PhD THESIS DECLARATION

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Abstract

The first chapter of the thesis studies the effects of trade policy uncertainty on the extensive and the intensive margins of trade for a sample of 75 countries at HS6 digit level. We measure trade policy uncertainty as the gap between biding tariff commitments under trade agreements (multilateral and regional agreements) and applied tariffs- what is also known as tariffs' water. Our results show that trade policy uncertainty is an important barrier to export. On average a one fourth decrease in water increases the probability of exporting by 3 percent. A one percent decrease of water also increases export volumes by one percent. We also find that the negative impact of trade policy uncertainty is higher for countries with low quality of institutions and in the presence of global value chains.

The second chapter examines the relationship between vertical foreign direct investment (FDI) and preferential trade agreements (PTAs). Recent data show that the institutional content of PTAs has evolved over time. While pre-1990s PTAs mostly focused on tariff liberalization, recent agreements increasingly contain deep provisions in diverse areas such as intellectual property rights, investment, and standards. At the same time, we have witnessed to a remarkable increase in the internationalization of production through FDI and outsourcing. Consistently with the model of contractual frictions and global sourcing by Antràs and Helpman (2008), we find evidence that the depth of trade agreements is correlated with vertical FDI and that this is driven by the provisions that improve the contractibility of inputs provided by suppliers, such as regulatory provisions.

The last chapter analyzes the role of institutions in the determination of comparative advantage and the gains from trade. Weak institutions create uncertainty over the provision of intermediate goods demanded by final producers. Firms adapt the organization of their production to the local institutional environment. We allow heterogeneous producers to choose their sector of production and we study how trade affects the relocation of final producers and resources across sectors. The quality of institutions and the ex-ante distribution of productivity determine the endogenous organization of firms and, in turn, the sector in which each final producer specializes. More productive firms always produce more complex goods. We study how trade liberalization leads to asymmetric effects on the allocation of intermediate suppliers across final producers and across industries, as well as on aggregate productivity and welfare, when countries differ in institutional quality. Consistent with results in the literature, the model finds a positive effect of trade liberalization on aggregate productivity in the country with good institutions. On the other hand, it unveils a negative effect in the country with weak institutions. This asymmetric effect is larger when the difference in institutions is higher.

Chapter 1

Trade policy uncertainty as a barrier to trade

joint with Roberta Piermartini (WTO) and Nadia Rocha (WTO)[1]

[1]This paper should not be reported as representing the views of the WTO. The views expressed are those of the authors and do not necessarily reflect, officially or unofficially, those of the WTO or its Members, nor the position of any other staff members. Any errors are the fault of the authors. We thank Valeria Groppo for facilitating access to the database on tariffs. We thank Nuno Limao, Aaditya Mattoo and the participants to the IMF/WB/WTO Workshop for their useful comments on previous drafts of the paper.

1.1 Introduction

Policy makers have long believed that an important contribution of trade agreements is to increase the predictability of trade policy. The WTO and its multilateral agreements of trade in goods aim at ensuring that trade flows as smoothly, predictably and freely as possible. Specifically WTO members make commitments not to increase tariffs above some bound rates.[2] Still, trade policy regimes are flexible and tariffs may change without the violation of WTO rules. In fact, a substantial portion of global trade occurs under flexible trade policy regimes. In 2011, on average 27 percent of world imports were either unbound or bound with a gap between the bound rate (the so called "tariff water") and the applied rate greater than 5 percentage points. The global average level of tariff water is about 18 percentage points, ranging from about 4 percentage points in high income countries to approximately 24 percentage points in middle and low income countries (Groppo and Piermartini [2014]).

Uncertainty of trade policy, defined as the risk of a tariff reversal has real economic effects. In a model of trade with heterogeneous firms, Handley [2014] shows that uncertainty over future conditions of trade creates an option value of waiting to enter a new market, thus inducing firms to delay the entry in a foreign market. The risk of a trade policy reversal acts as a fixed cost to enter an export market and therefore has a negative impact on the extensive margin of trade. In this set up, tariff commitments under the WTO should increase the number of products that countries trade.

Existing evidence supports the view that trade policy uncertainty has a negative effect on the number of traded products (the extensive margin of trade). Focusing on Australia's commitments under WTO, Handley shows that entry is higher in sectors characterized by lower binding overhangs (the gap between the applied and the ceiling level of the tariff). The interpretation is that the uncertainty-reducing effect of lower binding overhang favors exports to Australia. In particular, Handley estimates that if Australia unilaterally reduced tariffs to free trade levels, the number of traded products would increase by 4 percent. Alternatively, if Australia both reduced tariffs to zero and bound them through WTO commitments, the combined impact of removing the motives for caution and delay would increase the number of traded products by 11 percent. In another paper, Handley and Limão [2012] show a significant increase in Portuguese exports to the EU upon accession. In particular, they find evidence of increased entry of Portuguese firms even in sectors where applied tariffs did not change. They interpret this as evidence that

[2]Economic theory has recently shown that the reduction of trade policy uncertainty could per se be a motive to enter an agreement. Even if an agreement does not reduce applied tariffs' rates, there are welfare gains from reducing uncertainty Limão and Maggi [2013]. In support of these views, Groppo and Piermartini [2014] show that WTO commitments - of not increasing tariffs above a certain level - do reduce trade policy uncertainty. Mansfield and Reinhardt (2008) also find that GATT/WTO membership reduces export volatility by up to one-third.

Portugal's accession to the EU eliminated the (pre-accession) risk that tariffs faced by Portuguese exporters may increase to the level of EU external tariffs. Handley and Limão [2013] also point at large positive effects on trade and welfare following China's accession to WTO. They estimate that reducing the threat of a trade war explains 22 percent of Chinese export growth to the U.S.. In addition, reduced policy uncertainty lowered U.S. prices, thus increasing consumers' income by at least 0.8 percent, the welfare equivalent of an 8 percentage point tariff decrease.

The aim of this paper is to deepen our understanding on the quantitative impact of more predictable market access conditions deriving from trade agreements on trade flows and in particular on the extensive margin of trade. For this purpose, we define trade policy uncertainty as the degree of flexibility that both multilateral and preferential trade agreements provide. Specifically, applied tariffs are allowed to vary, and in particular to freely increase up to certain limit or bound.

Our paper contributes to the existing literature in several ways. First, it extends the analysis of the quantitative effects of trade policy uncertainty (TPU) to the volume of exports. To the extent that uncertainty of trading conditions imposes an extra fixed cost to trade, it will also affect the intensive margin of trade. Focusing on the insecurity of trading conditions -be it in the form of exporters' risk to lose their shipment because of hijacking, to having to pay a bribe, or to facing particular delays related to poor governmental regulations, Crozet et al. [2008] show that an increase in insecurity decreases both the number of exporters and the volume of their exports.[3]

Second, we aim at understating whether the impact of trade policy uncertainty on both the intensive and extensive margins of trade differs across countries and sectors and we identify factors explaining such differences. For this, we extend the analysis of the impact of TPU on trade to a sample of 149 countries and run the analysis at HS6 digit.

We expect that TPU is a more important obstacle to trade for countries with poor quality of institutions. The intuition behind this reasoning is that firms perceive countries with better institutions as countries that are more credible in terms of the policies that they adopt or as countries that would vary less their trade policies. Since both regional and multilateral commitments may work as a credibility devise for countries with weak institutions, in our analysis we take into account not only countries commitments under the WTO but also under PTAs.

We also look at whether the sectoral sensitivity of trade to TPU depends on specific industry characteristics. In particular, several authors have argued that uncertainty is a particular important obstacle to trade when production takes place in global supply chains. Uncertainty is a source of agglomeration when production is fragmented (Harrigan

[3]Crozet et al. [2008] describe insecurity as an exogenous probability for firms to be directly hurt by a negative event when trying to enter the export market. Unlucky exporters have to pay an extra fixed cost to sell on the foreign market.

and Venables [2006]).[4] Therefore, one may expect that TPU has a stronger negative effect in the export margins of intermediate goods input into further processing. To this purpose we test whether the relationship between TPU and export margins is stronger for intermediates goods. We also test whether the sensitivity of trade to TPU depend on the degree of differentiation of a product. Whilst the empirical literature shows that tariffs have a higher negative impact on homogeneous goods (add references), the impact of uncertainty on this kind of goods could go either way. In contrast to differentiated goods providers, firms supplying more standardized inputs could more easily offer their products in other markets once a trade policy reversal takes place in a certain destination. Therefore, they should be less affected by TPU.

Our results are subject to the problem of endogeneity deriving from reverse causality and omitted variables bias. Reverse causality arises for example if governments may be more willing to bound tariff lines where they are less likely to change their MFN tariff. This would bias our results downwards. We address this issue by running our regression for the sub-sample of countries acceding the WTO after the Uruguay Round (UR). Our claim is that compared with pre-existing members, these countries, not being involved in the UR negotiations, had less of a say on the level at which to bound their tariffs. To control for omitted variables bias we add a series of fixed effects in our estimation.

Finally, we assess whether our results are robust to prohibitive tariffs. There is a maximum range above which changes in tariffs do not have any effect on trade. That is the range between the applied rate and the prohibitive tariff (the tariff above which trade falls to zero). Even unbound tariffs are de facto bound to the prohibitive tariff. Failing to consider this may provide bias results. Hence, we run regressions using the prohibitive tariff as the actual bound rate whenever the bound tariffs are above their prohibitive level

After controlling for endogeneity and for prohibitive tariffs we find robust results that multilateral and preferential trade commitments have a positive impact on both the extensive and the intensive margins of trade. In particular we find that on average a 24 percent increase in TPU decreases the probability to export by 3 percentage points. The impact of TPU on the intensive margin of trade is also negative and the elasticity of exports to water is around 1 on average. Finally, our results confirm that the negative impact of trade policy uncertainty is higher for countries with low quality of institutions,in

[4]Harrigan and Venables [2006] show that the demand for timeliness in delivery generates incentives for the clustering of plants around the assembler or retailer. In their model, time costs are qualitatively different from other costs of distance because of uncertainty. To stress this point, they show that in a model where final assembly occurs in two locations, uses a number of components and cannot be completed until all parts have arrived, component production will tend to cluster around just one of the assembly plants. The incentive to agglomerate arises due to an increasing marginal value of timeliness stemming from the fact that all components are needed for final assembly. This is because the late arrival of any one component may disrupt production and thus can have a very high cost as a percentage of the cost of each component. A parallel point can be made for uncertainty in the cost of an input.

the presence of global value chains and for differentiated products.

1.2 Data

Trade policy uncertainty can be measured in different ways. To reflect the theoretical prediction that what matters for a firm when deciding if exporting to a certain destination and/or how much to export is the risk of a trade policy reversal rather than volatility in import tariffs, we measure TPU as the gap between bound rates and effectively applied tariffs -what is also known as water or binding overhang.[5] The reasons are twofold. First, independently on whether water changes a lot or not over time, the simple fact that it exists has an impact on export decisions; second, volatility captures the temporary movements of tariffs that for an exporter are not as important as the long term levels of water.

In the case of two WTO member countries that have not formed a preferential trade agreement between them, bound tariff rates are represented by the ceiling rates at which individual WTO members have committed under the WTO. WTO members have the flexibility to increase applied tariffs up to their bound levels and can take another member to dispute settlement only when it increases its applied tariff above the bound level. The size of water measures the possibility of a country to freely increase its applied MFN tariffs up to the bound rate without incurring into a dispute at WTO. The simple presence of water makes trade policy less predictable and therefore more uncertain.

In our analysis we take commitments under PTAs into account by setting the bound rate equal to the preferential tariffs for those country pairs that have signed a preferential agreement. Specifically, the level of water is equal to zero for those country pairs making part of a PTA with the exception of those cases where the MFN rate is lower that the preferential tariff.[6] Algebraically, we define water in sector k for a country pair ij as follows:

$$Water_{ijk} = \begin{cases} \max\left\{Pref\ rate_{ijk} - MFN_{jk}, 0\right\} & \forall ij \in PTA \\ Bound\ rate_{ijk} - MFN_{jk} & \text{otherwise} \end{cases}$$

Data on MFN applied and WTO bound rates are obtained from Groppo and Piermartini [2014]. Their database combines information on MFN applied tariffs from the

[5] One often suggested alternative is to consider the second moment of the distribution of tariffs. However, such measure would capture also the possibility of tariff reductions which are not relevant for the export choice of firms.

[6] For example, the MFN rate of Australia and Indonesia in "Liquid dielectric transformers<650 KVA" and other electrical machinery and equipment is lower than the preferential rate agreed with Thailand on those products.

WTO's Integrated Data Base (IDB) and UNCTAD's Trade Analysis and Information System (TRAINS).[7] The latter database is also used to extract data on effectively applied tariffs for country pairs belonging to a PTA. Data on WTO bound rates are from the WTO Consolidated Tariff Schedules (CTS) database.

Trade data has been retrieved from the UN COMTRADE database. We use bilateral exports at the 6-digits level of the Harmonized System 1996. Since the number of observations in the full sample is huge and creates computational challenges. Therefore we establish a set of restrictions to reduce the sample size. First, we focus on a cross section analysis for the year 2011. Second, we exclude agricultural sectors. These sectors are characterized by a relevant portion of non-ad valorem tariffs and other country-specific distortions such as agricultural subsidies, for instance, and therefore the calculation of the equivalent bound rates could be misleading or biased. Third, we exclude importers and exporters that were not WTO members in 2011.[8] Fourth, we omit from the sample countries whose share of world trade is less than 0.1 percent. Finally, we disregard zero trade observations in products for which certain countries, mainly small countries, do not export to any destination, under the assumption that such countries do no produce these products. After applying these restrictions, we have information on trade, tariffs, bounds and additional control variables for 149 developed and developing countries exporting up to 4381 different products to 102 countries. The number of observations in our baseline regression is therefore almost 10 million.

Table 1.1 presents some summary statistics on our main variables of interest for the sub-sample of observations that are actually used in our econometric analysis. The average value of export is almost 1.2 million of dollars. The average applied tariff rate is 4.94 percent while the bound rate is almost twice the tariff, 9.12 percent. The average level of water in our sample is slightly more that 4 percent. Tariffs and bound rates vary considerably in our data as does the level of water. There are cases when the water is negative. For example, we record negative water for the EU on certain footwear from China due to an anti dumping duty in that year. However, given that we run our analysis using log (water), our results are not affected by these outliers; applied tariffs can be higher than 100 percent;[9] bound rates and water can be higher than 350 percent.[10] Almost half

[7]In particular the authors use TRAINS as the primary source for tariff data and IDB to fill the missing values.

[8]Considering only WTO members and manufacturing products, we have information about 151 countries exporting to 123 countries in 4399 products. This translates into a sample of more than 81 million observations.

[9]Indonesia has a tariffs higher than 100 percent for the HS1996 product code 330210, "Mixed odoriferous substances - food and drink industries".

[10]Panama has a tariff and binding on the HS code 871000 "Tanks and other armoured fighting vehicles, motorised, whether or not fitted with weapons, and parts of such vehicles" of 368 and 353 per cent respectively.

of the country pairs in the sample are involved in a preferential trade agreement.[11] In our sample of countries, after adjusting water for the presence of trade agreements, around 15 percent of exports is subject to trade policy uncertainty (see figure 1.1). Developing and emerging countries present wider flexibility compared to developed ones (see figure 1.2).

