_i^* \quad (1.54)$$

The targets are increasing in domestic aggregate investment and in the preference parameter for emissions reductions. In the case of cooperation between countries in fixing their target, the maximisation problem of governments is:

$$\begin{aligned} &Max_{M^{FR}, M^{FR*}} (a + a^*)(M^{FR} + M^{FR*}) \\ &\quad - \frac{M^{FR^2}}{2n^2} \sum_{i=1}^n \frac{1}{k_i} - \frac{M^{FR*^2}}{2n^2} \sum_{i=1}^n \frac{1}{k_i^*} \end{aligned} \quad (1.55)$$

The resultant targets are increasing in the preference parameters of both countries:

$$M^{FR} = (a + a^*)n^2 \sum_{i=1}^n k_i \text{ and } M^{FR*} = (a + a^*)n^2 \sum_{i=1}^n k_i^* \quad (1.56)$$

As can be seen in equations (1.54) and (1.56), both in the non-cooperative and cooperative case, targets will be a function of the aggregate investment by firms. Hence, when firms invest at time 0, they will anticipate that to minimize their future costs they should invest nothing at all. This is the hold-up problem identified by Gersbach and Glazer (1999) in a single-country setting. In that case, it would be extremely costly for the government to remain committed to its regulation. The only way to induce firms to invest would be to commit to a strong penalty for not meeting the regulation. However, these authors consider that the government is unable to commit itself to the stringency of the regulation. By making the same assumption, I here replicate their result.

As in their setting, the hold-up problem they have identified can be solved by assuming that the government makes a commitment to issue marketable permits rather than opting for regulation. If firms acted cooperatively, they could collude, invest nothing and make sure that the government issues no permits, as shown in equations (1.13), (1.19) and (1.40), in which the chosen target is always positively related to aggregate investment. Yet, there will be an incentive for firms to deviate from such a collusion, by deciding to invest. If one firm decides to invest, it will induce the government at time 1 to issue permits. In the case of national permits, as can be seen from equation (1.8), if only firm j had invested, $p^{FN} = \frac{M^{FN}}{k_j}$ such that it will be the only one to make the emission reductions and will sell the other firms permits as $v_j = M^{FN}$. Given the revenue of equation (1.5), it would make

a positive profit on the emissions market as long as there are at least two firms and that the other has not invested and will therefore not abate:

$$\pi_j^{FN} = \frac{(2n - 3)M^{FN2}}{2k_j} \quad (1.57)$$

Profits will attract other firms into investing, so that they, too, become permit sellers, and in equilibrium, all firms will invest.

The same logic holds when considering international permits. Given the international price of equation (1.33), if one firm in one of the two countries deviates and invests, $p^{FI} = \frac{(M^{FI} + M^{FI*})}{k_j}$. With the original definition of revenue in equation (1.34), firm j 's return at time 2 is then given by equation (1.58).

$$\pi_j = \frac{(n - 2)(a + a^*)^2 k_j}{2n} \quad (1.58)$$

As long as there is a total of at least three firms in both countries, this anticipated revenue will be positive and induce other firms to invest, too. In equilibrium, when firms anticipate that governments will introduce an international permits market, all firms will invest. The result differs slightly to that of Gersbach and Glazer (1999) given that the investment decision is continuous and not binary, such that investment will be increasing in the number of firms in the country. However the main mechanism at play remains equivalent to that in their paper.

Chapter 2

A Swing-State Theory of Trade Protection in the Electoral College

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Introduction

In this chapter we develop a multi-jurisdictional, infinite horizon, elections model characterised by asymmetric information between politicians and voters and an absence of policy commitment with regards to trade policy. The political districts of the model, or states, form an electoral college that elects the president from two candidates from rival parties. The model is used to investigate how the distribution of voters with heterogeneous preferences across swing states gives rise to incentives for strategic trade protection by incumbent politicians who wish to maximise their chances of re-election.

The chapter contributes to the literature in three ways. First, the model presented extends the trade policy literature by using a political agency methodology that has never been used to address trade policy issues. The approach examines the electoral incentives for the strategic choice of secondary policy issues in a framework characterised by asymmetric information between politicians and voters regarding politicians' preferences over trade policy and lack of pre-commitment to a particular trade policy prior to election. Electoral incentives can cause political incumbents to alter their policy choice in early years in power in order to influence voter beliefs about the nature of future trade policy. By building a reputation as a protectionist or free-trader, the incumbent attracts swing voters to his platform.

The type of policy modelled in this type of framework is characterised by the inability to tailor it to satisfy the preference of voters at the state level, making it a national policy. Trade policy is thus an excellent candidate for a policy with this feature. Hence, it is

the ability to garner electoral college votes nationally that drives results, rather than ‘pork-barrel’ type state level politics. Moreover, it is assumed that the political incumbent has discretion over the selection of trade policy. While this is a reduced form of a more general notion of a cohesive government whose policy decisions are influenced by the desire to retain control of power, it is also the case that over the past few decades there have been periods where the US President was granted trade promotion authority (formerly fast-track authority) to determine trade policy. When granted such authority, the President is able to negotiate trade agreements faster, and while Congress retains power to reject proposed legislation, it has no power of amendment and room for limited debate. While discretion of certain policy instruments is constrained by multilateral agreements, there is still considerable scope for erecting Non-Tariff Barriers, or implementing safeguards, granting relevance to the assumptions of our framework.

Second, we contribute to the political agency literature by developing a tractable multi-jurisdictional framework that extends the single-district political agency framework of recent contributions to the literature by List and Sturm (2006) and Besley and Burgess (2002). We model the electoral system as an electoral college, where electoral votes are attached to political states. This innovation adds a spatial dimension that delivers additional results on how the distribution of single-issue voters across swing states can influence trade policy decisions. The framework delivers three new propositions that relate the location of swing voters across swing states to the likelihood that incumbents engage in strategic trade protection.

The third contribution of the chapter is that we provide empirical evidence using data for the United States that lends support for the type of mechanisms present in the theoretical model. By augmenting the benchmark empirical specification used by Gawande and Bandyopadhyay (2000) we find evidence in the data to support the theoretical hypothesis that the concentration of a sector across states that are both swing and decisive for election outcomes is a significant determinant of the level of trade protection of that sector. This provides formal support for the claims made in the popular press about the politics behind the recent United States - European Union steel tariffs dispute, “that steel tariffs were in-

troduced for short-term political advantage ... in order to gain votes in key states like West Virginia, Ohio, Pennsylvania and Michigan where the steel industry is a major employer” (The Guardian, November 17th, 2003).

The literature with regards to the role of concentration on endogenous protection is, in general, very different to the framework employed in this chapter. The first strand of the literature is the long-standing tradition that addresses the role of concentration for collective action. The effect of geographical concentration on facilitating lobby formation and therefore positively affecting trade policy, was first put forward in Olson (1971). The relationship between the location of industry and import barriers has been debated at length in this literature. The "close group" hypothesis that the concentration of firms allows them to overcome free-rider problems and organise lobbying efficiently is widely accepted and Hansen (1990), among others, provides supporting empirical evidence. This contrasts with the "dispersed group" argument which posits that geographically dispersed industries enjoy broader political representation (depending on the electoral rules) as empirically supported by Pincus's (1975) findings, for instance. Busch and Reinhart (1999) explicitly distinguishing between geographical concentration, and 'political concentration', defined as the spread of industry across political districts, in order to reconcile the two hypotheses. Their finding that geographically concentrated, but politically dispersed industries in the US are more likely to be protected, suggests that the mechanisms linking location, concentration and protection are more complex than simply those that can be captured through standard measures of concentration. This chapter is not related to the collective action literature on concentration, focusing instead on the effects of concentration for electoral outcomes and thus electoral incentives to protect. Our framework suggests concentration might not always matter as such, but rather it is the presence of industrial concentrations in pivotal locations that has an impact on trade protection.

The second strand of the literature stems from the seminal contribution of Grossman and Helpman (1994,1996) on "Protection for Sale" that analyses the effects of campaign contributions for policy decision-making. Mitra (1999) considers endogenous lobby formation in a theoretical extension of the Grossman and Helpman framework. A multitude of pa-

pers have followed in this strand to explain the determinants of trade policy and are surveyed in Helpman (1997) and Grossman and Helpman (2002). Recent contributions to the lobbying literature for trade include Bombardini (2005) who introduces the decisions of individual firms and hence the role of size distributions within industries in determining protection. The relevance of lobbies has been widely tested, for example by Goldberg and Maggi (1997), Gawande and Bandyopadhyay (2000), Eicher and Osang (2002). While geographical concentration measures have also been included in empirical tests of the lobby model, such as Gawande and Bandyopadhyay (2000), they have not been linked to location in swing states. We augment their specification in the empirical section of this chapter to show that political decisions also react to electoral incentives.

The most common electoral approach to the political economy of trade and secondary policy issues is that of median voter models, such as Mayer (1984) and probabilistic voting frameworks such as Yang (1995). These have been used, for example, to explain differences in protectionism based on countries' constitutional set-up (Roelfsema, 2004) or to consider how trade retaliation and liberalisation is affected by the ideological distribution of voters in trading partners (Wiberg, 2005). Our framework is distinct from these approaches since we examine the effects of swing voters in a model of the electoral college without policy commitment. We show that a redistribution of voters between states in the electoral college, holding the population of each voter type constant, can make trade protection more or less likely. Such redistributions have no impact in frameworks in the spirit of Mayer (1984).

Strömberg (2007) builds a probabilistic-voting model of the Electoral College system with political competition. The model is applied to presidential elections in which the probability of winning each state depends on the distribution of state visits during the election campaign. However, this setting cannot be transposed directly to trade protection, since as noted above, such policy cannot be differentially applied in the various states, as can the number of campaign visits of Strömberg's model.

Willmann (2005) employs a median voter model to offer an explanation for the empirical relationship between geographical concentration and protection by introducing regional voters who anticipate that their representatives will internalise the costs of protection, once

at the national level. The model cannot offer an explanation, however, as to why industries with the same degree of geographical concentration, that are located in different political states, may be systematically awarded different levels of protection.

Finally, a growing political agency literature has more recently addressed the issue of electoral incentives for policy choices in secondary policy issues, such as trade policy or environmental policy, about which smaller groups of voters have very strong views. Recent contributions to this literature include Coate and Morris (1998), Besley and Case (1995), Besley and Burgess (2002) and List and Sturm (2006). Our basic modelling approach is closest to Besley and Burgess (2002) and List and Sturm (2006), while extending to a multi-jurisdictional framework.

The remainder of the chapter proceeds as follows. Section 2.1 develops the theoretical model of the electoral college and discuss the testable empirical implications of the model. The theoretical predictions of the model are tested empirically with US data in section 2.2. Section 2.3 concludes.

2.1 The Model

In this section we develop a multi-jurisdictional, infinite horizon, elections model characterised by asymmetric information between politicians and voters and an absence of policy commitment with regards to trade policy. Political incumbents with private preferences over trade policy may have an incentive to build a reputation through the strategic selection of trade policy, in order to swing single-issue voters to their platform in forthcoming elections.

The model contributes to the political agency literature by extending the single-district political agency framework of List and Sturm (2006) and Besley and Burgess (2002) to include a continuum of political districts that form an electoral college. This innovation adds a spatial dimension to the political agency framework that delivers results on how the distribution of single-issue voters across swing states can influence trade policy decisions. Moreover, the model extends the trade policy literature by using a methodology from the

political agency literature that has not been used before to examine the strategic incentives for trade policy choice. The empirical implications that arise from the theoretical framework are then tested in section 2.2.

2.1.1 Economic Environment

Consider a country with a continuum of political districts², or states, s , over the interval $[0, 1]$, each with a unit mass of voters. These states form an electoral college, through which electoral outcomes are determined. In particular, let each state contribute to the electoral outcome through a single electoral college vote, so the aggregate measure of electoral college votes over the continuum of unit interval is also 1.

Further suppose that in any presidential election in the infinite-horizon game there are two candidates from rival parties, Democrat (D) and Republican (R), competing for votes. An election may be between two newcomers, or alternatively, between an incumbent politician and a challenger. If a candidate wins a majority of votes in a state, then the electoral college vote of that state is won by that candidate. The election is won by the candidate with the majority of electoral college votes, which corresponds to gaining a majority in a measure of states greater than $\frac{1}{2}$.

Politicians are assumed to face a binding term limit of two periods. After two terms of holding office an incumbent leaves the political arena and a new candidate from within the party competes with the rival candidate in the presidential elections.

A. Incumbents Policy Preferences

During each term of office the incumbent politician must choose the level of public spending, or ‘ideology’, denoted by g , and a secondary policy, such as trade policy for a particular sector, denoted by r . Politicians of either party whose personal views are in favour of free trade are referred to as ‘free-traders’ (F), while those in favour of trade protection are referred to as ‘protectionists’ (P). Suppose that a randomly selected candidate,

² The assumption of a continuum of political districts allows us to appeal to the law of large number in the calculation of electoral college votes won by each candidate. This facilitates the analysis greatly by making the framework tractable. The role of this assumption is discussed in more detail in section 1.4.

of either party, is a protectionist with probability π . While politicians' preferences over public spending are assumed to be public knowledge, their preferences over r are private. Moreover, electoral candidates are unable to commit to a particular trade policy prior to election.

The level of public spending is assumed to be continuous, or, equivalently, ideology is selected from a continuous spectrum. In contrast, trade policy takes the form of a binary choice, to be made by the incumbent politician, between trade protection ($r = 1$) and free trade ($r = 0$). The trade policy is assumed to have negligible financial impact on government revenue, and so the model abstracts from any possible revenue-raising incentives for trade protection.

Suppose politicians earn an 'ego-rent', ζ , from holding a term in office and receive zero payoff when out of office. In addition, a politician faces a utility cost $c = \{c_L, c_H\}$ from deviating from his own preferred trade policy, where $c_H > c_L$. Let the probability of any politician having a low utility cost be $\Pr(c = c_L) = p$. Cost c can be interpreted as a psychological cost of setting a policy in conflict with personal views. Moreover, let β denote the common discount factor, where β is assumed to satisfy the following restriction:

$$c_H > \beta\zeta > c_L > 0 \quad (2.1)$$

Inequality (2.1) states that the ego-rent from holding one more term in office lies between the high and low utility costs.

B. Voter Preferences

Voters are assumed to have heterogeneous preferences over the two policy issues. Suppose four types of voters comprise the measure of voters in each state. A voter of type k in state s , can be either a Democrat (D), a Republican (R), a free-trader (F), or a protectionist (P). Let γ_k^s denote the proportion of voter type k in the unit measure of voters in state s , such that:

$$\sum_k \gamma_k^s = 1, \text{ where } k \in \{D, R, F, P\} \text{ and } \gamma_k^s \in [0, 1] \quad (2.2)$$

The D and R voters are indifferent about the trade policy issue and vote purely on the basis of their preferences over public policy. Politicians' choice of g may also be interpreted as reflecting their ideological position, so D and R voters cast their vote according to their ideological preferences. Even though trade protection, e.g. a tariff, raises the relative domestic price of the protected good, we assume this negative effect is negligible compared to the intensity of their ideological preferences. That is, although a price increase in one good in the consumption basket lowers consumer surplus, it is not a sufficient cost to cause voters to shift their support to another platform. Hence, measure γ_D^s of voters always vote Democrat, while γ_R^s always vote Republican, in any presidential election.

P and F voters are 'single-issue voters' or 'swing voters' with strong preferences over the secondary policy issue, trade policy. Protectionists may be voters employed in import-competing sectors, whose jobs may be at risk from foreign competition under free trade e.g. Steel industry workers whose employment may be secured through a steel tariff. In contrast, free-traders reflect any voters with strong preferences against trade protection, such as, perhaps, students of economics.

The intensity of swing voters' preferences is assumed to be such that the payoff received from the implementation of their preferred trade policy dominates any ideological considerations. Suppose protectionists receive a payoff of $x > 0$ if $r = 1$ and 0 otherwise, while supporters of free trade receive x if $r = 0$ and 0 otherwise. Swing voters thus vote for the candidate they believe has the highest probability of implementing their preferred policy. Where candidates are perceived to be identical in this respect, swing voters are assumed to cast their vote by flipping a coin.

Note that r , referred to as trade policy in this chapter, can be interpreted as any secondary policy about which a subset of voters have strong views and which has two key characteristics. The first is that r represents a national policy decision that cannot be tailored to satisfy the preferences of voters at the state level. While some voters may have strong preferences regarding, say, the introduction or abolition of the death penalty, it is possible for a policy decision to be made at the state-level, as is observed in the US. In contrast, a tariff on steel imports, or any other trade policy, can only apply at the national level. Other national poli-

cies include immigration policy, foreign policy, participation in a regional trade agreement (e.g. European Union membership), membership in international organisation (e.g. WTO), to mention a few.

The second key characteristic of policy r is that the political incumbent is assumed to have discretion over its selection. Whilst we model the decision-maker as an incumbent politician, the model is consistent with a broader interpretation, where decisions are made by a group of government agents operating as a cohesive entity, whose decisions may be influenced by their desire to perpetuate their control of power.

C. Electoral Uncertainty

Uncertainty in the outcome of the election stems from uncertainty at both the state level and the national level. Each state is assumed to be subject to an idiosyncratic pro- D shock, ν^s , that can be interpreted as a shock to voter turnout. Since a vote gained by the D candidate, is also a vote lost by the R candidate, a positive (or negative) ν^s gives the D candidate an advantage (or disadvantage) of $2\nu^s$. For convenience, we redefine $2\nu^s$ as ε^s . Assume ε^s is distributed identically and independently according to a symmetric, single-peaked probability density function $h(\varepsilon^s)$, with support $[-\psi, \psi]$, and a continuous cumulative distribution function $H(\varepsilon^s)$. The value of ψ is important to the extent that it affects the degree of uncertainty over the outcome of elections in each state. We assume a sufficiently wide support so that all states are ‘swing states’. That is, no candidate can be certain of winning a majority in any state, but the probability of each candidate winning a majority can be computed for any state with a distribution of voter types, γ_k^s , where $k \in \{D, R, F, P\}$, given the incumbent’s policy choice r and the cumulative distribution function $H(\varepsilon^s)$.

In addition to uncertainty at the state level, we introduce aggregate uncertainty³ in the form of a ‘pro-incumbent shock’, u , in electoral college votes. In an election between two untested politicians, the shock can be in favour of either. Shock u widens (or narrows) the difference in electoral college votes between candidates by $2u$. For convenience, we

³ The uncertainty reflected in the state-specific shocks is insufficient to give rise to aggregate uncertainty, as a result of the infinite nature of states along the continuum. We thus introduce aggregate uncertainty in the form of a shock to electoral college votes at the national level. The importance of this assumption is made clear in section 1.4.

redefine $2u$ as η , where η is distributed according to a symmetric, single-peaked probability density function, $f(\eta)$ and a continuous cumulative distribution function $F(\eta)$. Again, we assume a sufficiently wide support so that no candidate can secure a majority of electoral college votes. In combination, the state-level and national shocks ensure that no candidate can guarantee to win any state s , or the electoral college overall.

In the US, the president is elected indirectly through the Electoral College. Voters vote for state electors who pledge to vote for a particular candidate. These electors cast their electoral vote and the candidate with a majority of electoral votes wins the presidency. In our model, voters are assumed to vote for the candidates directly, while the electoral college system is embodied by the fact that candidates need to win a majority in a majority of states to win the election, rather than a direct majority. The assumptions we make are equivalent to assuming that state-level elections are between two honest electors that have pledged to vote for the D or R candidate, respectively, if elected. A state-level majority won by a D elector corresponds to an electoral college vote won by the D presidential candidate, and similarly for states where the R elector wins a majority. Interpreting our model in this way allows shock η to be interpreted as mistakes made by electors when voting, or the presence of a random measure of ‘faithless electors’ who vote for a candidate other than the candidate pledged. Assuming $f(\eta)$ is symmetric around 0 and single-peaked implies that large measures of mistakes in electoral votes cast or large measures of faithless electors are increasingly unlikely.

D. Timing of the Elections Game

Events in the infinitely repeated elections model with infinitely-lived voters occur in the following order.

1. The incumbent politician draws a period one utility cost $c = \{c_L, c_H\}$, observed only by the incumbent.
2. The incumbent makes policy decisions g and r .

3. Policy choices are observed by voters and the election for the presidency in period two takes place.
 - (a) If the term limit is non-binding, then the election is between the incumbent and a randomly selected rival from the other party.
 - (b) If the term limit is binding, the election is between two randomly selected candidates from either party.
4. The winner of the presidential election is in office in the next period.

The game is then repeated infinitely through stages (1) to (4). In the next few sections we solve the game by backwards induction and characterise the unique equilibrium strategies of voters and politicians, for a given distribution of voters. The strategic incentives for trade policy choice are examined and the role that the distribution of swing voters plays in shaping these incentives is analysed.

2.1.2 Political Equilibrium

The Markov Perfect equilibria of the game between politicians and voters can be characterised by restricting attention to strategies that depend only on payoff-relevant past events, rather than the entire history of the game. Markov strategies for the incumbent politician, C_{ij} , where $i \in \{D, R\}$ and $j \in \{F, P\}$ and for type k^s voters, where $k^s \in \{D, R, F, P\}$, can be said to form an equilibrium if they maximise the value functions of voters and the incumbent politician, given the strategies of the other players.

For the incumbent politician choosing trade policy, the payoff-relevant history of the game is fully described by (a) his utility cost draw, and (b) the number of terms he has already spent in office. Hence, we define a strategy for an incumbent politician as a rule that describes the probability with which he implements trade protection as a function of para-

meters describing the distribution of voters⁴ across the electoral college, his realised utility cost c and whether he is in his first or second term of office.

For type k^s voters, the payoff-relevant history of the game is, where applicable, the first term trade policy decision of an incumbent who is up for reelection against a randomly selected challenger. In elections between two new candidates, there is no payoff-relevant history on which voters can condition their behaviour. For voter types $k^s = \{D, R\}$ a strategy is a rule that specifies the probability with which they vote for the Democrat or Republican candidate. For voter types $k^s = \{P, F\}$, a strategy is a re-election rule that specifies the probability with which they vote for the incumbent in elections between an incumbent and a challenger, where this probability depends on the updated beliefs regarding the incumbent's private preferences regarding r , conditional on the incumbent's trade policy decision in his first term of office.

Let $g^*(D)$ and $g^*(R)$ be the unique preferred levels of public spending for D and R voters, respectively, where $g^*(D) > g^*(R)$. It follows directly that D and R candidates always find it optimal to select public spending accordingly⁵ and measure γ_D^s of voters always vote Democrat, while γ_R^s always vote Republican, in any presidential election.

The game between incumbents and swing voters⁶ has two symmetric reputation-building equilibria, where incumbents choose r strategically in order to swing either P or F voters to their platform. Which of the two applies depends on the distribution of swing voters in the electoral college, as is discussed in more detail in section 2.1.5. If the incumbent stands to gain from choosing free trade relative to trade protection, then a protectionist incumbent may have an incentive to deviate from his preferred policy choice and choose free trade. The focus of our analysis is the converse case where the distribution of swing voters is such that the Free-trader incumbent may find it optimal to build a reputation as a protectionist. Note that the incentives for Republican and Democrat incumbents are symmetric, since the incentives for trade policy choice hinge on the extent to which free-trader incumbents

⁴ These are defined fully in the next sections.

⁵ For simplicity, we abstract from strategic incentives in public spending

⁶ The focus of the chapter is the strategic interaction between incumbents and swing voters. For completeness, a discussion of elections between two untested politicians is included in Appendix C.

of either party can improve their re-election probability through trade protection. Since ideology plays no part in the voting decisions of swing voters, the effects are symmetric for D and R incumbents.

The trade policy game is solved by backward induction, starting from the incentives of any politician facing a binding term limit. For any distribution of ideologists and single-issue voters across the electoral college, an incumbent politician in his second term of office has no incentive to choose a trade policy that conflicts with his personal views, since he can never be re-elected. Hence, incumbents always find it optimal to implement their preferred trade policy in their final term of office.

Over the next sections we derive the conditions under which the following strategies constitute an equilibrium of the trade policy game in incumbents' first term of office: free-trader incumbents deviate from their preferred policy and implement trade protection in the first term of office following a low utility cost draw; protectionist incumbents always implement their preferred policy in the first term of office. Furthermore, protectionist voters vote for the incumbent if trade protection has been implemented in the first term of office, and for the challenger otherwise, while free-trader voters vote for the incumbent if trade protection has not been implemented, and for the challenger otherwise. Moreover, this 'reputation-building' equilibrium is unique for distributions⁷ of swing voters under which incumbents can expect to improve their re-election chances through trade protection.

The strategy of a protectionist incumbent is clearly optimal since by implementing trade protection he improves his reelection probability while simultaneously setting his preferred policy. Moreover, if a free-trader incumbent draws a high utility cost $c = c_H$, then he always follows his preferred policy choice, since $c_H > \beta\zeta$. The benefits in re-election probability can never outweigh the costs of a policy deviation.

In contrast, a draw of c_L may induce a free-trader to set $r = 1$ if protectionism sufficiently increases the proportion of electoral college votes won so as to alter the election outcome.

⁷ Appendix B shows this reputation building equilibrium to be unique for distributions of swing voters where the measure of protectionists versus free-trader voters, and their distribution across the electoral college is such that incumbents stand to gain from implementing trade protection in the first term. A symmetric unique equilibrium exists in the case where incumbents stand to gain through free trade.

Since the incumbent's personal preference over r is hidden from voters, a free trade incumbent in his first term may have an incentive to build a reputation⁸ as a protectionist in order to attract protectionist voters to his platform in the next election. The lack of a credible commitment to a choice of r implies that pre-election promises carry no weight with single-issue voters, who recognise that politicians can deviate *ex post*. The only opportunity for candidates to convey information to voters regarding their preferences over trade policy, is through policy decisions made when in power. Voters can update their beliefs on the basis of the incumbent's historical trade policy decisions and thus condition their vote on the history of the elections game. It is this feature of the political agency model that can give rise to strategic behaviour by political incumbents.

Consider the incentives of swing voters in the election for the period two presidency, given the policy deviation strategy of free-trader incumbents described above. Protectionist and free trade voters maximise their expected payoff by supporting the candidate with the highest probability of implementing $r = 1$ and $r = 0$, respectively, in their second term. Consider a free-trader incumbent who can improve the probability of winning a majority of electoral college votes if protectionists support his platform (and free traders support the challenger). If nature draws c_H , the incumbent sets $r = 0$, thus revealing himself as a free trader and gaining the support of γ_F^s voters in all states over the continuum. Protectionists support the challenger who is a free-trader with probability $1 - \pi$. If c_L is drawn, the D free-trader incumbent strategically sets $r = 1$ to build a reputation as a protectionist.

The observed first-term trade policy choice provides voters with information with which they update their beliefs about the preferences of the incumbent. Let $\tilde{\pi}$ denote the updated

⁸ Besley and Case (1995) as well as List and Sturm (2006) examine how term limits change the incentives of politicians to build a reputation, with significant effects on policy choice. In this chapter, the optimality of a reputation-building strategy depends on both the measure and distribution of P voters relative to F voters across states in the electoral college.

probability, derived from Bayes' rule, where:

$$\begin{aligned}
 \tilde{\pi} &= \Pr(r = 1 \text{ in 2}^{\text{nd}} \text{ term} \mid r = 1 \text{ in 1}^{\text{st}} \text{ term}) \\
 &= \frac{\Pr(r = 1 \text{ in 2}^{\text{nd}} \text{ term}) \Pr(r = 1 \text{ in 1}^{\text{st}} \text{ term} \mid r = 1 \text{ in 2}^{\text{nd}} \text{ term})}{\Pr(r = 1 \text{ in 1}^{\text{st}} \text{ term})} \\
 &= \frac{\pi}{\pi + (1 - \pi)p}
 \end{aligned} \tag{2.3}$$

Since politicians set their preferred trade policy when the term limit is binding, the probability that trade protection is set in the second term is the probability that any randomly selected politician is a protectionist, i.e. π . Moreover, if the incumbent protects in his second term, he is revealed to be a protectionist and thus protects in the first term with probability 1. The probability that the industry in question is protected in the incumbent's first term in office is the composite probability of being a protectionist, π , or being a free trader who had low cost draw, $(1 - \pi)p$.

Swing voters contrast $\tilde{\pi}$, the updated probability of the incumbent being a protectionist, with the probability that a randomly selected challenger sets $r = 1$ in his first term of office. For a sufficiently small value⁹ for p , first term protectionism is a sufficiently strong signal of protectionist preferences, so that:

$$\tilde{\pi} > \pi + (1 - \pi)p \tag{2.4}$$

For the rest of the chapter we assume p is sufficiently small to satisfy condition (2.4) so as to ensure that γ_P^s support the incumbent government if trade protection is implemented in the first term, while γ_F^s voters support the challenger, given politicians' strategies in equilibrium. The optimality of swing voters' re-election strategies is confirmed in Appendix 2.A, where these are shown to maximise voters' value functions, given politicians' strategies.

The next section examines how a deviation from free trade in the first term of office affects the incumbent's probability of winning a majority in any state s , given its characteristics. State level probability changes are translated into electoral college votes that in turn allow

⁹ List and Sturm (2006) identify two conflicting effects. Applied to our trade policy game, these are: first, an incentive effect that follows from the term limit assumption that lowers the probability of $r = 1$ in the second term, since a free-trader will set $r = 0$ with certainty; and second, a selection effect that raises the likelihood of $r = 1$, since re-elected politicians in their second term of office are more likely to be protectionist. The size of p determines which of the two effects dominates.

the change in probability of re-election to be derived. We examine incentives for trade protection and confirm that politicians' and voters' strategies constitute a Markov Perfect equilibrium of the game.

2.1.3 Trade Policy and State-Level Majority

Recall that in each state s , $\sum_k \gamma_k^s = 1$. Let $\omega_p^s = (\gamma_D^s - \gamma_R^s)$ represent the lead of the D candidate in state s , referred to as the 'political lead', and $\omega_t^s = (\gamma_P^s - \gamma_F^s)$ represent the excess of P voters relative to F voters, referred to as the 'trade policy lead'. A state with a larger proportion of Republican voters than Democrat voters has a negative political lead, while a state with a larger proportion of free trade supporters relative to protectionists has a negative trade policy lead.

Let $\rho_{r=0}^s$ denote the probability that the incumbent wins a majority in state s given free trade in the first term, and $\rho_{r=1}^s$ if trade protection is implemented. Given voters' strategies, protectionists vote for the incumbent if trade protection is implemented in the first term of office and for the challenger otherwise, and *vice versa* for free-trader voters.

Consider a Democrat incumbent in his first term of office. Consider the implications of switching from free-trade to trade protection in his first term of office on the probability of winning a majority in state s . The D incumbent gains $\gamma_D^s + \gamma_F^s + \nu^s$ by setting $r = 0$ in his first term, while the R challenger gains the remaining votes. The incumbent wins a majority of votes in state s , given $r = 0$, if $\gamma_D^s + \gamma_F^s + \nu^s > \gamma_R^s + \gamma_P^s - \nu^s$, that implies ε^s must exceed $\omega_t^s - \omega_p^s$. If the D incumbent sets $r = 1$, he gains $\gamma_D^s + \gamma_P^s + \nu^s$ and the remaining $\gamma_R^s + \gamma_F^s - \nu^s$ are gained by the R challenger. Hence, a majority in state s is won if ε^s exceeds $-\omega_t^s - \omega_p^s$. It follows from the distribution¹⁰ of ε^s that:

¹⁰ Voter turnout across US states has been repeatedly found to be positively correlated with the closeness of electoral competition (Geys, 2006, Matsusaka, 1993, Cox and Munger, 1989). This suggests that the state-specific turnout shock may plausibly depend on ω^s . For simplicity and so as to be able to characterise the political equilibrium, we abstract from this and maintain the assumption of independently and identically distributed state-specific shocks.

$$\rho_{|r=0}^s = \Pr(\varepsilon^s > \omega_t^s - \omega_p^s) = H(\omega_p^s - \omega_t^s) \quad (2.5)$$

$$\rho_{|r=1}^s = \Pr(\varepsilon^s > -\omega_t^s - \omega_p^s) = H(\omega_p^s + \omega_t^s) \quad (2.6)$$

Now consider the probabilities $\rho_{|r=0}^s$ and $\rho_{|r=1}^s$ for a Republican incumbent. The R incumbent gains $\gamma_R^s + \gamma_F^s - \nu^s$ by setting $r = 0$ in his first term, while the D challenger gains the remaining votes. A majority is won by R in state s if $\gamma_R^s + \gamma_F^s - \nu^s > \gamma_D^s + \gamma_P^s + \nu^s$, that is, if $\varepsilon^s < -(\omega_t^s + \omega_p^s)$. If the Republican sets $r = 1$ in his first term, he gains $\gamma_R^s + \gamma_P^s - \nu^s$ and the remaining $\gamma_D^s + \gamma_F^s + \nu^s$ are gained by the D challenger. A majority in state s is won if $\varepsilon^s < \omega_t^s - \omega_p^s$. An R incumbent's probability of majority can thus be expressed by as:

$$\rho_{|r=0}^s = \Pr(\varepsilon^s < -\omega_t^s - \omega_p^s) = 1 - H(\omega_p^s + \omega_t^s) \quad (2.7)$$

$$\rho_{|r=1}^s = \Pr(\varepsilon^s < \omega_t^s - \omega_p^s) = 1 - H(\omega_p^s - \omega_t^s) \quad (2.8)$$

Let $\Delta\rho^s = \rho_{|r=1}^s - \rho_{|r=0}^s$ denote the change in the probability of winning a majority in s through trade protection. Combining (2.5) and (2.6), as well as (2.7) and (2.8), yields that $\Delta\rho^s = H(\omega_p^s + \omega_t^s) - H(\omega_p^s - \omega_t^s)$ for both a Democrat incumbent and a Republican incumbent. The incentives for trade policy implementation are thus symmetric for incumbents of either party. Furthermore, symmetry of $h(\varepsilon^s)$ allows $\Delta\rho^s$ to be summarised by:

$$\Delta\rho^s = H(|\omega_p^s| + \omega_t^s) - H(|\omega_p^s| - \omega_t^s) \quad (2.9)$$

Equation (2.9) shows that the impact of the implementation of first term trade protection by an incumbent, of either party, on the probability of that incumbent winning a majority in state s depends on two factors. First, the absolute value of the political lead, $|\omega_p^s|$, that reflects the degree of electoral competition in state s , and second, the trade policy lead, ω_t^s , the reflects the 'swingness' of state s , as measured by the difference between protectionist voters and free-trader voters.

For any given level of electoral competition, the magnitude and sign of ω_t^s determine the extent to which trade policy can ‘swing’ the state in the incumbent’s favour. If $\gamma_P^s > \gamma_F^s$, then deviating from free-trade to trade protection improves the incumbent’s probability of a majority, so $\Delta\rho^s > 0$. Conversely, if $\gamma_P^s < \gamma_F^s$ then an incumbent of either party worsens the probability of winning a majority of votes in s , so $\Delta\rho^s < 0$. Finally, if P and F voters have equal measure in state s , then $\omega_t^s = 0$ and trade policy has no power in altering electoral outcomes for state s . Moreover, the greater the trade policy lead (lag), the greater the impact on the probability of a majority in s .

For a given trade policy lead, ω_t^s , the closer is electoral competition between the candidates, the larger the impact of the existing swing voters on $\Delta\rho^s$. To see why this is the case, consider that distribution $h(\varepsilon^s)$ is symmetric around 0 and single-peaked. For a given ω_t^s , as $|\omega_p^s| \rightarrow 0$, the probability gain is from the centre of the distribution, implying a larger $\Delta\rho^s$.

The pair of leads, (ω_p^s, ω_t^s) , therefore provides a complete description of state s , in terms of assessing the probability of it being won by either candidate. The discussion has shown that in states where $\gamma_P^s > \gamma_F^s$ the incumbent stands to improve the probability of winning a majority, while chances are worsened in states where $\gamma_P^s < \gamma_F^s$. States where $\gamma_P^s = \gamma_F^s$ are neutral to the trade policy decision. In a multi-jurisdictional setting, the implications of the trade policy decision for incumbents’ overall re-election probability depends crucially on the distribution of trade policy and political leads across states in the electoral college. If some states have more P than F voters, and others the converse, the incumbent stands to worsen his chances of winning certain electoral college votes and improve the probability of winning others. The next section turns to the question of aggregation of these effects and characterises the probability of the incumbent winning the election overall.

2.1.4 Trade Policy in the Electoral College

Section 2.1.3 establishes how the trade policy lead and degree of electoral competition in a state determine how the incumbent’s first term policy decision alters his subsequent probability of winning the electoral college vote of that state. This section examines how

the distribution of state probability changes, $\Delta\rho^s$, arising from pairs of leads (ω_p^s, ω_t^s) , can be translated into a measure of electoral college votes. The conditions under which reputation-building occurs in the political equilibrium are then characterised.

The law of large numbers implies that if each state along a continuum is subject to an identically distributed and independent shock ε^s described by a particular distribution, $h(\varepsilon^s)$, then the distribution of realised shocks over the infinite number of states along the continuum is exactly described by $h(\varepsilon^s)$. This implies that if all states over a continuum have identical $|\omega_p^s|$ and ω_t^s , then $\Delta\rho^s = H(|\omega_p^s| + \omega_t^s) - H(|\omega_p^s| - \omega_t^s)$ not only describes the change in the incumbent's probability of winning the electoral college vote of each state s , but also describes the change in electoral college votes *actually* won over the continuum of unit length.

There is no aggregate uncertainty, despite the individual uncertainty reflected in the state-specific shocks, as a result of the infinite nature of states along the continuum. It follows that in the absence of an additional national shock, there is no aggregate uncertainty over the continuum and election outcomes can be predicted deterministically for different policy choices. To add smoothness to our results, and capture the uncertainty of election outcomes, we introduce aggregate uncertainty in the model through the national pro-incumbent shock η , distributed by $f(\eta)$. The distribution of shock η is assumed to be symmetric around 0 and single-peaked, and distributed over a sufficiently wide support so that no candidate can be certain of a majority of electoral college votes.