Table 1.1: Summary statistics for baseline sample

	mean	sd	min	max
Exports (1000s $)	1148.82	62466.7	0	69194976
Exports (log)	10.53	3.28	0	24.96
Product traded (binary)	0.297	0.457	0	1
Water	0.418	0.107	-0.3	3.533
Water (log)	0.0366	0.0886	-0.3566	1.5114
Tariff	0.0494	0.0626	0	1.0167
Tariff (log)	0.04659	0.0564	0	0.7015
Binding	0.0912	0.1338	0	3.6833
Binding (log)	0.081	0.1077	0	1.544
PTA	0.47	0.5	0	1
N	10032922			

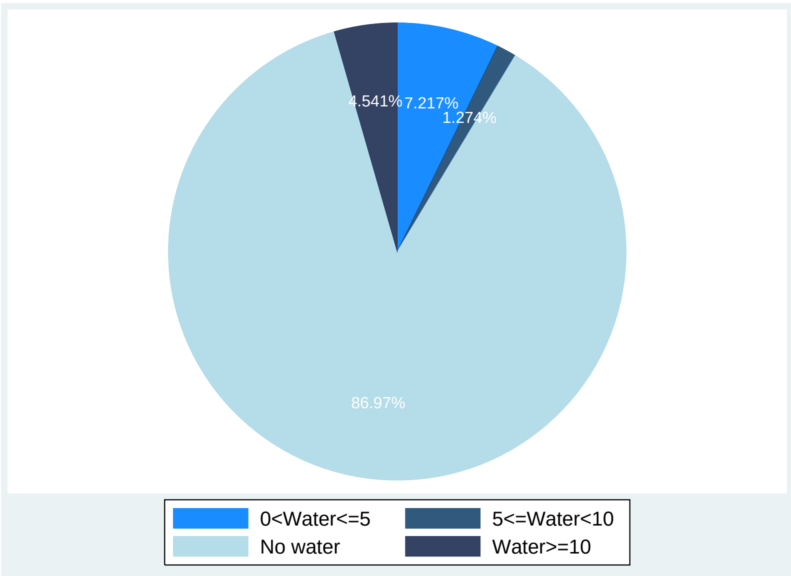

Figure 1.1: Percentage of exports by level of water, 2011

[11] Regarding the PTA variable, we rely on a newly built database by the WTO Secretariat (see WTO, World Trade Report 2011).

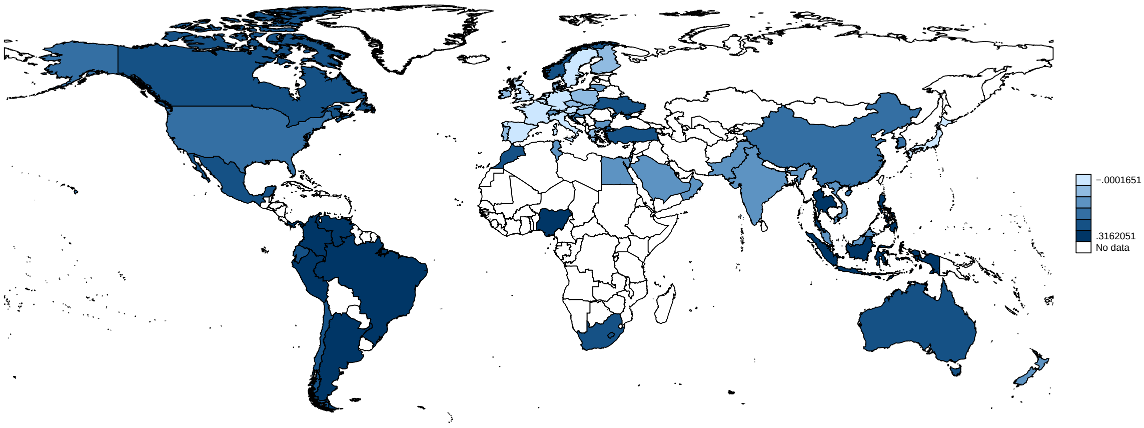

Figure 1.2: Average water by country, 2011

1.3 Empirical analysis

1.3.1 Econometric specification

We are interested in the effect of trade policy uncertainty on the extensive and intensive margins of trade. Our dependent variable captures either the probability that country i exports product k to country j, $Pr(Export_{ijk})$, or the log of total export values of product k from country i to country j, $log(Export_{ijk})$.

The equations we will estimate are:

$$\begin{aligned} Pr(Export_{ijk}) =& \alpha + \beta_1 log(Water_{ijk}) + \beta_2 log(\tau_{ijk}) + \beta_3 SizeRel_{jk} + \\ & \beta_4 X_{ij} + \delta_{jk_{2d}} + \delta_{ik_{2d}} + \epsilon_{ijk} \end{aligned} \tag{1.1}$$

for the extensive margin, and

$$\begin{aligned} log(Export_{ijk}) =& \alpha + \beta_1 log(Water_{ijk}) + \beta_2 log(\tau_{ijk}) + \beta_3 SizeRel_{jk} + \\ & \beta_4 X_{ij} + \delta_{jk_{2d}} + \delta_{ik_{2d}} + \epsilon_{ijk} \end{aligned} \tag{1.2}$$

for the analysis on the intensive margin of trade. In both regressions $Water_{ijk}$ is a measure of trade policy uncertainty faced by country i when exporting product k to country j. In some specifications, we also explore the impact of the binding levels on the intensive and extensive margins of trade by using the bound rates instead of water.

All the regressions in this paper include importer-industry ($\delta_{jk_{2d}}$) and exporter-industry ($\delta_{jk_{2d}}$) fixed effects in order to control for any unobservable country-industry specific characteristics. Note that due to the size of the dataset, the inclusion of importer- and exporter-product fixed effects at the HS 6 digits level would presents computational challenges. Thus, in our baseline regressions we use importer-industry and exporter-industry fixed effects where industries are defined at the HS Section level (2 digits). Moreover, we include in each regression the relative size of a sector in the importer country, namely the ratio of product k's share in country j's exports to its share in world trade, $SizeRel_{jk}$.[12] This is done in order to control for the relative importance of the importer in sector k.

In order to control for country-pair characteristics, we include standard gravity variables, such as the log of distance, contiguity, common language, colonial relationship, and common legal origin. As a robustness check and to control for the omitted variables bias, we also run the regressions using country-pair and importer-industry fixed effects. Finally, robust standard errors clustered at the import-product level.

For the intensive margin estimation In addition, we also run three regressions using dummy variables to identify positive water, water higher than 5 and water higher than 10. This in order to calculate the tariff equivalent of trade policy uncertainty for different thresholds of water.

1.3.2 Baseline Results - Extensive and Intensive Margin

Table 1.2 reports the results of the linear probability model estimated in equation 1.1.[13] As expected, column 1 shows that higher applied tariffs in country j are negatively related to exports from country i to j. The coefficient of log tariff is negative and significantly different from zero. Tariffs are on average 4.94 per cent. This implies that decreasing tariffs by one percentage point- equivalent to a 20 percent reduction of the average tariff, increases the probability of export by 0.11 percentage points ($\beta_2 * 0.20$).

The size of a sector in the importer country is positively related to trade. This result may be interpreted as a sign of the importance of intra-industry trade. The sign of the other control variable is in line with the economic literature. In particular, countries that are far away have a lower probability to trade while countries that share borders, language and a common colonial relationship tend to trade more.

Column 2 shows how the trade commitments (multilateral and regional) affect the probability of trade between two countries. The negative and significant coefficient of the (log of the) bound rate suggests that countries are less likely to export to countries with lower bound rates. At the average level, a reduction of bindings of one percentage point (from 9.1 to 8.1 percent) is associated to an increase in the probability of export of 1.5 percent. Similarly, a reduction of applied tariff by one percentage point is also associated to a higher probability of export of 8.6 percent. This result indicates that not only lower

[12]In formula, the variable has been constructed as $\frac{Export_{jk}/\sum_k Export_{jk}}{\sum_j Export_{jk}/\sum_j \sum_k Export_{jk}}$ where $Export_{jk}$ is country j's exports of good k. The variable has then been normalized in order to take values between -1 and 1 and where 0 is the threshold that establishes whether a country specializes in a product or not.

[13]The coefficients have been estimated using the Stata command reg2hdfe developed by Guimãres and Portugal [2010].

Table 1.2: Trade policy uncertainty and probability to export - Baseline results extensive margin

	Probability to export		
	(1)	(2)	(3)
Water (log)			-0.121***
			(0.00325)
Tariff (log)	-0.541***	-0.426***	-0.559***
	(0.0121)	(0.0124)	(0.0121)
Bound rate (log)		-0.141***	
		(0.00348)	
Relative size of k in j	0.0664***	0.0663***	0.0663***
	(0.000872)	(0.000872)	(0.000872)
Distance (log)	-0.118***	-0.115***	-0.115***
	(0.000279)	(0.000286)	(0.000285)
Observations	10,048,382	10,032,922	10,032,922
R-squared	0.356	0.356	0.356
Other gravity variables	Yes	Yes	Yes
Importer-Industry FE	Yes	Yes	Yes
Exporter-Industry FE	Yes	Yes	Yes

Robust SE in brackets clustered by importer-product. All regressions include a set of standard gravity controls such as contiguity, common language, colonial relationship and legal origins.
*** p<0.01, ** p<0.05, * p<0.1

tariff rates, but also more stringent bindings are related to more international trade. The coefficients of all other variables are equal in sign and magnitude to the previous column.

Our baseline result is shown in column 3. Trade policy uncertainty, as captured by water, reduces the probability to trade and the magnitude of the coefficient is economically significant. At the average level of water, improvements in commitments through a reduction of water by one point, from 4.2 to 3.2 percent (almost 24 percent decrease), is associated to an increase of the probability of export of 2.9 percentage points. This is in line with the theoretical prediction that trade policy uncertainty represents a cost that induces firms to wait and postpone the entry to foreign markets. Firms are more likely to export their products to countries that have lower tariffs (the coefficient is negative and significant), but also to countries with lower water because this makes it more difficult to increase tariffs.

The OLS results for the intensive margin are presented in table 1.3. Given our specifications, the coefficients of tariff, bound rate and water can be interpreted as elasticities. Column 1 shows that a one percent reduction of tariff is associated to a 2.9 percent increase in the value of exports. When we add the bound rate (column 2) the coefficient, this effect is estimated 1.8 percent. Moreover, a reduction in bound rate is also negatively associated to the value of exports: reducing the bound rate by one percent increases exports by a 1.1 percent.

Column 3 shows our baseline results. A reduction of water has a positive effect on the intensive margin of trade. In particular, a one percent decrease in water is associated with a 1.1 percent increase in the value of exports. Also the coefficient of tariff remains negative and significant. The last three columns of table 1.3 report the results when we substitute water with dummies identifying different thresholds of policy space. Using the formula calculated in kee, we can compute the tariff equivalent of having tariff water bigger than 0, 5 and 10.[14] Specifically, the coefficient of the dummy in column 4 implies that having positive water is equivalent to having a tariff of 1.7 percent. However, the tariff equivalent of having water of at least 5 is equal to 8.7 percent. Similarly, the tariff equivalent of water bigger than 10 is 7.5 percent. The fact that the tariff equivalents of water bigger than 5 and bigger than 10 are very similar is likely due to the fact that there are few observations in our sample with water between 5 and 10 (see figure 1.1).[15]

1.4 Endogeneity

Our results may suffer from an endogeneity bias due to potential reverse causality. Negotiated bound rates, and therefore water, may be affected by trade: the terms-of-trade

[14] The tariff equivalent is calculated as: $TE = e^{\beta_1} - 1/\beta_2$.

[15] Calculations of tariff equivalents by country are available from the authors upon request.

Table 1.3: Trade policy uncertainty and volume of export - Baseline results intensive margin

	Log of exports					
	(1)	(2)	(3)	(4)	(5)	(6)
Water (log)			-1.060***			
			(0.0477)			
Tariff (log)	-2.860***	-1.772***	-2.825***	-2.826***	-2.730***	-2.795***
	(0.113)	(0.127)	(0.113)	(0.114)	(0.113)	(0.113)
Bound rate (log)		-1.089***				
		(0.0501)				
=1 if water>0				-0.0504***		
				(0.0102)		
=1 if water>5					-0.272***	
					(0.0101)	
=1 if water>10						-0.236***
						(0.0107)
Relative size of k in j	0.465***	0.464***	0.464***	0.465***	0.464***	0.464***
	(0.00933)	(0.00934)	(0.00934)	(0.00933)	(0.00933)	(0.00933)
Distance (log)	-0.802***	-0.785***	-0.785***	-0.797***	-0.782***	-0.786***
	(0.00315)	(0.00320)	(0.00320)	(0.00326)	(0.00320)	(0.00319)
Observations	2,985,267	2,980,211	2,980,211	2,985,267	2,985,267	2,985,267
R-squared	0.321	0.321	0.321	0.321	0.321	0.321
Other gravity variables	Yes	Yes	Yes	Yes	Yes	Yes
Importer-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust SE in brackets clustered by importer-product. All regressions include a set of standard gravity controls such as contiguity, common language, colonial relationship and legal origins.
*** p<0.01, ** p<0.05, * p<0.1

argument for tariff setting suggests that a large importer of a product may wish to set its bound rate high, in order to have the flexibility to realize TOT gains. To control for endogeneity, we re-estimate our equations on the subsample of importers that acceded the WTO after 1995. The rationale behind this choice is that given that new acceding countries were not involved in the UR negotiations, at the moment of accession, they have to accept the conditions set by the previous members. Hence, it is unlikely that the MFN and bound rates of new acceding countries depend on their trade structure.

Table 1.4 shows the results of equations 1.1 and 1.2 for the subsample of new acceding countries importing from any WTO member. These results are similar to the ones presented in the previous table. Higher tariffs, higher bound rates and more water reduce the probability of export from a country to a new acceding member of WTO. The coefficients are all negative and significant. As to the magnitudes, the coefficients of water and log tariffs in column 3 and 6 are now bigger than the coefficients in the table 2 and 3. This is due to the sample of countries included in the regression.[16]

Table 1.4: Robustness to endogeneity - Sample of new acceding countries

	Probability to export			Log of exports		
	(1)	(2)	(3)	(4)	(5)	(6)
Water (log)			-0.686***			-5.090***
			(0.0398)			(0.250)
Tariff (log)	-0.886***	-0.430***	-1.133***	-4.105***	-0.394	-5.503***
	(0.0279)	(0.0344)	(0.0325)	(0.291)	(0.322)	(0.301)
Bound rate (log)		-0.737***			-5.214***	
		(0.0396)			(0.257)	
Relative size of k in j	0.0493***	0.0480***	0.0480***	0.00193	-0.00641	-0.00660
	(0.00256)	(0.00255)	(0.00255)	(0.0323)	(0.0320)	(0.0320)
Distance (log)	-0.114***	-0.105***	-0.105***	-0.799***	-0.743***	-0.745***
	(0.000854)	(0.00101)	(0.00101)	(0.0123)	(0.0127)	(0.0127)
Observations	1,051,481	1,051,481	1,051,481	262,481	262,481	262,481
R-squared	0.344	0.349	0.349	0.310	0.313	0.313
Other gravity variables	Yes	Yes	Yes	Yes	Yes	Yes
Importer-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust SE in brackets clustered by importer-product. The estimates are based on the subsample of importers that acceded the WTO after 1995. All regressions include a set of standard gravity controls such as contiguity, common language, colonial relationship and legal origins.
*** p<0.01, ** p<0.05, * p<0.1

The coefficients in column 3 indicate that at the average level of water, a reduction of

[16]The average level of water in this subsample is 5.4 while average tariff is 6.2 percent.

one point in water from 5.4 to 4.4 is indeed associated to an increase in the probability of export of 12.7 points. Similarly the probability of export increases by 18.3 points when tariffs go from the average level of around 6 to 5 percent. The coefficient of water in the intensive margin regression reported in column 6 also increases in the subsample of new acceding countries. The elasticity of exports to water is now -5, almost equal to the elasticity of exports to tariffs. A 1 percent reduction of water is associated with an increase in the value of exports of 5 percent.

Endogeneity bias may also arise from the presence of omitted variables. To address this concern, we run an additional set of regressions where we use country-pair fixed effects in addition to importer-industry fixed effects.[17] In addition, as in the baseline regressions, we capture exporter-product characteristics by adding the exporter's world share of exports in a sector and, we control for importer-product characteristics by adding the relative size of a sector in the importer country.

The results, reported in Table 1.5 are in line with the baseline regressions both for the extensive and the intensive margins. In the former case both tariff and water still have a negative effect on the probability of trade. The coefficient of water is somehow smaller: reducing water from the average level of 4.2 to 3.2 is associated with an increase in the probability of trade equal to 1.6 percentage points. The increase in the probability of trade due to a decrease of tariff from5 to 4 percent is equal to 11.7 percent (see column 3 of Table 5). A marginal increase of 1 percent of the level of water is associated to a decrease in the value of exports equal to 0.6 percent. The decrease due to an increase in tariff is higher and equal to 3.7 percent (see column6 of table 5).

1.5 Robustness

In our analysis we include both bound and unbound tariff lines. In particular, for unbound tariffs -tariffs without a maximum ceiling-, we have imputed a rate equal to the peak tariff, defined as three times the average tariff.

A potential problem deriving from our estimations is that tariff water may provide an overestimation of the extent of the flexibility of multilateral and preferential trade agreements since, for certain tariff lines the bound levels may be above the prohibitive tariff levels -tariff levels above which trade would be equal to zero (see Foletti et al. [2011]). As a robustness check, we re-estimate our equations 1.1 and 1.2 using the level of effective water as explanatory variable for trade policy uncertainty. This is calculated replacing water with the difference between the prohibitive tariff and the applied rate for all those tariff lines where the bound rate or the imputed rate for the unbound lines is above the prohibitive tariff, and using the prohibitive water as the bound rate in unbound lines:

[17] Where industries are defined at the HS 2 digits level.

Table 1.5: Robustness to omitted variable bias - Country-pair FE

	Probability to export			Log of exports		
	(1)	(2)	(3)	(4)	(5)	(6)
Water (log)			-0.0651***			-0.588***
			(0.00819)			(0.104)
Tariff (log)	-0.563***	-0.486***	-0.577***	-3.642***	-3.186***	-3.721***
	(0.0126)	(0.0144)	(0.0126)	(0.132)	(0.158)	(0.134)
Bound rate (log)		-0.0991***			-0.547***	
		(0.00880)			(0.109)	
Relative size of k in j	0.0676***	0.0676***	0.0676***	0.483***	0.483***	0.483***
	(0.000867)	(0.000867)	(0.000867)	(0.00926)	(0.00926)	(0.00926)
World share of exports of k from i	0.980***	0.980***	0.980***	10.35***	10.35***	10.35***
	(0.00320)	(0.00320)	(0.00320)	(0.0290)	(0.0291)	(0.0291)
Observations	10,048,382	10,032,922	10,032,922	2,985,267	2,980,211	2,980,211
R-squared	0.356	0.356	0.356	0.331	0.330	0.330
Importer-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Country pair FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust SE in brackets clustered by importer-product.
*** p<0.01, ** p<0.05, * p<0.1

$$Water_{ijk}^{eff} = \begin{cases} B_{jk} - \tau ijk & \text{if } B_{jk} < \tau jk^P \\ \tau jk^P - \tau ijk & \text{otherwise} \end{cases}$$

where $\tau jk^P = \tau jk + \frac{1+\tau jk}{\sigma_{jk}}$ and σ_{jk} is the import demand elasticity Estimated at the HS 6 digit level by Kee et al. [2008].

The results for the extensive margin of trade including the effective level of water are presented in table 1.6. These results are in line with our main predictions. Specifically, the presence of larger size of water reduces the probability that a product is traded. Reducing effective water by one, from the average of 3.9, is associated to an increase of the probability of export of 2.6 points in the full sample (column 2). The general result holds also for the subsample of importers that acceded WTO after 1995: a reduction of effective water from 5.3 to 4.3 is associated to an increase in the probability of trade of 13.3.

The coefficients of effective water are also consistent with the baseline results for the intensive margin regression (see table 1.7). A reduction of water has still a positive effect on export volumes. In particular, a one percent decrease in effective water is associated with a 0.9 percent increase in the value of exports. As in the baseline regressions, the coefficients of all variable of interest increase when only new acceding countries are included

Table 1.6: Probability a product is traded - Robustness to prohibitive tariff and effective water

	Full sample		New acceding	
	(1)	(2)	(3)	(4)
Effective water (log)		-0.0999***		-0.700***
		(0.00349)		(0.0236)
Tariff (log)	-0.371***	-0.586***	-0.481***	-1.199***
	(0.0123)	(0.0122)	(0.0276)	(0.0305)
Effective bound rate (log)	-0.0233***		0.0971***	
	(0.000346)		(0.00125)	
Relative size of k in j	0.0664***	0.0665***	0.497***	0.477***
	(0.000873)	(0.000875)	(0.00251)	(0.00257)
Distance (log)	-0.128***	-0.117***	-0.146***	-0.106***
	(0.000308)	(0.000287)	(0.000960)	(0.000929)
Observations	9,894,489	9,894,489	1,028,518	1,028,518
R-squared	0.358	0.357	0.321	0.321
Other gravity variables	Yes	Yes	Yes	Yes
Importer-Industry FE	Yes	Yes	Yes	Yes
Exporter-Industry FE	Yes	Yes	Yes	Yes

Robust SE in brackets clustered by product-importer. The bound and water take into consideration the prohibitive tariffs when the line is unbound. The estimates in columns 3 and 4 are based on the subsample of importers that acceded the WTO after 1995. All regressions include a set of standard gravity controls such as contiguity, common language, colonial relationship and legal origins.

*** p<0.01, ** p<0.05, * p<0.1

in the sample.

Table 1.7: Intensive margin - Robustness to prohibitive tariff and effective water

	Full sample		New acceding	
	(1)	(2)	(3)	(4)
Effective water (log)		-0.886***		-4.956***
		(0.0491)		(0.249)
Tariff (log)	-3.532***	-2.829***	-3.662***	-5.479***
	(0.120	(0.114	(0.305	(0.308
Effective bound rate (log)	0.0775***		-0.122***	
	(0.00434)		(0.0164)	
Relative size of k in j	0.467***	0.466***	0.00721	-0.000502
	(0.00936)	(0.00936)	(0.0325)	(0.0323)
Distance (log)	-0.780***	-0.794***	-0.829***	-0.754***
	(0.00346)	(0.00323)	(0.0129)	(0.0128)
Observations	2950880	2950880	258918	258918
R-squared	0.321	0.321	0.31	0.313
Other gravity variables	Yes	Yes	Yes	Yes
Importer-Industry FE	Yes	Yes	Yes	Yes
Exporter-Industry FE	Yes	Yes	Yes	Yes

Robust SE in brackets clustered by product-importer. The bound and water take into consideration the prohibitive tariffs when the line is unbound. The estimates in columns 3 and 4 are based on the subsample of importers that acceded the WTO after 1995. All regressions include a set of standard gravity controls such as contiguity, common language, colonial relationship and legal origins.
*** p<0.01, ** p<0.05, * p<0.1

Finally, to show that our results are robust to different years we re-estimate the impact of water on the extensive and intensive margin for the year 2007. The results reported in table 1.8 are qualitatively and quantitatively similar to the results for 2011. At the average level of tariff in 2007, a decrease in tariffs by one percentage point increases the probability of export by 6 points, at the average level of water, a decrease in water by one point increases trade by 1 point.[18] Table 1.8 also shows that the results for the intensive margin in 2007 are qualitatively the same as the results for 2011, yet the magnitudes of

[18]In 2007, the average tariff and water in our sample are 6.2 and 6.4 respectively. The average bound rate is 12.6 percent.

the coefficient of water is smaller in 2007. [19]

Table 1.8: Probability a product is traded and intensive margin - Results in 2007

	Probability to export			Log of exports		
	(1)	(2)	(3)	(4)	(5)	(6)
Water (log)			-0.0643***			-0.681***
			(0.00244)			(0.0363)
Tariff (log)	-0.369***	-0.296***	-0.372***	-3.198***	-2.469***	-3.162***
	(0.00867)	(0.00907)	(0.00867)	(0.0937)	(0.103)	(0.0937)
Bound rate (log)		-0.0797***			-0.721***	
		(0.00271)			(0.0391)	
Relative size of k in j	0.0610***	0.0610***	0.0610***	0.401***	0.401***	0.401***
	(0.000792)	(0.000793)	(0.000793)	(0.00842)	(0.00843)	(0.00843)
Distance (log)	-0.125***	-0.124***	-0.124***	-0.754***	-0.743***	-0.744***
	(0.000250)	(0.000255)	(0.000255)	(0.00281)	(0.00286)	(0.00286)
Observations	12,104,556	12,078,392	12,078,392	3,469,514	3,462,684	3,462,684
R-squared	0.353	0.353	0.353	0.313	0.313	0.313
Other gravity variables	Yes	Yes	Yes	Yes	Yes	Yes
Importer-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust SE in brackets clustered by importer-product. All regressions include a set of standard gravity controls such as contiguity, common language, colonial relationship and legal origins.
*** p<0.01, ** p<0.05, * p<0.1

1.6 Trade Policy Uncertainty and Institutions

Countries with better institutions are likely to have more credibility in terms of the policies that they adopt. Potential exporting firms may perceive the presence of policy flexibility as a lower concern in such countries. We explore this aspect by adding an interaction term between water and the level of institutions in our regressions.

In table 1.9, we report the results of our regressions. Using the Worldwide Governance Indicator database to measure the quality of a country's institutions, we show the coefficients of the interaction term for three indicators of institutional quality -rule of law, regulatory quality and control of corruption. All coefficients, both for the intensive and the extensive margin of trade, are positive and statistically significant meaning that the negative effect of water on the probability to export is attenuated for countries with bet-

[19] The differences in the magnitude of the coefficient is mainly due to the different samples available in 2007 and 2011. If we select the observations in the sample such that we have the same country-pairs in both year, the coefficients become very similar to the coefficients for 2011 reported in tables 1 and 2.

ter institutions. In particular, we estimate that an improvement of one point in the level of institutional quality reduces the negative effect of water on the probability of export between 40 and 60 percent on average. The elasticity of export to water is also reduced by improvements in institutions: an increase of one point in the level of institutions reduces the elasticity by an amount between 32 and 58 percent.

Table 1.9: Interaction with institutions: extensive and intensive margins

	Probability to export			Log of exports		
	(1)	(2)	(3)	(4)	(5)	(6)
Water (log)	-0.0935***	-0.116***	-0.0943***	-0.879***	-1.084***	-0.932***
	(0.00480)	(0.00340)	(0.00458)	(0.0548)	(0.0477)	(0.0524)
Tariff (log)	-0.560***	-0.561***	-0.560***	-2.838***	-2.833***	-2.836***
	(0.0121)	(0.0121)	(0.0121)	(0.113)	(0.113)	(0.113)
Water*Rule of law	0.0507***			0.516***		
	(0.00540)			(0.0675)		
Water*Regulatory quality		0.0473***			0.350***	
		(0.00509)			(0.0677)	
Water*Control of corruption			0.0570***			0.445***
			(0.00577)			(0.0676)
Relative size of k in j	0.0663***	0.0663***	0.0663***	0.464***	0.464***	0.464***
	(0.000872)	(0.000872)	(0.000872)	(0.00934)	(0.00934)	(0.00934)
Distance (log)	-0.115***	-0.115***	-0.115***	-0.785***	-0.784***	-0.785***
	(0.000286)	(0.000285)	(0.000286)	(0.00320)	(0.00320)	(0.00320)
Observations	10,032,922	10,032,922	10,032,922	2,980,211	2,980,211	2,980,211
R-squared	0.356	0.356	0.356	0.321	0.321	0.321
Other gravity variables	Yes	Yes	Yes	Yes	Yes	Yes
Importer-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust SE in brackets clustered by importer-product. All regressions include a set of standard gravity controls such as contiguity, common language, colonial relationship and legal origins.
*** p<0.01, ** p<0.05, * p<0.1

1.7 Trade Policy Uncertainty and Product Characteristics

We now turn to the analysis of whether the impact of trade policy uncertainty is magnified in the presence of global value chains (GVCs). Yi [2003] shows that tariffs and non-tariff measures matter more in GVCs, because in GVC goods cross borders multiple time and each time they do so, they incur the cost of the trade barrier they face . Following the same logic, TPU should have a stronger negative effect in the export margins of intermediate goods inputs into further processing. Papers such as Harrigan and Venables [2006] also show that uncertainty is an important obstacle to trade when production takes place in global supply chains: it is a source of agglomeration when production is fragmented.[20]

To test whether TPU has an amplified impact in the presence of GVCs, we include the interaction between water and a dummy that identifies the sectors involved in global value chains (GVCs). The dummy is equal to one for parts and components defined as the Standard International Trade Classification (SITC Rev.3) equivalent of Broad Economic Categories (BEC) parts and components plus unfinished textiles in SITC section division 65.[21] Results are presented in column 1 and 4 of table 1.10. The coefficients of water and log tariff are still negative and significant. At the average tariff, a decrease in the applied tariff of one percentage point increases in the probability of trade by 11.2 points. At the average level of water, a decrease of one point in the level of water for a product that is not an intermediate is associated to an increase in the probability of export of 2.8 points. The coefficient of the interaction is also negative and significant, intermediate goods are more sensitive to trade policy uncertainty. At the average level of water, a reduction of water on an intermediate good is associated to an increase in the probability of exporting such intermediate of 3.4 points.

In addition, we examine whether water has a different effect for products that are more or less differentiated. We have no prior expectations about the difference between homogeneous and differentiated goods. A trade-off between at least two mechanisms is at play. On the one hand, homogeneous goods are more sensitive to changes in prices. This would suggest that homogenous goods are also more sensitive to uncertainty. Conversely, providers of standardized goods can more easily redirect their supply of intermediates towards countries with lower levels of trade policy uncertainty compared to providers of more differentiated and tailor-made goods. As a consequence, differentiated goods are more sensitive to uncertainty.

To investigate this we add in our regressions an interaction term between water and a categorical variable capturing the level of differentiation of goods. In particular we use the classification of products created by Rauch [1999], that groups sectors at the 4 digits SITC level into differentiated products (Rauch index=2) reference priced (Rauch index=1), or homogeneous goods (Rauch index=0). Columns from 2 and 3 of table 1.10 show the results of regression (1) augmented with the interaction between water and different formulations of the Rauch classification.

[20]The authors focus on uncertainty in time costs but a similar logic could be applied for uncertainty in trade policy.

[21]Product nomenclatures have then been converted using the conversion tables prepared by the UN Statistics Division.

Table 1.10: Interactions with industry variables: extensive and intensive margins

	Probability to export			Log of exports		
	(1)	(2)	(3)	(4)	(5)	(6)
Water (log)	-0.113***	-0.0294***	-0.0753***	-1.020***	-0.859***	-0.907***
	(0.00353)	(0.00810)	(0.00491)	(0.0476)	(0.177)	(0.0922)
Interaction water *GVC	-0.0313***			-0.567***		
	(0.00943)			(0.106)		
Interaction water *Rauch class (con)		-0.0535***			-0.153	
		(0.00472)			(0.0955)	
Interaction water *differentiated (Rauch con)			-0.0606***			-0.279***
			(0.00598)			(0.101)
Tariff (log)	-0.489***	-0.573***	-0.561***	-2.804***	-2.765***	-2.793***
	(0.0112)	(0.0117)	(0.0117)	(0.107)	(0.110)	(0.110)
=1 if parts & components	0.0968***			0.0200		
	(0.00173)			(0.0163)		
Rauch classification (con)		0.0545***			-0.205***	
		(0.000963)			(0.0124)	
=1 if differentiated (Rauch con)			0.0637***			-0.221***
			(0.00130)			(0.0150)
Distance (log)	-0.116***	-0.117***	-0.117***	-0.785***	-0.783***	-0.783***
	(0.000277)	(0.000284)	(0.000284)	(0.00314)	(0.00323)	(0.00323)
Size of domestic market	0.0644***	0.0638***	0.0638***	0.465***	0.458***	0.457***
	(0.000839)	(0.000855)	(0.000856)	(0.00917)	(0.00933)	(0.00934)
Observations	10,724,481	10,163,763	10,163,763	3,093,033	2,917,553	2,917,553
R-squared	0.359	0.359	0.359	0.325	0.326	0.326
Other gravity variables	Yes	Yes	Yes	Yes	Yes	Yes
Importer-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust SE in brackets clustered by importer-product. All regressions include a set of standard gravity controls such as contiguity, common language, colonial relationship and legal origins.
*** p<0.01, ** p<0.05, * p<0.1

In column 2 the coefficient of water is negative and significant suggesting that water has a negative impact on the probability of exporting homogeneous goods. The negative coefficient of the interaction shows that such negative effect of water is stronger the more differentiated the goods. In column 3 we interact water with a dummy equal to one for differentiated goods only. The coefficient of the interaction term is still negative and significant.