To apply the law of large numbers and be able to convert changes in probability into changes in electoral college votes won, it must be the case that $|\omega_p^s|$ and ω_t^s are identical for all states over the continuum. Assuming all states are identical, however, removes all interesting effects that can arise from having a non-uniform distribution of $|\omega_p^s|$ and ω_t^s . We thus choose to 'discretise' the continuum into N state 'types', each forming a sub-continuum of the overall continuum of states. States of a given type have identical $|\omega_p^s|$ and ω_t^s , but states from different types may differ in their characteristics. Since there are infinitely many states in a continuum of small measure and a continuum of large measure, it follows that we can apply the law of large numbers on a type-by-type basis. Hence the

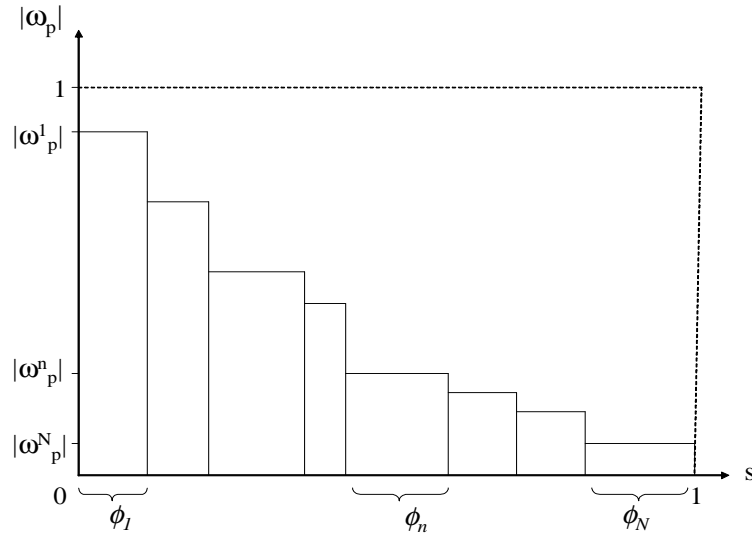


Fig. 2.1. Representation of N state types in the continuum.

analysis is facilitated greatly through the assumption of a continuum of states, while the discretization of the continuum into types allows us to investigate the role of voter distribution in a tractable way.

Let there be N state types, denoted by n , where $n = \{1, 2, \dots, N\}$. All states of a given type are assumed to be identical in terms of their degree of electoral competition $|\omega_p^n|$ and the trade policy lead ω_t^n . Let $\phi_n \geq 0$ denote the proportion of states s that are of type n , such that $\sum_{n=1}^N \phi_n = 1$. Moreover, suppose state types are ranked in declining $|\omega_p^n|$ such that $|\omega_p^j| \geq |\omega_p^k|$, where $k > j$ and $k, j \in \{1, 2, \dots, N\}$. Further assume $|\omega_p^1| \leq 1$ and $|\omega_p^N| \geq 0$. The ranking of discrete state types over the continuum implies that the distribution of $|\omega_p|$ across the electoral college is a step function, as illustrated in figure (2.1). The distribution of states across the electoral college can be changed through (i) the relative weight of state types in the electoral college through ϕ_n , (ii) the finite number of types N , and (iii) the distribution of $|\omega_p^n|$.

Let Δv^n denote the change in electoral college votes of type n won by the incumbent as a result of implementing trade protection in his first term. Moreover, let $\Delta v = \sum_{n=1}^N \Delta v^n$ denote the total change in electoral college votes over the whole continuum of states from a deviation from preferred trade policy in the first term. For any state of type n , the change in the incumbent's probability of winning a majority by deviating from free trade is $\Delta \rho^n$, where $\Delta \rho^n = H(|\omega_p^n| + \omega_t^n) - H(|\omega_p^n| - \omega_t^n)$. It follows from the law of large numbers that $\phi_n \Delta \rho^n$ gives the change in electoral college votes of type n won by the incumbent. Aggregating over all state types yields:

$$\Delta v = \sum_{n=1}^N \Delta v^n = \sum_{n=1}^N \phi_n \Delta \rho^n \quad (2.10)$$

It follows from (2.10) that Δv is a weighted sum of the state type probability changes. The incumbent may gain or lose electoral college votes from setting $r = 1$ depending on sign and magnitude of $\Delta \rho^n$ for each state type, and the weight of that state type in the electoral college, given by ϕ_n . If the characteristics and distribution of state types are such that $\Delta v < 0$ overall, then the free-trader incumbent cannot improve his chances of re-election through the implementation of trade policy and always selects $r = 0$ in his first term. The reputation building equilibrium described in section 2.1.2 requires that $\Delta v > 0$, so that free-trader incumbents gain from the deviation from free trade. As discussed, there are two symmetric reputation-building equilibria, where $\Delta v > 0$ and where $\Delta v < 0$, respectively. We focus on the former, where free-trader incumbents may have an incentive to implement trade protection. In the latter, a protectionist incumbent may choose to build a reputation as a free-trader by abstaining from trade protection in his first term. We return to this issue in the next section where we examine how a redistribution of swing voters gives results in a shift from one equilibrium to another.

It is appealing to interpret Δv in (2.10) as the change in electoral college votes when there are N states (rather than N measures of states), each with ϕ_n electoral college votes, where $\Delta \rho^n$ represents the change in the probability of winning the electoral college votes of state n . This interpretation is intuitive but important conceptual differences exist between the discrete state interpretation and the continuous measures of states assumed in the model.

Under a discrete state interpretation, the electoral votes of a state n , are won or lost as a block ϕ_n , while in the continuous measures of state types imply that proportions of votes ϕ_n are won or lost. Hence, with a continuum of states, Δv reflects the *actual* change in electoral college votes won by the incumbent, not the expected change in electoral college votes.

Recall that u is the pro-incumbent shock in electoral college votes won. Moreover, let v_I^r denote the electoral college votes won by the incumbent when he sets trade policy r in his first term of office. Similarly, v_C^r denote those won by the challenger, given r . Let $\omega_v^r = (v_I^r - v_C^r)$ denote the incumbent's lead over the challenger in the electoral college, given r , where ω_v^r can take values between -1 and 1 and reflects the degree of electoral competition at the national level.

For the incumbent to be re-elected, given r , it must be the case that $v_I^r + u > v_C^r - u$. Hence, $2u = \eta$ must exceed $v_C^r - v_I^r$. Finally, let θ^r denote the incumbent's probability of re-election, given trade policy selection r in the first term of office. Given distribution $F(\eta)$ probabilities θ^0 and θ^1 can be expressed as:

$$\theta^0 = \Pr(\eta > v_C^0 - v_I^0) = 1 - F(v_C^0 - v_I^0) = F(\omega_v^0) \quad (2.11)$$

$$\theta^1 = \Pr(\eta > v_C^1 - v_I^1) = 1 - F(v_C^1 - v_I^1) = F(\omega_v^1) \quad (2.12)$$

Since Δv reflects the change in electoral college votes won by the incumbent from a policy deviation, it follows that $v_I^1 = v_I^0 + \Delta v$ and $v_C^1 = v_C^0 - \Delta v$. Hence, $\omega_v^1 = v_I^1 - v_C^1 = v_I^0 - v_C^0 + 2\Delta v = \omega_v^0 + 2\Delta v$. The re-election probabilities can thus be re-written as:

$$\theta^0 = F(\omega_v^0) \quad (2.13)$$

$$\theta^1 = F(\omega_v^0 + 2\Delta v) \quad (2.14)$$

Defining $\Delta\theta$ as the change in re-election probability from a policy deviation, it follows directly from (2.13) and (2.14) that $\Delta\theta = \theta^1 - \theta^0 = F(\omega_v^0 + 2\Delta v) - F(\omega_v^0)$. Furthermore, symmetry of $f(\eta)$ allows $\Delta\theta$ to be summarised by:

$$\Delta\theta = F(|\omega_v^0| + 2\Delta v) - F(|\omega_v^0|) \quad (2.15)$$

It follows from (2.15) that the incumbent enjoys an improvement in reelection probability ($\Delta\theta > 0$) from the implementation of trade protection provided there is an overall gain in electoral college votes from the policy ($\Delta v > 0$). If $\Delta v > 0$, then the expected payoff from implementing trade protection in the first term is $(\Delta\theta)\beta\zeta$ for a free-trader incumbent of either party. For $r = 1$ to be an optimal strategy, the expected payoff must exceed the incumbent's utility cost draw. Since $(\Delta\theta)\beta\zeta < \beta\zeta$ and $c_H > \beta\zeta$, the analysis confirms that a free-trader incumbent with a high utility cost draw never finds it optimal to deviate from free trade. If a low utility cost c_L is drawn, then $(\Delta\theta)\beta\zeta$ must be larger than c_L for the reputation-building strategy to be optimal.

In the symmetric equilibrium where $\Delta v < 0$, a protectionist incumbent improves his reelection probability by setting $r = 0$ in his first term. Since $\Delta\theta$ is defined as the change in re-election probability from a policy deviation, then $\Delta\theta = \theta^0 - \theta^1 > 0$. If the expected payoff exceeds c_L then his reputation-building strategy is optimal.

Proposition 2.1 *If $(\Delta\theta)\beta\zeta > c_L$, then there is a unique equilibrium in which incumbent politicians with a low utility cost draw (c_L) deviate from their preferred trade policy in their first term of office if this increases their re-election probability and follow their private preferences otherwise. **Proof.** It follows from (2.9) that $\Delta\rho^n = H(|\omega_p^n| + \omega_t^n) - H(|\omega_p^n| - \omega_t^n)$ is the change in the probability of winning the electoral college vote of a state of type n . The resulting change in type n electoral college votes won is $\phi_n\Delta\rho^n$. Aggregating over state types gives the total change in electoral college votes from a policy deviation, $\Delta v = \sum_{n=1}^N \phi_n\Delta\rho^n$. If $\Delta v > 0$, then a free-trader incumbent of either party enjoys a gain in re-election probability $\Delta\theta$ from setting $r = 1$ in his first term of office. Provided a low cost is drawn and $(\Delta\theta)\beta\zeta > c_L$, the F incumbent enjoys a positive net expected payoff from setting $r = 1$, so finds it optimal to deviate from his preferred private policy. If a high utility cost c_H is drawn by an F incumbent or the gain in re-election probability $\Delta\theta$ is not sufficiently large for $(\Delta\theta)\beta\zeta > c_L$ to be satisfied, then*

the incumbent sets his preferred policy, free trade. In this equilibrium, a protectionist incumbent cannot increase his re-election probability through a policy deviation, so always finds it optimal to follow his private preferences and set $r = 1$.

Conversely, if $\Delta v < 0$, then a protectionist incumbent of either party enjoys a gain in re-election probability $\Delta\theta$ from setting $r = 0$ in his first term of office. Provided a low cost is drawn and $(\Delta\theta)\beta\zeta > c_L$, the P incumbent enjoys a positive net expected payoff from setting $r = 0$, so finds it optimal to deviate from his preferred private policy. If a high utility cost c_H is drawn by a P incumbent or the gain in re-election probability $\Delta\theta$ is not sufficiently large for $(\Delta\theta)\beta\zeta > c_L$ to be satisfied, then the incumbent sets his preferred policy, trade protection. In this equilibrium, a free-trader incumbent cannot increase his re-election probability through a policy deviation, so always finds it optimal to follow his private preferences and set $r = 1$.

For a given distribution of voters in the electoral college, and thus given Δv , the equilibrium in which reputation-building forms part of incumbent's optimal strategies is the unique equilibrium. A proof of uniqueness can be found in Appendix 2.B. ■

Inspection of (2.15) reveals that the reputation-building equilibrium depends on two key national-level parameters of the model. First, the closeness of electoral competition at the national level, as measured by $|\omega_v^0|$ and second, the gain in electoral college votes Δv from a policy deviation. The characteristics of $f(\eta)$ imply that a closer degree of electoral competition between candidates at the national level, the greater the probability gain from an increase in electoral college votes from a policy deviation.

Intuitively, the closer the competition between the two candidates, that is the smaller is $|\omega_v^0|$, then the more likely it is that the pro-incumbent shock perturbs the election outcome. Since the pro-incumbent shock is more likely to be near 0, a given gain in electoral college votes through a strategic trade policy decision is more beneficial the closer $|\omega_v^0|$ is to 0.

Conversely, relatively weak electoral competition, reflected by high $|\omega_v^0|$, implies that one of the candidates has a large lead in electoral college votes over the other. The probability that a sufficiently large shock is realised to change the election outcome is relatively low. A gain Δv implies a smaller shock is sufficient to change the election result, but the further

from 0 is the initial difference in electoral college votes, the smaller the associated gain in probability.

Furthermore, for any given degree of national electoral competition, the greater the increase in electoral college votes Δv that can be won through a policy deviation, the greater is the incumbent's gain in re-election probability. Intuitively, the more votes that can be 'swung' at the national level from trade policy, the larger the impact of the trade policy decision on re-election probability.

A change in either $|\omega_v^0|$ or Δv has an impact on re-election probability $\Delta\theta$ and thus on the likelihood that condition¹¹ $(\Delta\theta)\beta\zeta > c_L$ is satisfied. These results are summarised in proposition 2.2.

Proposition 2.2 *An increase in the number of electoral college votes that can be won by deviating from preferred trade policy (Δv) or an increase in electoral competition at the national level (lower $|\omega_v^0|$) make reputation-building through the strategic selection of trade policy more likely.*

Proof. Consider a distribution of voters such that $\Delta v > 0$. It follows directly from $\Delta\theta = F(|\omega_v^0| + 2\Delta v) - F(|\omega_v^0|)$ that an increase in Δv , *ceteris paribus*, increases the change in the incumbent's re-election probability from the implementation of trade protection. Moreover, since $f(\eta)$ is symmetric around 0 and single-peaked, $\Delta\theta$ increases as $|\omega_v^0| \rightarrow 0$. A higher $\Delta\theta$ from either increase makes it more likely that condition $(\Delta\theta)\beta\zeta > c_L$ is satisfied, and thus that reputation building takes place. ■

Propositions 2.1 and 2.2 confirm the same properties apply in the multi-jurisdictional framework as in the related literature with one jurisdiction. Namely, that there exists a unique reputation-building equilibrium that is more likely the larger the number of votes that can be swung through a policy decision, and the closer is electoral competition between candidates.

The multi-jurisdictional framework extends the literature in two ways. First, the electoral college structure provides new insights into how state-level characteristics in the electoral

¹¹ An increase in the discounted ego-rent, $\beta\zeta$, or decrease in c_L also increase the likelihood of there being a reputation-building equilibrium.

college combine to influence the incentives for strategic trade protection at the national level. This provides for a more nuanced analysis of how swing-voters affect policy decisions. Second, the framework adds a spatial dimension that allows distributional effects to be examined in a highly tractable way. The analysis delivers three new propositions that describe how the distribution of voters in the electoral college influence trade policy decisions. These effects are analysed in the next section.

2.1.1 Distribution of Voters and Electoral Incentives

Section 2.1.4 establishes that the reputation building equilibrium depends on parameters, $|\omega_v^0|$ and Δv , that contribute to the change in the incumbent's re-election probability arising from a first term policy deviation. While these national-level parameters confirm the importance of electoral competition and the change in electoral college votes won as key determinants, they represent summary statistics of the underlying state-level characteristics in the electoral college. Expressing $\Delta\theta$ in terms of state-level parameters gives rise to proposition 2.3.

Proposition 2.3 *The likelihood of strategic trade policy implementation depends on the distribution of swing voters and ideologists within states of a given type $(|\omega_p^n|, \omega_t^n)$, the distribution of state types in the electoral college (ϕ_n) and the probability distributions of state-level $(H(\varepsilon^s))$ and national shocks $(F(\eta))$.*

Proof. Consider the change in re-election probability summarised by (2.15). Recall that $\Delta v = \sum_{n=1}^N \phi_n \Delta\rho^n$. This can be expressed in terms of state-level characteristics by substituting for $\Delta\rho^n$. This yields:

$$\Delta v = \sum_{n=1}^N \phi_n \Delta\rho^n = \sum_{n=1}^N \phi_n (H(|\omega_p^n| + \omega_t^n) - H(|\omega_p^n| - \omega_t^n)) \quad (2.16)$$

Moreover, electoral competition at the national level $|\omega_v^0| = |v_I^0 - v_C^0|$, where v_I^0 and v_C^0 are the electoral college votes won by the incumbent and challenger, respectively, under free trade in the first term. v_I^0 is the weighted sum of electoral college votes won by state type, when $r = 0$. Thus $v_I^0 = \sum_{n=1}^N \phi_n \rho_{r=0}^n$. Moreover, since $v_I^0 + v_C^0 = 1$, it is straightforward

to express the challenger's electoral college votes as $v_C^0 = 1 - \sum_{n=1}^N \phi_n \rho_{|r=0}^n$. Combining these allows national-level electoral competition to be expressed in terms of state-level characteristics:

$$\omega_v^0 = 2 \sum_{n=1}^N \phi_n \rho_{|r=0}^n - 1 = 2 \sum_{n=1}^N \phi_n H(|\omega_p^n| - \omega_t^n) - 1 \quad (2.17)$$

Substituting (2.16) and (2.17) into (2.15) allows the incumbents re-election probability to be expressed in terms of state-level variables and distributional parameters:

$$\begin{aligned} \Delta\theta &= F(|\omega_v^1|) - F(|\omega_v^0|) \\ &= F\left(2 \sum_{n=1}^N \phi_n H(|\omega_p^n| + \omega_t^n) - 1\right) - F\left(2 \sum_{n=1}^N \phi_n H(|\omega_p^n| - \omega_t^n) - 1\right) \end{aligned} \quad (2.18)$$

Inspection of (2.18) shows that the change in re-election probability, and thus the likelihood of strategic trade policy implementation, hinges on (i) the distribution of swing voters and ideologists within states of a given type, summarised by $(|\omega_p^n|, \omega_t^n)$, (ii) the distribution of state types in the electoral college, reflected by proportions ϕ_n and (iii) the distributions of state-level and national-level shocks, $H(\varepsilon^s)$ and $F(\eta)$. ■

To show how the spatial position of swing voters can influence policy decisions, we consider two redistribution experiments that satisfy the following conditions:

1. The aggregate population of each voter type in the electoral college is kept constant.

In particular, if we let Γ_k denote the total measure of k voters in the electoral college, then the distribution of k voters across n state types, as reflected by γ_k^n , must satisfy the following condition:

$$\Gamma_k = \sum_{n=1}^N \phi_n \gamma_k^n, \text{ where } k \in \{D, R, F, P\} \quad (2.19)$$

2. All states always have a unit measure of voters, so $\sum_k \gamma_k^n = 1$. This implies that an increase in the measure of voters of a particular type in a state, must be accompanied by a decrease in voters of some other type. Denoting the total measure of voters by Γ , conditions 1 and 2 imply that the total measure of voters in the electoral college must

be 1:

$$\Gamma = \sum_k \Gamma_k = \sum_k \sum_n \phi_n \gamma_k^n = \sum_n \phi_n \sum_k \gamma_k^n = 1 \quad (2.20)$$

3. Feasibility constraints regarding pairs of values (ω_p^n, ω_t^n) for all state types n are adhered to. To see how these apply, consider pair $(|\omega_p^n|, \omega_t^n)$ that describes states of type n . Since the sum of all voter types is 1 in each state, there is a finite range of values that leads ω_p^n and ω_t^n may feasibly take. In particular, the larger is the lead in any one dimension, the smaller the scope for variability in the lead in the other dimension. For example, if $\omega_p^n = 1$ (or -1), then a state of type n is made up entirely of D voters (or R voters) so $\omega_t^n = 0$. At the other extreme, $\omega_t^n = 1$ (or -1) implies $|\omega_p^n| = 0$. Figure (2.2) illustrates the set of all feasible combinations of (ω_p^n, ω_t^n) , given $\sum_k \gamma_k^n = 1$. Consider $|\omega_p^n| = \alpha$. This implies that D voters exceed R voters by α , or *vice versa*. For example, suppose $\gamma_D^n = 0.4$ and $\gamma_R^n = 0.2$, in states of type n , implying a Democratic lead $\omega_p^n = 0.2$. The sum of ideologists is 0.6, so the swing voters represent 0.4 of each state. If all swing voters are protectionist, then $\omega_t^n = 0.4$, while if all are free-traders, then $\omega_t^n = -0.4$. Suppose instead that $\omega_p^n = 0.2$ arises from $\gamma_D^n = 0.3$ and $\gamma_R^n = 0.1$. In this case, ω_t^n ranges from -0.5 to 0.5 . It is straightforward to see that if there are no R voters at all, then ω_t^n ranges from -0.8 to 0.8 . This gives the largest possible range consistent with $\omega_p^n = \gamma_D^n = 0.2$. Similar reasoning applies for a state where $\omega_p^n = -0.2$.

In general, the maximum measure of single-issue voters consistent with $|\omega_p^n| = \alpha$ is thus $1 - \alpha$. Hence, the maximum trade policy lead is $\omega_t^n = 1 - \alpha$, where all swing voters are protectionists. Conversely, the minimum trade policy lead consistent

with $|\omega_p^n| = \alpha$ is $\omega_t^s = \alpha - 1$, where all single-issue voters are free-traders. These maximum and minimum leads form the rhombus in figure (2.2). States with positive measures of *all* voter types are described by (ω_p^n, ω_t^n) that lie inside the rhombus. The discussion can be summarised by the following range for ω_t^n , given $|\omega_p^n|$:

$$\omega_t^n \in [\alpha - 1, 1 - \alpha], \text{ if } |\omega_p^n| = \alpha, \text{ where } \alpha \in [0, 1] \quad (2.21)$$

Any redistribution of voters across state types must be consistent with the (2.21).

The analysis in the chapter up to this point has been concerned with politicians' optimal strategies for a given distribution of voters. The two redistribution experiments in this section address a different set of questions. In particular, how a change in the spatial location of a measure of swing voters can alter the electoral incentives for trade protection of a given industry, whether through variation in the degree of state-level competition across the electoral college, or through institutional parameters, such as variation in the contribution of electoral votes of different state types in the electoral college. While we model the redistribution as a physical migration of voters with fixed preferences, this need not be the case. Preferences of voters may change in a given location, without migration, through changes in the pattern of industrial concentration and employment. The experiments reveal two key distributional determinants of electoral incentives. First, state 'swingness', as measured by the closeness of state-level electoral competition, and second, state 'decisiveness', as measured by the proportion of electoral college votes represented by states of a given type. Let us define the initial distribution of swing voters prior to any redistribution. This is referred to as the 'benchmark distribution' in the rest of the section. Suppose the N state types are ranked such that $1 > |\omega_p^1| > \dots > |\omega_p^n| > \dots > |\omega_p^N| > 0$. Condition (2.21) implies that the maximum measure of single-issue voters in states of type n consistent with $|\omega_p^n|$ is $1 - |\omega_p^n|$. Assume the maximum feasible measure of single-issue voters is present in all states of types n . It follows that the measure of swing voters is increasing with n since $|\omega_p^n|$ is decreasing with n . Further assume that in the benchmark distribution, the swing

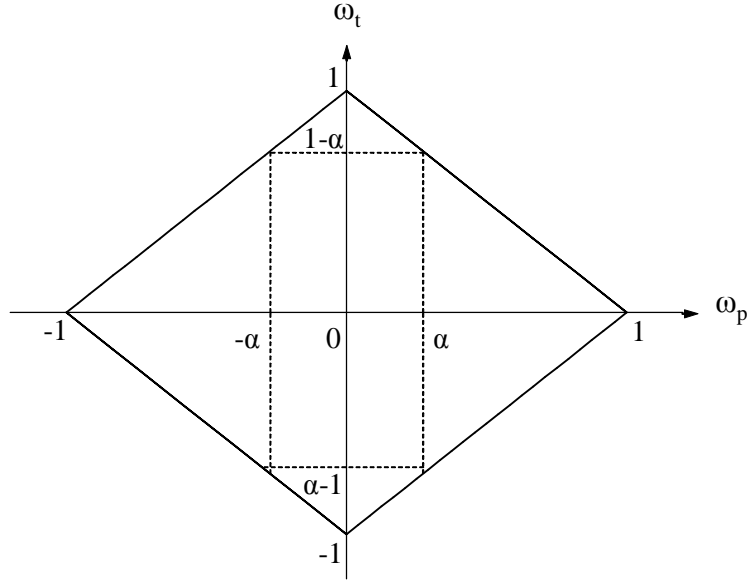


Fig. 2.2. Feasible pairs of political and trade leads.

voters of each state of type n are split evenly between P and F voters, such that $\gamma_P^n = \gamma_F^n = \frac{1}{2} [1 - |\omega_p^n|]$. This implies that for each state of type n , $\omega_t^n = 0$, thereby placing the distribution of state types along the ω_p axis in Figure (2.2). Hence, by construction, the benchmark distribution is characterised by $\Delta \rho^n = \Delta v^n = 0, \forall n$, and thus $\Delta v = \Delta \theta = 0$, so trade policy has no impact on re-election probability. The conditions for a reputation-building equilibrium are not satisfied under the benchmark distribution so all incumbents set their preferred trade policy in their first term of office.

A. Redistribution A - 'Swingness'

From the benchmark distribution, consider a redistribution of P and F voters that increases the concentration of protectionist voters in states with relatively low $|\omega_p^n|$, and *vice versa* for free-traders. The additional assumption is made that all state types contribute equally to the electoral college¹², such that $\phi_n = \phi, \forall n$. Under these assumptions and provided the redistribution satisfies conditions (1) to (3), the following proposition holds.

¹² This simplifying assumption controls for the effects on reputation-building incentives arising from different state-type contributions of electoral college votes.

Proposition 2.4 *A redistribution of protectionist voters from states with weaker electoral competition (higher $|\omega_p^n|$) to states with stronger electoral competition (lower $|\omega_p^n|$) makes it more likely that incumbents engage in strategic trade protection.*

Proof. Starting from the initial distribution where there are $\frac{1}{2} [1 - |\omega_p^n|]$ protectionists and free traders in each state of type n , and state types are ranked in decreasing $|\omega_p^n|$, it follows by construction that if a positive measure $k \leq \frac{1}{2} [1 - |\omega_p^i|]$ of protectionist voters is redistributed from each state of type i to each state of type j , where $i < j$, then:

(i) there are sufficient free-trader voters in each state of type j to replace the k voters redistributed to j from state i , since $\frac{1}{2} [1 - |\omega_p^i|] < \frac{1}{2} [1 - |\omega_p^j|]$.

(ii) this exchange of swing voters redistributes P voters towards a measure of states with closer electoral competition and F voters towards states with a weaker electoral competition.

In each j state, the measure of protectionists rises by k and the measure of free traders falls by k , hence $\omega_t^j = \gamma_P^j - \gamma_F^j = 2k > 0$. Conversely, in each state i , $\omega_t^i = \gamma_P^i - \gamma_F^i = -2k < 0$. For all states of type n , where $n \neq \{i, j\}$, $\omega_t^n = 0$. Consider the effects of a deviation from free trade by an incumbent in his first term of office post-redistribution. For states of type i and j , the change in a free-trader incumbent's probability of winning a majority from setting $r = 1$ in his first term are:

$$\Delta\rho^j = H(|\omega_p^j| + 2k) - H(|\omega_p^j| - 2k) > 0 \quad (2.22)$$

$$\Delta\rho^i = H(|\omega_p^i| - 2k) - H(|\omega_p^i| + 2k) < 0 \quad (2.23)$$

It follows from (2.22) and (2.23) that setting $r = 1$ improves the incumbent's probability of winning j state electoral college votes, where P voters exceed F , but worsens his chances of winning i state electoral votes where the opposite is the case. The overall change in electoral college votes is given by:

$$\begin{aligned} \Delta v &= \phi \Delta\rho^i + \phi \Delta\rho^j + \phi \sum_{n \neq i, j} \Delta\rho^n = \phi (\Delta\rho^i + \Delta\rho^j) \\ &= \phi [H(|\omega_p^j| + 2k) - H(|\omega_p^j| - 2k)] - \phi [H(|\omega_p^i| + 2k) - H(|\omega_p^i| - 2k)] > 0 \end{aligned} \quad (2.24)$$

Since $|\omega_p^i| > |\omega_p^j|$, it follows from the characteristics of $h(\varepsilon^n)$ that the change in electoral college votes won by the incumbent from $r = 1$ increases, from 0 in the benchmark

distribution, to $\Delta v > 0$. It follows that from having no effect on re-election probability under the benchmark distribution, the redistribution of protectionists to states with closer electoral competition increases their relative importance in the electoral college, giving rise to an improvement in re-election probability through first term trade protection. Thus an increase in the concentration of protectionists in states with closer electoral competition makes strategic trade protection by incumbents more likely. ■

The redistribution considered has the dual effect of giving protectionists a lead in one group of states, and free-traders a lead in another group of states, where both groups have equal measure. It is the closeness of electoral competition in the former group of states that gives protectionists a greater weight in the overall assessment of the change in electoral college votes and thus in re-election probability. If the degree of electoral competition were the same in the two state types, then these probability changes would entirely offset each other. It is the difference in the ‘swingness’ of states across which redistribution takes place that drives the electoral incentives to implement trade protection after the redistribution.

A symmetric redistribution that gives free-traders a lead in groups of states that are more competitive has the opposite effect, such that $\Delta v < 0$ holds post-redistribution. This corresponds to the symmetric reputation-building equilibrium where protectionist incumbents override their protectionist views and choose free-trade in their first term following a low cost draw. Thus a population-preserving redistribution of swing voters can generate either of the two symmetric reputation-building equilibria.

Intuitively, the preferences of concentrations of swing voters that contribute most in probability terms to election outcomes are given more weight by incumbents when making policy decisions. Moreover, the concentrations that contribute most are those in swing states whose electoral outcome is most uncertain.

B. Redistribution B - ‘Decisiveness’

From the benchmark distribution, consider a redistribution of protectionists from states of type i to states of type j , where both states types are characterised by the same degree of electoral competition, but where j states represent a larger proportion of electoral college

votes than do i states. The assumption that $|\omega_p^i| = |\omega_p^j| = |\omega_p|$ controls for the ‘swingness’ effect, while $\phi_j > \phi_i$ isolates the effect of distributing swing voters across larger or smaller measures of swing states. Suppose that all states of type n , where $n \neq \{i, j\}$ remain unchanged.

Starting from $\omega_t^i = \omega_t^j = 0$, the redistribution described has the effect of concentrating a measure of F voters over a smaller measure of swing states, i , while the same volume of P voters is spread evenly over a larger measure of states, j , with an identical degree of electoral competitiveness. This gives rise to two conflicting effects on the electoral incentives for trade protection. On the one hand, the relatively large concentration of free-traders in i states implies that a first term protectionist policy reduces the incumbent’s probability of winning a majority in each state i by more than the probability gain in winning a majority in each state j , where protectionists are less concentrated. On the other hand, j states represent a larger measure of electoral college votes than i states.

Whether the former ‘concentration effect’ or the latter ‘decisiveness effect’ dominates determines whether the redistribution increases or decreases the electoral college votes won overall by setting $r = 1$ in the first term of office. If $\Delta v > 0$ overall, then trade protection is more likely than under the benchmark distribution of swing voters. Otherwise, $\Delta v < 0$ and the symmetric reputation-building equilibrium is more likely.

The decisiveness effect dominates the concentration effect when the degree of electoral competition is strong in states i and j . Intuitively, the greater the swingness of states, the greater the impact in probability terms of even a small lead in protectionist swing voters. Thus the gain in electoral college votes from trade protection is larger, *ceteris paribus*, when a given measure of protectionist voters is spread over a large measure of highly swing states, than when concentrated over a smaller measure of identical states. Conversely, a small protectionist lead has less potency when electoral competition is weak than when electoral competition is strong, causing the concentration effect to outweigh the decisiveness effect such that the more concentrated F voters in states of type i have a larger impact on electoral college votes won than the less concentrated P voters in type j states, under first term strategic trade protection.

Proposition 2.5 *A redistribution of protectionist voters from swing states that constitute a smaller proportion of electoral college votes (lower ϕ) to swing states that constitute a larger proportion of electoral college votes (higher ϕ) makes it more likely that incumbents engage in strategic trade protection.*

Proof. Consider state types i and j where $|\omega_p^i| = |\omega_p^j| = |\omega_p|$ and $\phi_j > \phi_i$. The total population of swing voters over states of type i is $\phi_i [1 - |\omega_p|]$, which is less than the total population of swing voters over j states, given by $\phi_j [1 - |\omega_p|]$. Recall that P and F voters are assumed to have equal measure in the benchmark distribution, such that $\Gamma_P^i = \Gamma_F^i = \frac{\phi_i}{2} [1 - |\omega_p|]$ and $\Gamma_P^j = \Gamma_F^j = \frac{\phi_j}{2} [1 - |\omega_p|]$. Since, by construction, $\Gamma_P^i < \Gamma_F^j$, any redistribution of protectionist voters from i to j states is feasible up to Γ_P^i . Suppose k protectionist voters from each state i are redistributed evenly across states j . It follows that $\phi_i k$ voters are distributed evenly over ϕ_j states. Let λ denote the additional protectionist voters in each state j , where $\lambda = \frac{\phi_i}{\phi_j} k$. Moreover, $\phi_j \lambda$ free-traders are redistributed evenly across i states. Thus $\phi_i k = \phi_j \lambda$. Since $\phi_j > \phi_i$, it follows that $\lambda < k$.

In each j state, the measure of protectionist rises and free traders falls by $\frac{\phi_i}{\phi_j} k$. Hence, $\omega_t^j = \gamma_P^j - \gamma_F^j = 2k \frac{\phi_i}{\phi_j} > 0$. Conversely, in each state i , $\omega_t^i = \gamma_P^i - \gamma_F^i = -2k < 0$. For all states of type n , where $n \neq \{i, j\}$, $\omega_t^n = 0$. Consider the effects of a deviation from free trade by an incumbent in his first term of office post-redistribution. For states of type i and j , the change in a free-trader incumbent's probability of winning a majority from setting $r = 1$ in his first term are:

$$\Delta \rho^j = H \left(|\omega_p| + 2k \frac{\phi_i}{\phi_j} \right) - H \left(|\omega_p| - 2k \frac{\phi_i}{\phi_j} \right) > 0 \quad (2.25)$$

$$\Delta \rho^i = H (|\omega_p| - 2k) - H (|\omega_p| + 2k) < 0 \quad (2.26)$$

Since $\phi_j > \phi_i$, it follows that $2k \frac{\phi_i}{\phi_j} < 2k$ so the protectionist lead in j states is smaller than the free-trader lead in i states. Inspection of (2.25) and (2.26) reveal that setting $r = 1$ improves the incumbent's probability of winning each j state electoral college vote but worsens his chances of winning each i state electoral college vote. Moreover, since the degree of electoral competition is the same across the two state types, it follows that $\Delta \rho^j < -\Delta \rho^i$. This reflects the 'concentration effect' of the redistribution of swing voters

across state types of different measure. However, $\phi_j > \phi_i$, so there is also a ‘decisiveness effect’ since there are more j state than i state electoral college votes. Using $\lambda = k \frac{\phi_i}{\phi_j} < k$ and $\phi_j = \phi_i \frac{k}{\lambda} > \phi_i$ for simplification allows the overall change in electoral college votes won by the incumbent as a result of first term protectionist to be expressed as

$$\begin{aligned} \Delta v &= \phi_i \Delta \rho^i + \phi_j \Delta \rho^j + \sum_{n \neq i, j} \phi_n \Delta \rho^n = \phi_i \Delta \rho^i + \phi_j \Delta \rho^j \\ &= \phi_i \frac{k}{\lambda} [H(|\omega_p| + 2\lambda) - H(|\omega_p| - 2\lambda)] - \phi_i [H(|\omega_p| + 2k) - H(|\omega_p| - 2k)] \end{aligned} \quad (2.27)$$

Inspection of (2.27) reveals the trade-off between the two conflicting effects. The first term shows a smaller probability change per j state, with weight ϕ_i magnified by $\frac{k}{\lambda}$ as a result of the larger scale of electoral college votes. The second term shows the larger probability change for i states weighted only by ϕ_i . The characteristics of $H(\cdot)$ imply that $\Delta v > 0$ when electoral competition is sufficiently close. Hence, when states i and j are characterised by low $|\omega_p|$ and thus a high degree of swingness, the redistribution of protectionist voters across a measure of more decisive states makes strategic trade protection more likely.

■

Propositions 2.4 and 2.5 provide new insights concerning how the distribution of voters can influence the decisions of policy makers driven by electoral incentives. The model emphasizes the differences between direct and indirect voting for a presidential candidate by showing how the electoral college system places different weights on the preferences of swing voters, depending on their location. The propositions show analytically that incremental distributional changes *between* states that alter the distribution of leads *within* states can have a significant effect on the incentives for policy implementation.

The propositions show that concentrations of swing voters with a particular trade policy stance have a larger impact on electoral outcomes when located in swing states. Moreover, their overall impact on the re-election probability of incumbents increases if their influence is spread over swing states that constitute a larger proportion of electoral college votes and are thus more decisive for the election.

The propositions thus combine to give the overall prediction that the trade policy preferences of a measure of swing voters are more likely to be satisfied if these swing voters are

concentrated in states that are both swing and decisive for the election outcome. Since voters with strong views over the protection of a particular industry are likely to be stakeholders in that industry, whether employees, entrepreneurs, shareholders etc., the main testable empirical implication of the model is that industries that are concentrated in swing and decisive states are more likely to be protected. The next section describes the results of our empirical investigation using US data that tests for the empirical implication of the model.

2.2 Empirical Analysis

This section provides evidence supporting the theoretical prediction that industries with large concentrations in swing and decisive states are more likely to be protected. The empirical analysis employs a benchmark test of the “Protection for Sale” mechanism of Grossman and Helpman (1994) using the empirical model and data of Gawande and Bandyopadhyay (2000). This baseline constitutes the “state-of-the-art” in empirical political economy of trade. We augment it with the data necessary to test our hypothesis that industrial concentration in key political districts is a significant determinant of trade policy. While the empirical specification does not form a direct test of our model, we present reduced form evidence that suggests previous empirical studies of the Grossman and Helpman (1994) model have omitted variables from their analysis that our theoretical analysis puts forward as being relevant.

The rest of the section proceeds as follows. First we outline the model and data of Gawande and Bandyopadhyay (2000). Second, we present the data and method of construction for the measure used to capture the swingness and decisiveness elements of the model. Finally, our results are described.

2.2.1 Data and Empirical Specification

The theoretical model developed in section 2.1 considers how electoral incentives influence a binary trade policy decision that reflects either free trade or trade protection. The precise

nature of this trade protection instrument is unspecified in the model, but is distinguished by the discretion the political incumbent is assumed to have over it.

In practice, unilateral political discretion over trade policy, in particular import tariffs, is constrained by multilateral agreements. Import tariffs are thus jointly determined through multilateral trade negotiations rather than the sole result of a government's political agenda. Moreover, tariff levels for manufacturing products are very low since they have been greatly reduced over last few decades under the GATT and WTO. In contrast, Non-Tariff Barriers (NTBs) allow governments to exercise more discretion in trade protection since these are not regulated to the extent of tariffs. For this reason, the literature has mainly employed coverage ratios for non-tariff barriers as a measure of trade protection, where these represent the share of products within an industry that benefit from one or more quantitative or qualitative trade restrictions: quantity-oriented barriers such as voluntary export restraints and quotas, price-oriented measures such as antidumping and countervailing duties, and threats of quantity and quality monitoring. We therefore adopt the same approach as in the related literature¹³ in considering NTB coverage ratios as our measure of trade protection. Data on Non-Tariff Barriers for 1983¹⁴ has been collected by the UNCTAD¹⁵ and combined with data from World Bank tapes¹⁶.

The benchmark specification by Gawande and Bandyopadhyay (2000) tests the original "Protection for Sale" equation of Grossman and Helpman (1994), reproduced in (2.28).

$$\frac{t_i}{1 + t_i} = \frac{I_i - \alpha_L z_i}{\alpha + \alpha_L e_i} \quad (2.28)$$

They demonstrate that lobbying competition and lobbying spending have an influence on protection in the US by estimating a system of three equations, of which only one is relevant to our chapter. This equation is reproduced in (2.29), where t_i is the coverage ratio for

¹³ Leamer (1990) details the construction of NTB coverage ratios. These have been widely used, for example, in Leamer (1990), Treffer (1993), Gawande (1998), Lee and Swagel (1997), Goldberg and Maggi (1997), Gawande and Bandyopadhyay (2000) and Bombardini (2005).

¹⁴ Since 1983 is the only year for which NTB data is available, it is not possible to test the term limit effects predicted by the model.

¹⁵ UNCTAD: United Nations Conference on Trade and Development.

¹⁶ This dataset has been kindly provided by Kishore Gawande.

industry i , z_i is the inverse of the import penetration ratio, the share of imports to total production in sector i , e_i is the price elasticity of imports and I_i is a dummy variable that describes whether the sector is politically organised and represented by a lobby. Moreover, Z_{1i} includes tariffs on intermediate goods and Z_{2i} includes NTBs on intermediate goods as controls. The error term is denoted by s_i .

$$\frac{t_i}{1+t_i} = \gamma_0 + \gamma_1 I_i \frac{z_i}{e_i} + \gamma_2 \frac{z_i}{e_i} + Z_{1i} + Z_{2i} + s_i \quad (2.29)$$

A simultaneity problem was raised by Treffer (1993). Higher trade protection is likely to reduce import penetration, as reflected in the following equation, in which ε_i is the error term.

$$\frac{1}{z_i} = \phi \frac{t_i}{1+t_i} + \varepsilon_i \quad (2.30)$$

Import penetration and trade protection are therefore determined simultaneously. In order to correct for the simultaneity bias implied by the system of equations (2.29) and (2.30), an instrumental variables approach is adopted. The capital-labour ratio interacted with industry dummies and comparative advantage variables (fractions of managers, scientists and unskilled labour per industry) are used as instruments, as in Treffer (1993). A complete list of the instruments used is reported in Appendix 2.D. As in Gawande and Bandyopadhyay (2000), we use a two-stage least-squares estimator, and include for each of the instruments a linear term, a squared term, and the interactions of the linear term with, e_i , the price elasticity of imports. While the use of the exhaustive list of instruments introduces some difficulties in our regression analysis, we use the same set of instruments as Gawande and Bandyopadhyay (2000), as our aim is to keep their benchmark specification, only adding our variable.

The data used for import penetration ratios for the US are identical to those used by Treffer (1993). Considered as the most accurate estimate of sector-level price elasticity of imports, the data was taken originally from Shiells *et al.* (1986). The dummy variable, I_i , indicates

whether a sector is politically organised and is constructed by Gawande and Bandyopadhyay (2000) based on US data from the Federal Election Commission¹⁷.

2.2.2 Measuring Concentration

To test the hypothesis that sectors whose activity is concentrated in US states with strong electoral competition ('swingness') and with the electoral votes to influence electoral outcomes ('decisiveness') are more likely to be protected, we require a measure to capture this form of geopolitical concentration. We therefore construct a measure of this concentration by combining two datasets. The first dataset allows us to construct the geographical concentration of industries across US states, based on employment. We use the 1987 Standard Industrial Classification (SIC) data from the Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages (QCEW) for the year 1983, which gives us state-level employment at the four digit SIC.

The second dataset measures the swingness and decisiveness of electoral states in the presidential election¹⁸ of 1984. Strömberg (2005) develops a probabilistic voting approach to presidential election campaigns and estimates an approximate measure Q_s of the joint probability of a state s being both decisive in the Electoral College and a swing state with a very close state-level election. It therefore encompasses the two factors put forward by Propositions 2.4 and 2.5 as being important in determining trade policy. He shows how measure Q_s depends on several factors, such as the variance of national popularity-swings or the variance of electoral vote distribution, which could be interpreted as the state level and aggregate level uncertainties in the model of Section 2.1.

The Q -values are estimated for each presidential election using national and state-level measures. We use measure Q_s , estimated by David Strömberg for the 1984 presidential election for each state, whose mean and median are respectively 0.02 and 0.012, and that ranges between a value close to zero and 0.07. Table 2.1 presents the states with the highest and lowest measures of Q_s for the 1984 presidential election. Larger states with higher

¹⁷ Gawande and Bandyopadhyay (2000) give a detailed description of the derivation of this dummy.

¹⁸ This data was kindly provided by David Strömberg.

Table 2.1. Q_s measure for 1984 presidential election

States	Electoral college votes	Q_s
Texas	29	0.0719
Pennsylvania	25	0.0704
California	47	0.0691
Illinois	24	0.0685
Ohio	23	0.0653
Michigan	20	0.0542
Florida	21	0.0524
.....
Arizona	7	0.0015
Nevada	4	0.0011
Rhode Island	4	0.0008
Nebraska	5	0.0003
Wyoming	3	0.0002
Idaho	4	0.0000
Utah	5	0.0000

numbers of electoral college votes tend to have a higher value of Q_s . The most swing and decisive state is Texas, and states such as Ohio and Florida also exhibit higher than average values in 1984. States that are least swing and decisive are smaller states and strong political orientation such Utah (Republican). The probability of being swing and decisive is never 0 or 1, reflecting, as in our model, that no state is expected to be won with certainty. The NTBs in place in 1983 would, according to our model, be related to the expected swingness and decisiveness for the forthcoming election. This is exactly what the Q_s^{1984} measure. At the national level, the Democrat proportion of the two-party vote share in trial-heat polls, economic growth, incumbency and incumbent president running for re-election are used. Moreover, at the state level, the difference from the national mean of the Democrat proportion of the two-party vote share in the 1980 election, the average ADA-scores¹⁹ of each state's Congress members the year prior to the election and the difference between state and national polls are included. Appendix 2.E describes the construction of this measure by Strömberg in detail.

¹⁹ ADA (Americans for Democratic Action) scores, ranging from 0 to 100, are used as a measure of legislator ideology.

The well-established Q_s measure of Strömberg (2005) constitutes a convenient measure for the reduced form specification as it combines the ‘swingness’ of states, reflecting the electoral competitiveness, with ‘decisiveness’, reflecting the size of states and the necessity of winning a certain number of states to win the overall election. To check the suitability of this measure, we calculate the correlation between the Q_s for the 1984 presidential election and a state-industry Herfindahl index in 1983. This is found to be -0.4 (significant at the 1% level), showing that industrial concentration is not directly correlated with the probability of being swing and decisive.

Since the political data, encapsulated by measure Q_s , is constructed at the state level, while trade protection is measured at the industry level, we use the BLS dataset to link the two dimensions by creating an industry-specific measure of swingness and decisiveness. Besides being necessary for the empirical analysis, it also corresponds to the assumption of our model that employees of a sector in a state are protectionist swing voters in that state. In order to abstract from any size effects, we measure the state specialisation of each industry as the deviation in each state from its mean share of national employment. We can then compute a 4-digit SIC ‘ Q_s ’ measure, denoted by q_i using:

$$q_i = 1000 \times \sum_{s=1}^S \left[Q_s \times \left(\frac{L_{is}}{L_s} - \frac{L_i}{L} \right) \right] \quad (2.31)$$

where $i \in I$ denotes each of the 242 4-digit SIC industries used by Gawande and Bandyopadhyay (2000) and $s \in S$ denotes each of the 48 continental states²⁰. Total US employment is represented by L , while aggregate industry and state employment are respectively L_i and L_s . Industries that constitute a higher proportion of a state’s employment than their proportion of national employment, for a given Q_s , have a higher q_i . Conversely, if an industry constitutes a lower proportion of a state’s employment than it does of national employment, then q_i is lower. Moreover, for a given proportion of a state’s employment, if the state has a low joint probability of being both swing and decisive, then q_i is low. Taking the deviation from the mean rather than a pure state level measure of concentration allows us to abstract from the possibility that nationally important industries will be important in all

²⁰ Excluding the District of Columbia, Alaska, Hawaii, Puerto Rico and the Virgin Islands.

Table 2.2. Descriptive statistics of q

Descriptive statistics of q_i		Correlation of q_i with
Mean	Min	Labour intensity
0.07	-0.49	0.14
Median	Max	Proportion of unskilled workers
0.03	1.45	-0.04
sd	Range	Total employment
0.17	1.94	0.49

Notes: Industry- specific measure of swingness and decisiveness, q_i , computed from data for 242 four-digit SIC industries using Strömberg's (2005) measure of the probability of being swing and decisive and the Bureau of Labour Statistics employment dataset. Summary statistics are provided in the first two columns of the table. The third column reports the correlation of the measure with three other industry characteristics: Labour intensity, as the fraction of payroll in value added in 1982, Proportion of unskilled workers as the share of employees in an industry classified as unskilled in 1982, and total employment measured in millions of persons for 1982. Source: BLS (1983), 1982 Census of Manufacturing, Strömberg (2005).

states. The sum is multiplied by 1000 as multiplying the probability Q_s by a share yields very small numbers.

Table (2.2) presents the descriptive statistics of this constructed measure, which show that it varies widely across industries. This confirms that industrial concentration through space and in specific swing and decisive states is not uniform. We check that our results are robust to excluding outlying observations of q_i . The correlations with other industry characteristics are reported in the third column of the table. Total employment, labour and skill intensity are not correlated with q_i , demonstrating that larger, or more skill or labour intensive industries do not systematically concentrate more in states that are more likely to be swing and decisive.

Augmenting the specification of Gawande and Bandyopadhyay (2000) to include the constructed industry level swingness and decisiveness variable, q_i , gives the following specification:

$$\frac{t_i}{1+t_i} = \gamma_0 + \gamma_1 I_i \frac{z_i}{e_i} + \gamma_2 \frac{z_i}{e_i} + \gamma_3 q_i + Z_{1i} + Z_{2i} + s_i \quad (2.32)$$

which is also corrected for the simultaneity bias by using IV. The campaign contributions literature does not suggest the concentration of industries in swing and decisive states as a determinant for trade policy decision-making, implying that γ_3 is zero. The next section provides evidence that q_i is a significant determinant of NTB protection of an industry, thus lending support to our theoretical results.

2.2.3 Empirical Results

Our findings are reported in table (2.3). The first column reports the results of the benchmark specification given by (2.29). It is consistent with the coefficients reported²¹ in Gawande and Bandyopadhyay (2000) and qualitatively close to those obtained by Goldberg and Maggi (1999). As predicted by Grossman and Helpman (1995), in politically organised sectors, higher industry output relative to imports and a lower price elasticity of imports increases the level of protection ($\gamma_1 > 0$). In politically disorganised sectors, the coefficient has the opposite sign ($\gamma_2 < 0$). As mentioned above, there is a slight concern about the number of instruments used by Gawande and Bandyopadhyay and Trefler. The J-test of overidentification, or Hansen test reports low p-values thus rejecting the validity of the instruments. By including our variable of swingness and in our willingness to keep the same instruments as those used in our benchmark, the problem remains although the p-value improves slightly. In future work, it would be necessary to improve the choice of instruments so as to solve this problem.

The results from specification (2.32) appear in column (2). Our measure of “industry swingness and decisiveness” does not affect the sign, magnitude of the coefficients on $I_i(z_i/e_i)$ and z_i/e_i . Their significance is only slightly reduced, indicating a relative robustness of the Grossman Helpman model. The point estimate of γ_3 is 0.192 (significant at the 1%, with a robust standard error of 0.038). Thus sectors that concentrate more than their national average in swing and decisive states receive more protection. This estimate translates

²¹ The significance levels of the coefficients are smaller than those reported in their paper due to our use of robust standard errors.

Table 2.3. Reduced form regression results

Dependent Variable:	NTB _i / (1+NTB _i)			
	(1)		(2)	
	Beta		Beta	
q _i			0.192** (0.038)	0.233
I _i (z _i /e _i)	4.761+ (2.781)	1.383	3.330 (2.532)	0.967
z _i /e _i	-4.704+ (2.664)	-1.384	-3.319 (2.402)	-0.977
Intermediates' tariffs	0.734* (0.319)	0.190	0.809** (0.312)	0.209
Intermediates' NTBs	0.378** (0.090)	0.388	0.337** (0.086)	0.345
Observations	242	242	242	242
F-test model (p-value)	0.00	0.00	0.00	0.00
J-test overidentification (p-value)	0.04	0.04	0.08	0.08
Centered R ²	0.21	0.20	0.29	0.28
Estimator	2SLS		2SLS	

Notes: IV-2SLS regressions, instruments reported in appendix D. Robust standard errors in parentheses; + denotes statistical significance at the 10% level; * denotes statistical significance at the 5% level; ** denotes statistical significance at the 1% level. Includes constant not reported. The dependent variable is the Non Tariff Barriers coverage ratio. In both specifications, (z_i/e_i) is the ratio of inverse import penetration to import elasticity. I_i (z_i/e_i) is the same ratio multiplied by a dummy I_i that indicates whether a sector is politically organized or not. Intermediates tariff is computed as the average tariff on intermediate goods used by industry I and Intermediates Ntb's the average Non Tariff Barriers coverage of these intermediates. In the second specification, an additional explanatory variable is added. Industry- specific measure of swingness and decisiveness, q_i, computed from data for 242 four-digit SIC industries using Strömberg's (2005) measure of the probability of being swing and decisive and the Bureau of Labour Statistics employment dataset. The beta coefficients are reported for both specifications. The p-values of the F-test model and J-test overidentification are reported. Data source: Gawande and Bandyopadhyay (2000), Strömberg (2005), BLS (1983) and authors own calculations.

into a normalised beta coefficient of 0.233, such that a one standard deviation increase in the industry's swingness and decisiveness will increase the US NTB coverage ratio for that sector by approximately 0.233 standard deviations. Although this beta is smaller than that of the Grossman-Helpman variables, it is more significant, and as important as the trade protection measures on intermediates. Moreover, including our measure of swingness and decisiveness explains a larger proportion of the variation of protection levels across sectors, as it increases the centered R^2 by 30 per cent relative to the Gawande and Bandyopadhyay (2000) benchmark specification.

These findings provide supporting evidence for the hypothesis that industrial concentration in swing and decisive states is an important determinant of trade protection of that industry, highlighting geographical concentration of industries in politically key states an important, and previously overlooked, determinant of trade protection in the US Electoral College.

2.3 Conclusion

The political agency model developed in this chapter offers a multi-jurisdictional framework for analysing electoral incentives for trade protection. For distributions of voters where support by swing voters increases re-election probability, a unique equilibrium is shown to exist where political incumbents build a reputation of protectionism through their policy decisions in their first term of office. The extension to a multi-state framework modelled as an electoral college introduces a spatial dimension that shows how the incentives driving trade policy hinge on the distribution of swing voters across swing states. We show that strategic trade protection is more likely when protectionist swing voters have a lead over free-trade supporters in states with relatively strong electoral competition, swing states, that also represent a larger proportion of electoral votes, thus being more decisive in the overall election. The analytical results offer a theoretical explanation for why governments may sometimes push for the protection of industries with concentrations in pivotal locations, such as the US steel production industry. Moreover, our empirical strategy aims at augmenting the benchmark test of the lobbying political economy of trade literature to

include a measure of how industries specialise geographically in these swing and decisive states. The reduced form evidence is that the concentration of industries in politically important states is a significant element in explaining trade policy. These findings provide support for the theory highlighting an important, and previously overlooked, determinant of trade protection.

2.A Voter Value Functions

Section 2.1 establishes the optimality of the incumbents' strategies, given voters' strategies, for the equilibrium where $\Delta v > 0$. This appendix shows that the re-election rule of the infinitely-lived F and P swing voters is also optimal, given politicians' strategies. This confirms that the politicians' and voters' strategies constitute a Markov Perfect equilibrium of the game.

Let V_P denote the value function for a protectionist voter. Further, let σ_P^r denote the probability that a P voter votes for the incumbent, given policy r in his first term of office. σ_P^r contributes to the incumbent's re-election probability by a tiny amount, thus marginally affecting his prospective payoffs. σ_P^r is thus introduced in V_P as an argument of the incumbent's re-election probability, $f(\cdot)$, which is smooth and continuous from the assumptions of the model. Further, let $u_P^1(\pi)$ denote the utility of P voters in the incumbent's first term of office, where π is the probability of the incumbent having protectionist views. Similarly, denote P voters' second term utility as $u_P^2(\tilde{\pi}^r)$, where this is a function of update beliefs after observing r in the first term. Finally, β is the common discount factor. Combining these allows the value function, V_P , to be expressed as follows:

$$V_P = u_P^1(\pi) + \beta \sum_r [f(\sigma_P^r) (u_P^2(\tilde{\pi}^r) + \beta V_P) + (1 - f(\sigma_P^r)) V_P] \quad (2.33)$$

The following proof uses (2.33) to show that given incumbents' strategies, $\sigma_P^0 = 0$ and $\sigma_P^1 = 1$ are optimal responses. That is, protectionists vote for the incumbent if he chooses trade protection in his first term and for the challenger if free trade is chosen. In order for $\sigma_P^r = 1$ to be an optimal response, it must be true from (2.33) that $u_P^2(\tilde{\pi}^r) + \beta V_P \geq V_P$. This can be rearranged to the following condition:

$$u_P^2(\tilde{\pi}^r) \geq (1 - \beta)V_P \quad (2.34)$$

To see this, consider that $f(\sigma_P^r)$ and $1 - f(\sigma_P^r)$ are weights for $u_P^2(\tilde{\pi}^r) + \beta V_P$ and V_P , respectively, in the value function. Voter P maximises his effect on $f(\sigma_P^r)$ through $\sigma_P^r = 1$,

and thus places the largest possible weight on $u_P^2(\tilde{\pi}^r) + \beta V_P$ relative to V_P . Hence, $\sigma_P^r = 1$ can only be optimal if (2.34) holds.

Recall that P voters receive a payoff x if $r = 1$ and 0 otherwise. Since $\Pr(r = 1 \text{ in 1st term}) = \pi + (1 - \pi)p$, it follows that $u_P^1(\pi) = [\pi + (1 - \pi)p]x > 0$. Moreover, since $\Pr(r = 1 \text{ in 2nd term} \mid r = 0 \text{ in 1st term}) = 0$, it follows that $u_P^2(\tilde{\pi}^0) = 0$. That is, the incumbent reveals himself to be a free-trader if he chooses $r = 0$ in his first term, given $\Delta v > 0$. Since the incumbent follows his preferences in his final term in office, P voters can be certain of a 0 payoff. If the incumbent sets $r = 1$ in his first term, then voters can update their beliefs regarding the probability of $r = 1$ being chosen in his second term, if re-elected. Applying Bayes' rule for $\tilde{\pi}^1$, P voters can expect $u_P^2(\tilde{\pi}^1) = \frac{\pi x}{\pi + (1 - \pi)p}$.

It must be true that $V_P \geq \frac{1}{1 - \beta} u_P^1(\pi)$, where $\frac{1}{1 - \beta} u_P^1(\pi)$ is the discounted stream of period 1 utilities, if the incumbent is never re-elected. Substituting into (2.34) yields:

$$u_P^2(\tilde{\pi}^r) \geq u_P^1(\pi) \quad (2.35)$$

This must hold for $\sigma_P^r = 1$ to be optimal, for all r , but leads to a contradiction. It cannot be true that $u_P^2(\tilde{\pi}^0) \geq u_P^1(\pi)$ since $u_P^2(\tilde{\pi}^0) = 0$ and $u_P^1(\pi) > 0$. Hence, $\sigma_P^r = 1$ (for all r) cannot be an optimal response. Since $u_P^2(\tilde{\pi}^0) < u_P^1(\pi)$, a new politician is always a better bet than an incumbent who set $r = 0$ in his first term. Hence, $\sigma_P^0 = 0$ is optimal. Moreover, continuation payoff $\frac{1}{1 - \beta} u_P^1(\pi)$ must be smaller than $\frac{1}{1 - \beta} u_P^2(\tilde{\pi}^1)$ under the equilibrium strategies of incumbents', so $\sigma_P^1 = 1$ is an optimal response.

The value function of free-traders, V_F , is symmetric to V_P and the optimality strategies $\sigma_F^0 = 1$ and $\sigma_F^1 = 0$ follows with arguments symmetric to those used above. We can thus conclude that the politicians' and voters' strategies constitute a Markov Perfect equilibrium of the game.

2.B Equilibrium Uniqueness

There are two symmetric cases, $\Delta v > 0$ and $\Delta v < 0$, where reputation-building through strategic policy implementation forms part of incumbents' optimal strategies. In each of

these symmetric cases, there is a unique equilibrium. To show that the equilibrium found in the chapter is unique, consider a distribution of swing voters under which $\Delta v > 0$ from the implementation of trade protection in the first term.

Recall that when a high cost c_H is drawn, it is a dominant strategy for free-trader politicians to set $r = 1$. Moreover, let σ_P^r denote the probability that a P voter votes for the incumbent, given policy r in his first term of office. Under a sufficiently low cost draw, c_L , it must be the case that $\sigma_P^1 > \sigma_P^0$ for a free-trader to deviate from $r = 0$. Similarly, for a protectionist to deviate from $r = 1$ in his first term of office, it must be true that $\sigma_P^1 < \sigma_P^0$. Hence, in any equilibrium at most one type of politician deviates from his preferred policy in the first term.

Moreover, to show that mixing between $r = 0$ and $r = 1$ cannot be an equilibrium, consider a strategy where a free-trader incumbent sets $r = 1$ with a probability less than 1 when $c = c_L$. For this to be an equilibrium, it must be the case that $\sigma_P^1 \beta \zeta - c_L = \sigma_P^0 \beta \zeta$ and hence that $c_L = (\sigma_P^1 - \sigma_P^0) \beta \zeta$. Inspection of V_P in Appendix A shows that $\sigma_P^1 = 1$ and $\sigma_P^0 = 0$ remain optimal. This, however, implies that $c_L = \beta \zeta$ that contradicts the assumption that $\beta \zeta > c_L$.

It can similarly be shown that a strategy in which a protectionist sets $r = 1$ with less than certainty can never form part of an equilibrium. Such a strategy requires that $\sigma_P^1 \beta \zeta = \sigma_P^0 \beta \zeta - c_L$, that implies $c_L = (\sigma_P^0 - \sigma_P^1) \beta \zeta$. This is impossible, however, since voters' optimal strategy in this case is to set $\sigma_P^1 = 1$ and $\sigma_P^0 = 0$. It follows that the unique equilibrium outcome is for an F incumbent to set $r = 1$ when $c = c_L$ and for a P incumbent to also set $r = 1$ under a low cost draw.

We can conclude that the equilibrium discussed in the chapter is unique for distributions of swing voters that satisfy the conditions for this case, and sufficiently low p and c_L . Symmetric arguments apply for the alternative case where $\Delta v < 0$.

2.C Untested Candidates

Consider an election taking place between two randomly selected candidates, each with a probability π of being protectionist. Since neither candidate has a history of a trade policy decision on which swing voters can condition their voting decision, the swing voters cast their vote on the basis of a coin toss. Each candidate can thus expect to gain $\frac{1}{2}(\gamma_P^s + \gamma_F^s)$. Hence, the Democrat candidate gains $\gamma_D^s + \frac{1}{2}(\gamma_P^s + \gamma_F^s) + \nu^s$ and the Republican candidate gains $\gamma_R^s + \frac{1}{2}(\gamma_P^s + \gamma_F^s) - \nu^s$. For the D candidate to win a majority in state s , $2\nu^s = \varepsilon^s$ must exceed $\gamma_R^s - \gamma_D^s = -\omega_p^s$. Let ρ^s denote the probability that the D candidate wins a majority in state s . It follows from the distribution of ε^s that:

$$\rho^s = \Pr(\varepsilon^s > -\omega_p^s) = 1 - H(-\omega_p^s) \quad (2.36)$$

$$= H(\omega_p^s) \quad (2.37)$$

Hence, $1 - H(\omega_p^s)$ is the probability that R wins majority in state s . Hence state-level outcomes depend only on the political lead in s and $H(\varepsilon^s)$. This stems from the assumption that single-issue voters randomly select between the two candidates, so each candidate can expect to gain support by half. An alternative voting strategy could allocate swing voters in a different proportion. For example, when candidates are not distinguishable with regards to trade policy, voters may cast a vote on the basis of underlying ideological position, that is otherwise dominated by trade policy considerations.

2.D Variables and Instruments

The following table provide a descriptions of all the variables and instruments used in the empirical analysis of section 2.2.

Table 2.4. Variables and instruments list

Variable	Description
NTB_i	Aggregate US Non Tariff Barriers coverage ratio across all partners for industry i
q_i	Constructed measure of the concentration of 4-digit SIC industry i in swing and decisive political states
I_i	Dummy variable, value 1 when sector i is politically organized
z_i	Inverse of import penetration ratio divided by 10000 (= (US consumption in 1983/ US total imports)/10000) in sector i
e_i	Price elasticity of imports in sector i , corrected for errors-in-variables (GB, 2000)
Interm. tariffs	Average tariff on intermediate goods used in industry i
Interm. NTBs	Average NTB coverage ratio on intermediate goods used in industry i
Instrument	
1	Average tariff on intermediate goods used in industry i
2	Average NTB coverage ratio on intermediate goods used in industry i
3	Price elasticity of imports (1986)
4	Logarithm of the price elasticity of imports e_i
5	Measure of the size of firms in an industry: Value added per firm, 1982, (\$Bn/firm)
6	Share of output in a sector produced by the four largest producers. concentration ratio, 1982
7	Share of employees in the industry defined as scientists and engineers, 1982
8	Share of employees in the industry defined as managerial, 1982
9	Share of employees in the industry defined as unskilled, 1982
10	Real Exchange Rate elasticity of imports
11	Cross price elasticity of imports with respect to domestic prices, corrected for errors-in-variables (GB, 2000)
12	Log percentage of an industry's output used as intermediate good in other sectors
13	Logarithm of the intermediate goods buyer concentration
14	Herfindahl index of the industry
15	Ad valorem tariff
16	Capital-Labor ratio of the industry x Dummy for food processing industry
17	Capital-Labor ratio of the industry x Dummy for resource-intensive industry
18	Capital-Labor ratio of the industry x Dummy for general manufacturing industry
19	Capital-Labor ratio of the industry x Dummy for capital intensive industry
20-36	Instruments 3 to 19 squared
37-52	Instruments 4 to 19 x price elasticity of imports e_i

2.E The Q_s measure by Strömberg

Strömberg (2007) builds a probabilistic-voting model of the Electoral College system with political competition. The model is applied to presidential elections in which the number of visits to the different states influences the probability of winning the state. Abstracting from non-Democrat or Republican parties and candidates, the model first identifies the approximate probability of winning the election, and then characterises the Nash Equilibrium in which the two candidates will spend the same number of days visiting a given state. It is also

characterised by candidates spending more time in states with a higher value of $Q_s = \frac{\partial P^D}{\partial \Delta u_s}$. $P^D(\Delta u)$ is the approximate probability of winning the election and

$$\Delta u = (\Delta u_1, \Delta u_2, \dots, \Delta u_s, \dots, \Delta u_S)$$

is the vector of utility differentials Δu_s that follows from the two candidates allocating campaign time differently in each state $s \in [1, S]$. Q_s can be separated in two components reflecting the reason for favouring states with high Q_s : first, the candidates have an incentive to increase the expected number of electoral votes won, and second, they also seek to influence the variance in the number of electoral votes.

According to the model, the value of Q_s depends on several parameters: the number of electoral college votes assigned to each state, e_s , the expected state-level Democratic vote shares for each state and each election, μ_{st} , the national, σ , and independent state-level uncertainty, σ_{st} , in these shares. t denotes the year of the election. Apart for the electoral college votes, e_s , the other elements need to be estimated by Strömberg. Strömberg (2007) initially assumes that all states have an equal variance of preferences, that the variance in state specific shocks is equal across states and that the predicted mean μ_{st} of the ideological preference distribution is a linear function of a set of observable variables, such that $\mu_{st} = \beta X_{st}$. Through a standard maximum-likelihood estimation of the time random-effects model hence derived from the main model, he estimates the parameters β , σ_{st} and σ .

The variables in X_{st} are taken from a state-level election-forecast model derived in Campbell (1992). At the national level, they are: the previous election Democratic vote share, Democratic vote share of the two-party vote share in trial-heat polls from mid September, second quarter economic growth, incumbency at the party and candidate level. At the state level, they are: difference from the national mean of the Democratic two-party vote share in the two previous elections, average ADA-scores of the states' Congress members in the year prior to the election and the difference between the state and national polls. As these were only available after 1984, prior to that, other variables used were the president's home state, the Democratic vote-share in the midterm state legislative election and first quarter state economic growth.

Using data for 50 states between 1948 and 2004, the parameters β , σ_s and σ are estimated by $\hat{\beta}$, $\hat{\sigma}_s (=0.073)$ and $\hat{\sigma} (=0.035)$. Also, $\hat{\mu}_{st} = \hat{\beta}X_{st}$ is estimated and used in conjunction with $\hat{\sigma}_s$ and $\hat{\sigma}$ to calculate Q_s , according to the main model.

Strömberg (2007) then shows that Q_s measures the joint probability of state being *ex post facto*, a swing state (as having a very close state-level election) *and* decisive in the Electoral College. Simulating the electoral vote outcomes of one million elections in 2000 and 2004, it is shown that the correlation between the simulated probabilities of a state being a decisive swing state and Q_s is 0.998. Also, the correlation between these probabilities per electoral college vote and Q_s per electoral vote is 0.998, so the probability does not just reflect size.

The measure Q_s , reflecting the probability of being a decisive swing state, is proportional to the number of electoral votes, implying that smaller states will hold an advantage. Another characteristic shown by the author is that this probability per electoral vote is higher in states where the forecasted state election result is between 50% and the forecasted national election outcome. Besides, the optimal allocations of campaign visits or other resources will be concentrated among fewer states as the forecasts of state-elections outcomes become more precise. Finally, a lagging candidate will have an incentive to increase the variance in electoral votes by spending more resources in large states in which he is behind than those in which he is ahead.

This appendix has described how Strömberg (2007) theoretically derives and then estimates the measure Q_s . Moreover, it has interpreted the measure and described its characteristics. Given that it reflects above all the swingness and decisiveness of each state, it constitutes a very well suited measure for our purpose and we use its values for the 1984 election in our empirical analysis.

Chapter 3

Imports and Exports at the Level of the Firm: Evidence from Belgium

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Introduction

It is a well known fact that the world is becoming economically more integrated. Between 1990 and 2004, world exports of goods and non-factor services increased by 116 per cent, surging to \$9,216 billion. This outstripped the rise in world GDP (in nominal terms), which during the same period rose by 63 per cent (UNCTAD, 2005). Recently, research efforts on the effects of the rising internationalisation of national economies on such outcomes as growth, employment and wage levels, have increasingly relied on the availability of firm-level data sets. This has shifted the focus of research from the level of countries and industries to the underlying micro-economic determinants of trade flows and their effects on firms and workers.

In this chapter, we extend the evidence of the micro-econometric literature on international trade by offering a complete view of the international trading activities of firms. While the next chapter will concentrate on the determinants of exports, and in particular on liquidity constraints, this chapter seeks to describe and understand the patterns of trade transaction data. For this purpose, we use a data set covering the whole population of Belgian companies matched with export and import data covering the period 1996-2004. This allows us to identify importers and exporters along with the country of destination of exports and origin of imports. In addition, we observe which and how many products are traded by individual companies as well as a number of other firm-level characteristics. The dataset also allows us to consider the broad Belgian economy rather than manufacturing firms only, and

to compare both importing and exporting activities. With the exception of Bernard, Jensen and Schott (2005) for the US, this is a clear improvement on the literature²².

This burgeoning micro-econometric literature on international trade has mostly focused on exports. This branch of the literature, starting from Bernard and Jensen (1995) and Aw and Hwang (1995), has allowed a detailed investigation of the choices of export market participation at the level of the firm. Greenaway and Kneller (2005) and Wagner (2007) provide two recent surveys of the literature. One of the main findings of this research is that exporters are superior to non-exporting firms along several firm-level characteristics, such as productivity, employment and R&D expenditure. The existing evidence suggests that trade is mostly conducted by a relatively small number of companies²³.

Thus far, imports have been less studied by the empirical literature. This is unwarranted given the recent surge in imports of intermediates²⁴. There are also strong theoretical reasons to expect that access to a larger variety or better quality of inputs, and technological spillovers across international borders, might have a positive impact on firm-level productivity (Ethier, 1982; Markusen, 1989; Grossman and Helpman, 1991; Feenstra, Markusen and Zeile, 1992).

Studies have overwhelmingly found that exporters are larger and more productive than non-exporters. This is mostly explained by the presence of fixed costs of exporting combined with the coexistence of firms with different productivity levels operating within a given industry²⁵. Theoretical models (Melitz, 2003; Bernard, Eaton, Jensen and Kortum, 2003) formally show that the most productive firms self-select into export markets. Firms whose

²² MacGarvie (2006) also considers the importing and exporting activities of French firms, but she focuses on their effects on patent citations. Tucci (2005), using a survey of Indian firms, finds that those engaged in both imports and exports have higher productivity levels than those that are not.

²³ Bernard and Jensen (1995) for the US and Eaton, Kortum and Kramarz (2004) for France, using comparable data sets in terms of coverage, find that only a minority of manufacturing firms (15 per cent in US and 17 per cent in France) export.

²⁴ Hummels, Ishii, and Yi (2001) find that, for OECD countries, around 20 per cent of total exports are due to imported intermediate inputs being used for further processing. Besides, one should not neglect the fact that imported final goods reach final consumers through firms operating as intermediaries.

²⁵ Bartelsman and Doms (2000) report that there is great dispersion in productivity levels across firms even in narrowly defined industry.

productivity is above a certain cut-off point will find it profitable to pay the fixed costs of exporting and start shipping goods abroad.

Part of our results corroborate existing findings while others are novel and lay the ground for future research. Considering firms operating in all sectors of the economy and not in manufacturing only, we find that the number of firms engaged in international trade has been increasing, along with their employment levels. However, their share in the total number of firms and employees in the economy has decreased during the sample period, due to new firms and jobs being generated mostly in the service sector. By definition, service firms are less likely to trade goods than firms in manufacturing or in the wholesale and retail sectors. Similarly, companies trading internationally are larger in terms of value added and employment than non-trading ones, although their contribution to value added and employment of the whole economy declined over the sample period.

Among traders, we find firms that solely import are the only category of traders accounting for a rising share of total value added and employment. This is also because importers are the only kind of trading firms whose share in the total number of firms increased. This suggests that importing activities (including international outsourcing and offshoring) are becoming an increasingly common practice even among service firms. Importers grew faster in terms of value added than exporters, but slower than companies that both import and export²⁶.

Our findings also point to the existence of fixed costs of importing besides fixed costs of exporting. Both imports and exports appear to be strongly concentrated among the largest, in terms of both employment and value added, and most productive firms. As previously described in the literature focusing on exporters only, we show that traders outperform non-traders. They are more productive and spend on average more on R&D. Furthermore, two-way traders do better than traders on these two scores. The concentration of international trade among the largest and most productive firms may be generated by fixed costs, since only the best firms can afford to meet them and then start trading internationally.

²⁶ Henceforth, we will refer to companies that both import and export as two-way traders to distinguish them from firms that just export or import, which we will simply call traders.