As far as the intensive margin is concerned, table 1.10 (columns 4-6) show the impact of TPU for intermediates and for products with different levels of differentiation on the intensive margin of trade. Also in this case the coefficient of the interaction between water and parts and components is negative and significant. The elasticity to water of non-intermediate goods is around two thirds of the elasticity of intermediates. This means that increases in the level of water are associated with bigger decreases in exports of intermediate goods. Similarly, differentiated goods are more sensitive to increases in the level of water.

1.8 Conclusion

This paper contributes to the emerging economic literature that studies the role of uncertainty on the choice of firms to export. It also investigates the impact of trade policy uncertainty on the intensive margin of trade.

Our main results show that TPU has a negative impact both on the probability to export and on export volumes for a wide set of importers and exporters using disaggregated data. Our findings are robust to endogeneity.

We also analyze the impact of TPU across countries and sectors. Our results show that for countries with better institutions the impact of TPU is dampened: stability and credibility of importers reduces the cost due to the presence of policy space. In addition the presence of policy space is an important obstacle to trade when production takes place in global supply chains and has a higher negative impact for more differentiated good compared to standardized ones.

Finally, in terms of policy implications, this paper provides evidence on the importance of trade commitments. In particular it supports the view that trade policy uncertainty act as a barrier to trade. Hence there is a commercial value of binding tariffs even when the bound rate is above the applied rate.

Chapter 2

Deep Trade Agreements and Vertical FDI: The Devil is in the Details

joint with Nadia Rocha (WTO) and Michele Ruta (IMF)[1]

[1]The views expressed are those of the authors and do not necessarily reflect, officially or unofficially, those of the IMF or WTO or their Members, nor the position of any other staff members. Any errors are the fault of the authors.

2.1 Introduction

How are trade agreements and the international organization of production related? The recent wave of Preferential Trade Agreements (PTAs) has brought this question to the forefront of trade research and of the trade policy debate. The key insight of this literature is that the "depth" of trade agreements is associated with the international fragmentation of production.[2] This paper adds to this line of work by looking at how the content of trade agreements, that is the specific provisions embedded in PTAs, relates to the way through which goods are traded internationally (i.e. within-firms or arm's length). The underlying idea is that "deep" trade agreements affect - and are affected by - firms' make-or-buy decisions, that is whether producers outsource to trading partners' suppliers or vertically integrate production processes with affiliates in foreign economies.

Trade agreements are usually thought of as reciprocal market access exchanges involving tariff cuts and the reduction of other border measures. But most modern day trade agreements contain provisions that cover a wide array of non-tariff measures, both at the border and behind-the-border. An incomplete list includes: technical barriers to trade (TBT) and sanitary and phytosanitary (SPS) measures, rules on investment and intellectual property rights (IPR) protection, provisions on anti-corruption, competition policy, labor standards, etc. While some of these areas are regulated at the World Trade Organization (WTO), recent PTAs tend to go beyond multilateral rules (see, WTO [2011] for detailed evidence). The literature refers to these new trade agreements as "deep" to distinguish them from traditional PTAs that focus only on market access commitments -sometimes referred to as "shallow".

Similarly, while most non-experts tend to think of international trade as involving the exchange of final goods produced with (mostly) local inputs, trade has radically changed in the past thirty years in response to a growing international fragmentation of production processes. This phenomenon has been widely documented in a number of studies using different methodological approaches.[3] A variety of technological reasons, most notably the information and communication technology (ITC) revolution, lie beneath this transformation. But institutions, and in particular trade institutions, are recognized as a determinant and a consequence of the evolving international trade structure. Orefice and Rocha [2014] show that signing deeper agreements increases trade in parts and components between PTA members and that, on the other hand, higher levels of trade in parts

[2]See Lawrence [1996] and Baldwin [2011] for a discussion of the relationship between PTAs and the international fragmentation of production and Antràs and Staiger [2012] for a first formal model that combines offshoring and the design of trade agreements. A survey of the academic literature and of the policy debate is in WTO [2011].

[3]Different measures are provided by Feenstra and Hanson [1996], Hummels et al. [2001], Johnson and Noguera [2012]. Koopman et al. [2014] provide a unifying framework to measure the international fragmentation of production..

and components increase the likelihood of signing deeper agreements.

In this paper, we dig further into the relationship between deep trade agreements and the process of internationalization of production. The specific question that we address is how deep agreements relate to the way goods are traded internationally (i.e. inside or outside the boundary of the firm). When firms choose their global sourcing strategy, a key decision is the extent of control they want to exert over their foreign production processes. Certain firms in certain sectors choose to own foreign assets through vertical Foreign Direct Investments (FDIs) as a means to enhance such control.[4] Others offshore production, but instead rely on independent foreign suppliers, a sourcing strategy commonly known as foreign outsourcing. Importantly, these control decisions are associated to different modes of international trade: FDIs give raise to within-firm trade, while foreign outsourcing results in arm's length trade.

As is well understood from the trade and industrial organization literature, the incomplete nature of international contracts affects firms' vertical integration decisions (i.e. FDI versus foreign outsourcing).[5] In the so called "property rights" approach adopted in Antràs [2003] and in much of the international trade literature, ownership is a means to reduce the hold-up problem created by contractual incompleteness. Underlying this notion, there is the idea that contractual frictions are pervasive in international transactions because of differences in legal systems, poor institutional quality in certain countries involved in one end of the transaction and limited enforcement ability. Deep trade agreements reduce contractual uncertainty, because in addition to smoothing differences in contractual institutions (either by setting common rules or by allowing mutual recognition of heterogeneous practices among PTA members) they provide a commitment device to countries with weaker institutions and a mechanism to enforce rules through dispute settlement. By so doing, deep agreements interact with the make-or-buy decisions of firms and, hence, with the way goods are traded internationally.

To guide our empirical analysis of the impact of PTAs on vertical FDI, we employ the model by Antràs and Helpman [2008] (henceforth, AH). AH's framework introduces varying degrees of contractual frictions across countries in a model of the international organization of production. This setting allows to study the impact of changes in the quality of contracting institutions, such as the ones brought about by a deep PTA, on firms' location and control decisions. The main insight of the theory is that deep provisions in PTAs may increase or decrease vertical FDI, depending on whether they improve the

[4]The theoretical literature has long distinguished market seeking (i.e. horizontal) FDIs and efficiency seeking (i.e. vertical) FDIs (Markusen [1984], Helpman [1986]). For brevity, unless otherwise specified, whenever we refer to FDI in the rest of the paper, we imply vertical FDI. As is well known, in practice this distinction is not the only relevant one and we will come back to this point in the next section.

[5]There are a number of excellent surveys that discuss different angles of this literature, including Helpman [2006], Antràs [2014], and Antràs and R.Yeaple [2013].

contractibility of inputs provided by the headquarters (headquarter services) or by the suppliers (components). As we put it in the title: when it comes to the effects of deep agreements on vertical FDI, the devil is in the details (i.e. the content) of the agreement. The reason for this finding is entrenched in the logic of the property right approach to the boundary of multinational firms. Because ownership is a means to reduce hold-up problems created by contractual incompleteness, it matters if the PTA provisions improve the relative contractibility of different inputs.

We test this theory using a new dataset on the content of PTA provisions and using detailed firm-level information on vertical FDI from the ORBIS dataset constructed by the Bureau Van Dijk. We find that deeper agreements, measured with different indexes, are associated with a higher value of vertical FDI. However, once we look at the composition of PTAs, depth per-se is not anymore positively correlated with vertical FDI, whereas the type of provisions included in an agreement matters. In fact, provisions that improve the contractibility of inputs provided by suppliers have a positive relationship with vertical FDIs. On the other hand, provisions that improve the contractibility of headquarter services are almost always uncorrelated with FDIs.

Our work fits in the broader research effort to understand the relationship between international trade and institutions (see, Nunn and Trefler [2014] and WTO [2013] for recent surveys). Specifically, our findings complement other recent works in this area. First, Bernard et al. [2010] and Nunn and Trefler [2013] have empirically investigated how contractual frictions affect intra-firm trade. There are two main differences with these studies. On the empirical approach: we employ firm-level information to construct our measure of vertical FDI, rather than focusing on intra-firm trade. Among other things, this allows to expand the analysis beyond the US. Moreover, our focus is on changes in contractibility determined by deep agreements rather than by domestic institutions or by other technological determinants of contractibility. Second, recent empirical work has looked at the relationship between international agreements -PTAs and bilateral investment treaties (BITs)- and FDIs (among others, Blanchard and Matschke [2012]; Baltagi et al. [2008]; Egger and Merlo [2012].Blanchard [2007] Blanchard [2010] presents formal models of FDI and trade agreements. Differently from our work, these models study the implications of international investment for trade/tariff negotiations. Overall, these studies show that trade and investment agreements affect and are affected by FDI/offshoring. Aside from the use of a new measure for vertical FDI, our work adds to these findings by focusing on the depth/content of trade agreements, which allows to disentangle an important channel through which trade institutions affect the ways goods are traded internationally.

The rest of the paper is organized as follows. Section 2 presents the theory of how PTA provisions are related to the international organization of production. Section 3 describes the methodology used to assess the depth and composition of trade agreements and to measure vertical FDI. The empirical analysis and the key findings of the paper are presented in Section 4. Concluding remarks follow.

2.2 Theory: Deep PTAs and the international organization of production

In this section, we briefly present the theory that we use to guide our empirical analysis. Since the model is a simplified version of the well-known model by AH, we only review its most important features and stress the key difference introduced in this paper and the relevant testable implications.

Antràs and Helpman [2004] present a framework to analyze the determinants of firms' global sourcing strategies and describe an equilibrium where firms with different productivity levels choose different ownership structures (outsourcing or vertical integration) and different supplier location (domestic or foreign). AH build on this framework to explicitly model contracting institutions and to allow for partial contractibility of the inputs needed in the production process. The essential idea is that certain characteristics of inputs (or activities needed to supply these inputs) can be written in ex ante contracts and verified by a court of law, while others are not contractible. They show that the contractibility of inputs (i.e. the share of contractible input characteristics/activities) plays an important role in the ownership and location decisions of firms. As domestic institutions such as a country's quality of the legal system are a determinant of inputs contractibility, AH find that the global sourcing strategies of firms depend on the domestic institutions of the countries where they operate. We extend the model of AH and allow for the contractibility of inputs to be a function of domestic institutions and the rules embedded in deep trade agreements. This simple extension permits to precisely identify the channels through which different provisions in trade agreements affect the international organization of production.

Following Antràs and Helpman [2004] and AH, we assume that there are two countries: the North, which is a high-cost country and has good contracting institutions, and the South, which is low-cost but has weaker contracting intuitions relative to the North. Final good producers are located in the North. We focus on a firm that produces a brand of a differentiated product and for notational simplicity we drop the indexes. Demand is generated by CES preferences. Production is Cobb-Douglas using two inputs headquarter services (produced in-house by the final good producer) and components, which can be sourced in the North or in the South. Specifically, final good production is given by:

$$q(\theta) = \theta \left(\frac{h}{\eta}\right)^{\eta} \left(\frac{m}{1-\eta}\right)^{1-\eta}$$

where θ captures the firm's productivity, $\eta \in (0, 1)$ is a measure of the headquarter intensity of technology, and h and m are headquarter services and components respectively. Both inputs are brand specific, in the sense that they are customized to fit the needs of this brand and cannot be usefully employed for other brands.

Each input is produced with a continuum of activities in the interval $[0, 1]$ according to the following technology:

$$\omega = exp\left[\int_0^1 log\omega(i)di\right]$$

where $\omega = h, m$.

Following AH, we assume that only activities in the interval $[0, \eta_{omega}]$ are contractible, where $0 \leq \eta_{omega} \geq 1$. As discussed above, by this we mean that only a fraction of the characteristics of these activities can be specified in enforceable ex ante contracts, while the remaining fraction is non-contractible. As usual in the literature, this assumption can also be interpreted as all activities/characteristics being only partially contractible.[6] For simplicity, we assume full contractibility in the North and focus on incomplete contracting in the South only. [7]

Differences in contractibility across production processes and across countries reflect technological and institutional variation. In particular, we assume that the institutional environment is not only determined by the characteristics of domestic institutions (as in AH), but also by the deep provisions that a country commits to in the context of a PTA. To clarify this point, let λ be an index of the quality of domestic institutions and define $\gamma = (\gamma_1, .., \gamma_N)$, as the set of deep provisions that can be introduced in a trade agreement. Then we can write

$$\mu_h = h(\lambda, \gamma_1, .., \gamma_N) and \mu_m = m(\lambda, \gamma_1, .., \gamma_N)$$

with $h'(.), m'(.) > 0$,

where, without loss of generality, we have ordered the first T provisions as the ones that affect the contractibility of headquarter services, such as protection of intellectual property rights or investment provisions, and the remaining provisions as the PTA rules that affect the contractibility of components, such as standards and other regulatory requirements that promote harmonization or mutual recognition.[8]

[6] See Acemoglu et al. [2007].

[7] As further discussed below, this assumption allows to abstract from the control decision in domestic sourcing.

[8] The marginal impact of domestic and PTA provisions can vary substantially and we are agnostic on the different effects. However, the point that we want to make is that certain PTA provisions will only affect the contractibility of headquarters, while others only impact on the contractibility of components. Naturally, there will be provisions in a trade agreement, such as anti-corruption rules, that (if effective) may well be equivalent to an improvement in the domestic legal system (λ).

A final good producer decides whether to source components (m) in the North or in the South and whether to vertically integrate or not. Sourcing components from the South gives raise to within-firm trade under vertical integration or arm's length trade in the case of foreign outsourcing. As we have assumed that there are no contractual imperfections in the North, the choice between vertical integration and outsourcing in the domestic market is immaterial and we, therefore, abstract from it in what follows. Different organizational choices are associated to different fixed costs. Following the literature, these costs are assumed to satisfy: $f_V > f_O > f_D$, where f_V is the fixed cost of FDI, f_O is the fixed cost of foreign outsourcing and f_D is the fixed cost of domestic sourcing.

In what follows, we provide an informal discussion of the location/control decision of the final good producer and of the organizational forms that emerge in an industry equilibrium (the full characterization of the equilibrium is in AH).

When a final good producer in the North chooses to source components abroad, it is exposed to weaker contractual institutions in the South. The resulting uncertainty leads to under-investment in the supply of those h and m activities that are non-contractible (*a two-sided hold-up problem*).[9] For these activities, the price of the exchange between the final good producer in the North and the supplier of components in the South is decided ex post (i.e. after the initial investments were made) through bargaining. This bargaining process determines the distribution of the surplus from the international production relationship. Importantly, how the surplus is divided between the two parties depends on the organizational form of production. Specifically, when the final good producer in the North owns the input supplier (i.e. under FDI), it obtains the larger share of surplus compared to arm's length trade. Conversely, foreign outsourcing increases the share of surplus for the component supplier in the South. Because the expectation of a larger surplus creates stronger incentives to supply inputs, ownership alleviates one side of the two-sided hold-up problem. In this environment, the choice of the organizational form by the final good producer depends on the relative importance that non-contractible headquarter services and components have in the production of the final good. Intuitively, if the supplier's non-contractible activities are relatively more crucial in production, then it is efficient for the final good producer to incentivize the supplier through arm's length contracts. Vertical integration, on the other hand, is the optimal organization structure when non-contractible headquarter services are relatively more important in production.

As firms within a sector vary by productivity (θ) and because different location/control choices imply different fixed costs, the AH model can generate multiple organizational forms within an industry. Specifically, AH show that in sectors with sufficiently high headquarter intensity, final good producers obtain components through domestic sourcing,

[9]Note that foreign sourcing reduces the contractibility of headquarter services even though they are supplied in the North, because all parts of a contract governing an international transaction are harder to enforce.

foreign outsourcing and FDI (Proposition 9(i)). There is a simple intuition for this result. Consider first the location choice. Foreign sourcing has higher fixed costs than domestic sourcing. Therefore, it is optimal for the final good producer to source components in the South only when its productivity is sufficiently high so that the efficiency gains more than compensate the fixed costs. Consider next the control decision. The choice between FDI and foreign outsourcing presents a trade-off between fixed costs and efficient production. On the one hand, vertical integration is associated to higher fixed costs. On the other hand, vertical integration increases the surplus for the final good producer and, therefore, the incentives to invest in non-contractible headquarter activities that are relatively more important in high headquarter intensive sectors. For more productive producers, it is more efficient to pay the fixed cost of vertical integration and reduce the under-investment problem in headquarter intensive activities.