Only a minority of firms import and when they do so, most firms source intermediate goods from a small number of countries. This corresponds to the behaviour of exporting business. Firms tend to export only a small share of their output and serve only few foreign markets. There is a negative relationship between the number of exporting firms and the number of export destinations they serve²⁷. The same type of relationship holds true at product level. Traders export or import a relatively small number of goods and the number of trading firms decreases as the number of products traded increases.

Our results also suggest that the number of export markets served and the number of import origins increases with productivity. Furthermore, productivity is also increasing as the number of products exported or imported rises. These positive relationships suggest that both fixed costs of imports and of exports are incurred for each new country or product with which firms start trading.

The rest of the chapter proceeds as follows. The next section briefly overviews the existing literature concerning importing and exporting behaviour at the level of the firm. The data set is described in Section 3.2. The evidence we provide is discussed in Section 3.3, while Section 3.4 presents some conclusions.

3.1 Exports, Imports and Firm-Level Characteristics

The micro-economic literature in international trade was pioneered by the work of Bernard and Jensen (1995) and Aw and Hwang (1995) on export market participation. These and many successive studies spanning different countries and time periods have overwhelmingly confirmed the theory that exporters enjoy better performance characteristics than non-exporters. The theoretical models of Melitz (2003) and Bernard, Eaton, Jensen and Kortum (2003) build these stylised facts into an international trade general equilibrium model to show how the most productive firms self-select into export markets.

²⁷ Eaton, Kortum and Kramarz (2004) and Damijan, Polanec and Prasnikar (2004) present similar findings concerning the exporting activities of French and Slovenian firms.

An alternative explanation has been also put forward to explain the productivity advantage of exporters over non-exporting firms (Clerides, Lach and Tybout, 1998), namely the learning-by-exporting hypothesis. Testing the self-selection versus learning-by-exporting hypothesis has attracted a great deal of research effort. Initial evidence provided convincing support for self-selection. The arguments were perhaps most powerfully put by Bernard and Jensen (1999, 2004). In their study of US plants, they found that even though exporters had a higher level of productivity, the rate of their productivity growth was not significantly different from that of non-exporters. They also provided evidence that new exporters were already among the best and differed significantly from the average non-exporter²⁸.

More recently, the hypothesis under test has evolved and started to consider whether or not there is any productivity improvement that is conditional on self-selection: does the performance of newly-exporting firms improve relative to similar firms that did not start exporting? This involves controlling for the selection effect in the export decision. Here, the results are less clear-cut. On the one hand, Baldwin and Gu (2004) for Canada, Castellani (2002) for Italy, Damijan, Polanec and Prasnikar (2004) and De Loecker (2004) for Slovenia and Van Biesebroeck (2005) for a set of African countries find evidence of productivity improvements in companies after they started to export. On the other hand, Wagner (2002) for Germany find no evidence supporting the learning-by exporting hypothesis.

Recently, Eaton, Kortum and Kramarz (2004) and Damijan, Polanec and Prasnikar (2004) have added a new dimension to the literature on exports at company level by investigating export-destination data. Eaton, Kortum and Kramarz (2004) look at a cross section of French firms in 1986. Their contribution runs along two main lines of thought. Firstly, they show that there is a negative relationship between the number of firms selling to multiple markets and the number of foreign markets they serve. Secondly, the variation of French exports across destinations is mostly evident at the extensive margin (i.e. number of firms selling there) rather than the intensive margin (i.e. output firms already exporting sell there).

²⁸ In this literature, different measures of productivity have been used. Some studies have used labour productivity (i.e. value added per worker). Others have employed total factor productivity measures, which take into account the contribution of all inputs. Results overall appear to be robust the methodology used to compute productivity.

They show that a 1 per cent increase in the French export market share of a foreign country market (i.e. gross production plus imports less exports) reflects a rise of around 0.88 per cent in the number of firms exporting there, whereas only 0.12 per cent is due to higher sales of firms already exporting to the same destination.

Damijan, Polanec and Prasnikar (2004) show that productivity is positively associated with the number of export markets firms serve²⁹. This suggests that fixed costs of exporting re-occur at the entrance of each new export market. Also, they show how firms penetrate new export markets gradually (on average one every two years) and start exporting to the countries with low fixed costs.

The abundance of empirical evidence concerning the export behaviour of firms contrasts with the paucity of studies focusing on their importing activities³⁰. It is a truism to say that the surge in international trade is due not only to the rise in exports, but also in imports and that therefore both sides of the coin deserve to be investigated. However, anecdotal evidence of the rise in international outsourcing makes the study of imports at the level of the firm all the more interesting in itself. Surprisingly, there is little systematic and consistent evidence across countries on the increase in trade in intermediates. Hummels, Ishii and Yi (2001) calculate the degree of vertical specialisation for a number of OECD countries using input-output tables. They find that, between 1970 and 1990, the share of imported inputs used to produce goods that are exported rose by around 30 per cent to 21 per cent of the total exports of the countries considered³¹.

Also, there are theoretical reasons to expect that imports of intermediates will impact upon firms, in particular on productivity levels. Building on Ethier (1982), Markusen (1989) argues that trade liberalisation of intermediates raises technical productivity at the final good production stage, if the final and intermediates sectors have non-constant returns to scale. This is because of the complementarities of domestic and foreign specialised inputs. With

²⁹ They analyse a Slovenian firm-level data set from 1994 to 2002.

³⁰ There are a number of empirical works that have investigated the effect of import competition. For instance, Pavcnik (2002) shows that firms in import-competing industries experienced productivity gains after trade liberalisation.

³¹ See Campa and Goldberg (1997) for the US, UK and Canada and Strauss-Kahn (2003) for France.

free trade in inputs, "each country essentially confers a positive technological externality on its trading partner" (Markusen 1989). Feenstra, Markusen and Zeile (1992) show that an increase in input variety is positively correlated with total factor productivity (TFP). In endogenous growth models with international trade, the productivity level of a country can increase because of externalities not only from its own R&D spending, but also from R&D expenditure by trading partners. (Grossman and Helpman, 1991).

To date, there is only scant empirical evidence on the effects of imports on firm-level characteristics. The available studies suggest the existence of a positive relationship between imports and productivity³². Only Bernard, Jensen and Schott (2005) for the US, Tucci (2005) for India and MacGarvie (2006) for France have so far provided a comparative analysis of the exporting and importing behaviour of firms and its impact. The analysis that follows is more in the spirit of the study of Bernard, Jensen and Schott (2005). They show how US imports and exports are both heavily concentrated in the hands of a relatively small number of firms. Furthermore, they show how traders account for a disproportionate share of total employment, when compared with their numbers, and how firms that trade with more countries and/or more products tend to be larger³³. They also argue that companies which both import and export tend to dominate US trade flows and employment among trading firms.

³² Schor (2004) compares the effect of output and input tariff cuts on Brazilian manufacturing productivity and finds that they are similar in magnitude. Muendler (2004) extends her analysis to consider explicitly the role of imported inputs in a production function. He finds that imported equipment and intermediates have a larger effect on output than domestically produced analogous inputs. However, their contribution to aggregate productivity changes is minor when compared to productivity improvements within individual firms and the exit of less productive firms due to import competition. Amiti and Konings (2005) make a comparative analysis in the spirit of Fernandes (2007). They study the different effects of output and input tariff cuts on firm-level productivity in Indonesia. They find that both tariff cuts boost productivity, but that the effect of reducing input tariffs is three times larger than that of cutting output tariffs. Furthermore, the effect is even stronger for importing firms. Halpern et al. (2005) show that the significant effect of imports on total factor productivity in Hungary in the 1990s operates through productivity improvements and through the reallocation of capital and labour to importers.

³³ MacGarvie (2006) studies the effect of imports and exports of French firms on foreign patent citations. Importing activities cause the number of foreign patents cited by importers to increase, whereas this is not true for exporters. This is taken as evidence that imports, contrary to exports, facilitate access to foreign technology. Tucci (2005) finds a combined effect of imports and exports within trade networks when analysing a survey of Indian firms. She shows that the more a firm participates in international networks, defined by the combination of import and export shares, the higher its productivity advantage. Also, Indian firms that concentrate export and import activities on a specific geographical area are more productive.

3.2 Description of the data and sample coverage

Firm-level accounts. The Central Balance Sheet Office at the National Bank of Belgium (NBB) collects the annual accounts of all companies registered in Belgium. Most limited liability enterprises, plus some other firms, have to file their annual accounts and/or consolidated accounts with the Central Balance Sheet Office every year. Large companies have to file the full-format balance sheet. Small companies may use the abbreviated format³⁴. There are some exceptions. Some enterprises do not have to file any annual accounts³⁵. In certain cases, these companies have to submit a social balance sheet to the Central Balance Sheet Office. The social balance sheet contains specific information about the workforce, such as the number of people employed, personnel movements, training, etc.

The data set does not cover firms in the financial sector. For this study, we selected those companies that filed a full-format or abbreviated balance sheet between 1996 and 2004³⁶. To avoid double counting, we did not select firms filing consolidated balance sheets, either. Those balance sheets that cover more than one year or report data from two different calendar years were annualised to match the customs data.

Customs data. Trade data on individual transactions concerning exports or imports are collected separately at company level for intra-EU (Intrastat) and extra-EU (Extrastat) trade. Different types of international trade transactions are reported. To classify firms as exporters and/or importers, we consider only those involving a change in ownership³⁷. Com-

³⁴ Under the Belgian Code of Companies, a company is regarded as large if: the annual average of its workforce exceeds 100 persons or more than one of the following criteria are exceeded: 1) annual average of workforce: 50; 2) annual turnover (excluding VAT): 7,300,000 euro; 3) balance sheet total: 3,650,000 euro.

³⁵ These include: sole traders; small companies whose members have unlimited liability: general partnerships, ordinary limited partnerships, cooperative limited liability companies; large companies whose members have unlimited liability, if none of the members is a legal entity; public utilities; agricultural partnerships; hospitals, unless they have taken the form of a trading company with limited liability; health insurance funds, professional associations, schools and higher education institutions.

³⁶ This is because social balance sheets contain only limited information.

³⁷ Records of international trade transactions also have to register movements of goods across borders which do not involve any change of ownership. These concern movements of stock, or goods sent or received for further processing, or for repair (after the repair has been executed). Furthermore, international trade transactions have to register the return of merchandise and other special movements of goods. For more details, see also Institut des comptes nationaux (2006). In order to give more information, recorded international trade transactions regard only goods that have actually transited the country. This therefore excludes the so-called triangular trade, whereby two firms in two different countries (for instance A and C) exchange goods through

panies report Intrastat transactions monthly. Companies are only liable for Intrastat declarations if their annual trade flows (receipts or shipments) exceed the threshold of 250,000 euro.

There are two kinds of declaration, the standard one and the extended declaration. Both declarations must include for each transaction the product code, the type of transaction, and the destination or origin of the goods, the value, the net mass and units. Companies which exceed the threshold of 25,000,000 euro for their annual receipts or shipments must fill up the extended declaration³⁸. In addition to the same common variables of the standard declaration, the means of transport and the conditions of delivery must be included in the extended declaration.

Extrastat contains exactly the same information as Intrastat for transaction flows with countries outside the European Union. The data is collected by customs agents and centralised at the National Bank of Belgium. The Extrastat data cover a larger share of the total trade transactions than Intrastat data, because all flows are recorded, unless their value is smaller than 1000 euro or their weight smaller than one tonne.

an intermediary operating in a third country (B). The intermediary buys the goods from the seller in country A and sells them to the buyer in country C. However, the goods are shipped by the original seller (in country A) to the final buyer (in country C), without transit through country B. Official figures suggest that this kind of trade is a non-negligible phenomenon in Belgium, but it will be recorded among imports or exports of services and not of goods.

³⁸ They must file an extended declaration for the flow of goods which exceeds this threshold. The extended declaration was introduced in 2002.

Table 3.1. Merged balance sheet data and customs data

	Number of firms		Number of employees (thousands)		Value added (thousands of Euros)	
	1996	2004	1996	2004	1996	2004
Firms included in the balance sheet data set	216,137	301,674	1,590.89	1,817.1	99,790.8	147,668.7
<i>of which, firms with at least 1 full-time employee</i>	96,417 (44.61%)	107,180 (35.53%)	1,589.43 (99.91%)	1,804.1 (99.29%)	93,931.09 (94.12%)	137,351.2 (93.01%)
Firms included in the customs data set, but not in the balance sheet data set	15,601	94,223				

Source: NBB-BBSTTD.

Merger of balance sheet and customs data. The Belgian Balance Sheet Transaction Trade Dataset (BBSTTD) results from the merging of the balance sheet data and the customs data at the level of the firm through the value added tax (VAT) number. This is a unique code identifying each firm. The merger was highly successful. As shown in Table 3.1, only 7.22 per cent of the firms in the customs data in 1996 and 4.67 per cent of them in 2004 were not merged with the balance sheet data set. These legal entities have a VAT number but do not file any accounts with the Central Balance Sheet Office³⁹. Although these firms only make up a marginal fraction of the whole population, they accounted for 26.4 and 35.9 per cent of total imports in 1996 and 2004 and 25.5 and 37.2 per cent of total exports. More information about these unmatched firms is given in Table 3.2. The bulk of trade conducted by unmatched firms in 2004 was attributed to foreign firms with no actual production site in Belgium. Therefore, our results are unlikely to be biased by this matching issue. In the data, there are a large number of firms reporting no employees at all or only one part-time equivalent employee. In the following analysis, we focus only on those firms with at

³⁹ These entities can well be firms that are part of larger group filing consolidated accounts. We do not use consolidated accounts. But even with consolidated accounts, it would be extremely difficult to disentangle the data related to those firms trading internationally but not filing accounts from the information concerning other firms in the group.

least one full-time equivalent (FTE) employee⁴⁰. Although selecting just these companies means losing more than half the total number of firms recorded in both 1996 and 2004 (see Table 3.1), this does not lead to any significant loss of information. The selected firms together account for most of the economic activity in Belgium. Table 3.1 shows that firms employing at least one worker accounted for 94.12 per cent of total reported value added⁴¹ in 1996 and 93.01 per cent in 2004. Hence, our matched data set appears to adequately represent the Belgian economy.

Table 3.2. Unmerged balance sheet data and customs data (year 2004)

Type of firms	% of unmatched exporting firms	% of unmatched exports	% of unmatched importing firms	% of unmatched imports
Foreign firms with no establishment in Belgium	14.4%	59.7%	13.7%	58.6%
Foreign firms	8.5%	21.4%	10.8%	21.1%
Non-profit organisations	2.5%	13.5%	3.6%	14.3%
Others	74.6%	5.4%	71.8%	6.0%

Source: NBB-BBSTTD. Note: The judicial situation of firms with no Balance Sheet is obtained through the Crossroads Bank for Enterprises (BCE-KBO).

Table 3.3 provides more information about the non-merged observations for 2004. As can be seen, more than 55 per cent of both export and import trade not merged with annual accounts data is conducted by foreign firms with no establishment in Belgium. These are trading firms with a VAT representative. They are most probably trading platforms of other European firms using Belgium as their port of entry. Some might have been established for

⁴⁰ Henceforth, if we refer to an employee or worker one should understand Full-Time Equivalent Employee. This corresponds to item 9087 in the balance sheet.

⁴¹ Value added is measured differently for firms filing full-format or abbreviated balance sheets. The difference between sales and inventory in products, services and miscellaneous goods is computed for full-format balance sheets as items (70/74 – 740 – 60 – 61). In the case of abbreviated accounts, it is approximated by the gross operating margin (70/61 or 61/70).

fiscal reasons by Belgian firms to conduct trade for them, but this cannot be checked in the data. About 20 per cent of the unmatched imports and exports can be attributed to foreign firms producing in Belgium. Their annual accounts are not available, but this is probably because they are part of a larger group of firms filing consolidated accounts.

To investigate the sample coverage at industrial level, Table 3.3 shows the shares of firms and employment levels for different sectors of the economy, considering firms with at least one employee and those with at least five employees. To provide an overview of the dynamics of broad sectoral divisions of the Belgian economy, we consider the following industries: agriculture, fishing and mining, manufacturing, recycling, utilities and construction, wholesale and retail, services, coordination centres and firms with no industry classification.

Overall, the figures in Table 3.3 are broadly consistent with anecdotal evidence suggesting that most of the new small firms and start-ups are in the service sector, whereas manufacturing is shrinking and moving towards a process of consolidation favouring large firms⁴². The share of manufacturing declined during the same period. Considering firms with at least five employees, their share decreased from 24.3 per cent to less than 20 per cent. The decrease was a little milder when including smaller firms. Recycling, utilities and construction - another important sector - maintained a stable share in the total number of firms.

The last two columns of Table 3.3 show the shares of employees in each broad sector. Manufacturing and services are the two largest employers, each accounting for between 30 and 40 per cent of total jobs in our sample. Other large employers are, in descending order, wholesale and retail (around 20 per cent), and recycling, utilities and construction (between 10 and 11 per cent). Services and manufacturing appear to be on divergent paths. In 1996, manufacturing accounted for more than 36 per cent of jobs in the whole economy. The contribution of services was around 31.5 per cent. This ranking was reversed in 2004

⁴² In both 1996 and 2004, the service and wholesale and retail sectors accounted for the majority of all firms in the economy. The number of firms in the service sector increased in both employment classes we consider. This sector's share rose from 33.1 per cent to nearly 38 per cent (for firms with at least one employee) and from 27 to 32.7 per cent (for those with at least five employees) from 1996 to 2004. The contribution of the wholesale and retail sector to the total number of firms, although still prominent in 2004, declined during the sample period. The decrease was sharper when considering firms with at least one worker.

as their respective shares were now 30 and 37 per cent. Also, during this period, the share of the wholesale and retail sector in terms of employment increased while that of recycling, utilities and construction remained stable.

Table 3.3. Number of firms and employees per sector

Sector	NACE Code Bel	Number of firms				Number of employees (thousands)			
		At least 1 full- time employee		At least 5 full- time employees		At least 1 full- time employee		At least 5 full- time employees	
		1996	2004	1996	2004	1996	2004	1996	2004
Total		96,416	107,180	37,518	42,730	1,589	1,804	1,477	1,660
of which:									
<i>Agriculture, Fishing, Mining</i>	1-14	1.9%	2.1%	1.6%	1.9%	0.8%	0.9%	0.7%	0.7%
<i>Manufacturing</i>	15-36	15.8%	13.3%	24.3%	19.9%	36.5%	29.6%	38.4%	31.4%
<i>Recycling, Utilities and Construction</i>	37-49	14.3%	14.6%	15.9%	15.5%	11.0%	10.5%	10.7%	10.2%
<i>Wholesale and Retail</i>	50-54	34.2%	31.9%	30.4%	29.6%	19.4%	21.1%	18.2%	20.1%
<i>Services</i>	55-98	33.1%	37.9%	26.9%	32.7%	31.6%	37.3%	31.4%	37.1%
<i>Coordination centres</i>	74152	0.3%	0.2%	0.7%	0.5%	0.5%	0.5%	0.5%	0.6%
<i>Unknown</i>		0.5%		0.1%		0.2%		0.1%	

Source: NBB-BBSTTD.

Overall, Table 3.3 suggests that, as expected, firms and jobs are deserting manufacturing and growing in the service and wholesale and retail sectors. This is likely to have an impact on the evolution of the number and percentage of companies trading goods.

3.3 Evidence

Having described the dataset and considered its coverage, this section aims at exploring its content and highlighting several key elements related to exports and imports. In the following subsection, we investigate the number and percentage of firms and jobs accounted for by non-traders, and by traders, distinguishing between importers, exporters and two-way traders. We then break down these dynamics even further for the manufacturing sector. Next, we examine and compare the degree of concentration of both imports and exports. Then, focusing on the manufacturing sector, we analyse the firm-level characteristics of traders and non-traders. The information on export destinations, origins of imports and products traded are explored in the following two subsections. Finally, we provide some evidence on the productivity differential between non-traders and the different types of traders.

3.3.1 Importers, Exporters and Two-way Traders

As discussed in the introduction, the literature on firm-level trade has so far concentrated mainly on the exporting behaviour of firms. Few papers have considered their importing activities. This subsection provides new stylised facts on how intertwined these two activities are, and on their frequency both over time and across broad sectors.

Table 3.4 considers the number of firms in the sample distinguishing between the shares of non-trading firms, importers, exporters and those that both import and export (i.e. two-way traders)⁴³. Again, we focus our attention on firms with at least one or five employees.

⁴³ We performed the same analysis considering trade with countries outside the EU only. Trade data relating to transactions with non-EU countries are more reliable than data relating to EU counterparts. This is because the recording of trade transactions with EU countries is undertaken by the firm. On the contrary, transactions with partners outside EU are recorded by customs at the borders. Also, if the EU is considered as one single economy, only extra-EU trade would be considered as trade. The results for non-EU trade are similar to those found in Table 4. They are available upon request.

Table 3.4. Number and employees of traders and non-traders

	Number of firms				Number of employees (thousands)			
	Firms with at least one FT employee		Firms with at least 5 employees		Firms with at least one FT employee		Firms with at least 5 employees	
	1996	2004	1996	2004	1996	2004	1996	2004
Total	96417	107180	37496	42730	1589.4	1804.1	1477.5	1660.3
of which:								
<i>Non-Traders</i>	72.4%	77.0%	56.8%	62.4%	38.4%	38.4%	34.4%	34.4%
<i>Importers</i>	6.6%	8.0%	8.1%	10.9%	10.8%	10.8%	11.1%	11.1%
<i>Exporters</i>	4.2%	4.3%	5.0%	6.2%	3.6%	3.6%	3.6%	3.6%
<i>Two-way Traders</i>	16.8%	10.7%	30.1%	20.5%	47.3%	47.3%	50.9%	50.9%

Source: NBB-BBSTTD.

Overall, only a minority of firms export or import, which is consistent with previous empirical studies. Firms that export, meaning those that just export and those that both export and import, accounted for around 21 per cent of all firms in 1996 and 15 per cent in 2004⁴⁴. Interestingly, our data suggest that importing goods is a slightly more common practice than exporting. The percentage of firms importing goods was 23.4 in 1996 and 17.7 in 2004⁴⁵. Also, companies are more likely to engage in two-way trade (export and import at the same time) than doing just one or the other. The share of firms doing both was 16.8 per cent in 1996, but dropped to 10.7 per cent in 2004. On the whole, larger firms are more likely to trade.

⁴⁴ Bernard, Jensen and Schott (2005) report for the US that only 3.1 per cent of firms exported in 2000. They nevertheless consider all firms in the US with no limit on employment. Bernard and Jensen (1995) find that 14.6 per cent of manufacturers exported, excluding small plants. Eaton, Kortum and Kramatz (2004) obtain similar findings for France using cross-section data for all French firms for 1986. They find that 17.4 per cent of all manufacturers export. The different coverage of the data sets used in other studies made direct comparisons with other countries difficult. For instance, Kneller and Pisu (2004) find for the UK that export participation stands at around 65 per cent. However, the data they use under-represents small firms.

⁴⁵ When considering all firms in the US economy in 2000 with no limit of size, Bernard, Jensen and Schott (2005) find that 2.2 per cent of firms import while 3.1 per cent export. With no size threshold, these figures in the BBSTTD would be respectively 8.5 per cent and 6.9 per cent.

The last four columns of Table 3.4 show that most jobs in Belgium are generated by firms that have some type of involvement in trading goods internationally. Besides, two-way traders are the largest employers. They account for around 50 per cent of total employment. Comparing the first four columns of Table 3.4 with the last four, we have the stark contrast that non-traders make up the majority of firms in 1996 and 2004, but at the same time their share of total employment is much lower (being below 40 per cent).

As shown in Table 3.5, the growth in the total number of firms is mostly generated by both the service sector and non-trading firms. Thus, although the manufacturing sector has become more open and trade in goods has increased in value, a lower proportion of firms in the economy is involved in importing and/or exporting goods because new firms are mostly concentrated in the (relatively closed) service sector. The share of trading and non-trading firms is evolving differently in different industries. In manufacturing, the percentage of exporting- and importing-only firms increased. Surprisingly, however, the share of non-traders also rose over the sample period.

These changes are counterbalanced by the drop in the relative number of two-way traders⁴⁶. In services, traders of any type account for the decreasing share of the total number of firms, whereas the share of non-traders is increasing. Wholesale and retail trade is instead characterised by the rise in the share of importing-only companies.

⁴⁶ The share of two-way traders decreased in all broad sectors considered. This is at first sight surprising, above all in manufacturing, given the increasing importance of international trade. However, it may be possible that this phenomenon reflects a concentration of firms on core competences. This leads firms to become less vertically integrated and therefore to focus on only a particular stage of the whole production process, with the result that they will become just importers or exporters.

Table 3.5: Sectoral distribution of traders and non-traders (all firms with at least one full-time equivalent employee)

	Manufacturing		Wholesale and Retail		Services		Agriculture, Fishing and Mining		Others		TOTAL	
	1996	2004	1996	2004	1996	2004	1996	2004	1996	2004	1996	2004
Total, of which:	15,193	14,265	32,995	34,188	31,918	40,650	1,840	2,273	14,471	15,804	96,417	107,180
<i>Exporters only</i>	4.4%	7.3%	7.4%	6.6%	2.2%	2.1%	3.2%	7.2%	1.4%	1.7%	4.20%	4.3%
<i>Importers only</i>	6.4%	9.1%	11.4%	15.4%	3.3%	3.2%	3.0%	5.4%	3.4%	3.7%	6.60%	8.0%
<i>Two-way Traders</i>	36.8%	28.7%	26.6%	17.4%	3.0%	2.5%	16.3%	6.2%	3.8%	1.9%	16.80%	10.7%
<i>Non-Traders</i>	52.4%	55.0%	54.6%	60.6%	91.5%	92.1%	77.4%	81.2%	91.4%	92.7%	72.40%	77.0%

Source: NBB-BBSTTD.

Table 3.6: Sectoral distribution of employees of traders and non-traders (all firms with at least one full-time equivalent employee, thousands)

	Manufacturing		Wholesale and Retail		Services		Agriculture, Fishing and Mining		Others		TOTAL	
	1996	2004	1996	2004	1996	2004	1996	2004	1996	2004	1996	2004
Total, of which:	579.8	534.8	309.0	381.5	502.7	673.3	13.5	15.5	184.5	198.9	1589.4	1804.1
<i>Exporters only</i>	1.1%	2.5%	6.4%	6.0%	12.5%	3.0%	1.8%	7.9%	1.8%	3.3%	5.8%	3.6%
<i>Importers only</i>	3.0%	5.5%	9.9%	14.1%	9.1%	11.6%	4.4%	9.4%	13.8%	16.0%	7.5%	10.8%
<i>Two-way Traders</i>	85.9%	80.9%	58.8%	53.2%	29.2%	26.2%	49.4%	26.3%	24.9%	18.3%	55.3%	47.3%
<i>Non-Traders</i>	10.0%	11.1%	25.0%	26.6%	49.3%	59.2%	44.4%	56.4%	59.4%	62.5%	31.3%	38.4%

Source: NBB-BBSTTD.

In Table 3.6, it can be seen that, not surprisingly, non-traders appear to generate fewer jobs than traders in the manufacturing sector. In both 1996 and 2004, only around 10 per cent of employees in manufacturing worked for firms that neither imported nor exported goods. Wholesale and retail firms' employment became increasingly concentrated in non-trading firms, rising from 25 per cent to 26.6 per cent, possibly because new firms tend not to trade immediately.

Another interesting pattern to emerge from Table 3.6 is that the share of employment generated by importing-only firms increased in all industries. On the other hand, the share of jobs of exporting-only firms increased in manufacturing (from 1.1 to 2.5 per cent), but decreased in wholesale\retail (slightly) and services (markedly). In services, this was mainly due to the switch in the trading status of one very large firm. Two-way traders' employment declined in all sectors.

Alternative explanations for these trends can be suggested. It could be that firms increasingly use trade intermediaries or platforms for one leg of the trading activity, thus switching status from two-way trader to importer or exporter only. The data only identifies direct trade by a company, so there could also be a shift to indirect trade via a domestic wholesaler or retailer. Alternatively, outsourcing, offshoring or a concentration on core competences might possibly be affecting these numbers in different ways. These are all questions that should be addressed by further research.

Our results concerning the dynamics of firms and jobs (as a share of the total economy) and their trading status are in stark contrast with what Bernard, Jensen and Schott (2005) report for the US. They find that, over the 1993-2000 period, the contribution of traders (whether exporters, importers or both) to the total number of firms and workers in the US economy increased. A possible explanation for the different Belgian and US experience in this respect is the dissimilar evolution of the service and manufacturing industries in the two countries. Between 1990 and 2004, the contraction of the manufacturing sector, and the corresponding growth of the service sector, was in fact more pronounced in Belgium than in the US. In this period in Belgium, the contribution of manufacturing value added to total GDP decreased by 9.96 per cent, from 20.28 to 18.26 per cent. On the contrary, the

relative weight of the US manufacturing sector was virtually unchanged, although it had shrunk in earlier years. Manufacturing value added accounted for 18.07 per cent of GDP in 1990 and 18.24 per cent in 2004⁴⁷.

Table 3.7. Export and import share by broad sector

	Export Value (million euros)		Import Value (million euros)		Employment	
	1996	2004	1996	2004	1996	2004
Total	86,794	127,187	79,076	120,006	1,589,388	1,804,072
of which:						
<i>Manufacturing</i>	71.7%	69.6%	47.6%	47.1%	36.5%	29.6%
<i>Wholesale and Retail</i>	25.8%	26.3%	47.3%	46.1%	19.4%	21.1%
<i>Services</i>	1.2%	2.1%	2.2%	3.0%	29.4%	33.6%
<i>Others</i>	1.3%	2.0%	2.9%	3.8%	14.7%	15.6%

Source: NBB-BBSTTD.

Different sectors contributed in very different ways to the total value of exports and imports in goods, as they do in terms of other variables such as employment. In 1996, manufacturing unsurprisingly accounted for 72 per cent of total exports, while wholesale and retail and services had respective shares of 25.8 and 1.2 per cent, as shown in Table 3.7⁴⁸. Imports are less concentrated on one particular sector, with manufacturing and wholesale and retail both importing around 47.5 per cent of the total in 1996, possibly due to the pres-

⁴⁷ We computed these percentages considering national aggregates in constant 1990 prices in US\$. These values come from the UN National Accounts Main Aggregates Database as downloaded in January 2007. For a comparative analysis of the evolution of the manufacturing sector in Belgium with that of other EU countries and the US in the last 20 years, see Robert and Dresse (2005)

⁴⁸ The very slight decrease in the share of manufacturing is possibly due to either a question of classification or to certain services being increasingly attached to manufacturing goods. For example, when a software company exports its product, the trade will be recorded as the shipment of a CD-Rom, valued as if it were blank.

ence of large retailer chains. These companies are likely to source their imports from the cheapest locations and serve predominantly in the country where they operate.

There are two main conclusions to be drawn from this subsection. First, although the Belgian economy is becoming more open, most of the new jobs and firms are being created in the service sector where trade in goods is marginal. Second, if firms trade internationally, they are more likely to engage in both exports and imports instead of just one or the other. This fact has not been properly considered thus far by the literature, which has mainly looked at exports only.

3.3.2 Entry, exit and job creation or destruction in the manufacturing sector

Given the importance of manufacturing for trade in goods, in this subsection we break down the described changes in the number of firms and employment across the different trading categories over our sample period. These dynamics are reported in Table 3.8 and Table 3.10⁴⁹.

One must note that we define entry as the filing of a balance sheet by a firm with a new VAT number, and exit as the absence of a balance sheet being filed by a VAT-entity who had done so at least in the previous year. This means we are capturing excessive entry and exit: production units that are bought by other firms will appear as an exit, and firms created as a spin-off of an existing company will appear as an entry. Although this would not be a straightforward exercise, some of these errors could be controlled for by a careful use of data on bankruptcies. However, data at the production unit level is not available to us, and there is no data that provides the links between various VAT entities of one given firm within Belgium.

The trend in our data differs strongly across trading groups considered. Within our sample period, importers and exporters have greatly increased in number. On the other hand, the number of both non-traders and two-way traders decreased.

⁴⁹ Similar tables are reported for the whole US economy by Bernard, Jensen and Schott (2005).

Table 3.8 also shows how common entry and exit of firms is in all four categories. It constitutes the most important source of dynamics compared to continuing firms switching trading status. There are, however, major differences in these movements. Firms are more likely to keep the same status when they are non-traders or two-way traders. Firm death is much more rare for firms engaged in international trade, and even more so for two-way traders. Furthermore, exit appears to be more likely than entry for all types of firms considered, except for exporters.

Table 3.8. Entry and exit of firms across trading status (manufacturing)

Number of firms								
Trading status	1996	Keep same status	Exits	Entry	Continuing firms			2004
					Start trading	Stop trading	Switched trading status	
Non-traders	7,962	3,782	-3,428	+3,203	-752	+856		7,841
Importers	975	233	-352	+322	+278	-263	+338	1,298
Exporters	661	100	-251	+303	+264	-213	+275	1,039
Two-way traders	5,595	2,944	-1,478	+753	+210	-380	-613	4,087
Total	15,193	7,059	-5,509	+4,581				14,265
Share of firms relative to 1996 levels (in percentage)								
Trading status	1996	Keep same status	Exit	Entry	Continuing firms			2004
					Start trading	Stop trading	Switched trading status	
Non-traders	100	48	-43	+40	-9	+11		98
Importers	100	24	-36	+33	+29	-27	+35	133
Exporters	100	15	-38	+46	+40	-32	+42	157
Two-way traders	100	53	-26	+13	+4	-7	-11	73
Total	100	46	-36	+30				94

Source: NBB-BBSTTD. Notes: The first sub-table gives firm counts, while the second gives values relative to 1996 values. The first column reports the number of firms existing in each category in 1996, while the second gives those that had not changed status in 2004. Columns 2 and 3 show death and birth of firms in and out of each status. The next three columns report the switches of continuing firms between the various trading categories. The movements between non-traders and the three types of traders are reported in columns 5 and 6, while in column 7 we report those traders that switch trading type. The last column gives the 2004 figure.

Table 3.9. Transition matrix and Markov(1) process ergodic distribution

	Entry/Exit	Non-trader	Importer only	Exporter only	Two-way trader
Entry/Exit	0	0.70	0.07	0.07	0.16
Non-trader	0.43	0.48	0.03	0.03	0.03
Importer only	0.36	0.27	0.24	0.02	0.11
Exporter only	0.38	0.32	0.04	0.15	0.11
Two-way trader	0.26	0.07	0.08	0.06	0.53
Steady state distribution	0.28	0.46	0.06	0.05	0.15

The rise in the number of importing- and exporting-only firms is also due to two-way traders discontinuing one of their trading activities and to non-traders starting to trade. Looking at the status of entrants and new traders, it seems that becoming a two-way trader is a gradual process. Once this status is acquired, a firm is also less likely to stop trading altogether.

The results in Table 3.8 can be written as the transition matrix of a Markov(1) process, as in Table 3.9. The steady state vector is reported in the last line of the table and provides the ergodic distribution of this Markov process. In steady-state, there will be simultaneous entry and exit of 28 per cent of firms. The near majority of firms would be Non-traders (46 per cent), while Two-way traders would constitute the majority of trading firms, with 15 per cent against 6 and 5 per cent respectively for Importers only and Exporters only.

Table 3.10. Entry and exit of firms across trading status in terms of employment

Change in employment (thousands)									
Trading status	1996	Keep same status	Exit	Entry	Continuing firms				2004
					Start trading	Stop trading	Firms keep trading		
							Switched trading status	Same trading status	
Non-traders	57.9	26.4	-22.2	+17.9	-9.3	+10.0		+4.9	59.1
Importers	17.2	5.4	-6.1	+6.8	+5.1	-3.2	+8.5	+1.0	29.3
Exporters	6.6	1.3	-2.2	+2.8	+3.3	-1.9	+4.9	+0.1	13.5
Two-way traders	498.1	367.7	-87.6	+52.1	+6.4	-7.9	-14.0	-14.1	432.9
Total	579.8	400.8	-118.2	+79.5					534.8
Change in employment relative to 1996 levels (in percentage)									
Trading status	1996	Keep same status	Exit	Entry	Continuing firms				2004
					Start trading	Stop trading	Firms keep trading		
							Switched trading status	Same trading status	
Non-traders	100	46	-38	+31	-16	+17		+8	102
Importers	100	31	-36	+40	+30	-19	+49	+6	170
Exporters	100	20	-34	+43	+50	-29	+74	+2	205
Two-way traders	100	74	-18	+10	+1	-2	-3	-3	87
Total	100	69	-20	+14				-1	92

Source: NBB-BBSTTD. Notes: See Table 8 notes. This describes the same dynamics but in terms of employment. For continuing firms, negative flows are 1996 employment figures, while positive flows are 2004 employment figures. Column 8 reports the change in employment of firms that did not change status over the sample period.

The surprising drop in the number of two-way traders is due to two elements. Firstly, exits of firms were not offset by the number of entries, both by new and old firms. Secondly, there was a relatively large number of two-way traders that stopped both importing or exporting to concentrate on only one of these two activities.

Most of these comments can be carried over to Table 3.10, which reports dynamics of job flows. Additionally, one notices that large firms that trade are even more likely to keep their status by comparing for example the percentage of firms that stay as two-way traders (53 per cent) and the percentage of workers they employ (74 per cent). This is not true for non-traders.

The number of jobs lost through exits is lower in percentage terms for two-way traders (18 per cent of their workers were displaced for this reason) and higher for non-traders (38 per cent of jobs lost). Importers and exporters are in between, with around 35 per cent of their jobs destroyed as a result of exits. The net job creation due to entries and exits varies with the trading status of the firm. Importing and exporting companies created more jobs than they destroyed, because of entries and exits, whereas the contrary is true for non-traders and two-way traders.

In the case of continuing firms, it is possible to see that the reallocation of employment among different types of firms was also caused by switching trading status. Comparing the employment changes due to starting and stopping trading, it is possible to see the net contribution is positive for importers and exporters and surprisingly negative for two-way traders.

Furthermore, considering those firms switching their trading status, but still remaining traders, the percentage change in employment is negative for two-way traders and positive for both importers and exporters. However, perusing the figures about the number of employees in Table 3.10 and number of firms in Table 3.8, it is possible to infer that those two-way traders that stopped one of their trading activities and became just importers or exporters were on average smaller firms, accounting for only a small percentage of two-way traders' total employment. Yet, this is still an important increase in the employment of importers and, even more so of exporters⁵⁰.

Finally, firms with the same trading status in 1996 and 2004 have different trajectories of employment creation, too. The surprising overall decrease in the employment levels of two-way traders is compounded by the fact that continuing firms in this category on average saw a drop in their employment levels. Given that the fall in both firm and employment numbers in the manufacturing industry is concentrated in this category of companies, these are particularly interesting results that should be analysed further in future research, as mentioned above.

⁵⁰ Respectively 68 per cent and 88 per cent, summarised in the 49 per cent and 74 per cent figures of Table 9 which sum up all trading status switches.

The main findings reported in this subsection highlight the role of firms' death and birth and the strength of larger and trading firms. One should also note the gradual process of entering trade and the drop in employment of two-way traders and their switch to single-trade activities.

3.3.3 Trade Concentration

Bernard, Jensen and Schott (2005) and Bernard, Jensen, Redding and Schott (2006) show for the US that trade is highly concentrated. This subsection looks at this issue in more detail. Table 3.11 shows the Gini coefficients of exports, imports and total trade (in addition to value added and employment by way of comparison)⁵¹. We report this information for the whole economy and for manufacturing and wholesale and retail sectors separately.

However it is measured, overall economic activity appears to be unevenly distributed. All Gini coefficients in Table 3.11 are larger than 0.740. It is noteworthy that international trade is more concentrated than employment and value added. This is true whether we consider the whole economy or the manufacturing or wholesale and retail sectors separately. Also, exports and imports have become more concentrated over time. This is in line with the evolution in the degree of concentration of employment and value added⁵².

The degrees of international trade concentration in Table 3.11 are similar to those that Bernard, Jensen, Redding and Schott (2006) report for the whole US economy in 2000. They find a Gini coefficient of 0.972 for exports, 0.965 for imports and 0.971 for total trade. These figures are marginally lower than those for the whole Belgian economy in 2004 and in 1996. So this suggests that international trade in Belgium appears to be even more concentrated than in the US. In both countries, exports appear to be more concentrated than imports.

⁵¹ The Gini coefficient is a measure of how much a certain variable, say, trade, is equally distributed across firms. It is bound between zero and one. A value of zero indicates that trade is uniformly distributed and that therefore all firms account for the same proportion of trade. A value of one points to the fact that just one firm is responsible for all trade.

⁵² Employment in manufacturing is the exception since its Gini coefficients decreased from 1996 to 2004.

In Table 3.12, we delve deeper into the data to investigate the degree of concentration of international trade, employment and value added for different parts of the size distribution. The largest firms, i.e. those with more than 500 employees, only make up 0.3 per cent of the total number of firms and 1.1 per cent of manufacturing firms. Yet, in 2004, they accounted for 33 per cent of total employment, and 37.2 per cent in manufacturing. Furthermore, they are responsible for over 40 per cent of exports and imports, and more than 55 per cent in manufacturing.

Table 3.11. Gini coefficients

	Whole Economy		Manufacturing		Wholesale Retail	
	1996	2004	1996	2004	1996	2004
Employment	0.826	0.833	0.824	0.815	0.746	0.747
Value Added	0.868	0.868	0.873	0.879	0.799	0.816
Exports	0.984	0.987	0.959	0.962	0.971	0.974
Imports	0.973	0.979	0.956	0.963	0.943	0.952
Total Trade	0.974	0.980	0.953	0.959	0.941	0.952

Source: NBB- BBSITD

The fact that exports are so highly concentrated among the largest firms is consistent with recent theoretical models (Melitz 2003; Bernard, Eaton, Jensen and Kortum 2003) and empirical evidence showing that only the largest and most productive firms will be able to meet the fixed costs of exports and start selling abroad. A similar phenomenon seems to be at work for imports. Fixed costs of imports could mean that importing is only profitable for the largest firms. It could also be that importing a greater variety of intermediates, possibly of higher quality, allows firms to improve their productivity and thus grow more.

Table 3.12. Concentration of exports and imports

Size of firms	1996						2004					
	Whole economy						Whole economy					
	Share of firms	Share of empl.	Share of total VA	Share of total exports	Share of total imports	Average VA/emp	Share of firms	Share of empl.	Share of total VA	Share of total exports	Share of total imports	Average VA/emp
1-20	88.8%	23.3%	20.9%	16.2%	18.2%	62,408	88.7%	24.8%	20.5%	11.4%	15.2%	67,335
21-50	7.4%	14.3%	13.3%	10.6%	13.1%	53,807	7.4%	14.1%	12.5%	9.7%	11.8%	66,307
51-100	1.9%	8.3%	7.8%	8.3%	7.7%	55,384	2.0%	8.4%	8.0%	8.0%	9.5%	71,992
101-200	1.0%	8.4%	8.5%	9.6%	10.4%	59,669	1.0%	8.4%	9.0%	10.1%	9.6%	81,311
201-500	0.6%	11.5%	11.9%	14.2%	15.7%	60,430	0.6%	11.3%	12.7%	15.1%	13.9%	86,413
>500	0.3%	34.2%	37.6%	41.1%	34.8%	67,864	0.3%	33.0%	37.2%	45.7%	40.0%	96,632
Size of firms	Manufacturing						Manufacturing					
	Share of firms	Share of empl.	Share of total VA	Share of total exports	Share of total imports	Average VA/emp	Share of firms	Share of empl.	Share of total VA	Share of total exports	Share of total imports	Average VA/emp
	1-20	74.1%	11.5%	8.4%	3.8%	4.7%	49,970	75.1%	12.5%	8.7%	3.3%	4.1%
21-50	14.7%	12.7%	10.2%	7.4%	7.4%	50,792	13.6%	12.2%	8.6%	6.0%	6.2%	59,185
51-100	5.3%	10.1%	8.3%	8.6%	7.6%	50,499	5.1%	9.9%	7.9%	7.4%	5.8%	67,355
101-200	2.8%	10.5%	9.1%	10.0%	9.7%	54,111	3.0%	11.0%	9.7%	9.8%	8.4%	74,856
201-500	1.9%	15.3%	14.8%	14.2%	13.5%	60,006	2.1%	17.3%	16.5%	16.4%	14.9%	81,063
>500	1.1%	40.0%	49.3%	55.9%	57.2%	73,399	1.1%	37.2%	48.6%	57.0%	60.7%	101,677
Size of firms	Wholesale and retail						Wholesale and retail					
	Share of firms	Share of empl.	Share of total VA	Share of total exports	Share of total imports	Average VA/emp	Share of firms	Share of empl.	Share of total VA	Share of total exports	Share of total imports	Average VA/emp
	1-20	92.6%	40.6%	36.0%	47.8%	31.5%	56,419	91.6%	38.1%	30.8%	29.9%	26.3%
21-50	5.5%	18.6%	16.8%	18.5%	18.9%	52,491	6.1%	17.3%	15.6%	17.6%	17.0%	68,332
51-100	1.0%	7.3%	7.6%	7.4%	7.5%	60,649	1.2%	7.3%	7.6%	7.2%	9.3%	79,675
101-200	0.5%	6.9%	10.3%	8.3%	11.8%	88,372	0.5%	6.9%	8.7%	10.8%	11.0%	94,807
201-500	0.3%	10.3%	11.8%	14.4%	18.8%	65,879	0.4%	9.4%	13.0%	12.6%	13.9%	108,847
>500	0.1%	16.3%	17.4%	3.6%	11.6%	81,068	0.2%	21.0%	24.3%	21.9%	22.7%	130,942

Source: NBB-BBSTTD. Notes: This table divides firms by size according to the number of employees (FTE) in each firm, as reported in the first column. The share of firm population, employment, total exports and imports is then reported for each size class. Average value-added per employee is also given. This is done for both 1996 and 2004. It considers the whole economy and the manufacturing and wholesale and retail sectors separately.

Over time, imports and exports have become even more concentrated. International transactions seem to be increasingly conducted by the largest firms. This is not consistent with the predictions of the Melitz (2003) model, where a fall in trade costs enables smaller and lower productivity firms to participate in export markets. However, this could be due to a strengthening of the selection process to start trading internationally. As trade is liberalised

further, foreign markets become more competitive. This makes it less likely for small firms to break into export or import markets. Looking at the broad industry figures at the bottom of Table 3.12, we can see that wholesale and retail trade appears to be less concentrated than manufacturing, but the degree of concentration has been increasing during the sample period⁵³.

Illustrating this concentration within the manufacturing sector, Figure 3.1 depicts the Lorenz curve of total trade (i.e. imports plus exports) with respect to total value added. The top ten per cent of firms in terms of value added account for around 90 per cent of the value of international trade transactions, and this proportion increased from 1996 to 2004. Firms in the top 50 per cent of the distribution of value added are responsible for nearly 100 per cent of the value of imports plus exports. As shown in Figure 3.2, the concentration in terms of productivity (measured by value added per employee) is slightly lower, with the top 10 per cent of firms accounting for around 45 per cent trade in 2004.

This subsection has depicted how extremely concentrated trade is. Both imports and exports are primarily conducted by the largest firms in terms of employment and value added, which are also those with higher levels of productivity. The higher concentration of both exports and imports among a relatively small number of firms may be generated by recurring sunk costs of exports and imports for different markets and products. This leads to the fact that only the most productive exporters and/or importers find it profitable to trade with more countries and more products. Therefore, more productive traders will trade more, and not only at the intensive margin, but also at the extensive margin. This will result in a higher degree of concentration than in the hypothetical case with just one foreign country and one product.

⁵³ The figures for wholesale and retail trade seem rather dubious because of the large share of international trade conducted by firms with less than 20 employees. We conducted a robustness check, looking at the concentration figures of wholesale and retail sub-industries at 2-digit NACE level. These are: sector 50 "sale, maintenance and repair of motor vehicles; fuel sale", 51 "wholesale trade & commission trade exc. motor veh." and 52 "retail trade exc. motor vehicles; repair of pers. goods". Industry 51 and 52 show a similar degree of concentration to the entire wholesale and retail sector. Sector 50 appears to be more concentrated, with a handful of firms with more than 500 employees accounting for around 50 per cent of international trade.

3.3.4 Firm-Level Characteristics of Traders vs. Non-Traders

The micro-econometric-based international trade literature to date has overwhelmingly shown that exporters are more productive than non-exporters (e.g. Bernard and Jensen (1999) for the US; Girma, Kneller and Pisu (2005) for the UK; Wagner (2002) for Germany; Castellani (2002) for Italy). Yet, due to a lack of data, importers have so far been almost completely neglected⁵⁴.

In this section, we explore the relationships between firm-level characteristics and international trading status. Table 3.13 exhibits regression results of firm-level variables, in log, regressed on trading-status dummies. These results, although showing simple correlation, have the advantage that estimated coefficients can be interpreted in percentage terms. Also, we are able to control for time and fixed effects, adding a full set of time and two-digit NACE-BEL industry dummies⁵⁵. Table 3.13 shows the percentage differences in the firm-level variables among different types of firms. Two-way traders appear to enjoy the largest premia for the various coefficient values followed in order by importers and exporters. Firms that both import and export are on average 35 per cent more productive than those doing neither. The productivity advantage of exporting- and importing-only firms is similar at around 17-18 per cent. Furthermore, Table 3.13 suggests that traders are more capital intensive and invest more per employee than non-traders. Again, two-way traders have the largest advantage followed by importers and exporters. The sum of the "Exporter only" and "Importer only" coefficients is significantly smaller than the "Two-way trader" coefficient for (the logarithms of) employment, value-added and investment, as reported in the last lines of Table 3.13. This suggests there might exist additional spillovers between importing and exporting that a two-way trader benefits from. The sum of the coefficients is significantly greater for (the logarithm of) value-added per employee, although

⁵⁴ Two exceptions are MacGarvie (2006) and Tucci (2005). The former shows, for a panel of large French firms, that importers have similar value added per worker to exporters and that they are more productive than both non-importers and non-exporters. However, she does not consider separately firms that both import and export at the same time. Tucci (2005), using a survey of Indian firms, finds that those engaged in both imports and exports have higher productivity levels to those that are not. Bernard, Jensen and Schott (2002 and 2005) also give a description of US import transactions, but with limited information on firm productivity.

⁵⁵ These regressions use firms in the whole economy from 1996 to 2004.

the difference is not large. This should be investigated further using alternative measures of productivity. As for investment per employee and capital per employee, the differences between the two-way traders and sum of exporter-only and importer-only coefficients are not significantly different from zero.

Table 3.13. Characteristics of firms per trading status - descriptive regressions (whole economy)

Dependent variable	(1) Log employment	(2) Log value-added	(3) Log VA per employee	(4) Log Capital	(5) Log capital per employee	(6) Log investment	(7) Log investment per employee
Exporter only	0.554** (0.006)	0.743** (0.006)	0.181** (0.004)	0.597** (0.009)	0.044** (0.008)	0.545** (0.010)	-0.020* (0.009)
Importer only	0.779** (0.005)	0.973** (0.006)	0.189** (0.003)	0.840** (0.008)	0.059** (0.006)	0.857** (0.008)	0.071** (0.007)
Two-way trader	1.504** (0.005)	1.865** (0.005)	0.356** (0.003)	1.601** (0.007)	0.102** (0.005)	1.560** (0.007)	0.059** (0.006)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	914935	897766	897766	845069	845069	785667	785667
R ²	0.22	0.25	0.13	0.16	0.08	0.13	0.04
Two-way - (exporter + importer)	0.171**	0.149**	-0.014**	0.164	-0.001	0.158**	0.008
Wald test: F-statistic	406.48	248.92	8.42	171.38	0.00	134.12	0.41
Wald test: p-value	0.00	0.00	0.0037	0.00	0.98	0.00	0.52

Source: NBB - BBSTTD. Notes: OLS regressions. Industry dummies for 2-digit NACE-Bel. Robust standard errors reported in parenthesis. *** denotes statistical significance at the 1% level. Constant included but not reported. The two-way trader coefficient minus the sum of the coefficients on exporter only and importer only is reported. Wald test (F-statistic and p-value reported) in last rows tests whether the sum of the coefficients on "Exporter only" and "Importer only" is significantly different from the coefficient on "Two-way trader".

In this subsection, we have provided evidence concerning possible relationships between international trading status and firm-level characteristics. Overall, two-way traders appear to be the largest and most productive companies whereas non-traders are the smallest and least productive. Also, importing-only firms enjoy larger premia when compared to non-

traders than exporting-only enterprises. These patterns hold true for capital intensity and investment per employee, albeit to a lesser degree.

3.3.5 Export destinations, import origins and products traded

Products and destinations have been the focus of recent literature on manufacturing firms' export behaviour, as described in Section 2. Given our previous evidence, and in order to obtain results comparable to other countries, we will concentrate on the manufacturing sector in this section. Trade flows are determined by several dimensions. The literature defines the intensive margin, quantities traded by a firm, and the extensive margin, the number of trading firms. This can be further separated between the "country extensive margin" of trade, how many countries a firm trades with, and the "product extensive margin", how many products a firm trades in.

We first consider destinations of exports and origins of imports. The number of firms exporting to at least a certain number of export destinations and the number of firms importing from at least a certain number of foreign countries are represented in Figure 3.3 and Figure 3.4. There is a clear negative relationship between the number of trading firms and the number of countries traders trade with. The maximum number of export destinations and origins of imports are respectively 157 and 62. The number of export destinations appears to decrease more quickly than the number of origins of imports.

This is more apparent from Figure 3.5, which plots the histogram of the number of countries importers and exporters trade with. The mean of trading partners is 11.3 for exporters and 6.6 for importers, whereas the median is at about 5 for both types of firms. Both distributions are skewed towards the right and have a mode at one. It is worth comparing in more detail our findings with those of Eaton, Kortum and Kramarz (2004) and Bernard, Jensen and Schott (2005) for French and US firms. Our result that the frequency of firms trading with a certain number of countries decreases as the number of partner countries increases is consistent with both. In 2000, US exporters traded with on average 3.5 countries and importers sourced from 2.8 countries. Around 56.6 per cent of US exporters ship products to

just one foreign country, while 7.7 per cent of them ship to ten or more overseas markets. The corresponding figures for French manufacturers are 34.5 per cent and 19.7 per cent. Our data suggest that 18.8 per cent of Belgian exporters serve just one market whereas 31 per cent of them ship to ten or more⁵⁶.

Thus, Belgian exporters appear to serve more markets than French and US exporting enterprises. French exporters fall somewhere in between Americans and Belgians. This could be attributed to the small Belgian domestic market: Belgian producers have to export to more destinations than French and US firms to take full advantage of increasing returns to scale, which is one of the reasons for Belgium being a more open economy than the US. The same is true when France is compared to the US.

Despite the similarities in the distribution of trading partners for exporters and importers, there are also interesting differences. The frequency of import origins seems to be bimodal. Declining from one to three countries, it then rises and peaks at five. Thereafter, it declines monotonically. Also of interest is that the distribution of export destinations dominates that of origins of imports in the one-to-three country range⁵⁷. Thereafter, the distribution of imports dominates that of exports for up to 13 trading partners. 57 per cent of importers trade with 4 to 13 countries while only 37 per cent of exporters do the same. Beyond 14 trading partners, export destinations dominate import origins again. Such a pattern is also reported by Bernard, Jensen and Schott (2005) for the US⁵⁸.

The distribution of export destinations and import origins is likely to be determined by fixed costs of exports and imports respectively. The degree of concentration of imports shown in the previous tables suggest that fixed costs of imports may be as relevant as fixed costs of exports⁵⁹. There is some evidence that fixed costs of exports re-occur at each new

⁵⁶ The French figures refer to the year 1986, the US and ours to 2000. Bernard, Jensen and Schott (2005) include manufacturing and other sectors of the economy, whose firms are less likely to trade in goods. By doing so, we find that 30.3 per cent of Belgian exporters ship products to just one destination, while 21.2 per cent of them ship to ten or more. Eaton, Kortum and Kramarz (2004) consider only manufacturing firms.

⁵⁷ 37 per cent of exporters export goods to one to three countries, whereas the corresponding figure for importers is 33 per cent.

⁵⁸ The figures they report suggest that exporters are more likely than importers to trade with just one or with ten or more countries. However, in the two-to-nine-countries range, the frequency of imports is higher than that of exports.

⁵⁹ The presence of fixed costs of importing are modelled by Kasahara and Lapham (2005).

foreign market entry (Damijan, Polanec and Prasnikar, 2004). This could constrain the majority of exporters to sell to just a few foreign markets. The same appears to be true for imports. If fixed costs relating to importing goods re-occur for each new sourcing country, the majority of firms will import goods from a relatively small number of countries. In our data, 90 per cent of importers import from less than 14 countries. Multi-stage production is an alternative and compelling explanation of firm importing behaviour, but the data does not allow us to distinguish such type of transactions.

We now turn to the product extensive margin, given that our data set allows us to investigate the number of products firms trade across national borders. Bernard, Jensen and Schott (2005) investigate the same issue using data for the US. They report that on average exporters traded 8.9 products in 2000, whereas importers purchased around 10 products from abroad. The BBSTTD suggests that Belgian manufacturing firms, in 2000, shipped to other countries on average around 12 products and sourced about 34 products from abroad⁶⁰. Therefore, Belgian companies appear to be more geared towards trading internationally than US firms.

Looking in more detail at imported and exported products, Figure 3.6 and Figure 3.7 show that the number of trading firms declines systematically with the number of products they trade internationally. As in the case of trading partners, however, the number of exported products appears to decline more steadily than the number of imported goods. Figure 3.8 depicts the histogram of the number of products exported or imported. Both exporters and importers are more likely to trade a single product: around 20 and 11 per cent of exporters and importers, respectively, do so. Both distributions are skewed towards the right, as when considering destinations and sourcing countries.

Furthermore, from Figure 3.8 it is possible to note that Belgian traders are more likely to source ten or more products from abroad than to export them: only around 31 per cent

⁶⁰ The median of the two distributions is around 5 for exports and 17 for imports. If all sectors of the Belgian economy are considered to compare with the US data, the average number of products exported by firms is 12 and 29 for imports.

of exporters sell more than ten products abroad compared with 62 per cent of importers sourcing more than ten goods⁶¹.

3.3.6 Destinations, origins and gravity

A very large strand of the literature in international economics has developed strong evidence that distance reduces trade flows. Heterogeneous firm models predict that market size is also a determinant of how many firms will enter a specific market, given that only the most productive firms can incur the fixed cost of serving many markets. Besides, higher income and market size implies that less productive firms will find it profitable to bear the fixed cost of exporting to a given market.

By simply looking at the top destinations and origins of trade, we show that the BBSTTD is consistent with these findings. The top ten export destinations and sourcing countries are shown in Table 3.14.

⁶¹ This is consistent with the findings of Bernard, Jensen and Schott (2005) for the US, where about 17 and 21 per cent of exporters and importers, respectively, trade more than ten products.

Table 3.14. Top ten export destinations and source countries for manufacturing firms (year 2000)

Top 10 export destinations	Number of firms	% of exporting firms	Average value of exports	Top 10 sourcing countries	Number of firms	% of importing Firms	Average value of imports
Netherlands	3,635	67.0%	3,028.5	Netherlands	4,095	73.1%	3,513.3
France	3,518	64.8%	4,329.6	Germany	3,958	70.6%	2,793.3
Germany	3,170	58.4%	4,802.1	France	3,779	67.4%	1,925.2
United Kingdom	2,429	44.8%	2,885.9	Italy	2,629	46.9%	672.4
Luxembourg	1,977	36.4%	496.2	United Kingdom	2,551	45.5%	1,263.0
Switzerland and Liechtenstein	1,896	34.9%	704.4	United States	1,730	30.9%	2,216.4
Italy	1,766	32.5%	2,734.1	Switzerland and Liechtenstein	1,681	30.0%	204.6
Spain	1,748	32.2%	1,862.1	Spain	1,656	29.5%	705.0
United States	1,661	30.6%	3,629.4	Austria	1,129	20.1%	334.4
Sweden	1,366	25.2%	1,149.0	Luxembourg	1,044	18.6%	245.5

Source: NBB-BBSTTD. Notes: Destinations and origins are classified according to the number of firms that trade with them, rather than the total trade value.

There is a high degree of overlap between the most frequent export and import trading partners⁶². The Netherlands, France and Germany share the top three places in both rankings. Other countries Belgian firms frequently trade with are the UK, Italy and the US. Austria and Sweden are the only two countries not appearing in both tables, the latter being the tenth most popular export destinations and the former being the ninth source of imports. The fact that direct neighbours are the most frequent destination for Belgian exporters confirms the importance of distance, whereas the variation in average shipments to each country illustrates the importance of market size.

⁶² This could be explained by the prevalence of multi-stage production within advanced industrialised countries.

The top ten export destinations and import origins outside the EU15 are shown in Table 3.15. Consistently with the market size hypothesis, the US is the most popular country among importers whereas the country exporters trade most with is Switzerland. Other common export destinations are countries relatively near Belgium, such as Norway, Poland and the Czech Republic or countries that are rich and large but distant, such as Japan or fast-growing economies like Turkey.

Table 3.15. Top ten export destinations and sourcing countries outside the EU for manufacturing firms (year 2000)

Top 10 export destinations	Number of firms	% of Exporting Firms	Average Value of Exports	Top 10 sourcing countries	Number of firms	% of Importing Firms	Average Value of Imports
Switzerland and Liechtenstein	1,885	34.7%	702.6	United States	1,730	30.9%	2,216.4
United States	1,642	30.3%	3,649.3	Switzerland and Liechtenstein	1,681	30.0%	204.6
Poland	1,198	22.1%	757.2	China	546	9.7%	962.0
Czech Republic	990	18.2%	501.0	Japan	533	9.5%	2,357.8
Norway	970	17.9%	393.5	Poland	526	9.4%	885.7
Israel	831	15.3%	904.8	Czech Republic	524	9.3%	587.4
Japan	824	15.2%	1,412.2	Canada	411	7.3%	1,032.3
Hungary	802	14.8%	683.4	India	400	7.1%	563.8
Turkey	797	14.7%	895.7	Taiwan	396	7.1%	451.2
Canada	763	14.1%	650.8	Turkey	360	6.4%	660.1

source: NBB-BBSTTD.

Among the top countries of origin of imports, we can see three Asian countries, namely China, Taiwan and India, and two European transition economies, Poland and the Czech Republic. These are usually associated with cheap imports. However, crude cost consider-

ations are probably not the only causes of imports since among the top sources of imports there are also other developed countries besides the US, such as Canada and Japan.

3.3.7 Exporting, Importing and Productivity

In this section, we explore the relationship between productivity, measured as value added per worker, and exporting and importing activities of firms. We also investigate the role of the number of products traded and the number of countries firms trade with. For comparability with existing studies, we focus on manufacturing.

Figure 3.9 and Figure 3.10 plot the relationship between value added per worker and total exports and imports. Labour productivity appears to be increasing as firms become more involved in international markets through exports or imports. Yet, no causal link should be deduced from these graphs, as we cannot say whether this is due to self-selection into international markets or to post-entry productivity improvements.

Figure 3.11 and Figure 3.12 show the relationships between labour productivity and the number of export destinations and the number of countries of origin of imports, respectively. There is a positive correlation in both cases.

Again, as explained in previous sections, this suggests that fixed costs of imports may be as relevant as fixed costs of exports: only the most productive firms are able to import inputs from a large number of countries.

The possible presence of fixed costs of importing and exporting each single product is illustrated in Figure 3.13 and Figure 3.14. They depict the relationship between labour productivity and number of products imported and exported. In both cases, there is a clear positive relationship between value added per worker and number of goods shipped to or sourced from abroad. These positive correlations suggest that fixed costs of imports and exports might be related to specific products in addition to countries.

To investigate further the relationship between types of involvement in international trade and productivity, we run simple value added per worker regressions on dummies identifying the trading status of firms. We control for year and industry effects by including time and

industry dummies. The results are shown in Table 3.16. The reference category is that identifying non-traders.

Table 3.16. Labour productivity regressions

Dependent Variable	Log (Value added per employee)	
	(1)	(2)
		Two-way traders
		0.27*** (0.010)
Importer	0.17*** (0.010)	Importers only
		0.15*** (0.013)
Exporter	0.09*** (0.010)	Exporters only
		0.06*** (0.015)
Log (Employment)	0.06*** (0.003)	Log (Employment)
		0.06*** (0.003)
Constant	10.24*** (0.017)	Constant
		10.24*** (0.017)
Year dummy	Yes	Year dummy
		Yes
2 digit sector dummy	Yes	2 digit sector dummy
		Yes
Observations	152,375	Observations
		152,375
R-squared	0.03	R-squared
		0.03

Source: NBB-BBSTTD. Notes: Table reports OLS regressions. Two-way traders are firms that both import and export. Robust standard errors are reported in parenthesis. *** denotes statistical significance at the 1% level.

We also add as regressor the log of employment to control for any size effect and capture genuine productivity differentials. In the first column, we consider firms that import and export, whereas in the second, we consider two-way traders as different categories⁶³.

The results show that importers have a larger productivity advantage than exporters when compared to non-traders. Importing companies appear to be 17 per cent more productive

⁶³ In the first columns, exporters may also import and importers may also export.

than non-traders, whereas exporters are 9 per cent more efficient. In the third column, however, our results show that two-way traders have the largest productivity advantage. They are 27 per cent more productive than non-traders. Importing- and exporting-only companies are, respectively, 15 and 6 per cent more productive than enterprises with no involvement in international trade. Overall, these results suggest that the current literature may have overstated the productivity advantage of exporters by not taking into account the role of imports.

3.4 Conclusion

Using a newly-available data set merging balance sheets and international trade transactions data, covering both imports and exports of Belgian firms, the BBSTTD, this chapter offers a broad view of international trade in goods at the level of the firm and of transaction trade data for Belgium. More specifically, we provide a comparative analysis concerning importers and exporters considering the destinations of exports, origins of imports and the number of products in which firms trade.

Some of the findings we report confirm previous results, whereas others are novel and deserve further investigation. Considering the whole economy, we find that the number of firms importing and/or exporting has been increasing, along with their employment levels. Also, companies trading internationally, whether importers, exporters or both, are larger in terms of value added and employment than non-trading firms. However, their contribution to the total number of firms, employees and value added has decreased during the sample period. This is mainly due to the fact that new jobs and firms are being generated mostly in the service sector, which are less likely to trade in goods than companies in manufacturing. This result is in contrast to Bernard, Jensen and Schott's (2005) findings for the US. We find conspicuous heterogeneity among different types of international traders. Importing-only firms' share of the total number of firms increased along with their contribution to the economy-wide value added and employment levels. Importing, whether through interna-

tional outsourcing or offshoring, thus appears as an increasingly common practice, even among service-sector firms.

Our results also suggest the existence of fixed costs of importing in addition to those of exporting and points to the existence of multi-stage production across countries. More specifically, and in keeping with the existing literature focusing on exports, we show that traders in general, whether importing, exporting or doing both, are more productive than non-traders. Furthermore, both imports and exports appear to be strongly concentrated among the largest and most productive firms. These facts suggest that a process of self-selection might characterise not only the entry into export markets, as suggested by the literature, but also the entry into import markets.

Using information about destinations of exports and origins of imports, we find that most manufacturing firms source intermediate goods from a small number of countries. This corresponds to the pattern of exporting activities. In general, the number of trading firms decreases as the number of countries they trade with rises. The same type of relationship holds at the product level. Traders export or import a relatively small number of goods and the number of trading firms diminishes as the number of products traded rises. These trading patterns are consistent with those reported by Bernard, Jensen and Schott (2005) for the US. In addition, labour productivity is increasing in the number of countries firms trade with and the number of products exported or imported. These positive relationships tend to suggest that fixed costs of imports and exports are incurred for each new country a firm starts trading with and for each additional new product shipped to or sourced from abroad.

Finally, simple OLS regressions exploring productivity differentials among firms involved in international trade in different ways suggest that firms that both import and export enjoy the largest productivity advantage when compared to non-traders. They are followed, in order, by importing- and exporting-only firms. Although we can not infer any causal link, this does suggest that the productivity advantage of exporters towards non-exporters may be overstated in the current literature, because imports were not taken into account as well as exports.

This chapter has described a newly available dataset and presented the patterns emerging in the trade transactions data for Belgium. In the next chapter, I use the export data from the BBSTTD to analyse in more detail the determinants of export behaviour, in particular the role of credit constraints.

3.A Figures

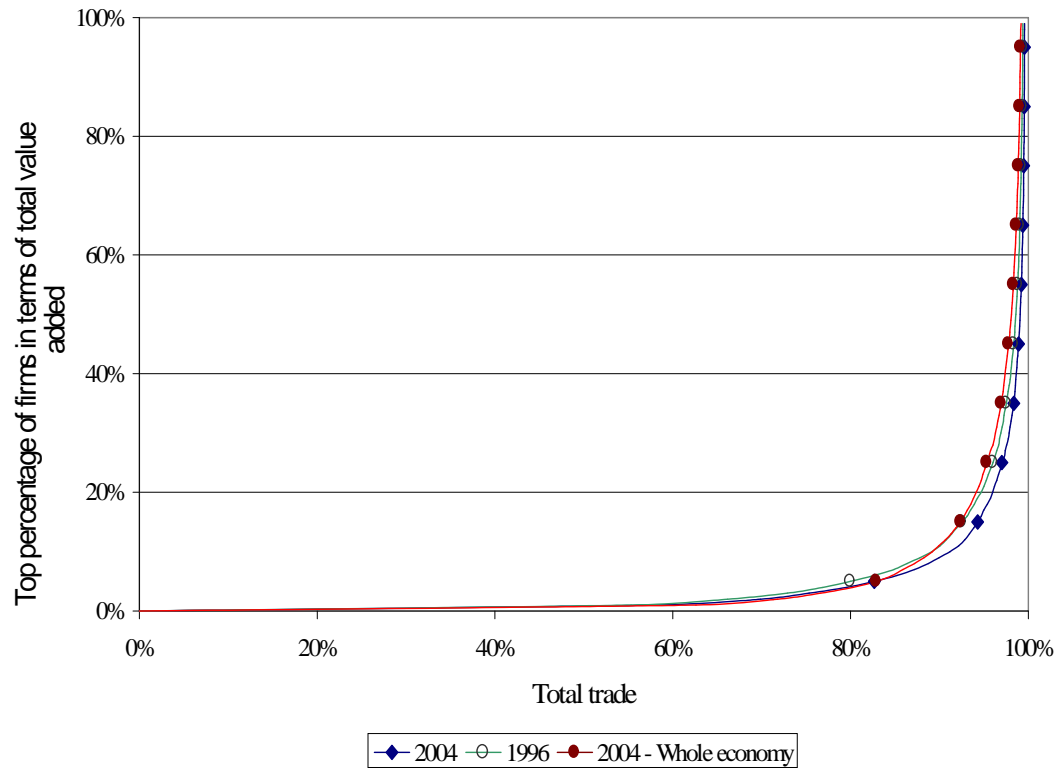
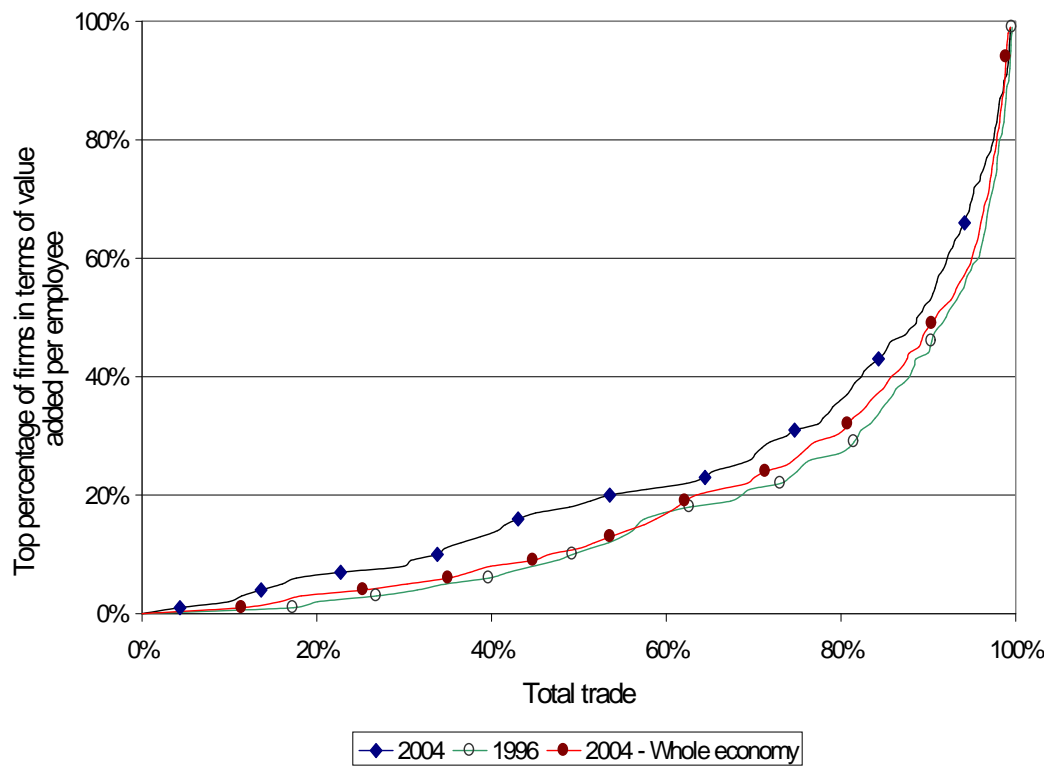
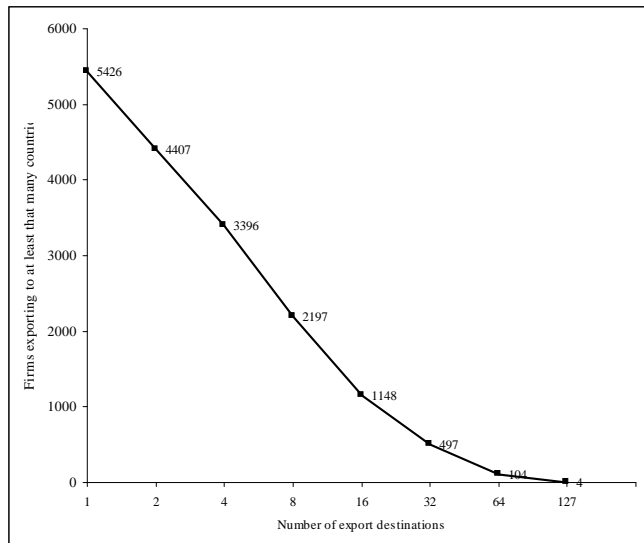


Fig. 3.1. Concentration of trade value across total value added percentiles (manufacturing)



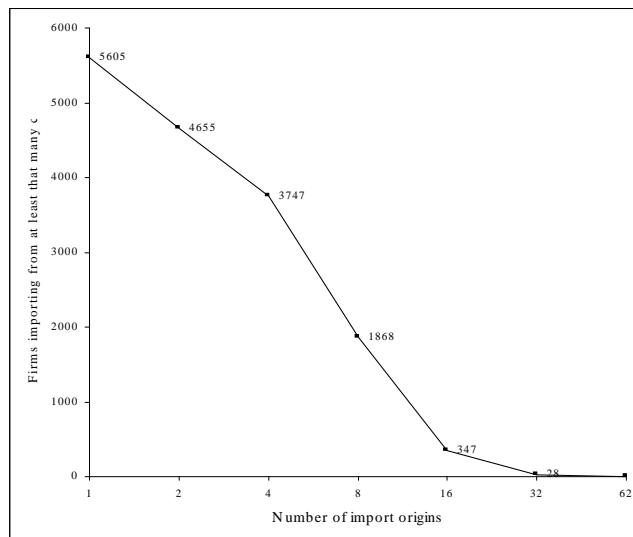
Source: NBB-BBSTTD

Fig. 3.2. Concentration of trade value across value added/employee percentiles (manufacturing)



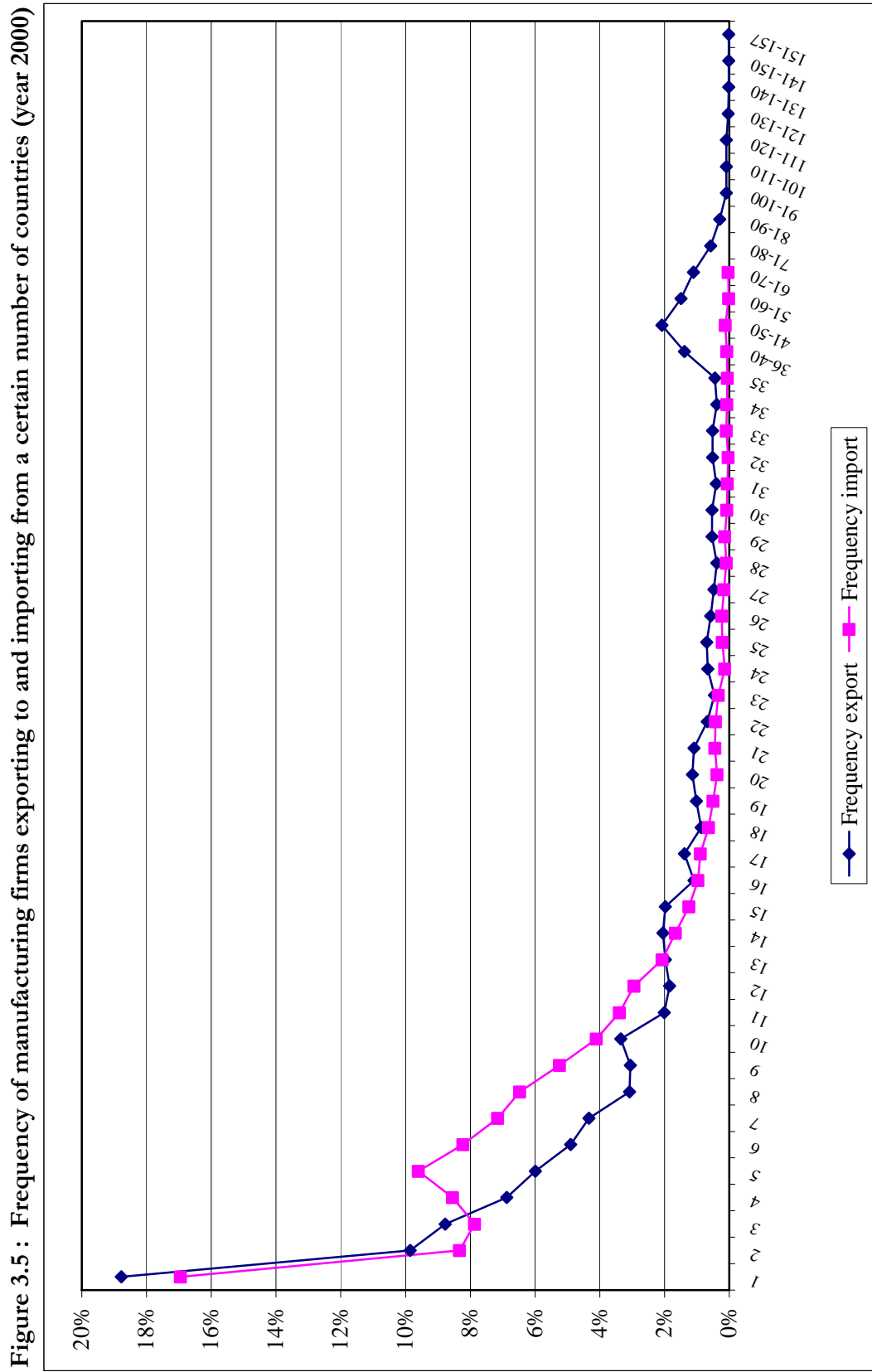
Source: NBB-BBSTTD.