Figure 2.1 illustrates this result in AH. The figure shows the profits of the final good producers under domestic sourcing (D), foreign outsourcing (O) and FDI (V):

$$\pi_i = Z_i \vartheta - f_i with i = D, O, V$$

where ϑ is a linear function of the firm's productivity θ and Z_i is a derived parameter that depends on the firm's location/control choice as discussed above. As the figure shows, firms with low productivity source domestically, those with intermediate levels of productivity choose foreign outsourcing, and firms with even higher productivity vertically integrate in the South.

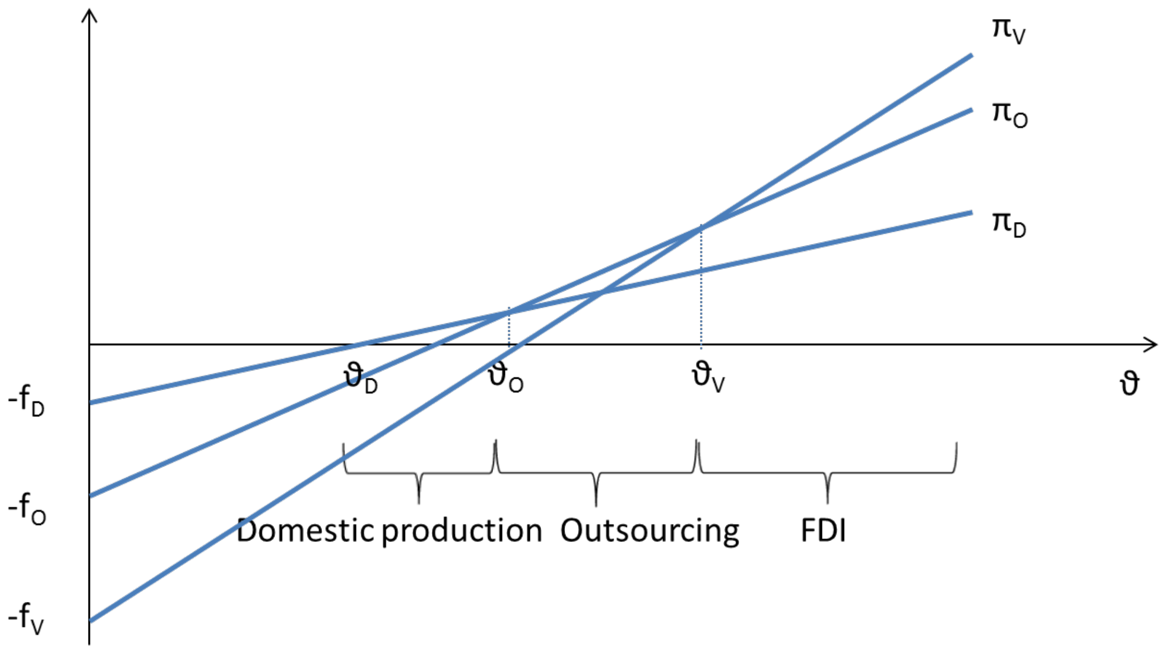

Figure 2.1: Organization choice in sectors with sufficiently high headquarter intensity

Starting from this industry equilibrium, we investigate how the location/control choice of final good producers is affected by the content of a trade agreement between the North and the South. We do this in two steps. First, we focus on PTA provisions that improve the contractibility of components (μ_m). AH show that the share of firms doing FDI on the total number of active firms (σ_V in AH) is increasing in μ_m (Proposition 9(ii)). The reason is that with better contracting of components, final good producers in the North are less dependent on the power of incentives they can offer to the suppliers of components in the South, thus making vertical integration more attractive. Figure 2.2 provides a graphical intuition of this effect. The dashed lines represent profits under a PTA that improves the contractibility of components (or, equivalently, that improves disproportionally the contractibility of components relative to headquarter services). Profitability of domestic sourcing (Z_D) is not affected by the trade agreement, profitability under vertical integration (Z_V) increases more than profitability under foreign outsourcing (Z_O), leading to an increase in FDI. Note that while the total share of firms engaging in vertical integration increases, an improvement in the contractibility of components may have an ambiguous impact on the share of global sourcing through FDI versus outsourcing (i.e. on the fraction of imports that are intra-firm). Intuitively, the latter is confounded by the positive impact that improved institutions in the South via a PTA has on the total number of firms in the North offshoring to the South (the sum of FDI and foreign outsourcing).[10]

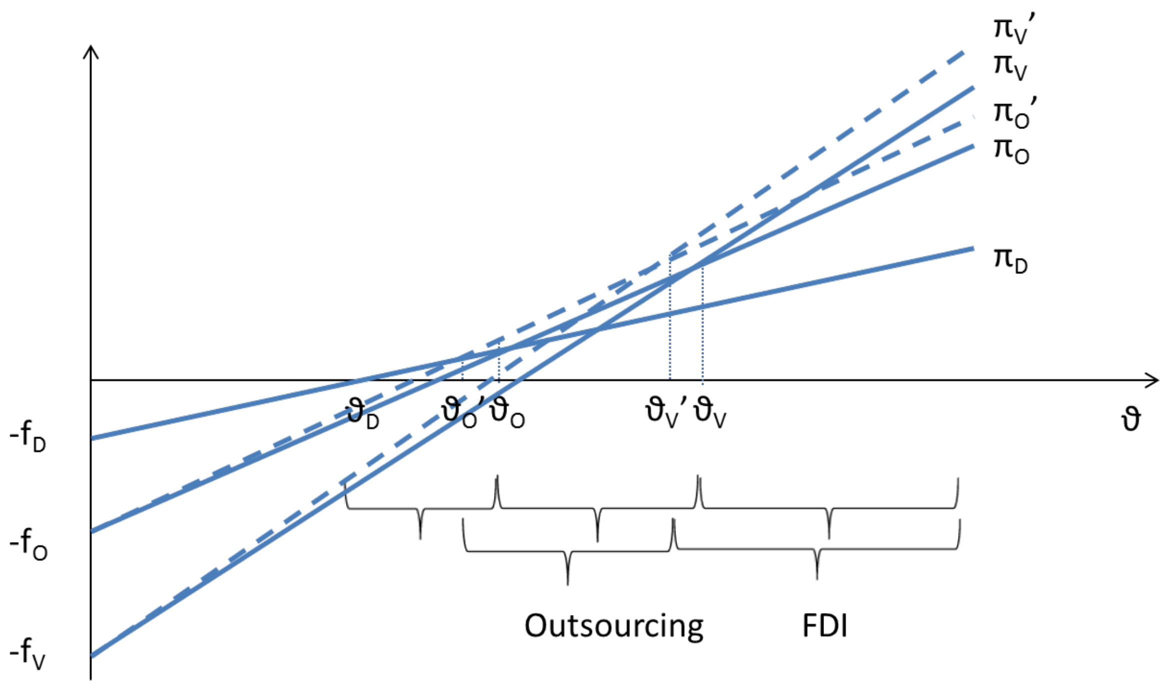

Figure 2.2: Effects of PTA provisions improving contractibility of components ($\uparrow \mu_m$)

[10]This ambiguity has limited the ability of empirical studies to test the predictions of the AH model using trade data (see, Nunn and Trefler [2013]).

Next, we consider the impact on FDI/outsourcing of the provisions in a PTA that improve the contractibility of headquarter services (μ_h). AH show that the share of firms that engage in FDI over the total number of active firms is decreasing in μ_h (Proposition 9(ii)). With better contracting of headquarter activities, under-investment in these services becomes relatively less important, so that a larger share of final good producers value more the incentives that they can provide to component suppliers in the South through outsourcing. The graphical intuition for this case is provided in Figure 2.3. As before, the dashed lines represent profits under a trade agreement, which in this case only contains provisions that affect (or affect disproportionally) the contractibility of headquarter services. The profitability of firms under vertical integration (Z_V) increases less than the profitability under foreign outsourcing (Z_O), leading to a decrease in FDI. As the profitability of firms engaging in domestic sourcing is not affected by the PTA, the figure shows that better contracting institutions for headquarter services in the South increase the number of firms in the North that offshore. This implies that the share of global sourcing through FDI versus outsourcing is unambiguously lower.

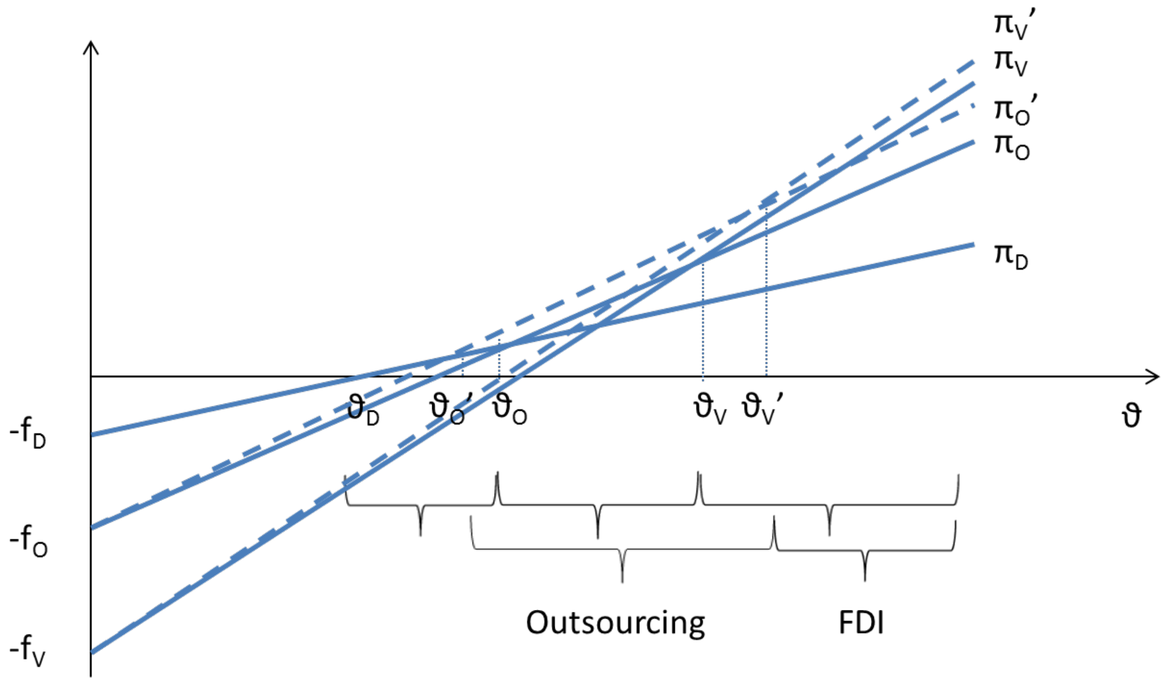

Figure 2.3: Effects of PTA provisions improving contractibility of components ($\uparrow \mu_h$)

Summing up, the AH model has two clear predictions on the relationship between deep trade agreements and firms' global sourcing strategies:

1. PTA provisions improving the contractibility of components (μ_m) are associated with an increase in the share of firms engaging in FDI;

2. PTA provisions improving the contractibility of headquarter services (μ_h) are associated with a decrease in the share of firms engaging in FDI.

In simple words, more than the depth of the agreement, it is its content that affects the choice between vertical integration and foreign outsourcing and that, therefore, will impact on the structure of trade (intra-firm versus arm's length). As others in the literature have recognized (e.g. Baldwin [2011], WTO [2011], Orefice and Rocha [2014]), the depth of a trade agreement is associated to more offshoring. But its relationship with FDI can, in general, be either positive or negative.

Before we move on to the empirical analysis, there are two considerations that concern the specific structure of the model used in this paper. Both considerations have important implications for the empirical strategy that follows. The first relates to an endogeneity problem. In the model, PTA provisions are introduced as exogenous shocks to the institutional environment. However, as a growing literature shows, international trade itself can have an impact on institutional choices, including the decision to sign a trade agreement and the depth and content of such agreement.[11] Specifically, negotiations of deep PTA provisions result from a two-level game, where governments interact strategically with special interests in the domestic arena and with other governments in the international arena, much like the tariff negotiations analyzed in Grossman and Helpman [1995]. In this environment, countries that have stronger FDI relationships may have a greater incentive to introduce in a trade agreement language that facilitates vertical integration. The correlations in Predictions 1 and 2 are still valid, but we need to recognize that the direction of causality may run in both ways, from the content of a trade agreement to the composition of trade and vice versa. We will come back to this point in Section 4.

The second consideration is that Predictions 1 and 2 are specific to the "property rights" theory of the firm Grossman and Hart [1986] underlying the AH model. Importantly, prediction i) stands in contrast to the "transactions cost" approach to the boundary of the firm (Williamson, 1975, 1985), which underpins several studies on the international organization of production (e.g. Grossman and Helpman [2005], and Costinot et al. [2011]. As discussed above, in the property rights approach what matters in the make-or-buy decisions of firms is the relative contractibility of different inputs. This is the deep reason why improvements in the contractibility of components increase FDI: creating incentives for the suppliers of headquarter services through vertical integration becomes a relatively more important problem when PTA disciplines improve the contractibility of components. To the contrary, in the transactions cost approach, vertical integration is an efficient response to any type of contracting difficulties. Therefore, PTA provisions that improve the contractibility of headquarter services and/or components are predicted to always lower FDI and increase outsourcing. The empirical analysis that follows, therefore,

[11] For recent surveys, see Nunn and Trefler [2014] and WTO [2013], chapter C.6.

provides an indirect test of the two theories.

2.3 Data description and methodology

We begin our empirical analysis by describing the data on the depth of trade agreements and on vertical FDI.

2.3.1 Depth and composition of PTAs

Preferential Trade Agreements are usually thought of as bilateral or multilateral agreements that aim at tariff reductions. Recently, the economic literature started to examine in more details the composition of trade agreements, allowing us to distinguish between shallow and deep agreements. Shallow agreements are those agreements that guarantee reciprocal tariff reductions. Instead, following Horn et al. [2010] and WTO [2011], we define deep agreements those that cover multiple provisions beyond tariff measures.[12]

The WTO constructed a dataset on the content of preferential trade agreements that maps the provisions of 100 PTAs signed between 1958 and 2011 that cover more than 90% of world trade.[13] Due to availability of FDI data, we focus on three countries, Germany, Japan, and USA. We are left with 57 mapped agreements, 35 signed by the European Union, 11 by Japan, and 11 by the USA. Table A.1 in the appendix lists all the mapped agreements that we use in our analysis.

In order to conduct quantitative analysis, it is necessary to have a measure of the depth of an agreement. In this we follow the procedure used by Orefice and Rocha [2014]. We quantify depth in three ways. First of all, we count the number of legally enforceable provisions covered in a PTA.[14] The higher the number of provisions in an agreement, the deeper is the agreement. The other two measures of depth are constructed using principal component analysis (PCA).[15] PCA allows us to construct two indexes that contain the provisions with the highest degree of commonality across the spectrum of deep agreements. The *Top5* index includes TRIPS, IPR, countervailing measures, state

[12]Horn et al. [2010] identify up to 52 provisions in US and EU agreements.

[13]The database has been assembled by the Economic Research division of WTO for the World Trade Report 2011, available at http://www.wto.org/english/res_e/publications_e/wtr11_dataset_e.htm

[14]As in Horn et al. [2010] legal enforceability is based on the language used in the agreements. Commitments expressed with a clear, specific and imperative legal language, can more successfully be invoked by a complainant in a dispute settlement proceeding, and therefore are more likely to be legally enforceable. In contrast, not clearly formulated legal language might be related with policy areas that are covered but that might not be legally enforceable.

[15]Principal Component Analysis is a procedure that orthogonally transforms a number of possibly correlated variables into a number of uncorrelated variables called principal components. This transformation is defined in a way such that the first principal component accounts for the highest level of variability in the data.

trading enterprise, and movement of capital provisions, whereas the *Top10* index includes also public procurement, competition policy, anti-dumping, investment, and state aid.