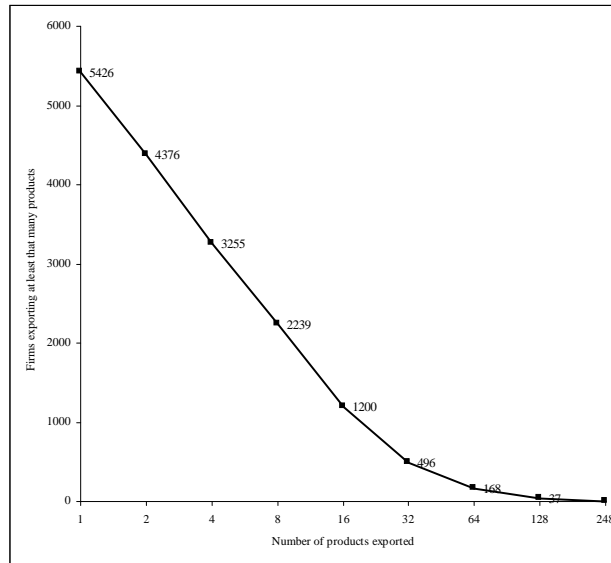
Fig. 3.3. Number of export destinations (year 2000)



Source: NBB-BBSTTD.

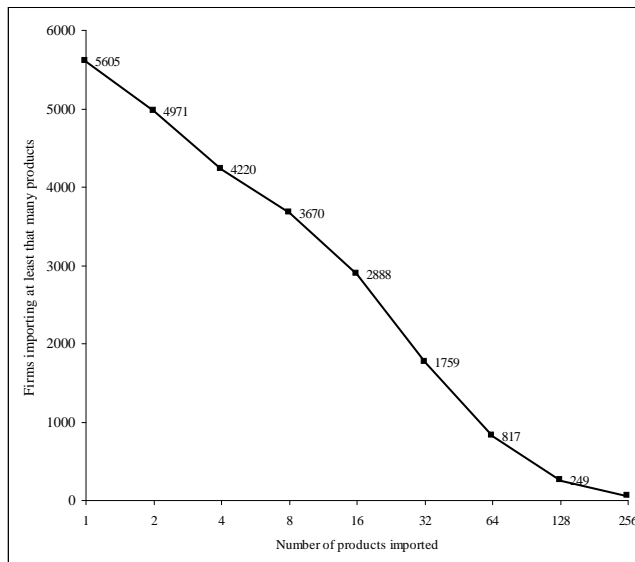
Fig. 3.4. Number of sourcing countries (year 2000)





Source: NBB-BBSTTD.

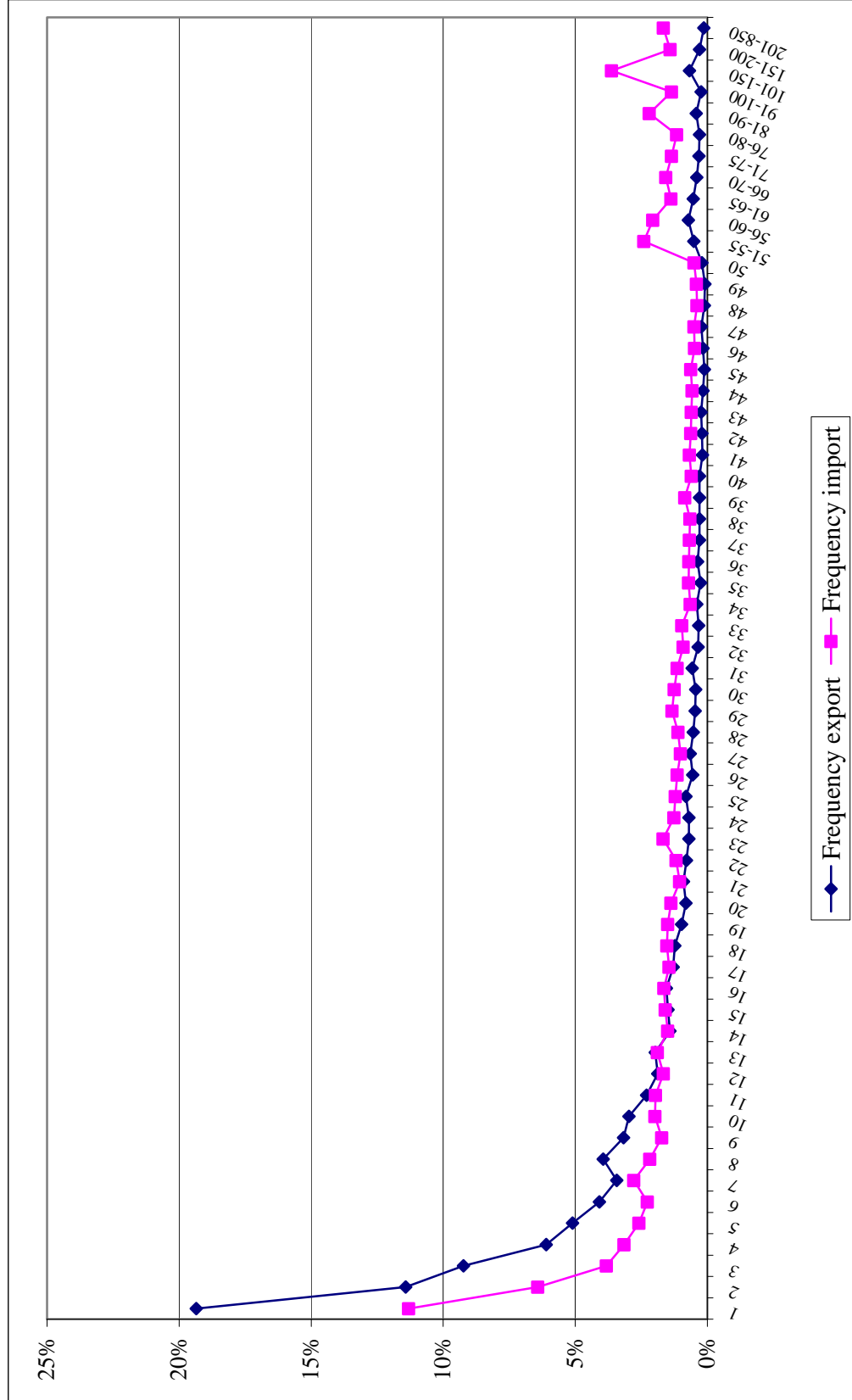
Fig. 3.6. Number of products exported (year 2000)



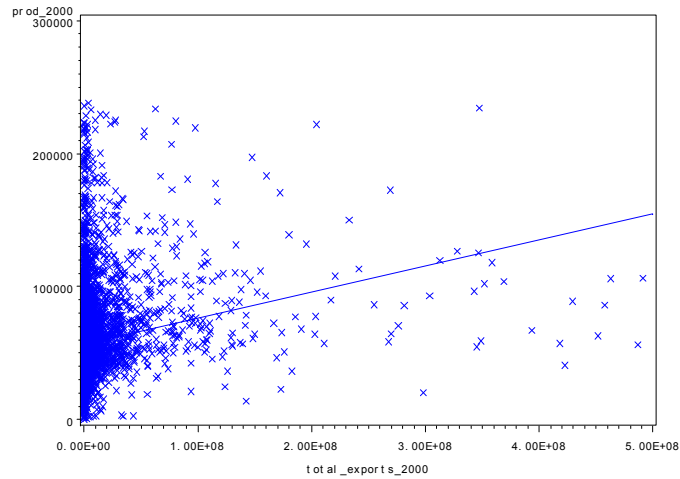
Source: NBB-BBSTTD.

Fig. 3.7. Number of products imported (year 2000)

Figure 3.8: Frequency of manufacturing firms importing and exporting a certain number of products (year 2000)

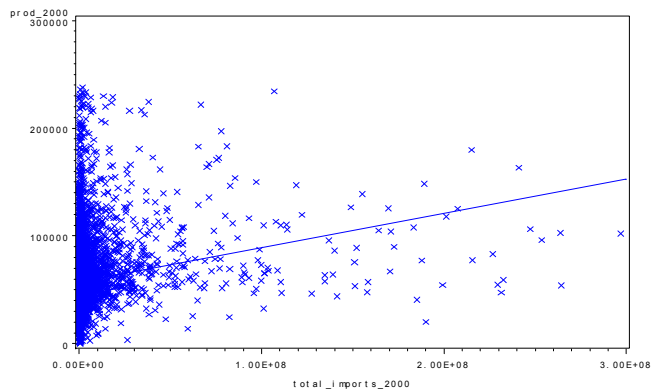


Source: NBB-BBSTTD.



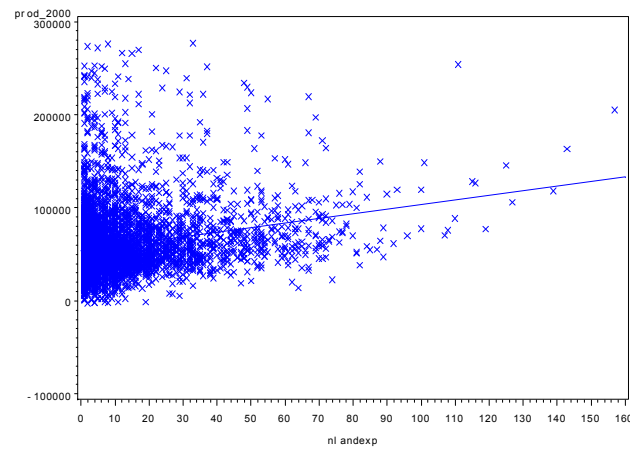
Source: NBB-BBSTTD. Notes: Firms in the top and bottom value added per worker percentile have been deleted, and so have firms that export more than 500 million Euros. The positive relation is statistically significant and robust to using a lower threshold and to using logarithms of the variables.

Fig. 3.9. Value added per employee and total exports for manufacturing firms (year 2000)



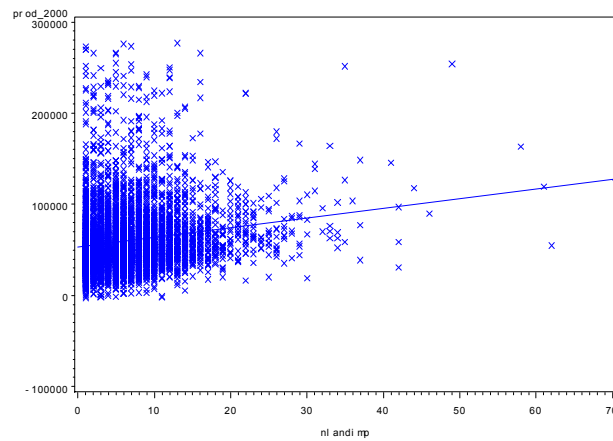
Source: NBB-BBSTTD. Notes: Firms in the top and bottom value added per worker percentile have been deleted, and so have firms that import more than 300 million Euros. The positive relation is statistically significant and robust to using a lower threshold and to using logarithms of the variables.

Fig. 3.10. Value added per employee and total imports for manufacturing firms (year 2000)



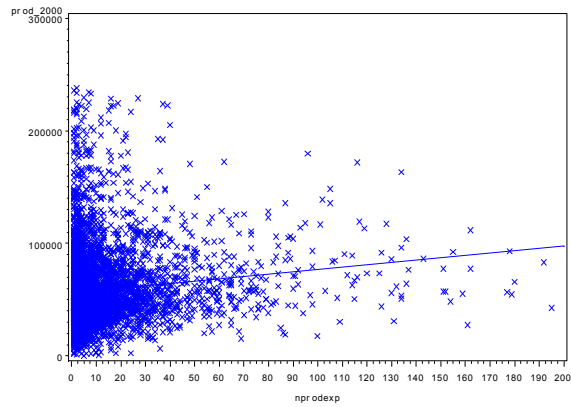
Source: NBB-BBSTTD. Notes: The sample is truncated by taking out firms that export to more than 170 destinations, and the top and bottom percentile in terms of value added per employee. The positive relation is statistically significant and robust to using a lower threshold and to using logarithms of the variables.

Fig. 3.11. Value added per employee and number of export destinations for manufacturing firms (year 2000)



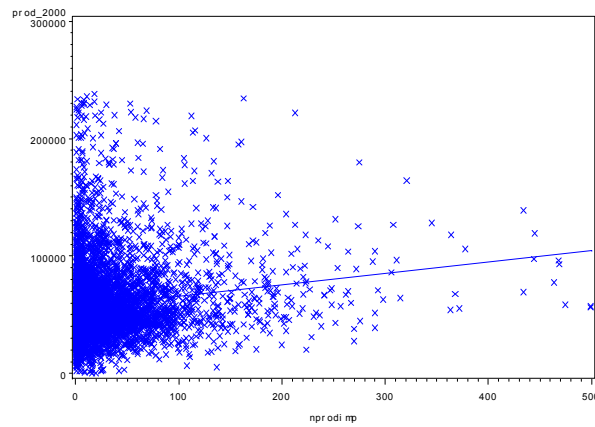
Source: NBB-BBSTTD. Notes: The sample is truncated by taking out firms that import from more than 70 destinations, and the top and bottom percentile in terms of value added per employee. The positive relation is statistically significant and robust to using a lower threshold and to using logarithms of the variables.

Fig. 3.12. Value added per employee and number of origins of imports for manufacturing firms (year 2000)



Source: NBB-BBSTTD. Notes: The sample is truncated by taking out firms that export more than 200 products, and the top and bottom percentile in terms of value added per employee. The positive relation is statistically significant and robust to using a lower threshold and to using logarithms of the variables.

Fig. 3.13. Value added per employee and number of products exported for manufacturing firms (year 2000)



Source: NBB-BBSTTD. Notes: The sample is truncated by taking out firms that import more than 500 products, and the top and bottom percentile in terms of value added per employee. The positive relation is statistically significant and robust to using a lower threshold and to using logarithms of the variables.

Fig. 3.14. Value added per employee and number of products imported for manufacturing firms (year 2000)

Chapter 4

Exporters and credit constraints. A firm-level approach

Introduction

In an era of increased globalisation, governments implement policies seeking to encourage local firms to become global and sell their goods on foreign markets. Governmental export agencies put in considerable effort and resources in setting up trade promotion trips, information packs, loans and subsidies, etc... Behind these policies lies the belief that it would be profitable for firms to export, but that they often lack the information and funds to go ahead, which is where their national authorities can help them. Despite the widespread use of these interventions, there is little empirical evidence on how important financial considerations are for the international expansion of firms.

Building a theoretical model and taking it to the data with two novel datasets, this chapter considers the determinants of firm exporting behaviour. In particular, it seeks to analyse whether there is any interaction between financial and credit constraints, and exports. The literature on firm-level trade has so far mostly concentrated on the interactions between trade and productivity. Another critical issue, besides productivity, in understanding the exporting decisions of firms is the financial situation of the firm, and in particular the credit constraints they face. Decisions by firms cannot solely rely on productivity considerations given that firms might be financially constrained. In particular, these constraints will affect volumes and patterns of trade and the efficiency of the equilibrium outcome.

Building a heterogeneous firms model of international trade with liquidity-constrained firms yields several predictions on the equilibrium relationships between productivity, credit constraints and exports that are then verified in the data. My main finding is that firms are more likely to be exporters if they are more productive *and* less credit-constrained. Regard-

ing the patterns of trade, I show that firms are more likely to start exporting to a new destination and to export to many destinations if they face fewer liquidity restrictions. Once they do start exporting to a given country, credit constraints do not affect the value and growth of their exports. There is therefore a strong relationship between the extensive margin of trade at the destination level and credit constraints, while the intensive margin is not affected. This is the second prediction of the model and holds in the data. Third, the data confirms the theoretical prediction of a pecking order of trade: firms exporting to the smallest and furthest away economies are more productive and less credit-constrained. Finally, the model allows me to consider an additional effect of the presence of credit-constrained potential exporters, by decomposing the consequences of a domestic currency appreciation on trade flows. I show in the data that three effects hold: existing exporters will export less, the least productive existing exporters stop exporting and the most productive constrained non-exporters start exporting.

The issue of financial constraints has very rarely been considered in the literature on international trade, and this is the main contribution of this chapter. As described in Chapter 3, there is a large literature on exporting behaviour at the firm level and the characteristics of exporters, with a strong emphasis on the link between trade and productivity. On credit constraints, Chaney (2005b) provides a theoretical model of trade with heterogeneous firms, along the lines of Melitz (2003), and introduces an exogenous liquidity constraint to derive his results. However, he does not include any empirical test of his predictions. The model in this chapter builds on his work but improves the way liquidity constraints are represented, thus yielding a richer framework. In Manova's (2006) paper, credit constraints interact with firm productivity, thus reinforcing the way those firms with higher productivity select into exporting. Despite the model being at the firm level, the focus of her paper is on the differences in countries' and sectors' access and need for external finance and how these shape export patterns. In my model, I borrow her specification of financial constraints to which I add an exogenous component, but by considering a general rather than partial equilibrium, I concentrate my analysis on the firm-level interactions between exports and credit constraints.

Empirically, an important contribution of this chapter is the detail of the datasets I use and their suitability for the question addressed. First, the trade and balance sheet data used covers the full sample of Belgian manufacturing, at the firm level, with detailed information on export participation, but also on the destinations and products exported. Manova (2006) uses industry- and country-level data to test the predictions of her model. The literature on financial institutions and trade does likewise, showing that export volumes from financially-vulnerable sectors are higher in financially-developed countries (Beck, 2002 and 2003, Svaleryd and Vlachos, 2005 and Hur et al., 2006). Using firm-level analysis allows a better understanding of how firms vary within a given sector. The implications of the results would therefore allow policies to be better targeted. Second, the measure of credit constraints I use is unique in its type, as it is a yearly measure of the creditworthiness of firms, established by an institution external to the firm, a credit insurer - Coface International. Campa and Shaver (2001) present evidence of the relationship between export status and liquidity constraints for manufacturing firms in Spain in the 1990's. However, their data does not allow the actual export patterns at the firm level to be analysed in detail. Greenaway et al (2005) explore the impact of financial constraints on export participation by using balance sheet variables to measure these constraints. Also, a vast literature on the importance of liquidity constraints for firms, which I will describe when presenting the Coface score and its advantages, has developed several measures which mainly allow to categorise firms between financially-constrained or unconstrained. It examines the effects of credit constraints on different decisions, such as investment, but none of them applies these techniques to understanding exporting behaviour.

This chapter demonstrates the importance of credit constraints when considering export patterns at the level of the firm. It leads to a more general question of the role of liquidity constraints for firm dynamics and growth (Rossi Hansberg and Wright, 2006) and for exports growth within the firm, fruitful areas for future research.

The chapter is organised as follows. Section 4.1 develops the model and its predictions. Section 4.2 presents the data, and demonstrates in particular why the Coface score is an

appropriate measure of credit constraints. Section 4.3 contains the empirical analysis of the links between export patterns and credit constraints and section 4.4 concludes.

4.1 The model

In this section, I present a model of trade with liquidity-constrained firms in a Melitz (2003)-type heterogeneous firms model of international trade. A firm's liquidity comprises two elements. One is exogenous, as in Chaney's model (2005b), while the other is due to imperfect financial contractibility which leads to credit constraints, as in Manova's approach (2006). The purpose of writing a model featuring both types of constraints will allow us to properly specify our empirical approach using firm-level data and capture certain specificities of the data.

4.1.1 Set-up

The economy consists of two countries Home and Foreign (which we hereafter denote with an asterisk *). The only factor of production is labour, and population is of size L . There are two sectors. One sector provides a single homogeneous good which is freely traded. This good is used as the numeraire, and its price is therefore equal to 1. Production in this sector is characterised by constant returns to scale with $q_0 = A \times l_0$, l_0 being the labour used to produce quantity q_0 of the good. By choice of scale, the unit labour requirement at home is $1/w$ ($A = w$) and $1/w^*$ in foreign ($A^* = w^*$). Therefore, as I shall assume, if both countries produce the homogeneous good, wages will be fixed by this sector's production at w and w^* respectively. The second sector produces a continuum of differentiated goods. Each firm operating in this sector supplies one of these goods and is a monopolist for its variety.

4.1.2 Demand

Consumers are endowed with one unit of labour and their preferences over the differentiated good display a constant elasticity of substitution (CES). Given their love of variety, they will consume all available varieties. I can therefore represent the utility function of the representative consumer by U :

$$U \equiv q_0^{1-\mu} \left(\int_{x \in X} q(x)^{\frac{\sigma-1}{\sigma}} dx \right)^{\frac{\sigma}{\sigma-1}\mu} \quad (4.1)$$

where the utility level is determined by the consumption of q_0 units of the homogeneous good and $q(x)$ units of each variety x of the differentiated good. The set X includes all varieties x and is determined in equilibrium. The constant elasticity of substitution between any two varieties of the differentiated good is denoted by $\sigma > 1$.

If all varieties in X are available domestically at price $p(x)$ the ideal price index will be:

$$P = \left(\int_{x \in X} p(x)^{1-\sigma} dx \right)^{\frac{1}{1-\sigma}} \quad (4.2)$$

This implies that the representative consumer has an isoelastic demand function for each differentiated variety $q(x)$:

$$q(x) = \mu w L \left(\frac{p(x)^{-\sigma}}{P^{1-\sigma}} \right) \quad (4.3)$$

This demand function, given the domestic price $p(x)$, implies that the representative consumer spends $r(x)$ on each variety x , where $\mu w L$ is the total amount spent on differentiated goods:

$$r(x) = \mu w L \left(\frac{p(x)}{P} \right)^{1-\sigma} \quad (4.4)$$

4.1.3 Production

Production in the differentiated goods sector is characterised by a constant marginal cost. Both countries enjoy the same technology and the marginal product of labour is constant.

As in Chaney (2005a), it is assumed that there is a fixed number of potential entrants proportional to the size of the country, such that the mass of firms in each country in that sector is also proportional to L or L^* . There are fixed costs for a firm to start producing: each firm has to pay a fixed entry cost C_d in terms of domestic labour, at a price wC_d in terms of the numeraire. This introduces increasing returns to scale in the production process.

Each firm draws a random unit labour productivity $x \geq 0$ which determines its production cost. There are also two types of trade barriers if a firm wishes to serve Foreign. First, the firm needs to pay a fixed cost of exporting C_f , paid exclusively in terms of foreign labour, which is w^*C_f in terms of the numeraire. The crucial assumption of this cost being borne in terms of foreign labour is justified, as firms need, for example, to cover the cost of travelling to the country for prospection, buying local information, carrying out marketing and competition studies, tailoring goods to local demand and establishing a distribution network. A second part of fixed costs of exporting paid at home in terms of domestic labour would lower the number of exporters and amount of total exports but would not change the qualitative results of the model. The same assumption is made in Chaney (2005b).

Serving the foreign market also involves a variable "iceberg" transport cost τ . Shipping one unit of any variety of the differentiated good implies only fraction $1/\tau$ arrives in Foreign because the rest melts on the way.

These different assumptions mean that the cost of producing quantity q_d for the home market is $c_d(q_d)$:

$$c_d(q_d) = q_d \frac{w}{x} + wC_d \quad (4.5)$$

and cost of producing q_f units for the foreign market is $c_f(q_f)$, given the firm is already producing for domestic consumers:

$$c_f(q_f) = q_f \frac{\tau w}{x} + w^*C_f \quad (4.6)$$

Given firms are monopolists for the variety they produce, they set the price. Given the isoelastic demand functions, the optimal price is a constant mark-up over unit cost, including transport cost. This implies:

$$p_d(x) = \frac{\sigma}{\sigma - 1} \times \frac{w}{x} \quad (4.7)$$

at home, and:

$$p_f(x) = \frac{\sigma}{\sigma - 1} \times \frac{\tau w}{x} \quad (4.8)$$

in foreign.

These pricing choices imply that any given firm having drawn productivity level x , could make a profit of $\pi_d(x)$ in the domestic market, and $\pi_f(x)$ abroad:

$$\pi_d(x) = \frac{r_d(x)}{\sigma} - wC_d = \frac{\mu}{\sigma} wL \left(\frac{\sigma}{\sigma - 1} \frac{w}{xP} \right)^{1-\sigma} - wC_d \quad (4.9)$$

$$\pi_f(x) = \frac{r_f(x)}{\sigma} - w^*C_f = \frac{\mu}{\sigma} w^*L^* \left(\frac{\sigma}{\sigma - 1} \frac{\tau w}{xP^*} \right)^{1-\sigma} - w^*C_f \quad (4.10)$$

In order to survive, a firm will need to produce domestically with a profit, whereas in order to export, it will need to profitably produce for foreign consumers. Given equations (4.9) and (4.10), this leads me, as in Melitz (2003) and Chaney (2005a and b) to define two productivity thresholds, \bar{x}_d and \bar{x}_f , at which firms respectively choose to start producing and exporting, when they face no liquidity constraint:

$$\pi_d(\bar{x}_d) = 0 \text{ and } \pi_f(\bar{x}_f) = 0 \quad (4.11)$$

The monopolistic competition setting and the heterogeneity of firms in terms of productivity implies a partition of firms between producers/non-producers and exporters/non-exporters if trade costs are sufficiently high. From the profit functions, it is clear that more productive firms will be able to charge lower prices, therefore ensuring themselves larger market shares and benefiting from larger profits, both in the domestic and exports market. On the domestic market, this means that the least productive firms do not survive, although the imperfect nature of competition implies that some low-productivity firms

are protected from competition if σ is finite and can therefore survive. Similarly, on foreign markets, a partition is made as only the most productive firms export. Given that $(\bar{x}_f/\bar{x}_d)^{\sigma-1} = (\tau^{\sigma-1}C_d/C_f) \times (L/L^*) \times (P/P^*)$, if I assume that trade barriers are high enough, $\bar{x}_f > \bar{x}_f$ will always hold. This implies that firms that are productive enough to export are also producing domestically.

The model so far is identical to Chaney (2005b), and almost identical to Melitz (2003) but for the presence of a numeraire sector, the firms' entry process and potential asymmetry between countries. I now introduce liquidity constraints.

4.1.4 Liquidity constraints

In the setting above, exporting involves fixed costs. These must mostly be paid before any profits are made abroad. If financial markets are imperfect, this leads to ex-ante underinvestment in exporting activities. A different nature of contracting and informational environment in Foreign implies that this is more the case than for domestic entry costs. Foreign activities are less verifiable and are considered more risky, they involve, for example, the use of a foreign currency. The weak contracting environment in some foreign countries means it is harder to recover unpaid dues abroad, and therefore firms are unable to pledge as much collateral for exports. These different elements mean that potential investors or lenders may not be willing to help would-be exporters cover the fixed cost of starting to export.

Combining the assumptions made in Chaney (2005b) and Manova (2006), allows the construction of a richer model, which will be better suited to analyse the data thereafter. Modelling the investor's decision in extending credit to firms more explicitly than in Chaney's set-up allows me to capture the interaction that exists between a firm's performance and its liquidity. But by including an exogenous component to liquidity as in Chaney (2005) allows for the presence of firms with no liquidity constraints but low productivity, as in the data. Also, by making some simplifying assumptions on price indices, as in Chaney, I can solve the model in a general equilibrium and thereafter analyse the effects of exchange rate

appreciations. The resulting model offers interesting predictions that are then taken to the data.

I assume, for simplicity, that there is no liquidity or credit constraint for firms to finance their domestic production. In a first step, I also consider, as in Manova (2006), that firms can finance the variable cost of exporting internally. I assume that the fixed cost of exporting is financed in three different ways. First, a firm can use the profits generated from domestic sales $\pi_d(x)$. Second, each firm is endowed with an exogenous random liquidity shock A , denominated in units of domestic labour. Its value is hence wA . A and x (the productivity parameter) are drawn from a joint distribution with cumulative distribution function $F(A, x)$ over $\mathbb{R}^+ \times \mathbb{R}^+$, and $F_x(x) \equiv \lim_{A \rightarrow \infty} F(A, x)$ over \mathbb{R}^+ . It is also assumed that the group of entrepreneurs, and hence the mass of firms entering the lottery, is proportional to L , the size of the country.

Third, a firm can decide to borrow an amount E on financial markets. In order to do so, it must pledge tangible assets as collateral, and it is assumed that these will be proportional to the fixed cost paid to enter domestic market (e.g. cost of building the factory). The proportionality t_s is inherent to the nature of the industry with s denoting the sector, as in Manova (2006) and Braun (2003): $t_s w C_d$ will be pledgeable as collateral on financial markets. The probability of a firm defaulting on its loan is $1 - \lambda$, which reflects the level of financial contractibility, exogenously determined by strength of financial institutions in the home country (in the empirical section, Belgium). The contracting timing is as follows. At the start of each period, potential investors receive a take-it-or-leave-it offer contract from each firm, detailing the amount to be borrowed, the repayment G and the collateral. Revenues are then realised and, at the end of the period, the creditor claims the collateral $t_s w C_d$ if the firm defaults, or receives payment $G(x)$ if the contract is enforced.

Given these three possibilities for financing the fixed cost of exporting, the liquidity constraint can be expressed as: $wA + \pi_d(x) + E \geq w^* C_f$. A higher domestic profit therefore relaxes the firm's credit constraint. The firm needs to borrow $k w^* C_f$ to cover the fixed cost of exporting, by defining the share $(1 - k)$ of this cost that can be covered internally by the

firm such that $(1 - k)w^*C_f = wA + \pi_d(x)$. As domestic profit increases, k decreases and the firm is less credit constrained.

Below, the expression for profits on the foreign market reflects the fact that the firm finances a fraction $(1 - k)$ of the fixed costs and all of its variable costs internally. As for the share k that is financed externally, the exporter pays with probability λ the investor $G(x)$ when the financial contract is enforced and with probability $1 - \lambda$ replaces the collateral claimed by the creditor. Exporters from Home, choose their price and output levels for foreign by maximising profits on the foreign market:

$$\pi_f(x) = p_f(x)q_f(x) - \frac{q_f(x)\tau w}{x} - (1 - k)w^*C_f - \lambda G(x) - (1 - \lambda)t_s w C_d \quad (4.12)$$

subject to

$$q_f(x) = \mu w^* L^* \frac{p_f(x)^{-\sigma}}{P^{*1-\sigma}}$$

$$NR(x) = p_f(x)q_f(x) - \frac{q_f(x)\tau w}{x} - (1 - k)w^*C_f \geq G(x)$$

$$B(x) = \lambda G(x) + (1 - \lambda)t_s w C_d - kw^*C_f \geq 0$$

There are three constraints to this maximisation problem. The first condition arises even without imperfect financial markets, as it represents the demand condition. The second condition reflects the maximum net revenues $NR(x)$ the firm can offer to the creditor: its revenue on the foreign market, minus the variable cost and share $(1 - k)$ of fixed cost, both financed internally. The third condition expresses the net return to the investor $B(x)$ being positive. This is equal to their expected return, given the probability of default, minus the amount they have lent to the exporter to finance a share k of the fixed cost. The investor will only finance the firm if he expects to at least break even. The amount borrowed by the firm from the external investor is $kw^*C_f = [w^*C_f - wA - \pi_d(x)]^{64}$.

⁶⁴ For simplicity, as in Manova (2006), I normalise the outside option of the investor to 0, rather than to the world-market net interest rate r . This does not change the qualitative predictions of the model.

As credit markets are competitive, all investors break even and have zero expected profits. Firms choose $G(x)$ so as to bring the investor to his participation constraint. $B(x) = 0$ in equilibrium. This implies that the firm's maximisation problem is identical to the case without credit constraints, except that $G(x)$ cannot be greater than net revenues. Hence, as in Melitz (2003):

$$p_f(x) = \frac{\sigma}{\sigma-1} \times \frac{\tau w}{x}, q_f(x) = \left(\frac{\sigma}{\sigma-1} \frac{\tau w}{x} \right)^{-\sigma} \frac{\mu w^* L^*}{P^{*1-\sigma}}, \quad (4.13)$$

$$\pi_f(x) = \frac{r_f(x)}{\sigma} - w^* C_f = \frac{\mu}{\sigma} w^* L^* \left(\frac{\sigma}{\sigma-1} \frac{\tau w}{x P^*} \right)^{1-\sigma} - w^* C_f, \quad (4.14)$$

$$r_f(x) = \mu w^* L^* \left(\frac{\sigma}{\sigma-1} \frac{\tau w}{x P^*} \right)^{1-\sigma} \quad (4.15)$$

If there are no credit constraints, the threshold \bar{x}_f is therefore defined by

$$\pi_f(\bar{x}_f) = 0 \text{ or } r_f(\bar{x}_f) = \sigma w^* C_f$$

$$\bar{x}_f = \left(\frac{\sigma C_f}{\mu L^*} \right)^{\frac{1}{\sigma-1}} \frac{\sigma}{\sigma-1} \frac{\tau w}{P^*} \quad (4.16)$$

Yet, taking into account the presence of imperfect financial markets and hence credit constraints, I include the second constraint of the profit maximisation problem of equation (4.12): $NR(x, p_f(\cdot), q_f(\cdot), B(x) = 0) = G(\bar{x}(A))$. This yields the following revenue function:

$$r_f(\bar{x}(A)) = \sigma \left[\frac{1}{\lambda} w^* C_f - \frac{(1-\lambda)}{\lambda} (t_s - 1) w C_d - \frac{(1-\lambda)}{\lambda} w A - \frac{(1-\lambda)}{\lambda} \frac{\mu}{\sigma} w L \left(\frac{\sigma}{\sigma-1} \frac{w}{\bar{x}(A) P} \right)^{1-\sigma} \right] \quad (4.17)$$

Therefore, if $\lambda = 1$, I am back to the original Melitz (2003) result of equations (4.13), (4.14), (4.15) and $\bar{x}(A) = \bar{x}_f$. If not, the productivity threshold for starting to export is defined by:

$$\bar{x}(A) = w \frac{\sigma}{\sigma-1} \left(\frac{\sigma}{\mu} \right)^{\frac{1}{\sigma-1}} \left[\frac{1}{\lambda} w^* C_f - \frac{(1-\lambda)}{\lambda} (t_s - 1) w C_d - \frac{(1-\lambda)}{\lambda} w A \right]^{\frac{1}{\sigma-1}} \quad (4.18)$$

$$\left[w^* L^* \left(\frac{\tau}{P^*} \right)^{1-\sigma} + \frac{(1-\lambda)}{\lambda} w L \left(\frac{1}{P} \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$$

Firms with productivity below $\bar{x}(A)$ will not be able to export due to credit constraints, despite being sufficiently productive to do so profitably.