For the second part of the empirical analysis, in order to analyze the relationship between the content of PTAs and FDIs, we distinguish between two types of provisions, namely $h-$ and $m-$provisions, according to whether these provisions are likely to affect headquarter services or the production of parts and components. We think of headquarter activities to be, for example, related to research and development, brand management, innovation, and financial decisions. Therefore, we consider GATS, TRIPS, IPR, investment, and movement of capital as $h-$provisions. On the other hand, the production of parts and components are likely to be affected by standards and custom regulations. Thus we classify SPS, TBT, consumer protection, customs, and export taxes provisions as $m-$provisions.

Table 2.1 below shows the frequencies of each h- and m-provisions in the 57 agreements taken into consideration. The table shows that there is variation in the type of provisions covered in the agreements. For example, only 22 agreements have TBT measures, whereas almost all of them have a provision regarding customs. Figure 2.4 plots the share of agreements that include h- and m-provisions by country. All the agreements signed by the EU contain customs provisions but only 11% of them cover consumer protection. On the other hand, all agreements signed by the US and Japan deal with consumer protection. In addition to consumer protection, provisions regarding GATS and customs are included in all Japanese agreements, whereas all US agreements include TRIPS provisions. The less frequent provision in the agreements signed by Japan is export taxes (45% of agreements), while the less frequent in US agreements are investments, movement of capital, and TBT.

Table 2.1: Frequencies of HQ- and M-provisions in PTAs

HQ-provisions	N. of Agreements	M-provisions	N. of Agreements
GATS	32	SPS	22
TRIPS	43	TBT	24
IPR	39	Consumer protection	26
Investment	31	Customs	56
Movement of capital	41	Export taxes	42

2.3.2 Identification and Measurement of Vertical FDI

In order to quantify FDI we apply the method proposed by Alfaro and Charlton [2009], used also by Lanz and Miroudot [2011], to firm level data obtained from the ORBIS dataset. The Bureau van Dijk collects information about location, ownership, detailed

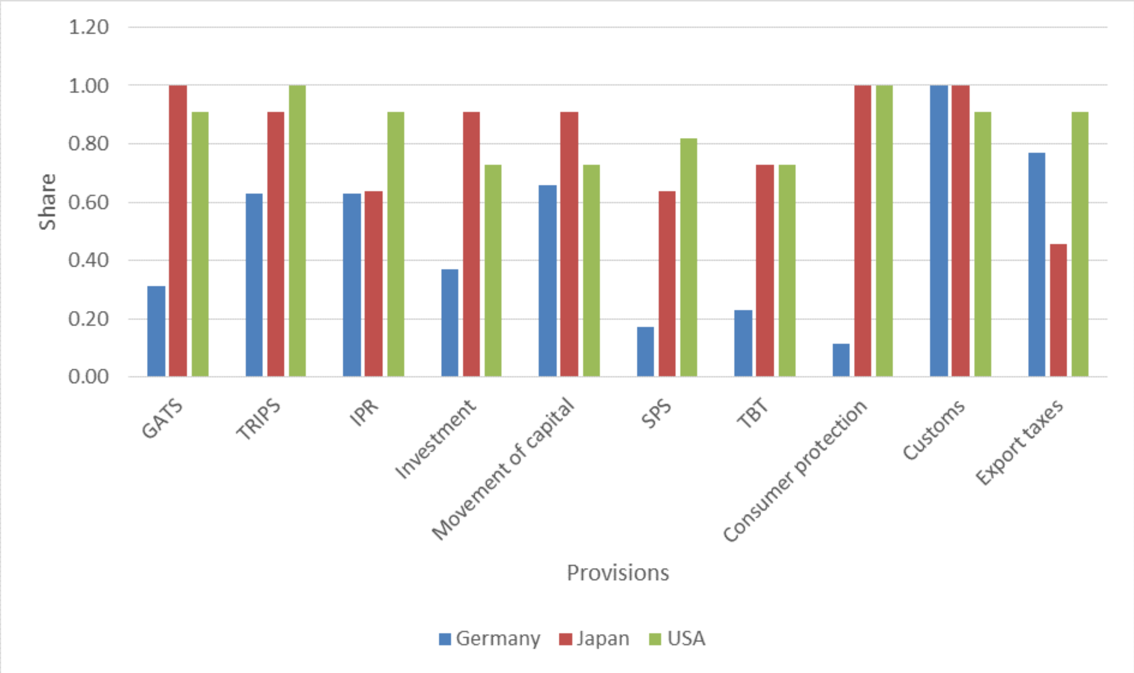

Figure 2.4: Frequency of HQ- and M-provisions in trade agreements by country

sector level, and operational data (e.g. revenues) for more than 100 million firms in Europe, Americas, and Asia-Pacific region.

We restrict our analysis to subsidiaries in any country of the world owned by parent firms located in Germany, Japan, or USA in 2003, 2007, and 2011.[16] ORBIS records the revenues of 125,212 subsidiaries and we can identify 42,984 ultimate owner parents. The definition of ownership provided in the ORBIS database "concerns the minimum percentage that must characterize the path from a subject company up to its ultimate owner" The example in Figure 2.5 illustrates this definition. The numbers between firms represent how much the firm at the bottom of the arrow owns of the firm at the arrowhead. Therefore, considering a path of minimum ownership of 25.01%, the ultimate owner of firm 4 is firm 1, while, considering a path of minimum ownership of 50.01% the ultimate owner of firm 4 is firm 3.[17]

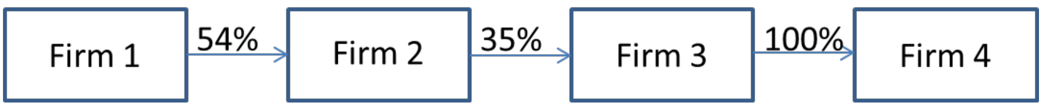

Figure 2.5: ORBIS definition of ownership

The identification of vertical FDIs follows closely Alfaro and Charlton [2009]. Their methodology allows to identify three types of foreign direct investments, namely vertical,

[16]We select firms such that only industrial parent firms are included in our dataset. This is done in order to exclude individuals, government, or financial institutions owners.

[17]These thresholds are the only ones available in ORBIS. In our analysis we use the 25.01% threshold.

horizontal and complex. Simply put, horizontal FDI is an activity of a foreign-owned subsidiary producing in the same NAICS 6-digits sector of the parent firm. Vertical FDI instead arises when the production of the subsidiary is an input for the production done by the parent firm. In Alfaro and Charlton's words, vertical FDI are defined "as the activity of the foreign-owned subsidiaries in industries upstream from the parent industry (according to the US input-output matrix)". If the activity of the subsidiary satisfies both these criteria, then the FDI is defined as complex. The remaining case in which the subsidiary produces in a different sector of the parent which is not an input is classified as non-identified investment.[18]

More formally, the definition of FDIs is based on the intersection of the sets of primary sectors of the parent firm and its subsidiary. Let S be the set of 6-digits NAICS codes of the subsidiary and P be the set of 6-digits NAICS code of the parent. An element x of S is an input of an element z of P ($x \to z$) if the total requirements coefficient of the US-Input-Output (IO) table is bigger than 0.03.[19] Given these definitions, we can formally identify the 4 types of connections between the parent and the subsidiary:

i. Horizontal FDI: if S and P share any element (i.e. if $S \bigcap P \neq \emptyset$);

ii. Vertical FDI: if any element of S is an input of any element of P (i.e. if $\exists x, z$ s.t. $x \to z$ where $x \in S$ and $z \in P$);

iii. Complex FDI: if S and P share any element and any element of S is an input of any element of P (i.e. if $S \bigcap P \neq \emptyset$ and $\exists x, z$ s.t. $x \to z$ where $x \in S$ and $z \in P$);

iv. Non-identified: if none of the above is satisfied.

For each subsidiary and parent we know the unique core industry at 4-digit NAICS 2007 level and a set of 6-digits NAICS primary codes.[20] To identify the link between two firms, we use the sets of primary codes of a subsidiary and its parent. If the two sets intersect and all the sectors of the subsidiary are not inputs of any sector of the parent, then these firms are linked by a horizontal relationship. Instead, if the subsidiary operates in at least a sector that is an input for any sector of the parent, then the firms are in a vertical relationship. If, moreover, the two sets intersect then the FDI is complex.

Table 2.2 summarizes the number of subsidiaries in each FDI category. Around 13 per cent of the subsidiary firms in our data are linked to their parents through a vertical

[18]Non-identified links can also be thought as conglomerates. Indeed, Herger and McCorriston [2013] define relationships between firms that neither share the same industry nor are they linked through the supply chain as conglomerate cross border acquisitions.

[19]The threshold has been chosen following Alfaro and Charlton [2009].

[20]The cardinality of the set of primary codes is not fixed ex-ante. Some firms report only one primary 6-digits code, some subsidiaries provide up to 36 primary codes.

link. A slightly bigger share of subsidiaries, almost 14 per cent, is involved in horizontal FDIs. The majority of firms, 72 per cent, are classified in a non-identified relationship. Comparing our numbers to the reference literature, Lanz and Miroudot [2011] find that in OECD countries 12.8% of total foreign direct investments links are horizontal, 12.9% vertical, 14.8% complex and 59.5% are not identified; in Alfaro and Charlton [2009] the shares are 23%, 25%, 11%, and 41% respectively. A possible explanation of the high share of non-identified links can be the presence of conglomerates. Conglomerates are formed by firms that are neither horizontally related through sharing the same industry nor are they vertically connected through the supply-chain. As Herger and McCorriston [2013] suggest a possible reason behind the formation of conglomerates lies in financial frictions or corporate governance problems such as principal-agent issues between shareholders and management. In fact, they document an increase of conglomerate cross-border acquisitions due to financial diversification needs.

Table 2.2: Distribution of Vertical, Horizontal, and Complex FDI

Type	Number of Subsidiaries	Share
Vertical	25230	13.11
Horizontal	26904	13.98
Complex	776	0.40
Non-identified	139603	72.52

Figure 2.6 below confirms one of the main points made by Alfaro and Charlton [2009]. At a more aggregate level, it is striking to notice that most of subsidiaries and parents that are in a vertical relationship operate in the same core industry. The figure focuses only on parents and subsidiaries both operating in manufacturing sectors for visual clarity; however a similar pattern can be detected even if we include all sectors. This is to illustrate that if we look at an aggregate level we would be detecting a lot less vertical FDI and probably misreport those foreign investments as horizontal FDI.

How do we measure the value of vertical foreign direct investments? Ideally, we would like to have information on intra-firm trade. Unfortunately, these data are not available. We, therefore, quantify foreign direct investment from country i (US, Japan, or Germany) in sector k, at time t as the aggregate value of the revenues of subsidiaries operating in sector k and country (destination) j (FDI_{ijkt}). For example, vertical FDIs of the automobile sector in the US are the sum of revenues of all the US-owned subsidiaries that produce car inputs, such as plastic, seat-belts, glass, and so on, in a foreign country.[21]

[21]Despite the fact that there is no availability of intra-firm trade data in the ORBIS database, total revenues of vertically integrated subsidiaries are a good proxy for it. In fact, the correlation between our data on vertical FDI and related party trade from the Bureau of Economic Analysis is 0.69.

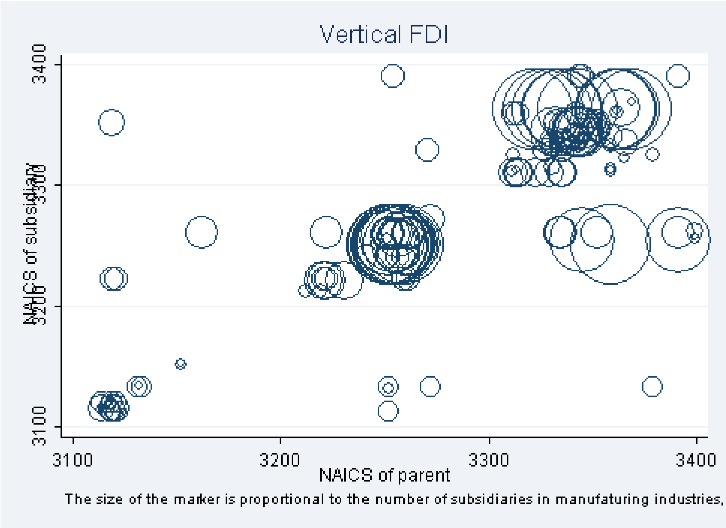

Figure 2.6: Vertical FDI

It is important to note here the difference with the measure of FDI in Alfaro and Charlton [2009]. In fact, as a measure of FDI, they use the value of sales aggregated at the sector of the subsidiaries. While their approach measures the value of FDI done in an industry, our way of aggregating firms' revenues allows us to evaluate the amount of FDI done by an industry. Following the previous example, they look at the total value of sales of all the firms in the plastic, seat-belts, or glass sector. On the contrary, since we are interested in the reasons why firms in a particular sector do more FDI, we aggregate revenues at the sector of the lead firm. In other words, instead of looking at the total amount of FDI done by firms in the car industry and wine sector in the production of glass, we focus on the amount of FDI done by firms in the cars (or wine) industry in all sectors that produce the inputs needed to produce cars (or wine).

2.4 Empirical findings

This section presents the results of our empirical analysis. First of all we show that deeper integration has a positive effect on vertical FDI. Then, we go a step further and illustrate the main finding that particular provisions in a trade agreement are related to FDIs in different ways. In particular, we show that m-provisions are positively related to vertical FDI.

2.4.1 PTA Depth and Vertical FDI

Before providing empirical evidence of the heterogeneous correlation between vertical foreign direct investments and different sets of provisions, we look at whether and how deeper agreements attract more FDIs. This is the first step in the investigation of the relationship between deep PTAs and the internationalization of production. In order to do this, we report OLS and IV coefficients of regressions of FDIs on depth and a series of controls. Table 3 reports the estimated OLS coefficients of the following regression:

$$\begin{aligned} FDI_{ijkt} = & \alpha + \beta_1 DEPTH_{ijt} + \beta_2 INSTITUTIONS_{jt} + \beta_3 \log(Tariff)_{ijkt} + \\ & + \gamma_1 X_{jt} + \gamma_2 X_{ij} + \delta_t + \delta_k + \delta_i + \delta_{it} + \epsilon_{ijkt} \end{aligned} \tag{2.1}$$

where k is the parent's sector, t is time, i and j are country indexes (i for the "origin" country and j for the "destination" country). As we already mentioned above, our dependent variable, FDI_{ijkt}, is the log of the value of the revenues of all subsidiaries in a particular sector k. In the regressions that follow we consider only positive values of FDI, focusing therefore only on the intensive margin.

$DEPTH_{ijt}$ is a variable that captures the depth of the agreements. More precisely, it can be a dummy equal to one if there is a PTA, the number of provisions included in the PTA, or the log of one of the two indexes constructed using the principal component analysis previously described. Institutions are captured by the variable Rule of Law from the Worldwide Governance Indicator database. We also control for the level of tariffs imposed by the origin country (Germany, Japan and the US) on imports of product k. This is to isolate the effect of a PTA beyond its impact on tariff barriers. X_{jt} is a vector of controls for characteristics of the destination country that vary over time. It includes GDP, GDP per capita, a dummy for bilateral investment treaties (BITs), and remoteness.[22] X_{ij} are country-pair variables such as geographical distance, contiguity, common language, colonial relationship.

Finally, δ_t, δ_k, δ_i, δ_{it} are time, sector, country (origin), and country-time fixed effect respectively. It is important to notice that the industry fixed effects δ_k are at the 4-digits NAICS, a more aggregate level with respect to the 6-digits level of disaggregation of FDI. This is done in order to be able to include a variable that captures the level of headquarter intensity of the sector. We measure η as the ratio between total capital expenditures and total wage at the industry level using data from the Annual Survey of Manufactures in 2007 provided by the U.S. Census Bureau and we introduce a dummy equal to one if η is above the average in the regressions.[23]

Country of origin fixed effects, i.e. dummies for Germany, Japan, and USA, are included in order to control for time-invariant characteristics of the country where the lead firm operates. Country-time fixed effects are used to control for time variant country specific variables such as domestic policies that might affect the location and control

[22] Remoteness is constructed following Head [2003] and Freund and Rocha [2010]: $Remote_{jt} = \frac{1}{\sum_{s \neq j}^{S} GDP_{st}/Dist_{js}}$ where S is the set of all countries in the world.