4.1.5 Open-economy equilibrium

In order to consider firm entry and exit and the effect of exchange rates variations, I will, in this sub-section, compute the open-economy equilibrium.

It is assumed for simplicity, as in Chaney (2005b), that the price index only depends on local firms' prices and that foreign firms do not face any liquidity constraints. Prices set by foreign firms for the varieties they sell at home only have a small impact on the general price index. In a relatively closed economy, it is a reasonable approximation, which allows for the model to be solved. The price index of equation (4.2) can be approximated by:

$$P \approx \left(\int_{x \geq \bar{x}_d} p_d(x)^{1-\sigma} L dF_x(x) \right)^{\frac{1}{1-\sigma}} \quad (4.19)$$

For convenience, I define function $h(\cdot)$ as:

$$h(\cdot) : \bar{x}^{\sigma-1} = \left(\frac{\sigma}{\mu} \int_{x \geq \bar{x}} x^{\sigma-1} dF_x(x) \right) \times C \iff \bar{x} = h(C) \quad (4.20)$$

with $h' > 0$

This allows me to rewrite the productivity thresholds of equations (4.11), (4.16) and (4.18)

⁶⁵.

⁶⁵ Note that these thresholds do not depend on market sizes. This is due to the assumption that prices are determined by domestic producers only, whose number is proportional to the size of the market. Larger markets will have more varieties, and therefore profits will not be higher.

$$\bar{x}_d = h(C_d) \quad (4.21)$$

$$\bar{x}_f = \left(\frac{C_f}{C_d^*} \right)^{\frac{1}{\sigma-1}} \tau \frac{w}{w^*} h(C_d^*) \quad (4.22)$$

which are equivalent to the results of Chaney (2005b), and

$$\bar{x}(A) = \left[\frac{(1-\lambda)(1-t_s)C_d + \frac{w^*}{w}C_f - (1-\lambda)A}{\lambda\tau^{1-\sigma} \left(\frac{w^*}{w}\right)^\sigma (h(C_d^*))^{1-\sigma} C_d^* + (1-\lambda)(h(C_d))^{1-\sigma} C_d} \right]^{\frac{1}{\sigma-1}} \quad (4.23)$$

All firms with productivity above \bar{x}_d will be producing for domestic consumers. Firms with a productivity above $\max\{\bar{x}_f, \bar{x}(A)\}$ will be able to export because they are both productive enough and have sufficient liquidity to cover the fixed costs.

Equation (4.23) reflects the way firms cover fixed costs of exporting and how productivity levels will affect their decision to export. First, note that if financial contracts were perfectly enforced and $\lambda = 1$, the two thresholds \bar{x}_f and $\bar{x}(A)$ are equal. If this is not the case, looking at A , the amount of exogenous liquidity matters. Firms with a small amount of exogenous liquidity will need to compensate with a higher productivity level to be able to have both a larger profit on the domestic market and a better access to external finance to pay up-front the fixed cost of exporting. Firms with higher productivity can obtain more outside finance because their net revenues and the repayments they offer their investors will be greater. Naturally, a higher fixed cost of exporting C_f also increases the threshold, all other things being equal. Firms in sectors in which tangible assets are more easily collateralisable (higher t_s) will need a lower level of productivity to obtain sufficient external finance and domestic profits to become exporters. The impact of domestic fixed-entry cost is ambiguous. On the one hand, a higher C_d implies lower profits on the domestic market, thus reducing available liquidity and increasing the threshold. On the other, it implies higher tangible assets, and also makes it more difficult for firms to start producing at home, hence reducing competition, increasing market shares of those that do survive and consequently their profits. The total effect depends on the distribution of firm productivity. Two other elements will be affecting the profitability of the foreign markets, and hence the productivity threshold. This is also true for the threshold with no liquidity constraints. First,

the greater the iceberg cost τ , the lower the profits in Foreign. A lower C_d^* means that more foreign firms will be entering their own market, hence reducing the market shares of home exporters and their profits. The reduction in the profitability of foreign markets has an additional effect in the presence of financial frictions, as it will reduce the repayments they can offer to investors. Finally, the relative wage w^*/w affects the productivity threshold through three channels. When it decreases, so does $\frac{w^*}{w}C_f$: the fixed cost of entry into the foreign market being paid in foreign wages will imply less domestic liquidity needed to be an exporter. Second, as in the absence of liquidity constraints, a decrease in Foreign's wage implies a smaller market abroad. A higher wage at home increases production costs. Together, these imply lower profits in foreign and therefore a higher productivity threshold. The third effect of a lower relative wage occurs in the presence of liquidity constraints, where $\lambda < 1$. Lower net revenues imply a higher liquidity constraint, and hence an even higher productivity threshold to compensate.

These various elements determine the productivity threshold for exporting that holds when firms are liquidity-constrained, and hence the number of exporters and their entry and exit into foreign markets. Some firms, despite being productive enough to profitably export will be liquidity-constrained and will therefore not export if $\bar{x}(A) > \bar{x}_f$. Proposition 4.1 states the condition under which there will be a set of such firms⁶⁶, and for the remainder of this chapter, I will assume this assumption holds.

Proposition 4.1 *If*
$$\left[\frac{C_d^*}{C_f} \frac{(1-\lambda)(1-t_s)C_d + \frac{w^*}{w}C_f}{\lambda\tau^{1-\sigma}\left(\frac{w^*}{w}\right)^\sigma C_d^* + (1-\lambda)\left(\frac{h(C_d)}{h(C_d^*)}\right)^{1-\sigma} C_d} \right]^{\frac{1}{\sigma-1}} > \frac{\tau w}{w^*},$$
 there is a non empty set of liquidity constrained firms that are prevented from profitably exporting because they have insufficient liquidity, both exogenously and on the external financial market.

Proof. See appendix 4.A. ■

Firms that have a very low productivity, below \bar{x}_d , will not even produce domestically. Some firms will be productive enough to produce domestically, but for which it will not

⁶⁶ This proposition is close to Chaney (2005)'s Proposition 1.

be profitable to export. Their productivity will be below \bar{x}_f . Firms whose productivity is between \bar{x}_f and $\bar{x}(A)$ either have a too low exogenous liquidity shock A , or are not productive enough to raise external finance, or a combination of both. Firms with productivity above $\bar{x}(A)$ have a sufficiently high A combined with a high enough productivity to both pay the fixed cost of exporting and profitably export. Some even more productive firms would be able to export whatever the A they have, as they would be able to cover the whole fixed cost of exporting with domestic profits and external finance. Finally, the most productive firms need neither an exogenous liquidity shock A , nor access to external finance, and exclusively finance their fixed cost of exporting through domestic profits.

4.1.1 Destinations

In this section, the model is extended to the case in which there are more than two countries, and each firm in Home can decide to export to more than one destination.

In that case, it needs to pay the fixed cost of exporting to each of the destinations it serves. Without credit constraints, all destinations to which a firm could profitably export are served. However, with credit market imperfections, if a firm decides to export to n destinations, then the available collateral for each destination will be $\frac{t_s w C_d}{n}$. The exogenous liquidity and domestic profits available for covering the fixed cost of serving each destination will be also divided by n .

In partial equilibrium analysis, in which the price index is taken as given and not affected by the productivity thresholds that determine entry and exit of firms, this yields the following productivity threshold:

$$\begin{aligned} \bar{x}_n(A) = & w \frac{\sigma}{\sigma - 1} \left(\frac{\sigma}{\mu} \right)^{\frac{1}{\sigma-1}} \left[\frac{1}{\lambda} w^* C_f - \frac{(1 - \lambda)}{\lambda} \left(\frac{t_s}{n} - 1 \right) w C_d - \frac{(1 - \lambda) w A}{\lambda n} \right]^{\frac{1}{\sigma-1}} \times \\ & \left[w^* L^* \left(\frac{\tau}{P^*} \right)^{1-\sigma} + \frac{(1 - \lambda)}{\lambda} w \frac{L}{n} \left(\frac{1}{P} \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \end{aligned} \quad (4.24)$$

In general equilibrium, domestic general price indices are determined in each country by domestic producers, as approximated in equation (4.19). Assuming C_f is identical for all

n countries served, the productivity threshold for exporting to one of the foreign countries with wage w^* and cost C_f , given you are exporting to $n - 1$ other countries is:

$$\bar{x}_n(A) = \left[\frac{\left(1 - \frac{t_s}{n}\right) (1 - \lambda) C_d + \frac{w^*}{w} C_f - (1 - \lambda) \frac{A}{n}}{\lambda \tau^{1-\sigma} \left(\frac{w^*}{w}\right)^\sigma (h(C_d^*))^{1-\sigma} C_d^* + (1 - \lambda) (h(C_d))^{1-\sigma} \frac{C_d}{n}} \right]^{\frac{1}{\sigma-1}} \quad (4.25)$$

The productivity threshold for firms to export will be increasing in the number of destinations they decide to serve when financial markets are imperfect and $\lambda < 1$. The exogenous liquidity shock and the domestic tangible fixed assets used as collateral (and hence the available external finance) will need to be shared to pay for the fixed costs of the n destinations served. This will increase the productivity level needed to ensure higher domestic profits and more external finance will compensate for the additional need of liquidity.

Proposition 4.2 *If the condition in Proposition 4.1 holds, there is a non empty set of liquidity constrained firms that are prevented from profitably exporting to n destinations because they have insufficient liquidity, both exogenously and on the external financial market. As a result, more productive and less credit constrained firms will export to more destinations.* **Proof.** : Given the condition in Proposition 4.1 holds, $\bar{x}(A) > \bar{x}_f$. In the

absence of financial constraints, with C_f common to all markets, \bar{x}_f does not vary across destinations, nor with the number of destinations served. Hence any firm productive enough to profitably export to one country will also be able to export to n destinations. This is not the case with credit constraints. As $\bar{x}_1(A) = \bar{x}(A)$ and $\frac{\partial \bar{x}_n(A)}{\partial n} > 0$, the thresholds are such that $\bar{x}_n(A) > \bar{x}_{n-1}(A) > \bar{x}_{n-2}(A) > \dots > \bar{x}_2(A) > \bar{x}_1(A) > \bar{x}_f$, hence the result. ■

Without considering entry and exit of firms, whatever the number of destinations being served, the productivity threshold for exporting to larger markets is lower, as can be seen from equation (4.24). Net revenues for firms exporting to such markets are also larger, which means they will be less credit-constrained, all other things equal. The effect of the size of the market needs to be balanced with that of iceberg trade costs: a very large market will be less profitable if it is located far from the Home economy and that trade costs are therefore higher. From equation (4.24) it is straightforward to show that :

$$\frac{\partial \bar{x}_n(A)}{\partial \left(\frac{L^*}{\tau^{\sigma-1}}\right)} < 0 \quad (4.26)$$

One can therefore order all potential destination markets according to $\frac{L^*}{\tau^{\sigma-1}}$, their size weighted by the iceberg cost that applies to them. This ordering will also correspond to the profits derived from exporting to those countries: the higher $\frac{L^*}{\tau^{\sigma-1}}$, the higher the profit as given by equation (4.14). This introduces a pecking order of trade:

Proposition 4.3 *Firms will add export destinations in decreasing order of trade cost weighted market size, $\frac{L^*}{\tau^{\sigma-1}}$. More productive firms will export to more destinations, but also to relatively smaller markets. **Proof.** : See appendix 4.B. ■*

This result is similar to that of Manova (2006), except for the important trade cost weighting dimension. It does not carry over directly to general equilibrium because of the assumption made on prices. In the open equilibrium economy, thresholds will depend on trade costs, but not on market size.

4.1.1 Exchange rate appreciation effect

An appreciation of the domestic currency with respect to the foreign currency means domestic exporters are less competitive in the foreign market. As argued by Chaney (2005b), it also relaxes the liquidity constraint faced by potential exporters given the fixed cost of exporting is paid in foreign currency. The value of their domestic liquidity in terms of foreign currency, be it domestic profits, exogenous cash flow or credit, has increased. Existing exporters export less, but some new firms, enter the market. These entrants are liquidity-constrained firms who are productive enough to export. The liquidity effect dominated the competitiveness effect, but the appreciation relaxes the constraint and allows them to start exporting. This means that the extensive and intensive margin of exports to a given destination are affected differently by an appreciation of the exchange rate. In the model, exchange rate variations can be modelled as a shock on relative wages. As used by Atkeson and Burstein (2005), an increase in the productivity in the homogeneous sector at home

leads to an increase in the domestic wages, and hence in the value of domestic assets (wA and $\pi_d(x)$). In foreign, $p_f(x)/P^*$ increases, reflecting the loss of competitiveness of domestic exporters, as in the case of an appreciation of the domestic currency.

Proposition 4.4 *An appreciation of the exchange rate between the domestic and the foreign currencies has three effects: (1) Existing exporters become less competitive and reduce their exports*

(2) The least productive existing exporters stop exporting

(3) The most productive constrained non-exporters start exporting

Proof. (1) The revenue, or total value of exports, of a firm that is already an exporter in foreign and with productivity x is given by $r_f(x)$. In the presence of liquidity constraints, plugging the productivity thresholds of equations (4.21), (4.22) and (4.23) with the price index in equation (4.19) into the revenue equation (4.4), revenue is then equal to

$$r_f(x) = \sigma w^* C_d^* \left(\frac{w^* x}{\tau w \bar{x}_d^*} \right)^{\sigma-1} \quad (4.27)$$

As domestic exporters face higher-priced inputs at home, they need to charge higher prices in foreign to maintain mark-ups, thus losing export market shares and reducing exports, as can be seen from differentiating equation (4.27):

$$\frac{\partial r_f(x)}{\partial w} = -r_f(x) \frac{(\sigma - 1)}{w} < 0$$

(2) As a consequence of (1), losing competitiveness also reduces the profits made in Foreign. Given equation (4.14) and the proof of (1),

$$\frac{\partial \pi_f(x)}{\partial w} = -r_f(x) \frac{(\sigma - 1)}{\sigma w} < 0$$

For the least productive firms, as the fixed cost of entering foreign w^*C_f is unchanged, exporting is not profitable anymore. The productivity threshold \bar{x}_f given in equation (4.22) increases, as $\frac{\partial \bar{x}_f}{\partial w} = \frac{\bar{x}_f}{w} > 0$

(3) An appreciation causes the exogenous liquidity and domestic profits to increase. This facilitates the obtention of credit for a given productivity level and therefore relaxes the

liquidity constraint. Constrained exporters who were prevented entering the foreign market are now able to do so. ■

These effects are similar to those described in Chaney (2005b), although the third effect is slightly modified by the financial market which is modelled here. In both cases, the presence of incomplete financial markets and liquidity constraints implies that exports do no longer depend only on the competitiveness of exporters. The relative cost of exporting relative to domestic assets is also important and it varies with exchange rates.

We now turn to the empirical analysis in order to verify whether the model's predictions are confirmed in the data.

4.2 Data

4.2.1 The Belgian Balance Sheet and Trade Transaction Data

This dataset was presented in detail in Chapter 3. The balance sheet part of the BBSTTD is used to extract firm-level annual characteristics, including employment, value added, financial situation, sector of activity and to compute total factor productivity. Only the export data side of the customs data is used in this chapter, and includes the destinations, products and value information⁶⁷.

Manufacturing firms only are selected as belonging to sectors 15 to 36 of the NACE-BEL classification. Firms from sector 232 (refined petroleum products) are excluded as their total factor productivity (TFP) measures are strong outliers.

4.2.2 Measuring Credit Constraints: the Coface score

As a measure of credit constraints, I use the Coface Services Belgium Global Score for around 9000 Belgian manufacturing firms between 1999 and 2005⁶⁸. This section describes the activities of Coface, the construction of the score, justification for using it as a measure for credit constraints, and an external validation through its comparison with other techniques found in the literature on credit constraints.

A. The Coface Score

Coface International

Established in France in 1945 as a credit insurance company, Coface has grown in the past 15 years to become a world provider of services to facilitate business-to-business trade.

⁶⁷ Given the difference of threshold for data to be available when a firm exports within the EU and outside the EU (see chapter 3), we do not consider as exporters firms that export only outside the EU and whose annual total of imports and exports is lower than 250,000 Euros.

⁶⁸ There are 62,569 year-firm observations. In 1999, 9,268 firms, and in 2005, reflecting the decline of manufacturing reported in chapter 3, only 8,411 firms

Besides offering receivables finance and managing and collecting commercial receivables for its clients, it also provides credit information and insurance services.

Through a worldwide network of credit information entities, it has constituted an international buyer's risk database on 44 million companies. Data from public and private sources are added to Coface's internal data in order to manage each company's rating and Coface's risk exposure on a continuous basis.

Based on this database, it can offer credit insurance policies and therefore allows its clients to tackle customer insolvency, bad debts, overdue accounts, commercial risks and political risks when trading on credit terms. With the same database, it also provides its clients with credit information on other firms.

Within the Basel II framework for regulatory capital requirements, banks may choose to compute their regulatory capital requirement through the internal ratings-based approach, hence providing a measure of the probability of default for each borrowing company. There has therefore been an incentive for credit insurance firms such as Coface to also offer their services to banks who wish to outsource this measurement.

Why is it a good measure of credit constraints?

The Coface score, despite being constructed as a bankruptcy risk measure, is highly correlated with how credit-constrained a firm is. It will reflect the same type of information that a bank would use to decide whether it lends to a firm. In some sense, by covering the risk for its clients of trading with firms that have a good score, Coface also provides these firms with a form of extra liquidity through a short-term debt from their suppliers: it gives a firm the opportunity to pay for the goods or services provided by Coface's client at a later date. This is reflected in the term "credit insurance".

Although it is clearly endogenous to the firm's performance and characteristics, it is not directly affected by its exporting behaviour, given that this is not public information in Belgium and that it does not enter the Coface's score determination model. Being determined independently by a private firm, the Coface score is therefore a very useful measure of credit constraint for our purposes. It is unusual for such data to be available and has a great advantage on measures of credit constraints used in the literature so far: it is firm-specific,

varies through time on a yearly basis and allows for a measure of the degree of credit constraint rather than classifying firms between the two constrained or unconstrained categories. Although the score is updated by Coface on a continuous basis, the data provided by the company for this chapter only reports the score of each firm on the 31 December. This corresponds to the date of closure of annual accounts, and therefore allows a good comparability with employment and productivity data. However, although the trade transactions data are aggregated annually, they occur throughout the year. Different events also make the score vary continuously. Having the time-continuous data for the score and for the exporting activity would allow for more precision when considering the interactions between the two.

The score is endogenous to other of the firm's characteristics, as illustrated in Figure (4.1). In the empirical section, I will therefore be estimating equilibrium relationships from the model and not establishing any causality relation. The model presented in the previous section predicts that credit constraints are endogenous. The score contains information about the credit constraints a firm faces but also about its quality, performance and productivity. Two firms with equally valuable projects, and identical profitability and productivity can be very different in terms of financial health, board structure, and other elements that will determine their score and their access to credit. The empirical analysis will therefore seek to control for a number of variables that could potentially influence both the Coface score and the exporting activity under study, such as size and productivity of firms.

The Coface score is a well-suited direct measure of creditworthiness used by other firms and by banks when extending loans, and will be used in my empirical analysis to measure how credit-constrained firms are.

Construction of the score

As presented in Mitchell and Van Roy, 2007, there is a large academic literature on bankruptcy prediction models such as that used to construct Coface's score (Vivet, 2004, for Belgium and see, for example, the review by Balcaen and Ooghe, 2006). However, privately-computed probability of default or credit scores such as Coface's are naturally less well-known. The aim of the score is to predict the risk of default of the firm and therefore

classify firms between “healthy” and “failing firms”. The precise model used to compute the Coface score is confidential, for obvious reasons. As summarised in Figure 4.1, it combines several quantitative and qualitative inputs: financial statements (leverage, liquidity, profitability, size, etc.), industry-specific variables, macro-economic variables such as industrial production, legal form, age, geographical location, type of annual accounts (full or abbreviated), life cycle, board structure, commercial premises, payments incidents, ONSS (social security) summons and legal judgments.

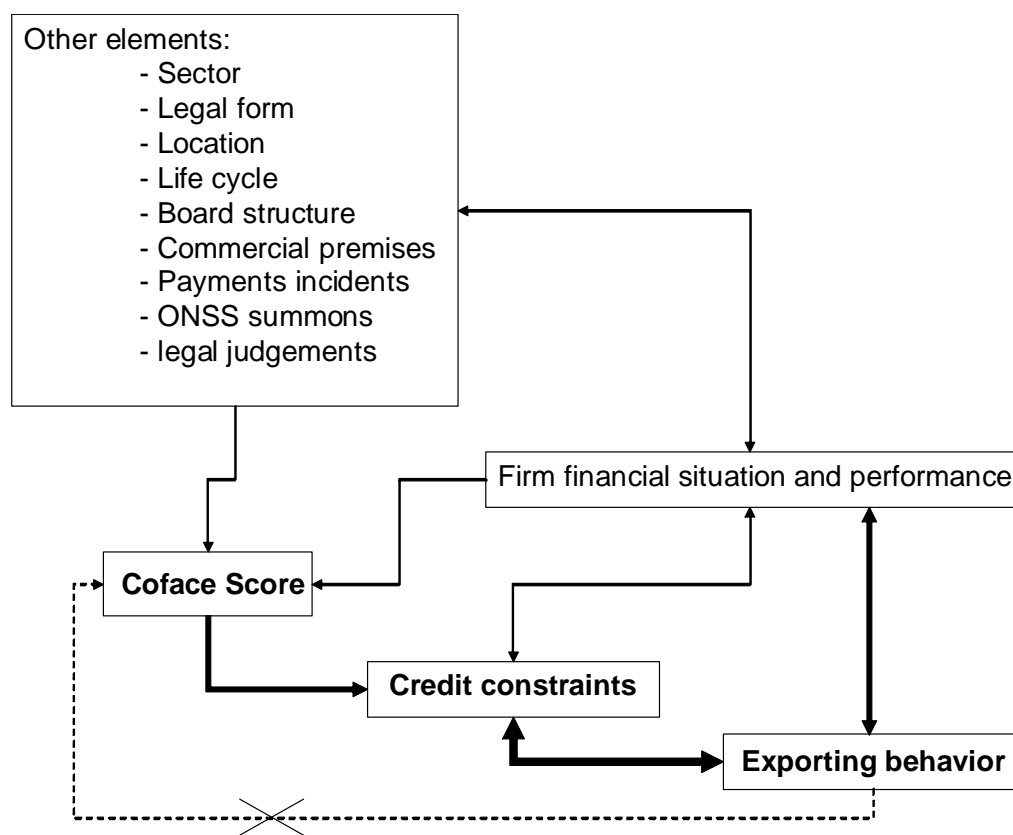


Fig. 4.1. The Coface Score

These various inputs are combined using several statistical methods. This combination has been constructed by a trial-and-error method, which is why I do not use data before 1999. The result is a score ranging from 3/20 to 19/20. Although the model predicts continuous scores they are rounded to unity in the data I have obtained. The three categories used by

Coface are the “maximum mistrust” (3 to 6/20 inclusive), “temporary vulnerability” (7 to 9/20 inclusive) and “normal to strong confidence” (10 to 19/20 inclusive).

Selection of firms with a score

Given there is no possibility for the moment to select which firms’ score are available, below I examine descriptive statistics to see if there are any systematic differences between firms with a Coface score and those without. Table 4.1 shows how firms with a Coface score are larger and more productive. Exporting firms with a score available export on average more, more products and to more destinations. However given the high correlation between size and these variables, a Probit analysis is carried out for the year 2003.

Table 4.1. Comparison of firms with or without available Coface score

		No Coface Score				Coface Score available			
		Mean	sd	Obs.	se	Mean	sd	Obs.	se
Employment		12.95	123.28	39092	0.62	53.92	219.63	62416	0.88
Log of TFP Lev-Pet		9.95	1.31	37889	0.01	10.50	1.43	61655	0.01
EXPORTERS	Total export value (in million Euros)	7.80	12.20	6819	0.15	12.53	16.42	29585	0.10
	Number of destinations	8.11	15.29	6819	0.19	13.51	23.16	29585	0.13
	Number of products	8.22	58.37	6819	0.71	16.59	102.92	29585	0.60

Notes: The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD in 99 three digit sector for the years 1999 to 2005. The first four columns depict firms that have no Coface score available. The firm is however in the BBSTTD (with Balance Sheet information, more than one employee and potentially trade data) for that year. The Coface Score is a credit rating score constructed for each year and each firm by Coface. In the four last columns, the score is available. Only firms for which a score is available for each year they file in a balance sheet over the period are kept in the sample. The mean, standard deviation (sd), number of observations (Obs.) and standard error of the means (se) are reported for the following variables. Employment represents the number of full time equivalent employees, “Log of TFP Lev-Pet” is the logarithm of Total Factor Productivity calculated according to Levinsohn and Petrin's (2003) method. The last three rows compare exporters in each category, comparing the total value of their exports, the number of destinations they serve and the number of products they export.

The results are reported in Table 4.2. Larger firms in terms of employees numbers are more likely to be included in the sample. It shows that once size of the firm is controlled for, there are no systematic differences between firms that are in the sample and those outside, given

that the coefficients on productivity and export characteristics are not significant. So, there is no bias to be taken into account in the empirical analysis as long as size is controlled for.

Table 4.2. Probit analysis of being included in the Coface sample

Dependent variable:	0/1 dummy: 1 = Firm with Coface score available 0 = no score available	
	(1)	(2)
Log (employment)	0.768** (0.022)	0.377** (0.025)
Log (TFP Lev-Pet)	-0.013 (0.013)	
Exporter – non Exporter dummy	-0.046 (0.031)	
Log (total exports)		-0.008 (0.013)
Log (number of destinations exported)		0.007 (0.031)
Log (number of products exported)		-0.024 (0.025)
Observations	13924	5126

Notes: The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD in 99 three digit sector for the year 2003. Robust standard errors in parentheses; + denotes statistical significance at the 10% level; * denotes statistical significance at the 5% level; ** denotes statistical significance at the 1% level. Includes constant, not reported. The dependent variable is the a dummy equal to 1 if a credit rating score constructed for each firm by Coface is available in 2003. The dummy is equal to 0 if the firm is in the BBSTTD (with Balance Sheet information, more than one employee and potentially trade data), but no score is available. Only firms for which a score is available for each year they file in a balance sheet over the period are kept in the sample. Log (x) is the logarithm of variable x. “TFP Lev-Pet” is Total Factor Productivity calculated according to Levinsohn and Petrin's (2003) method. “Exporter-non Exporter” is a dummy equal to 1 if the firm exports in 2003, and equal to 0 if not.

B. External validation

Having described the construction of the Coface score, I show how it is correlated to firm fundamentals and how it is related to higher debt. I then present the literature on credit constraints and see how the score compares to some alternative methodologies for measuring them.

Correlation with firm fundamentals

Given the methodology used to construct the score is not available publicly, I show here how correlated the score is with the firm's financial situation and productivity. I choose a selection of financial ratios (Lagneaux and Vivet, 2006) to measure each firm's solvency, liquidity, profitability and investment.

Profitability is measured with the return on equity (ROE) ratio, net profit after tax over equity capital. It reflects the return to be expected by shareholders once all expenses and taxes have been deducted. It is widely used in the literature as a indicator of firm performance (see, for instance, Gorton and Schmid, 2000).

Solvency is measured with two ratios, financial independence and coverage of borrowings by cash flow. These summarise the firm's ability to meet their short- and long-term financial liabilities. Financial independence is the ratio between equity capital and total liabilities. It also reflects how independent the firm is of borrowings. The coverage of borrowings by cash flow measures the firm's repayment capability, and its converse specifies the number of years it would take to repay its debts assuming its cash flow were constant.

Liquidity "in the broad sense" ratio is used to assess the firm's ability to repay its short-term debts. It divides total assets realisable and available by short-term liabilities.

Investment is assessed by computing the rate of investment and acquisitions of tangible fixed assets over value added for the year.

As shown in Table 4.3, the Coface score is correlated with all these ratios, confirming it reflects financial situation. The negative coefficient of the return on equity corresponds to a very low beta coefficient (-0.015) compared to the other ratios (for example, 0.47 for financial independence). Liquidity and solvability therefore appear to be more important elements than profitability in determining a firm's access to credit. Three-digit-sector and year fixed effects are included in the OLS regression, in order to control for possible differences in, for example, risk premia across industries and years which might affect the Coface score and other financial measures differentially. Such controls will be included in many other regressions in the chapter.

Table 4.3. The correlation between the score and financial ratios

Dependent variable:	Score				
	(1)	(2)	(3)	(5)	(6)
Return on equity	-0.135** (0.043)				
Financial independ.		7.500** (0.053)			
Borrowings coverage			4.706** (0.063)		
Broad liquidity				0.884** (0.015)	
Investment ratio					22.819** (8.018)
Log (empl.)	0.756** (0.013)	0.712** (0.012)	0.801** (0.012)	0.827** (0.013)	0.759** (0.016)
Observations	61237	61245	61190	61185	60114
R-squared	0.08	0.30	0.16	0.14	0.08
Year fixed effects	YES	YES	YES	YES	YES
Sector fixed effects	YES	YES	YES	YES	YES

Notes: OLS regression. The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSITD with Coface score available and includes an average of 8926 firms per year in 99 three digit sector over the period 1999 to 2005. Robust standard errors in parentheses; + denotes statistical significance at the 10% level; * denotes statistical significance at the 5% level; ** denotes statistical significance at the 1% level. Includes constant and 3-digit sector and year dummies, not reported. The ratios are defined as follows: Return on Equity = Net profit after tax / Equity capital; Financial independence = Equity capital / Total liabilities; Coverage of borrowings by cash flow = Cash flow / (Debt + Reserves + Differed tax); Liquidity "in the broad sense" = (Total assets - Long term Loans) / Short term liabilities; Investment ratio = Acquisitions of tangible fixed assets / Value-added. The extreme observations (top and bottom percentile) for each ratio across all years are removed for the corresponding regression. Log (empl.) is the logarithm of employment, and allows controlling for the size of firms. The dependent variable is the credit rating score constructed for each year and each firm by Coface and ranges from 3 to 19. Only firms for which a score is available for each year they file in a balance sheet over the period are kept in the sample. The variation in the number of observation is due to firms not reporting some of the variables used in the calculation of a given ratio in their balance sheet.

Effect of score on new loans

Given the Coface score measures credit constraints, I seek to measure in the data the relationship between the score and the credit extended to a firm. I therefore start by describing how the score will affect the probability of obtaining new loans and their size. Although I do not have exact details on the loans held by the firm, the balance sheet reports the total amount of financial debt. I can therefore compute the variation, and consider a positive increase in the total amount of financial debt as a new loan. On average, per year, 34% of firms increase their debt relative to the past year's level. I describe these new loans in Table 4.4.

Table 4.4. Descriptive statistics of new loan measure

New bank loan	
Mean	379,794
Median	92,240
Minimum	46
Maximum	7,367,197
Standard deviation	805,174
25th percentile	23,828
75th percentile	325,000

Notes: A new bank loan is defined as an increase in financial debt relative to the previous year. Financial debt is computed as the sum of short and long term financial debt, respectively variables 43 and 170/4 of the balance sheet. We drop outlying firm-year observations (top and bottom 1%). The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD with Coface score available and includes an average of 8926 firms per year in 99 three digit sector over the period 1999 to 2005.

Although they are not a perfect measure of new loans, it remains interesting to check whether they are influenced by our measure of credit constraint. The impact of the score, both on the probability to contract a new bank loan and on the size of this loan, after controlling for other credit constraints determinants are presented in Tables 4.5 and 4.6. When considering the probability of obtaining a new loan, the linear probability model is used because of the large number of fixed effects that are included.

Table 4.5. Effect of score on the size of new debt

Dependent variable:	Logarithm of debt increase			
	(1)	(2)	(3)	(4)
Score (t-1)	0.007** (0.001)	0.008** (0.001)	0.007** (0.002)	0.006** (0.002)
Score (t-2)		0.002 (0.001)	0.000 (0.002)	0.000 (0.002)
Log(Cash flow (t-1))		0.001 (0.006)	-0.002 (0.007)	-0.014+ (0.007)
Log(Employment (t-1))		-0.052 (0.040)	-0.046 (0.049)	-0.014 (0.051)
Log(Employment ² (t-1))		-0.008 (0.007)	-0.006 (0.009)	-0.010 (0.009)
Change in Log(Value added (t-1))			-0.004 (0.019)	-0.043* (0.021)
Change in Log(Value added (t-2))			0.009 (0.016)	-0.010 (0.017)
Log (TFP Lev-Pet (t-1))				0.119** (0.025)
Log (TFP Lev-Pet (t-2))				0.006 (0.010)
Observations	49229	35473	27025	26784
Number of firms	10094	9134	8340	8273
R-squared	0.01	0.00	0.00	0.00
Firm fixed effects	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES

Notes: Fixed effect OLS regression. The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD with Coface score available for each year they file in a balance sheet over the period. It includes an average of 8926 firms per year in 99 three digit sector over the period 1999 to 2005. Robust standard errors in parentheses; + denotes statistical significance at the 10% level; * denotes statistical significance at the 5% level; ** denotes statistical significance at the 1% level. Includes constant and year dummies, not reported. The variation in the number of observation is due to differences in the lags of variables used in the different columns. The dependent variable is constructed using the change in the logarithm of financial debt (sum of short and long term financial debt) with respect to the previous year, when there has been an increase in financial debt, interpreted as a new loan. If there has not been an increase in the debt, it is set to zero. (t-1) and (t-2) indicate the explanatory variable have been lagged by one or two years respectively. Log indicates the logarithm of the variable has been used. Score is the credit rating score constructed for each year and each firm by Coface and ranges from 3 to 19. TFP Lev-Pet is a measure of Total Factor Productivity measured according to Levinsohn and Petrin's (2003) method, for more details see main text in following section.

Table 4.6. Impact of score on probability of increasing debt

Dependent variable:	0/1 Dummy for debt increase			
	(1)	(2)	(3)	(4)
Score (t-1)	0.007** (0.001)	0.009** (0.001)	0.007** (0.002)	0.006** (0.002)
Score (t-2)		0.003* (0.001)	0.003* (0.002)	0.004* (0.002)
Log(Cash flow (t-1))		0.005 (0.004)	0.003 (0.006)	-0.002 (0.006)
Log(Employment (t-1))		-0.027 (0.032)	0.011 (0.044)	0.025 (0.045)
Log(Employment ² (t-1))		-0.014* (0.006)	-0.026** (0.009)	-0.028** (0.009)
Change in Log(Value added (t-1))			0.012 (0.015)	0.002 (0.019)
Change in Log(Value added (t-2))			0.029* (0.012)	0.020 (0.013)
Log (TFP Lev-Pet (t-1))				0.046* (0.021)
Log (TFP Lev-Pet (t-2))				0.016 (0.014)
Observations	50616	36397	27698	27440
Number of firms	10120	9166	8363	8299
R-squared	0.01	0.01	0.01	0.01
Firm fixed effects	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES

Notes: Firm fixed effect Linear Probability regression. The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSITD with Coface score available for each year they file in a balance sheet over the period. It includes an average of 8926 firms per year in 99 three digit sector over the period 1999 to 2005. Robust standard errors in parentheses; + denotes statistical significance at the 10% level; * denotes statistical significance at the 5% level; ** denotes statistical significance at the 1% level. Includes constant and year dummies, not reported. The variation in the number of observation is due to differences in the lags of variables used in the different columns. The dependent variable is a dummy equal to 1 if financial debt (sum of short and long term financial debt) increased with respect to the previous year, and zero otherwise. (t-1) and (t-2) indicate the explanatory variable have been lagged by one or two years respectively. Log indicates the logarithm of the variable has been used. Score is the credit rating score constructed for each year and each firm by Coface and ranges from 3 to 19. TFP Lev-Pet is a measure of Total Factor Productivity measured according to Levinsohn and Petrin's (2003) method, for more details see main text in following section.

Score and productivity

In this subsection I also describe the correlation between credit constraints and productivity, the two determinants, in our framework, of firms' exports decisions. Measuring productiv-

ity is prone to several problems that have been dealt with in different ways in the literature. I choose here to report the correlation of the score with three alternative measures of productivity.

The first is simply labour productivity, measured by value-added over employment. The second is total factor productivity according to the Olley and Pakes (1996) methodology which seeks to solve the simultaneity problem of factor input choices being made by firms once they observe part of their TFP. Olley and Pakes use the firm's investment decision to proxy unobserved productivity shocks. The third method, suggested by Levinsohn and Petrin (2003) measures TFP using materials as a proxy rather than investment, thus reducing the number of zero-observations often noted in the data for investment compared to materials.

Table 4.7 reports the coefficients of the various productivity measures. I regress the Coface score on productivity, controlling for size. Score is positively but not perfectly correlated with productivity, confirming that credit constraints and productivity are two different issues to be considered when analysing export behaviour. This is also illustrated in Figure 4.2, which shows there is no clear positive relationship between the score and the firm's productivity.

Table 4.7. Score and productivity correlation

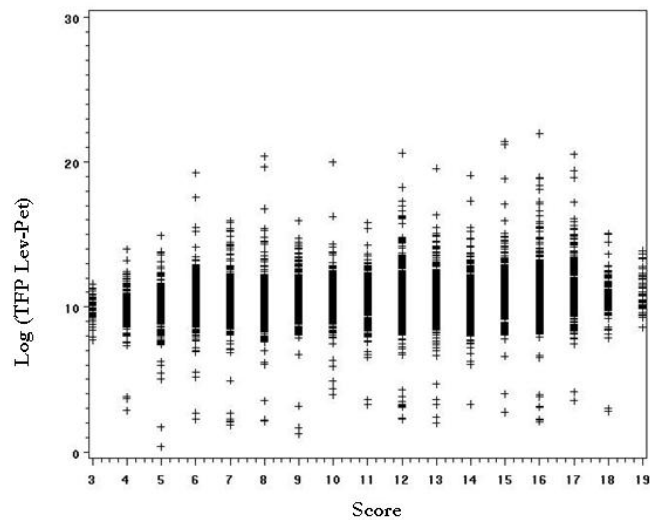
Dependent variable:	Score		
	(1)	(2)	(3)
Log (VA/empl.)	1.186** (0.028)		
Log (TFP Olley-Pakes)		1.368** (0.032)	
Log (TFP Lev-Pet)			1.155** (0.029)
Log (empl.)	0.700** (0.013)	0.723** (0.013)	0.363** (0.016)
Observations	62409	61714	61655
R-squared	0.11	0.11	0.10
Year fixed effects	YES	YES	YES
Sector fixed effects	YES	YES	YES

Notes: OLS regression. The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD with Coface score available and includes an average of 8926 firms per year in 99 three digit sector over the period 1999 to 2005. Robust standard errors in parentheses; + denotes statistical significance at the 10% level; * denotes statistical significance at the 5% level; ** denotes statistical significance at the 1% level. Includes constant and 3-digit sector and year dummies, not reported. The dependent variable is the credit rating score constructed for each year and each firm by Coface and ranges from 3 to 19. Only firms for which a score is available for each year they file in a balance sheet over the period are kept in the sample. The variation in the number of observation is due to firms not reporting some of the variables used in the calculation of a given variable in their balance sheet. Log (x) is the logarithm of variable x. (VA/empl.) is the labour productivity measured as value-added over employment. TFP Olley-Pakes is a measure of Total Factor Productivity measured according to Olley and Pakes's (1996) method while TFP Lev-Pet is a measure of Total Factor Productivity measured according to Levinsohn and Petrin's (2003) method, for more details see main text in following section. Log (empl.) is the logarithm of employment, and allows controlling for the size of firms.

The literature on measuring credit constraints

The effects of financial constraints on firm behaviour are an important area of research in corporate finance. As originally stated by Keynes (1936), firms with a liquid balance sheet and/or access to external capital markets will be able to invest in worthwhile projects when they arise.

In order to identify and classify firms between credit-constrained and unconstrained, one important strand of the literature has followed Fazzari, Hubbard and Petersen (1988) in identifying the cash flow sensitivities of investment. If there were no financial frictions, investment would only be determined by the availability of positive net present value projects. The validity of this argument and of the empirical work that followed has been challenged



Notes: The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSSTD with Coface score available in each year they file in a balance sheet over the period and includes an average of 8926 firms per year in 99 three digit sector over the period 1999 to 2005. This figure plots 8395 firms for the year 2005. On the horizontal axis, the credit rating score is reported, constructed for each year and each firm by Coface and ranges from 3 to 19. The vertical axis measures the logarithm of Total Factor productivity computed according to Levinsohn and Petrin's (2003) method.

Fig. 4.2. Total Factor Productivity and Score (2005)

by Kaplan and Zingales (1997 and 2000) among others. Nevertheless, the cash flow sensitivity of investment approach has, for example, been used to test the importance of credit constraints on R&D (Bond et al., 2003) or the importance of the number of bank relationships in the presence of adverse cash flow shocks in Belgium (Fuss and Vermeulen, 2006). However, using this approach to measure credit constraints would not have allowed me to test as many implications of the model, which is why I opted for a new and alternative measure, described above. This is because the cash flow sensitivity of investment only allows classifying firms between unconstrained and constrained and does not give any scale of the constraint, while the Coface measure ranges from 0 to 19. Also, a minimum of three years would be needed to measure how sensitive a firm's investment is to its cash flow, while the Coface score is a yearly measure and will be changed following precise events occurring within the firm, as detailed previously. Given its exporting behaviour varies through

time, it is much more convincing to have a precise annual scale of creditworthiness, than a three-year moving average of whether a firm is credit-constrained or not.

This is also true of a more recent contribution, by Almeida, Campello and Weisbach (2004), who suggest an alternative criterion. The intuition behind their approach is that firms that anticipate facing strong financing constraints will tend to hold more cash available for investment. They call it the cash-flow sensitivity of cash. In our sample of firms, however, the basic descriptive statistics that should appear if this approach was valid do not seem to hold, probably due to the presence of very small firms. The same caveats as those of the cash-flow sensitivity of investment would in any case apply. I will therefore not consider this alternative.

As for structural econometric models (e.g. Q models or Euler equations) used to determine financial constraints, their specifications have been strongly criticised once evidence of irreversible and lumpy adjustment costs emerged (Cabellero, 1997's review).

Other possible methodologies present in the literature are not available to us given the data I am using. For example, my willingness to keep in my sample private and small firms does not allow the use of bond or commercial paper ratings, nor Tobin's Q and therefore the Kaplan-Zingales index following Lamont, Polk and Saa-Requejo (2001) or Almeida et al. (2004).

One alternative approach to sorting firms into financially-constrained and unconstrained types on a yearly basis would be to rank firms according to their payout dividend ratio (Cleary, 1999). As in Almeida et al (2004) and based on the intuition in Fazzari et al. (1988), firms in the top three deciles will be considered as less financially-constrained than firms in the bottom three. Also, considering size as a good observable measure of credit constraints based on Gilchrist and Himmelberg (1995) and as in Almeida et al. (2004), ranking can be made according to total assets (Allayannis and Mozumdar, 2004). In the next point, I show that the score measure is consistent with these two approaches.

Compared to this important literature on credit constraints, it is clear that the Coface score provides many advantages. It is a direct measure of the credit ratings of firms, which is used by banks and other firms when they decide to extend credit or not. Adapted according to

the most recent information available and including many determinants, it is available for each year. Finally, it does not only classify firms between constrained and non-constrained, but provides a precise scale of the creditworthiness of the firm.

Dividend Payout and Total Assets

Dividend payout and total assets are two of the many alternative measures used in the literature to classify firms between financially-constrained and unconstrained. Firms whose dividend payouts are in the top 30 percentiles are considered as financially unconstrained, whereas those in the bottom 30 percentiles are financially constrained. I therefore test whether such classifications imply a larger score for unconstrained firms and present the results in Table 4.8. In the two alternative classification criteria, it appears that unconstrained firms will have a higher average score than financially-constrained ones. The means are significantly different from one another. This confirms that the Coface score offers a creditworthiness measure that is consistent with the existing literature.

Table 4.8. Score of financially constrained and unconstrained firms according to dividend payout ratio and total assets

Score	Mean	SE	Max	Min	N
Dividend payout					
Constrained	13.52	.054	19	3	3074
Unconstrained	14.12	.048	19	3	3073
Total assets					
Constrained	10.33	.028	19	3	18762
Unconstrained	13.00	.027	19	3	18767

Notes: The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD with Coface score available and includes an average of 8926 firms per year in 99 three digit sector over the period 1999 to 2005. The credit rating score constructed for each year and each firm by Coface ranges from 3 to 19. Its mean, standard error, maximum and minimum observations are reported for the different categories defined. Using the dividend payout criterion, only firms whose dividend payout is positive are included, which is why there is a difference in the number of observations. Firms whose dividend payout is in the top 30th percentiles are considered as financially unconstrained, whereas those in the bottom 30 percentiles are financially constrained. The same is done with total assets. The mean test is passed, meaning that constrained firms have a lower score than unconstrained firms, in both criteria. This is robust to using only one cross-section of the data, or taking out observations within the top and bottom percentiles of each measure.

4.3 Empirical results

4.3.1 The effect of credit constraints on the export status, destinations, total exports, and products.

As a first prediction of the model, we would expect that firms that are less credit-constrained are more likely to be exporters. This appears in the descriptive statistics presented in Table 4.9: exporters are not only larger and more productive, they also have a higher score, meaning they are more creditworthy and less liquidity-constrained.

Table 4.9. Descriptive Statistics

	Non-Exporters				Exporters			
	Mean	sd	Obs.	se	Mean	sd	Obs.	se
Employment	15.89	31.11	33425	0.17	97.45	314.65	29036	1.85
Log of TFP Lev-Pet	10.23	1.10	32769	0.01	10.80	1.66	28860	0.01
Score	11.06	3.78	33425	0.02	12.32	3.84	29036	0.02
Number of destinations	12.74	16.48	29036					
Number of products	13.75	23.32	29036					
Total export value (in million Euros)	16.90	104.0	29036					

Notes: The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD with Coface score available and includes an average of 8926 firms per year in 99 three digit sector over the period 1999 to 2005. Observations are at the firm-year level. The credit rating score constructed for each year and each firm by Coface ranges from 3 to 19. The means, standard deviations, numbers of observations and standard errors of means are reported for the different variables and categories defined. Exporters are firms that were exporting a positive amount in that year. Non-exporters were exporting zero in that year.

This is confirmed when considering the coefficients of firm characteristics effect on the probability of exporting in a given year from the linear probability model in levels reported in Table 4.10. The totality of the sample of firms for which a Coface score is available in each year it has filed a balance sheet is included. Given the number of fixed effects I want to include in my specification, using a linear probability model allows me to address the

incidental parameters problem that affects non-linear fixed-effects estimates. This specification is used in Bernard and Jensen (2004) for a very similar binary choice problem despite the problems this might provoke (e.g. predicted probabilities outside the 0-1 range). Dummies for three-digit industry and year are included, and control for lagged (one year) size and a measure of productivity: total factor productivity (a la Levinsohn and Petrin). Controlling for these observables and given the composition of the score described above, the residual is a good measure of credit constraints faced by a firm. Larger and more productive firms are more likely to be exporting. The first column replicates the result previously found in the literature that more productive firms are more likely to export. The coefficient on the lagged score is positive and significant in columns (2), confirming that firms which are less credit-constrained have a higher probability to be exporters. In that specification, the coefficient on productivity is not reduced compared to the first column, indicating the score captures the additional effect of credit constraints. The score is also included in column (3) which augments the model with an interaction term between the lagged score and lagged TFP. Probably due to the correlation between productivity and the score which reduces the significance of the variables, the result is not as predicted by the model. The positive effect of a higher credit score on the probability to be exporter is not decreased with a higher productivity. When including the lagged export status variable, as in Bernard and Jensen (2004), our results carry through although the positive coefficient on the score is not significant, as shown in columns (4) and (5). This is probably due to firms' scores not varying much through time, as creditworthiness might not change strongly from year to year. It could also point to the results of the model showing that credit constraints should have no impact on a firm's exporting status a given year if it was already an exporter in the previous year as the fixed cost of starting to export would have already been borne.

Table 4.10. Linear probability model on exporter status

Dependent variable:	0/1 Dummy non-exporter/exporter				
	(1)	(2)	(3)	(4)	(5)
Log (Score (t-1))		0.027** (0.005)	0.016 (0.035)	0.004 (0.003)	0.001 (0.004)
Log (TFP Lev-Pet (t-1))	0.090** (0.004)	0.087** (0.004)	0.085** (0.009)	0.013** (0.002)	0.026** (0.004)
Log (TFP Lev-Pet) x Log (Score (t-1))			0.001 (0.003)		
Exporter/non-exp. (t-1)				0.782** (0.004)	0.106** (0.010)
Log (empl.) (t-1)	0.143** (0.002)	0.142** (0.002)	0.142** (0.002)	0.032** (0.001)	0.067** (0.005)
Observations	50824	50824	50824	50824	50824
R-squared	0.33	0.33	0.33	0.74	0.02
Number of firms					10080
Firm fixed effects	NO	NO	NO	NO	YES
Year fixed effects	YES	YES	YES	YES	YES
Sector fixed effects	YES	YES	YES	YES	NO

Notes: Linear Probability regression in levels for columns (1) to (3) and with firm fixed effect for column (4). The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD with Coface score available or each year they file in a balance sheet over the period and includes an average of 8926 firms per year in 99 three digit sector over the period 1999 to 2005. Robust standard errors in parentheses; + denotes statistical significance at the 10% level; * denotes statistical significance at the 5% level; ** denotes statistical significance at the 1% level. Includes constant and 3-digit sector and year dummies, not reported. The dependent variable is a dummy indicating whether the firm exports or not in that year. (t-1) indicates the explanatory variable has been lagged by one year. Log (x) is the logarithm of variable x. The credit rating score, constructed for each year and each firm by Coface ranges from 3 to 19. Log (empl.) is the logarithm of employment, and allows controlling for the size of firms. TFP Lev-Pet is a measure of Total Factor Productivity measured according to Levinsohn and Petrin's (2003) method. For column (3), the interaction between productivity and the score is used as an explanatory variable. In columns (4) and (5), the lagged dependent variable, a dummy indicating export activity in the previous year, is also included.

Relative to destinations, Proposition 4.2 considers the number of destinations served by a firm, as being positively related to its productivity and negatively to credit constraints. This is confirmed in the OLS regression with firm fixed effects in the first column of Table 4.11, where it appears that the lagged score affects positively and significantly the number of markets served by a firm, while the positive coefficient on productivity is not significant⁶⁹.

⁶⁹ When using the logarithm of labour productivity measured by value-added per employee, rather than TFP, the coefficient is significant.

Going beyond the model, I also establish in Table 4.11 that this result is also true when looking at total exports and products. The number of products exported seems to be less dependent on credit constraints (the positive coefficient is only statistically significant at the 10.2% level) than the number of destinations.

Table 4.11. Total exports, destinations and products

Dependent variable:	Log (Number of destinations) (1)	Log (Total exports) (2)	Log (Number of products exported) (3)
Log (Score (t-1))	0.036** (0.011)	0.088** (0.026)	0.024+ (0.014)
Log (TFP Lev-Pet (t-1))	0.028** (0.010)	0.147** (0.024)	0.028* (0.011)
Log (Employment (t-1))	0.311** (0.019)	0.757** (0.047)	0.314** (0.023)
Observations	22137	22137	22137
Number of firms	4972	4972	4972
R-squared	0.04	0.05	0.02
Firm fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES

Notes: Fixed-effect OLS regressions. The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSITD with Coface score available or each year they file in a balance sheet over the period and includes an average of 8926 firms per year in 99 three digit sector over the period 1999 to 2005. Only observations in which the firm is exporting are kept. Robust standard errors in parentheses; + denotes statistical significance at the 10% level; * denotes statistical significance at the 5% level; ** denotes statistical significance at the 1% level. Includes constant and year dummies, not reported. The dependent variables are the logarithms of the number of destinations served (column (1)), of total exports (column (2)) and of the number of different 8-digit (CN nomenclature) products exported (column (3)) by a firm in one year. (t-1) indicates the explanatory variable has been lagged by one year. Log (x) is the logarithm of variable x. The credit rating score, constructed for each year and each firm by Coface ranges from 3 to 19. Log (empl.) is the logarithm of employment, and allows controlling for the size of firms. TFP Lev-Pet is a measure of Total Factor Productivity measured according to Levinsohn and Petrin's (2003) method.

These results clearly establish the relationship that exists between credit constraints and exporting behaviour, even once productivity and size are controlled for. They confirm the equilibrium relationship identified in the model holds empirically. In the next section, I aim at improving these results by analysing the interactions through time.

4.3.2 The effects of credit constraints over time

A. Becoming an exporter

In order to assess the importance of credit constraints in the decision to start exporting, I report in Table 4.12 the effects of lagged plant characteristics on the probability of being a new exporter. New exporters are defined as firms that have not exported in any previous years of the sample and export every year thereafter. A linear probability estimator with year and sector fixed effect is used to estimate the probability of starting to export, with two alternative measures of productivity as explanatory variables: TFP a la Levinsohn and Petrin (2003) and value-added per employee.

Table 4.12. New exporters

Dependent variable:	(1) 0/1 Dummy new exporter	(2) 0/1 Dummy new exporter
Log (Score (t-1))		-0.002 (0.003)
Log (TFP Lev-Pet (t-1))	-0.011** (0.004)	-0.011** (0.004)
Log (Employment (t-1))	0.026** (0.002)	0.026** (0.002)
Observations	21115	21115
R-squared	0.06	0.06
Firm fixed effects	NO	NO
Year fixed effects	YES	YES
Sector fixed effects	YES	YES

Notes: Linear Probability regressions in levels. The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD with Coface score available for each year they file in a balance sheet over the period and includes an average of 8926 firms per year in 99 three digit sector over the period 1999 to 2005. Robust standard errors in parentheses; + denotes statistical significance at the 10% level; * denotes statistical significance at the 5% level; ** denotes statistical significance at the 1% level. Includes constant and 3-digit sector and year dummies, not reported. The dependent variable is a dummy indicating whether the firm is a new exporter or not in that year. Being a new exporter is defined as a firm that did not export in any previous year in the sample and did export that year and every following year. Switchers and firms that export every year in the sample are dropped. Firms that were new exporters in a previous year are dropped. (t-1) indicates the explanatory variable has been lagged by one year. Log (x) is the logarithm of variable x. The credit rating score, constructed for each year and each firm by Coface ranges from 3 to 19. TFP Lev-Pet is a measure of Total Factor Productivity measured according to Levinsohn and Petrin's (2003) method. Log (Employment) is the logarithm of employment, and allows controlling for the size of firms.

However my results are surprising as I find that the probability to start exporting in a given year depends negatively on both productivity and credit constraints, year and three-digit sector being controlled for. This is also true when considering productivity as the only explanatory variable with year and sector dummies. One potential explanation for this result is that firms that have never exported and start exporting do not use external credit to overcome the fixed cost of exporting to their first destination, which will most probably be France. They will rely instead on internal liquidity, corresponding to the exogenous liquidity shock in the theoretical model. It can also be the case that Belgium being an open and small country, starting to export close to its borders is not very costly for firms, compared to the fixed cost of expanding to further markets. This is why the next section concentrates on export destinations.

B. Extensive and intensive margin for destinations

Having considered the decision of starting to export, I now disentangle the effect of credit constraints on the decision to export to more destinations. This is the extensive margin of exports to a given destination. According to the theoretical model, credit constraints should matter for the decision of existing exporters to start exporting to a new country. It should not however affect the value of exports per destination or its subsequent increases, that is the intensive margin. Adopting a linear probability specification, the first column of Table 4.13 shows how the probability of an exporter increasing the number of countries it serves is positively affected by size, productivity and a higher score (and hence weaker credit constraints). This result holds when controlling for firm fixed effect. When compared to our results in the previous section, this would suggest that credit constraints are more important in determining the increase in the number of destinations served than in explaining the decision to start exporting. The table also reports in the OLS regression of the second column that the actual increase in the number of destinations served relative to the previous year is also positively related to creditworthiness. Turning to the intensive margin of trade to a given destination, it appears in the third column of Table 4.13 that credit constraints have no effect on the increase in the value of exports to a given destination, as the coefficient

on the lagged Coface score is insignificant. This is consistent with the results of the model, as credit constraints affect the ability of firms to cover the fixed cost of exporting to an additional destination. Once the fixed cost has been borne, the amount exported to that destination is not dependent on the availability of credit.

Table 4.13. The extensive and intensive margins per destination

Dependent variable:	Increase in number of destinations		
	0/1 Dummy no increase/ increase (1)	Increase in Log (Number of destinations served) (2)	Increase in logarithm of mean value per destination (3)
Log (Score (t-1))	0.038* (0.017)	0.037** (0.014)	0.034 (0.028)
Log (TFP Lev-Pet (t-1))	-0.006 (0.012)	-0.022* (0.010)	-0.091** (0.021)
Log (Employment) (t-1)	-0.035+ (0.020)	-0.037+ (0.021)	-0.116** (0.039)
Observations	20097	19835	20097
Number of firms	4889	4827	4889
R-squared	0.01	0.01	0.01
Firm fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES

Notes: Linear Probability (column (1)) and OLS (columns (2) and (3)) regressions with firm fixed effect. The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD with Coface score available or each year they file in a balance sheet over the period and includes an average of 8926 firms per year in 99 three digit sector over the period 1999 to 2005. Only observations in which the firm is exporting are kept. Robust standard errors in parentheses; + denotes statistical significance at the 10% level; * denotes statistical significance at the 5% level; ** denotes statistical significance at the 1% level. Includes constant and year dummies, not reported. The first column's dependent variable is a dummy equal to 0 if the firm did not increase the number of destination it exports to relative to the previous year. The dependent variable for column two is the increase in the logarithm of the number of destinations relative to the previous year. The first year a firm starts exporting is dropped from the sample. In column (3), the dependent variable is the increase in the logarithm of the mean value per destination. This mean value is per firm, per year, how much (in Euros) it exports on average to each of its destinations. (t-1) indicates the explanatory variable has been lagged by one year. Log indicates the logarithm of the variable has been used. The credit rating score, constructed for each year and each firm by Coface ranges from 3 to 19. TFP Lev-Pet is a measure of Total Factor Productivity measured according to Levinsohn and Petrin's (2003) method. Log (Employment) is the logarithm of employment, and allows controlling for the size of firms.

4.3.3 Pecking order of trade

Proposition 4.3 shows how firms will follow a pecking order of trade when adding export destinations to their portfolio: more productive firms will export to more destinations, as we have shown above, and to smaller markets (weighted by the trade cost). This result holds in the data, as presented in Table 4.14. The trade cost weighted market size of each country in each year of our sample is constructed as the Gross Domestic Product⁷⁰, divided by a measure of distance from Belgium. GDP is taken as a proxy for L^* , the market size in the model, as it represents the market potential of a country. Distance is taken as a measure of trade costs, as it will be more costly for firms to ship goods to markets that are further away. Following Head and Mayer (2002) and Mayer and Zignano (2006), the distance is weighted by the geographic distribution within the country. This is measured by the share of the main city's population in the country's population and will reflect the trade cost of reaching the consumers around the country. For a given GDP, the further the country, the smaller its trade cost weighted market size. Similarly, between two equidistant markets, the larger in terms of GDP will be of a bigger size. For each firm in each year, I select the smallest market it exports to, as an indicator of how far down the pecking order a firm is situated. The logarithm of the trade cost weighted market size of that country is the dependent variable. The first specification in Table 4.14, an OLS regression with sector and year fixed effect shows how more productive firms export to smaller countries. The second column shows this result is robust to including financial constraints: less credit-constrained firms will go further down the pecking order of trade. When introducing firm fixed effects in the third column, the effects of productivity and credit constraints are not significant any more, yet this is probably due to firms not varying strongly from year to year the furthest market they manage to reach.

These results confirm that the equilibrium relationship between productivity, credit constraints and market potentials of destinations identified in Proposition 4.3 of the model hold in the data.

⁷⁰ The data used is that of the US Census Bureau International Database (www.census.org).

Table 4.14. Market size, productivity and credit constraints

	Log (GDP/Weighted Distance) of smallest destination		
	(1)	(2)	(3)
Log (Score (t-1))		-0.102* (0.051)	-0.044 (0.050)
Log (TFP Lev-Pet (t-1))	-0.494** (0.035)	-0.483** (0.036)	-0.033 (0.040)
Log (Employment) (t-1)	-0.603** (0.019)	-0.600** (0.019)	-0.523** (0.066)
Observations	20026	20026	20026
Number of firms	0.26	0.26	0.01
R-squared			4882
Firm fixed effects	NO	NO	YES
Sector fixed effects	YES	YES	NO
Year fixed effects	YES	YES	YES

Notes: OLS regressions, with firm fixed effect for the third specification in column (3). The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD with Coface score available or each year they file in a balance sheet over the period and includes an average of 8926 firms per year in 99 three digit sector over the period 1999 to 2005. Only observations in which the firm is exporting are kept. Robust standard errors in parentheses; + denotes statistical significance at the 10% level; * denotes statistical significance at the 5% level; ** denotes statistical significance at the 1% level. Includes constant and year and sector dummies, not reported. The dependent variable for all three regressions is the logarithm of the GDP-distance ratio, where the distance is weighted according to the share of the main city's population in the country's total population. (t-1) indicates the explanatory variable has been lagged by one year. Log indicates the logarithm of the variable has been used. The credit rating score, constructed for each year and each firm by Coface ranges from 3 to 19. TFP Lev-Pet is a measure of Total Factor Productivity measured according to Levinsohn and Petrin's (2003) method. Log (Employment) is the logarithm of employment, and allows controlling for the size of firms. Source: GDP from US Census Bureau International Data, Weighted distance from CEPII.

4.3.4 Exchange rates

The last result of the theoretical section of this chapter relates credit constraints and the sensitivity of trade flows to relative wages fluctuations. An increase in the domestic relative to foreign wages correspond to a loss of competitiveness of domestic exporters, as would occur following an domestic currency appreciation. The effects of exchange rates on aggregate trade flows have been shown in the literature to be mostly insignificant (see McKenzie (1999) for a overview). However, as shown in Proposition 4.4 of the model pre-

sented in the first section, this could be due to various effects at play at the firm level that cancel each other in the aggregate. The first effect of a domestic currency appreciation (depreciation) with respect to a given country is that existing exporters to that destination will respond with a decrease (increase) in their volume of exports. This is tested in our data by selecting firms that already exported in the previous year to a given destination, and considering their response to a change in exchange rates. The results are reported in the first column of Table 4.15. An appreciation (depreciation) of the domestic currency decreases (increases) the market shares of existing exporters to a given destination, as put forward by point (i) of Proposition 4.4.

The second effect of an appreciation (but not a depreciation) is that the least productive exporters to that country cannot export profitably anymore and are consequently forced out of the market. In the data, one can compare the productivity of firms that keep on exporting to a given destination, even after a domestic currency appreciation episode, with those firms that stop exporting. The result of a linear probability model with fixed-effects is presented in Table 4.15's second column. The productivity at the firm and year level is summarised by a dummy reflecting low productivity, as it is equal to one when the Total Factor Productivity is lower than the year-three-digit sector median. Being of the low productivity type will increase the probability of an exporter exiting the market it used to serve following an appreciation episode vis-a-vis this country's currency.

The third effect presented in point (iii) of Proposition 4.4, is that the most productive non-exporters that couldn't start exporting because they were liquidity-constrained will now be able to do so, because the fixed entry cost has decreased in terms of domestic currency. This is tested by considering only appreciation episodes, given that with a depreciation of the domestic currency, the fixed cost would increase. Existing exporters are more likely to start exporting to a destination whose exchange rate has depreciated (i.e. the Euro, for Belgian firms, has appreciated) in the past year if they were productive but credit-constrained in the previous year. This is shown in the last column of Table 4.15 where the dependent variable is a dummy that is equal to one when the firm started exporting to at least one destination that experienced an exchange rate appreciation with respect to the previous

year. It is equal to zero if the firm, an existing exporter did not add to its portfolio of served markets any destination with an exchange rate depreciation episode relative to the previous year. credit-constrained firms are those whose score is lower than the three-digit sector-year median. They are less likely to start exporting following a domestic currency appreciation. This is reflected in the significantly negative coefficient on the credit constraint dummy. The positive and significant coefficient on the interaction between TFP and credit constraint reflects the relationship shown in the theoretical model that the most productive of the constrained firms are now less credit-constrained and able to overcome the fixed cost of profitably exporting to those destinations.

These results confirm that the last proposition of the theoretical model is not contradicted by the data when considering the relationship between exchange rate movements and firm-level exporting behaviour.

Table 4.15. Effect of exchange rate movements firm level export patterns

Dependent variable:	(1)	(2)	(3)
	Change in logarithm of value exported per destination	0/1 dummy: 1 = exit from a given destination 0= continues exporting to a given destination	0-1 dummy of starting to export to at least one destination with recent Euro appreciation
% change in exchange rate	-0.285* (0.131)		
Low productivity dummy		0.047* (0.018)	
Log (TFP Lev-Pet (t-1))			-0.069** (0.012)
Credit constrained (t-1)			-1.456** (0.029)
Log(TFP Lev-Pet) x constrained (t-1)			0.112** (0.002)
Observations	212385	14781	14296
R-squared	0.00	0.07	0.24
Number of firms	4672	2873	3720
Firm fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Destination fixed effects	YES	YES	NO

Notes: The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD with Coface score available or each year they file in a balance sheet over the period and includes an average of 8926 firms per year in 99 three digit sector over the period 1999 to 2005. Only observations in which the firm is exporting are kept. Exchange rate data is obtained from the National Bank of Belgium Belgostat database. + denotes statistical significance at the 10% level; * denotes statistical significance at the 5% level; ** denotes statistical significance at the 1% level. Includes constant, destination and year dummies, not reported. In the first column, the dependent variable is the change with respect to the previous year in the logarithm of the value exported to a given destination, if the firm already exported there the previous year. Cases in which it is a new destination the firm exports to are dropped. The result is robust to dropping Euro-zone destinations in which the exchange rate did not vary. Clustered (year x destination) standard errors are reported in parenthesis.

In the second column, destinations are only kept for the years they have experienced an appreciation vis-à-vis the Euro. Robust standard errors in parentheses. The dependent variable reflects firm exit from a market. It is a dummy set to 1 if the firm had been exporting to the given destination for at least two years and stopped for that year and the following year at least. If they are still exporting to the given destination that year and the following the dummy is set to 0. Other observations are dropped. The explanatory variable is a dummy set equal to 1 when the TFP measure a la Levinsohn and Petrin is below the year and three digit sector median, and zero otherwise. The result is robust to using the TFP measure itself.

In the third column, as in the second, destinations-years are only kept if the Euro has experienced an appreciation vis-à-vis its exchange rate. Robust standard errors in parentheses. The dependent variable is a dummy which is equal to 1 if in that year, the firm, that was already an exporter in the previous year, started exporting to at least a destination that had experienced an appreciation of its exchange rate. It is equal to zero if the exporter did not start exporting to any destination that had experienced an appreciation of its exchange rate. The explanatory variables are a measure of the logarithm of TFP a la Levinsohn and Petrin (2003), a credit constraint dummy equal to 1 if the score is below the year-3-digit sector median, and the interaction between TFP and this dummy.

4.4 Conclusion

In this chapter, I have shown that credit constraints matter for export patterns. I use a very precise and complete dataset on export transactions at the firm level for the Belgian manufacturing sector. It is combined with an unusual and very useful yearly measure of credit constraints faced by firms, a creditworthiness score constructed independently by a credit insurer. These allow me to examine the relationship between credit constraints and exports in a novel way. The main prediction of the model is that some firms could profitably export but are prevented to do so due to a lack of liquidity which prevents them from reaching foreign markets. This is reflected in the data, where it is shown that firms are more likely to be exporting if they enjoy higher productivity levels and lower credit constraints. The second prediction of the model is that credit constraints are important in determining the extensive margin of trade in terms of destinations, that is the number of destinations a firm exports to and the decision of a firm to export to a new destination. The intensive margin of trade in that dimension, the average exports of a firm to the destinations it serves, should not be affected by credit constraints. This equilibrium derived from the model also holds in the data. Third, as derived in the model, firms follow a pecking order of trade, where more productive and less credit-constrained firms reach markets of smaller trade cost weighted market size. Finally, the model predicts that the sensitivity of trade flows to exchange rates variations is composed of several elements. An exchange rate appreciation will cause existing exporters to reduce their exports, entry of credit-constrained potential exporters and exit of the least productive exporters. All three effects appear in the data. These results confirm the link between credit constraints and export patterns. They also highlight the potential role of institutions in determining, through their policies on credit constraints, the patterns of trade and hence the productivity levels and gains of productivity, and the overall welfare. As credit constraints matter, they establish a connection between the number of markets served by a firm and the growth of its exports, as additional liquidity obtained on one market may enable entering another one. Examining the dynamics of firm-level exports and how they relate to liquidity and productivity is an exciting area for future research.

4.A Proof of Proposition 4.1

Proposition 4.1 (repeated): If $\left[\frac{C_d^*}{C_f} \frac{(1-\lambda)(1-t_s)C_d + \frac{w^*}{w}C_f}{\lambda\tau^{1-\sigma}\left(\frac{w^*}{w}\right)^\sigma C_d^* + (1-\lambda)\left(\frac{h(C_d)}{h(C_d^*)}\right)^{1-\sigma} C_d} \right]^{\frac{1}{\sigma-1}} > \frac{\tau w}{w^*}$, there is a non empty set of liquidity constrained firms that are prevented from profitably exporting because they have insufficient liquidity, both exogenously and on the external financial market.

Proof. All firms above \bar{x}_f are productive enough to profitably export. Firms whose liquidity is lower than $\bar{x}(A)$ are not able to export, even if they could profitably do so, because they do not have sufficient liquidity to cover the fixed cost of exporting. Suppose $(A, x) \in \Omega$ iff $\bar{x}_f \leq x < \bar{x}(A)$. Firms in Ω are prevented from exporting because they are liquidity constrained, despite being able to profitably do so. $\bar{x}(0) > \bar{x}_f$ is a necessary and

sufficient condition for Ω to be non-empty. Given equations (4.22) and (4.23) this will hold iff $\left[\frac{C_d^*}{C_f} \frac{(1-\lambda)(1-t_s)C_d + \frac{w^*}{w}C_f}{\lambda\tau^{1-\sigma}\left(\frac{w^*}{w}\right)^\sigma C_d^* + (1-\lambda)\left(\frac{h(C_d)}{h(C_d^*)}\right)^{1-\sigma} C_d} \right]^{\frac{1}{\sigma-1}} > \frac{\tau w}{w^*}$. Then Ω is non empty, and there exist firms that are liquidity constrained. ■

4.B Proof of Proposition 4.3

Proposition 4.3 (recalled): Firms will add export destinations in decreasing order of trade cost weighted market size, $\frac{I^*}{\tau^{\sigma-1}}$. More productive firms will export to more destinations, but also to relatively smaller markets.

Proof. : By making higher revenues on a larger market, lower productivity firms can export to larger markets. Yet, the higher the iceberg cost of exporting to that destination, the lower the revenues on that market. Hence the productivity cut-off is lower for a larger

trade cost weighted market: $\frac{\partial \bar{x}_n(A)}{\partial \frac{L^*}{\tau^{\sigma-1}}} < 0$. Besides, the relative ordering of countries with respect to the productivity threshold of firms exporting there remains the same. Therefore, a firm that increases the number of destinations it serves from n to $(n + 1)$ will still export to the n largest (trade cost weighted) markets and add the next largest (trade cost weighted) market to its portfolio of trade partners. ■

Conclusion

In this thesis, I have analysed various aspects of the interactions between firms and governments in climate change and international trade. First, I presented a novel result: firms anticipating a Nash-bargained agreement over climate change by their governments will over-invest ex ante relative to the second-best. The model analyses the effects of investment by firms on the bargaining position of states in international negotiations on climate change, or any other global public good. Firms anticipate that their investment in R&D ex ante will improve the bargaining position of their government in a Nash-bargained agreement on a global public good. This is due to the fact that investment reduces the surplus of the agreement by improving social welfare more under non-cooperation than under cooperation: effectively, cooperation means the foreign country reaps part of the benefits of domestic investment, and must therefore compensate the domestic government and, in turn, the country's firms, by a larger transfer. This partial-equilibrium result improves on the current literature by introducing an unanticipated effect of firms having to invest before this type of international negotiating occurs at government level.

The second chapter analysed trade protection in the presence of electoral incentives by presenting a new multi-jurisdictional political agency model. A unique equilibrium was proved to exist, in which political incumbents in their first term of office build a reputation for protectionism. The distribution of swing voters across decisive, swing states was shown to determine trade policy incentives. This theoretical hypothesis was supported empirically by augmenting the benchmark test of the lobbying political economy of trade literature. The results provided reduced-form evidence that the concentration of industries in politically-important states is a key, though previously disregarded, element in the determination of trade policy.

The third chapter sought to understand the patterns in the trade transaction data using a newly-available dataset for Belgium, the BBSTTD. Imports and exports both exhibit an increasing and strong concentration among few firms. Stylised facts from the literature on exports by manufacturing firms were shown to be valid for imports, too. Two-way

traders constitute around 80 per cent of exporters. The number of products traded, the destinations exported to, and origins of imports share a common particularity: the number of firms trading in such ways decreases as they increase. Finally, two-way traders are more productive, followed in descending order by importers only, exporters only and non-traders. In the last chapter, I analysed the determinants of firm exporting behaviour, in particular liquidity constraints. This policy relevant topic had so far not been considered much in the existing literature. Empirically, I used the BBSTTD and an unusually available and valid measure of credit constraints at the firm and year level. This allowed me to confirm that the equilibrium relations derived from a heterogeneous firms trade model, including liquidity constraints, hold in the data. Firms are more likely to be exporting if they enjoy higher productivity levels and lower credit constraints. Second, credit constraints are important in determining the extensive margin of trade in terms of destinations. The number of countries a firm exports to and adding a new destination are negatively related to credit constraints. On the contrary, the intensive margin of exports to a given destination is not affected by credit constraints. Third, more productive and less credit-constrained firms export to smaller trade-cost-weighted market-size destinations: this is the pecking order of trade. Lastly, as predicted in the model, a domestic currency appreciation will lead existing exporters to reduce their exports, while encouraging entry of credit-constrained potential exporters and exit of the least productive exporters. These results confirm that credit constraints really matter. They also emphasise the potential role for governments' credit-constraints-related policies in determining export patterns and hence the improvements of productivity, productivity levels and general welfare.

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