[23] The same data from the ASM have been used in Nunn and Trefler [2013] where they examine the importance of the relative contractibility of headquarter services and supplier inputs.

decisions of parent firms. Thus the set of fixed effects used should allow us to partially control for potential omitted variables at the year, country, country-year, and industry level. In all regressions included in the following tables, standard errors are clustered at the 6-digits sector level.

The results in column 1 of Table 2.3 show that having a trade agreement is associated with a higher level of FDIs. Signing a trade agreement corresponds to an increase in FDI of 77 percent. Also depth is positively associated with foreign direct investment. Columns from 2 to 4 report the coefficients for different measures of depth, namely the number of provisions, *Top5*, and *Top10* indexes. In particular, column 2 shows that including one additional provision in the agreement is associated with an increase in FDI of 1.85%. Since the indexes *Top5* and *Top10* are in logs, an increase of one per cent in the index is associated with an increase of 0.57 and 0.51 per cent respectively.

The other coefficients reported in the table show that capital intensive sectors are more likely to be vertically integrated, as predicted by the theory. Finally, better domestic institutions, using rule of law as a proxy, are positively correlated with our variable of interest. Results not reported in the table show that the coefficients of GDP, common language, and the dummy for China are positive and significant. On the other hand, contiguity is negatively correlated with vertical FDIs. The coefficients of all the other variables, namely distance, GDP per capita, colonial relationship, and remoteness are not statistically different from zero. The correlation between BITs and FDIs is worth further comments. Bilateral investment treaties are usually thought to be an important channel through which countries can attract foreign direct investment. However, the empirical literature on the topic is inconclusive. In particular, a recent paper by Baker [2012] shows that BITs had a positive impact on FDIs until the mid-1990s.[24] In line with this result, the coefficient of the BIT dummy in our regressions is not significant.

So far we have said nothing about the direction of causality. The control decisions of firms are expected to respond to the depth of PTAs, but firms may lobby for deeper integration. Moreover, countries tend to sign similar agreements in order to avoid potential trade diversion. We deal with this potential endogeneity issue by using an instrumental variable approach. More precisely, we instrument PTA depth between country i and country j with the weighted average depth of all the agreements signed by i and j with any other country excluding the agreement between i and j. This type of instrumental variable approach has already been used in the literature (see, for instance, Orefice and Rocha [2014]).

For example, to instrument the depth of the agreement US-Peru we use the average depth of the agreements signed by Peru with all other countries excluding the US and the agreements signed by the US with all other countries excluding Peru. Each agreement of

[24]See also the discussion about the literature on BITs and FDIs in Baker [2012].

Table 2.3: Vertical FDI and Deep Integration

	FDI (log of revenues in 1000$)			
	(1)	(2)	(3)	(4)
PTA	0.573**			
	(0.227)			
N. of Provisions		0.0185***		
		(0.00662)		
log(Top 5)			0.572*	
			(0.304)	
log(Top 10)				0.508**
				(0.225)
Rule of Law	0.319**	0.295**	0.292**	0.300**
	(0.124)	(0.121)	(0.122)	(0.123)
Tariff (log)	0.0420	-0.0588	-0.0110	-0.00303
	(0.235)	(0.236)	(0.231)	(0.231)
Dummy=1 if η >avg	0.779***	0.775***	0.777***	0.777***
	(0.280)	(0.281)	(0.280)	(0.280)
Observations	4,816	4,777	4,777	4,777
R-squared	0.244	0.240	0.239	0.239
Year FE	Yes	Yes	Yes	Yes
Industry-4dig FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes

Country and country-year fixed effects are referred to the country of the parent firm. All regressions control for distance, contiguity, colony relationship, common language, BIT, a dummy for China, GDP, GDP per capita, and remoteness of the country of the subsidiary. Robust standard errors in parentheses are clustered at the 6 digits NAICS level.

*** p<0.01, ** p<0.05, * p<0.1

Peru (USA) is weighted with an index of similarity between Peru (USA) and its partner. More formally, if we define as the set S of all countries excluding country i and j, the instrument is constructed as follows:

$$DEPTH_{ijt}^{IV} = \frac{\sum_{s \in S} w_{ist} DEPTH_{ist} + \sum_{s \in S} w_{jst} DEPTH_{jst}}{N_{it} + N_{jt}}$$

where N_{it} is the number of mapped agreements of country i in year t excluding the agreement with j, N_{jt} is the number of mapped agreements signed by country j in year t t excluding the agreement with i and w_{ist} and w_{jst} are weights that takes into account the GDP similarity between country i and s and between country j and s in time t.[25]

The rationale of this instrument comes from the domino effect theory of PTA first introduced by Baldwin and Jaimovich [2010]. If a pair of countries signs an agreement to increase FDIs, then a third country would like to sign a similar agreement to avoid investments diversion. We expect that the higher the level of integration between a country j and its partners, the higher the probability that country i will sign a PTA of similar depth with j to avoid trade diversion effects.[26] [27]

Table 2.4 reports the results of 2-SLS regressions.[28] The coefficients of all our measures of depth remain positive and significant suggesting that deeper integration is an important factor that drives the make-or-buy decision of firms.

The main message of this section is that deeper agreements matter for the decision of firms to vertically integrate in a foreign country. However, what the model suggests is that different provisions, affecting the contractibility of different types of input in the production process, are correlated with vertical FDIs. We examine this central issue in the next subsection.

2.4.2 Content of PTAs and Vertical FDI

The model outlined in section 2 has two clear predictions: i) PTA provisions improving the contractibility of components (μ_m) are associated with an increase in vertical FDI, and ii) PTA provisions improving the contractibility of headquarter services (μ_h) are associated

[25]More precisely: $w_{pst} = log\left(1 - \left(\frac{GDP_{pt}}{GDP_{pt}+GDP_{st}}\right)^2 - \left(\frac{GDP_{st}}{GDP_{pt}+GDP_{st}}\right)^2\right)$ for $p \in \{i, j\}$.

[26]A similar argument has been provided by Chen and Joshi [2010]. In a three-country theoretical model the authors highlight the importance of third-country effects in the formation of new PTAs. They examine how the incentives of a county pair to enter into a PTA with each other vary depending on whether the two countries already have existing PTAs with the third country.

[27]Potential direct effects of agreements with third parties are reduced by the system of weights that we use in the construction of the instrument. For example, for the agreement between the US and Peru, higher weights are given to agreements between Peru and other similar developing countries and to agreements between the US and other developed countries.

[28]The results of the first stage regressions are in the annex table XX.

Table 2.4: Vertical FDI and Deep Integration

	(1)	(2)	(3)	(4)
	FDI (log of revenues in 1000$)			
PTA	1.229***			
	(0.318)			
N. of Provisions		0.0558***		
		(0.0102)		
log(Top 5)			2.351***	
			(0.465)	
log(Top 10)				1.538***
				(0.296)
Rule of Law	0.382***	0.370***	0.389***	0.389***
	(0.123)	(0.126)	(0.125)	(0.125)
Tariff (log)	0.106	-0.133	0.0266	0.0389
	(0.210)	(0.233)	(0.220)	(0.220)
Dummy=1 if η >avg	0.773***	0.754***	0.752***	0.759***
	(0.277)	(0.284)	(0.282)	(0.281)
Observations	4,816	4,692	4,692	4,692
R-squared	0.240	0.232	0.229	0.233
Year FE	Yes	Yes	Yes	Yes
Industry-4dig FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes

Country and country-year fixed effects are referred to the country of the parent firm. All regressions control for distance, contiguity, colony relationship, common language, BIT, a dummy for China, GDP, GDP per capita, and remoteness of the country of the subsidiary. Robust standard errors in parentheses are clustered at the 6 digits NAICS level.

*** p<0.01, ** p<0.05, * p<0.1

with a decrease in vertical FDI. In simple words, it is the type of provisions included in a PTA that affects the choice between vertical integration and foreign outsourcing.

We divide provisions into two categories. The first set contains provisions that improve contractibility of headquarter services or h-provisions (i.e. the ones that improve μ_h). We include in this set GATS, TRIPS, IPR, investment, and movement of capital. The second set comprises PTA provisions that include the contractibility of components or m-provisions (i.e. the ones that improve μ_m). In this group we include measures that relate to SPS, TBT, consumer protection, customs, and export taxes.

Once we have distinguished the two types of provisions, we construct indexes, μ_h and μ_m, that measure how much an agreement is directed towards the improvement of the contractibility of headquarter services and intermediate inputs. We construct these indexes in two alternative ways. First of all, we create a dummy μ_ω that is equal to one if there is at least one provision of the ω-type in the PTA, where $\omega = h, m$. Alternatively, we use a discrete variable constructed as follows:

$$Discrete\mu_\omega = \begin{cases} 2 & \text{if all provisions of } \omega\text{-type in PTA} \\ 1 & \text{if at least one provision of } \omega\text{-type} \\ 0 & \text{otherwise} \end{cases}$$

Table 2.5 reports the estimated OLS coefficients of the following regression:

$$\begin{aligned} FDI_{ijkt} =& \alpha + \beta_1 \mu_{h,ijt} + \beta_2 \mu_{m,ijt} + \beta_3 DEPTH_{ijt} + \beta_4 INSTITUTIONS_{jt} + \\ &+ \beta_3 \log(Tariff)_{ijkt} + \gamma_1 X_{jt} + \gamma_2 X_{ij} + \delta_t + \delta_k + \delta_i + \delta_{it} + \epsilon_{ijkt} \end{aligned} \tag{2.2}$$

Columns from 1 to 3 show the results when we use the dummy variables constructed as we described above. The last three columns instead report the OLS coefficients when we include the discrete variable above. We include in each regression the number of provisions covered in a PTA in order to detect whether depth per-se is still correlated with vertical FDIs once we consider the composition of the agreements. All the other variables and fixed effects included in the regressions are identical to the ones described in the previous subsection. We control, in fact, for rule of law, GDP, GDP per capita, contiguity, distance, colonial relationship, common language, a dummy for China, remoteness, and BITs. In order to deal with potential omitted variables, we also include year, country of origin, year-country, and industry fixed effects. The only difference with respect to the regressions in section 4.1 is the disaggregation of the industry fixed effects. In fact, we now use 6-digits NAICS industry fixed effects. As a consequence of this, we cannot include anymore the variable that captures the capital intensity of an industry.[29]

[29] As a robustness check, we also run the regressions with industry fixed effects aggregated at the 4-digits level. Results are in line with the ones reported in the table and capital intensive sectors are more likely to engage in FDIs.

Table 2.5: Vertical FDI and the content of PTAs

	FDI (log of revenues in 1000$)					
	(1)	(2)	(3)	(4)	(5)	(6)
Dummy $\mu_h = 1$ if at least one HQ provision	0.399		-0.943*			
	(0.424)		(0.515)			
Dummy $\mu\_m = 1$ if at least one M provision		0.751**	1.479***			
		(0.374)	(0.457)			
Discrete μ_h				0.106		-0.0254
				(0.244)		(0.233)
Discrete μ_m					0.561**	0.570***
					(0.230)	(0.213)
N. of Provisions	0.00659	-0.00215	0.00783	0.0128	0.00162	0.00303
	(0.0150)	(0.0115)	(0.0148)	(0.0177)	(0.00832)	(0.0184)
Rule of Law	0.235**	0.255**	0.263**	0.230**	0.272**	0.272**
	(0.107)	(0.109)	(0.108)	(0.106)	(0.109)	(0.109)
Tariff (log)	-0.131	-0.0700	-0.0743	-0.154	-0.112	-0.116
	(0.224)	(0.227)	(0.231)	(0.231)	(0.216)	(0.237)
Observations	6,888	6,888	6,888	6,888	6,888	6,888
R-squared	0.333	0.334	0.334	0.333	0.334	0.334
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Country and country-year fixed effects are referred to the country of the parent firm. All regressions control for distance, contiguity, colony relationship, common language, BIT, a dummy for China, GDP, GDP per capita, and remoteness of the country of the subsidiary. Robust standard errors in parentheses are clustered at the 6 digits NAICS level.

*** p<0.01, ** p<0.05, * p<0.1

According to what is predicted by the theory, the results in the table show that, once we look more in detail the composition of agreements and we consider separately different sets of provisions, h- and m-provisions are related to FDIs in different ways. The variables that capture the presence of provisions that improve the contractibility of inputs always have a positive and significant coefficient. As to headquarter provisions, instead, the correlation is absent in most of the specifications. There is a negative and statistically significant coefficient only in column 3, where we include both the dummies μ_h and μ_m. The results in column 6 suggest that only provisions that improve the contractibility of components are positive related to vertical FDIs. Including at least one provision in the agreement or moving from an agreement with some provision to one with all m-provisions increases FDI by 77 percent.

These results confirm the predictions of the "property rights" model: the composition of PTAs and different sets of provisions included in an agreement are related to FDIs in different ways. The intuition behind the result is that m-provisions improve the contractibility of components in the country where the investment is made. Hence, under-investment by the supplier of inputs is less likely. Therefore, final goods producers (i.e. the providers of headquarter activities) have to be incentivized more through a higher share of surplus. Vertical integration is thus more attractive. A specular intuition holds for the relationship between the improvement of the contractibility of headquarter inputs through h-provisions but the empirical results do not support this implication of the model in a consistent manner.

Moreover, it is important to notice that once we go into the details of the composition of PTAs, deeper integration per-se is not anymore correlated with the organizational decisions of firms. This was expected since the theory predicts that deeper agreements are related to more offshoring but it does not provide any clear prediction about the relationship with vertical FDIs.

Regarding unreported coefficients, only GDP, common language, and colonial relationship present a positive correlation with FDIs; on the other hand, contiguity is, in some cases, negatively correlated with vertical FDIs. Finally, as before, BITs seem not to be correlated with foreign direct investments.

So far, we simply looked at the correlation between μ's and vertical FDIs. The model does not have clear predictions on the direction of causality.

Table 2.6 reports the results of 2-SLS regressions using an instrument constructed similarly to the instrument for the depth of agreements.[30] More precisely our instrument for the content of PTAs is the weighted average μ of all the agreements signed by i and j with any other country excluding the agreement between i and j. As before, the weight of each agreement w_{ijt} is a weight that takes into account the GDP similarity between

[30] The results of the first stage regressions are in the annex table A3.

country i and j in time t. The coefficients of μ_m remain positive and significant in each specification. The coefficient of μ_h, instead is not significant and it has the expected sign only when we use the discrete variable.

Table 2.6: Vertical FDIs and content of PTAs: 2-SLS results

	FDI (log of revenues in 1000$)					
	(1)	(2)	(3)	(4)	(5)	(6)
Dummy μ_h = 1 if at least one HQ provision	2.131***		-2.388			
	(0.491)		(1.606)			
Dummy μ_m = 1 if at least one M provision		2.452***	4.551***			
		(0.431)	(1.415)			
Discrete μ_h				-2.184***		-0.342
				(0.661)		(0.411)
Discrete μ_m					2.106***	2.493***
					(0.371)	(0.378)
N. of Provisions	-0.0357*	-0.0487***	-0.0367*	0.228***	-0.0351**	-0.0244
	(0.0202)	(0.0174)	(0.0204)	(0.0573)	(0.0152)	(0.0248)
Rule of Law	0.323***	0.348***	0.363***	0.281**	0.441***	0.462***
	(0.107)	(0.107)	(0.106)	(0.113)	(0.114)	(0.109)
logtariff	0.0465	0.176	0.212	-0.768**	0.0476	0.0195
	(0.196)	(0.208)	(0.215)	(0.347)	(0.212)	(0.230)
Observations	6,764	6,764	6,764	6,764	6,764	6,764
R-squared	0.326	0.328	0.325	0.279	0.323	0.319
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Country and country-year fixed effects are referred to the country of the parent firm. All regressions control for distance, contiguity, colony relationship, common language, BIT, a dummy for China, GDP, GDP per capita, and remoteness of the country of the subsidiary. Robust standard errors in parentheses are clustered at the 6 digits NAICS level.
*** p<0.01, ** p<0.05, * p<0.1

2.5 Conclusion

We use the AH model to guide our analysis of the relationship between deep trade agreements and the international organization of production. Then we test the theory by combining a new dataset on the depth and content of PTAs and a measure of vertical FDI derived from detailed sector-level information for more than one million firms worldwide.

Consistently with the theory, we establish two main findings. First, deep trade agreements are associated to an increase in FDI. Second, PTA provisions that improve the contractibility of components relative to headquarter services are associated to more FDI. However, once we look at the content of PTAs, deep integration is not associated to more vertical FDIs anymore. In other words, it is the content more than the depth of PTAs that affects the way goods are traded internationally -i.e. within-firms or at arm's length. As this result is consistent with the "property rights" approach to the boundaries of multinational firms, but not with the "transaction cost" theory, it provides evidence in support of the first approach.

A Appendix

Table A.1: Complete list of agreements

Germany (EU)		USA	
Agreement	Entry into force	Agreement	Entry into force
EC Treaty	1958	US-Israel	1985
EC-Overseas Territories	1971	NAFTA	1991
EU-Overseas Countries and Territories	1971	US-Jordan	2001
EC-Iceland	1973	US-Chile	2004
EC-Norway	1973	US-Singapore	2004
EC-Switzerland Liechtenstein	1973	US-Australia	2005
EC-Syria	1977	US-Bahrain	2006
EC Enlargement (12)	1986	US-Morocco	2006
EEA	1994	CAFTA-DR	2006
EC Enlargement (15)	1995	US-Oman	2009
EC-Turkey	1996	US-Peru	2009
EC-Faeroe Islands	1997		
EC-Palestinian Authority	1997	Japan	
EC-Tunisia	1998	Japan-Singapore	2002
EC-Israel	2000	Japan-Mexico	2005
EC-Mexico	2000	Japan-Malaysia	2006
EC-Morocco	2000	Chile-Japan	2007
EC-South Africa	2000	Japan-Thailand	2007
EC-FYR Macedonia	2001	Japan-ASEAN	2008
EC-Croatia	2002	Japan-Indonesia	2008
EC-Jordan	2002	Japan-Philippines	2008
EU-San Marino	2002	Japan-Switzerland	2009
EC-Chile	2003	Japan-Viet Nam	2009
EC-Lebanon	2003	India-Japan	2011
EC Enlargement (25)	2004		
EC-Egypt	2004		
EC-Algeria	2005		
EC-Albania	2006		
EC Enlargement (27)	2007		
EC-Bosnia Herzegovina	2008		
EC-CARIFORUM	2008		
EC-Montenegro	2008		
EC-Cameroon	2009		
EC-Côte d'Ivoire	2009		
EU-Serbia	2010		

Table A.2: Vertical FDI and Deep Integration: First stage

	PTA	N. of Provisions	log(Top 5)	log(Top 10)
	(1)	(2)	(3)	(4)
PTA IV	0.017***			
	(0.0005)			
N. of Prov IV		6.877***		
		(0.348)		
Top 5 IV			3.551	
			(0.221)	
Top 10 IV				3.242
				(0.189)
F-stat (p-value)	0.000	0.000	0.000	0.000
Observations	4,816	4,777	4,777	4,777

Robust standard errors in parentheses are clustered at the 6 digits NAICS level.
*** p<0.01, ** p<0.05, * p<0.1

Table A.3: Vertical FDIs and content of PTAs: First stage

	Dummy μ_h	Dummy μ_m	Dummy μ_h	Discrete μ_h	Discrete μ_h	Discrete μ_h
	(1)	(2)	(3)	(4)	(5)	(6)
Dummy μ_h	4.584***		-19.995***			
	(1.755)		(4.537)			
Dummy μ_m		5.110***	21.482***			
		(1.184)	(3.359)			
Discrete μ_h				-20.101***		-19.224***
				(1.916)		(1.958)
Discrete μ_m					3.208**	13.990***
					(1.133)	(2.211)
F-stat (p-value)	0.000	0.000	0.000	0.000	0.000	0.000
			Dummy μ_m			Discrete μ_m
Dummy μ_h			-8.997**			
			(3.950)			
Dummy μ_m			12.060***			
			(2.517)			
Discrete μ_h						-2.451**
						(1.084)
Discrete μ_m						3.067**
						(1.115)
F-stat (p-value)			0.000			0.000
Observations	6,764	6,764	6,764	6,764	6,764	6,764

Robust standard errors in parentheses are clustered at the 6 digits NAICS level.
*** p<0.01, ** p<0.05, * p<0.1

Chapter 3

Institutions and Firms' Organization: Asymmetric Effects of Trade on Productivity and Welfare

joint with Matteo Fiorini (EUI) and Mathilde Lebrand (EUI)

3.1 Introduction

The reallocation of resources across firms and sectors is a key factor for the economic development of a country. Theoretical papers such as Melitz [2003] and Bernard et al. [2007] and empirical studies such as Pavcnik [2002] and Trefler [2004] have shown that trade liberalization has a positive effect on aggregate productivity and it induces the reallocation of resources towards the most productive firms.[1] Some recent papers, however, provide evidence that these benefits depend on the existence of other non-trade distortions (see for example Freund and Bolaky [2008], Chang et al. [2009] and DeJong and Ripoll [2006]). These distortions, such as barriers to entry, financial constraints, or poor legal and political institutions, particularly affect developing countries and hamper their development.

Starting from the results of Melitz [2003] and Bernard et al. [2007], we develop a new channel that leads to distinctive results in terms of aggregate productivity and welfare. We propose a novel mechanism in which institutional distortions adversely affect the gains from trade. In particular the degree of difference in institutional quality between countries leads them to different specializations and creates asymmetric effects on productivity and welfare. This channel helps explaining how institutional distortions prevent countries, especially those with poor institutions, to benefit from the gains of trade described in the literature.

This paper focuses on differences in business-related institutions, such as contract enforcement, as an important source of comparative advantage (Levchenko [2007], Nunn [2007], Costinot [2009]). Institutional obstacles to doing business affect the firms' choice of production, e.g. which good to produce and the organization of its production. At the country level, the quality of institutions affects how resources are allocated and used across sectors and therefore, at an international level, triggers the pattern of comparative advantage. In particular, countries with better institutions specialize in the production of more complex goods, while countries with weaker institutions specialize in simple industries. Adding a source of comparative advantage in a monopolistic framework with heterogeneous firms allows us to characterize the asymmetric effects of trade on productivity and welfare for different frameworks (intra- versus inter-industry trade).

Our model has two innovative predictions on the effects of trade liberalization on aggregate productivity and welfare. First, it confirms a positive effect of trade on aggregate productivity in the country with good institutions, but it unveils a negative effect in the country with weaker institutions, especially when the difference in institutions is very high and trade mainly happens across industries. This prediction results from the reallocation of resources triggered by both the specialization of a country and the endogenous production choices of firms. In fact, after liberalization, resources are reallocated from

[1] See also the detailed discussion that can be found in Harrison and Rodríguez-Clare [2010].

the comparative disadvantaged sector towards the comparative advantage sector. In addition, since the most productive firms always choose to produce the more complex good, in the country with good institutions resources are attracted by more productive firms and aggregate productivity goes up. The opposite happens in the country with weak institutions: the most productive firms, being in the comparative disadvantage sector, release resources that are then absorbed by less productive firms. As a consequence of the expansion of the simple sector, new unproductive firms might even start producing. The country with weak institutions would thus see its resources be reallocated to the simple sector where less productive firms operate. This is part of the novel mechanism of our paper. Finally, the asymmetric effect on aggregate productivity is stronger and leads to a decline in aggregate productivity when the institutional difference between the countries, and thus the forces behind the reallocation of resources, are larger.

The second prediction has to do with how trade liberalization affects welfare through prices. In our model, a large difference in institutions is shown to increase the aggregate price and decrease consumers' welfare in the country with good institutions. The intuition is the following. In a monopolistic framework, consumers value diversity and consume all available goods. After trade liberalization, consumers from the country with good institutions have now access to and consume varieties produced in the other country. Since the other country has weaker institutions, the marginal costs of firms producing in this country are relatively higher and therefore their goods are relatively more expensive. In addition, in the presence of the negative effect of trade on aggregate productivity that we described above, the adverse effect of trade on prices and thus on welfare is amplified.

The two new results of our paper are achieved thanks to the introduction of two novelties in the theoretical framework, namely the firm's organization that reflect how heterogeneous producers adapt to their local institutional environment and the endogenous choice of the sector by final producers. As to the first novelty, while relying on Costinot [2009] to model the firm's level impact of contract enforcement on organization, we introduce heterogeneous firms and take into account the impact of contract enforcement on aggregate productivity through the reallocation of resources. Firms optimally choose their horizontal degree of fragmentation by dividing the provision of their intermediate inputs among different suppliers.[2] The key trade-off comes from the gains and the costs of specialization. The gains are due to a fixed learning cost for each intermediate inputs to be supplied, and the costs from the probability that a supplier does not provide its subset of intermediate inputs. This probability ultimately depends on institutions: better contract enforcement implies a higher probability that the supplier provides the intermediate inputs. This trade-off defines a marginal cost of production that depends on the productivity of each producer, the complexity of the good and the quality of contract

[2]In a different set up, also Conconi et al. [2012] examine how trade liberalization affects the organizational structure of firms.

enforcement.

Second, we build an original framework in which final producers endogenously choose their sector. Our approach differs from Bernard et al. [2007] where firms are directly assigned to a sector and only decide whether to produce or not. In our model, producers choose their sector depending on their marginal cost of production and the aggregate prices. The marginal cost of production in a sector depends on the idiosyncratic productivity of each producer and the quality of contract enforcement that determines its endogenous organization. Aggregate prices depend on the role of institutions in determining comparative advantages in the presence of heterogeneous firms. In line with Costinot [2009] we show that the country with the best institutions has a comparative advantage in the complex goods that require a high number of intermediates. In this framework, the most productive firms are shown to always choose to produce the complex good for all level of contract enforcement. In contrast with Bernard et al. [2007] who find positive effects of trade on aggregate productivity for all possible cases, our model shows that introducing this endogenous choice might lead countries with weak institutions to lose in terms of productivity and welfare from trade liberalization.

The outline of the paper is as follows. After describing some stylized facts about trade and productivity, we detail the equilibrium in autarky and the organizational choices of a firm. Then, we open to trade and focus on the free-trade case that gives us most of the results of the paper. We provide a series of simulations that give interesting results on production patterns, profits, and trade composition. Finally we discuss the extension of the equilibrium under costly trade which delivers similar qualitative results. The final section concludes.

3.2 Trade and productivity: stylized facts

Some recent works have provided evidence that benefits from trade depend on the existence and the degree of other non-trade distortions and the feasibility of removing them. For example, Freund and Bolaky [2008] show that business regulation is an important complementary policy to trade liberalization. Their empirical analysis show that in countries with low barriers to entry there is a positive relationship between openness to trade and growth whereas in regulated economies the relationship is negative. Chang et al. [2009] provide evidence that, in addition to barriers to entry, also infrastructure development and labor market flexibility are crucial to enhance the growth effects of openness. [3] Our paper adds to this literature by constructing a framework in which business related institutions are crucial in the determination of gains from trade.

[3] DeJong and Ripoll [2006] find a positive relationship between tariffs and growth rates for the world's poorest countries, but a negative relationship for rich countries.

We explore how trade can affect economic performance and growth through its direct effect on productivity. Our model predicts that opening to trade can adversely affect the aggregate productivity in a country with weak institutions. Evidence of this negative effect of trade can be found in two recent papers and the case study illustrated below. Lu [2010] embeds the one-sector Melitz [2003] model into a comparative advantage framework and shows that in sectors where China has a comparative advantage, Chinese exporters were on average less productive than firms serving only the domestic market. Using Chinese data, Fan et al. [2011] show that the number of exporters and the share of exporting revenues are positively correlated with tariff in sectors with a comparative disadvantage.

A recent liberalization episode among Commonwealth of Independent States (CIS) countries represents a good example of how institutional quality affects the gains from trade liberalization. The idea of a free trade area among CIS the emerged already right after the break up of the Soviet Union in 1991. Twenty years later, in October 2011, Russia, Ukraine, Belarus, Kazakhstan, Kyrgyzstan, Tajikistan, Moldova and Armenia signed a Treaty on a Free Trade Area between members of the Commonwealth of Independent States (CIS-FTA). The agreement was enforced starting from September 2012. The CIS-FTA simplified the network of trade relationship between CIS by replacing existing bilateral and multilateral trade agreements and effectively eliminated export and import duties on a host of goods.[4]

Export data from COMTRADE in figure 3.1 show that ex-Soviet countries are well integrated among each other: a part from Russia, between one fifth and more than half of the exports of CIS is directed towards other countries in the group. Moreover, figure 3.1 shows that intra-CIS exports increased for almost all countries in the period 2012-2013 after the entry into force of the CIS-FTA. The CIS-FTA thus represents a liberalization event that we can use to analyze the effects across industries of an increase in trade. Finally, the figure shows that countries like Armenia and Kyrgyzstan export mainly simple goods such as food and wearing apparel whereas Belarus and Russia export complex goods such as refined petroleum products and chemicals to other CIS countries.[5] The quality of institutions is a potential source of this pattern of specialization.

The historical experience and data from the World Bank suggest that business-friendly institutions are likely to be an important issue in CIS. The Doing Business database provides information about the quality of business related institutions for all countries in the World. Table 3.1 shows the quality of contract enforcement in the countries involved in the CIS-FTA.[6] Among this sample of countries, Belarus has the best contract enforcement

[4]Exemptions are included in the agreement but they will ultimately be phased out.

[5]Simple (complex) industries are industry with complexity below (above) the median. Details about the complexity of industries are reported in Appendix A.

[6]As defined in the dataset, contract enforcement assesses the efficiency of the judicial system by following the evolution of a commercial sale dispute over the quality of goods and tracking the time,

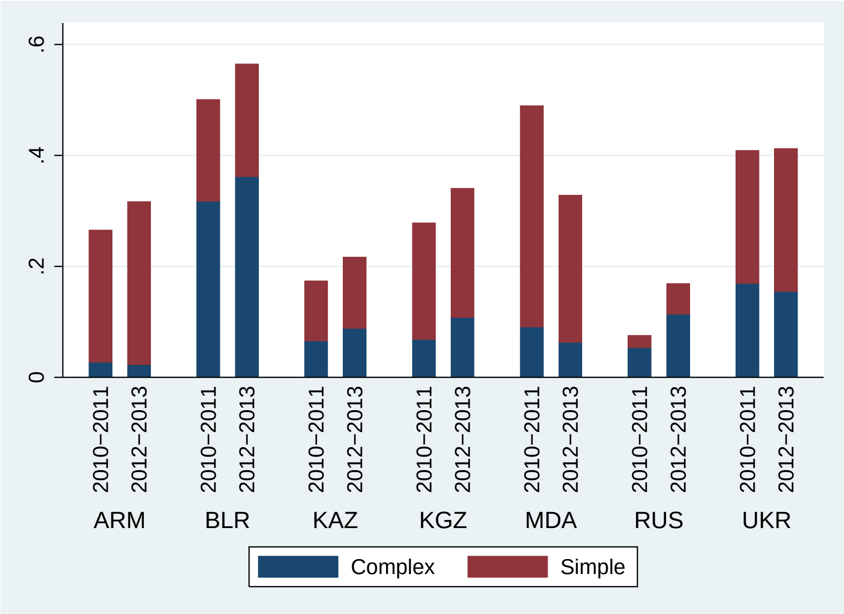

Figure 3.1: Average exports between CIS, 2010-2013

whereas Armenia lacks behind all other CIS.[7]

Measures of productivity for Armenia, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia and Ukraine at the industry level (2 digits ISIC Rev. 3.) before and after the CIS-FTA can be constructed using the firm level data available in the World Bank Enterprise Survey. Details about the dataset and the construction of productivity are provided in Appendix A. We can then determine if changes in exports or comparative advantage are positively related to changes in productivity in these countries during a liberalization episode.

Armenia and Kyrgyzstan, the countries with the lowest level of contract enforcement among CIS, experienced a decrease in average aggregate productivity after 2012.[8] Moreover, a more disaggregated analysis shows that, in the period under consideration, Armenia experienced an increase in revealed comparative advantage in manufacturing of food and beverages, a simple industry, but the average productivity in that industry decreased sharply.[9] A negative relationships between improvements in comparative advantage and declines in productivity can be found in manufacturing of textiles, another simple sector, in Kyrgyzstan. In Ukraine too, increases in comparative advantage in manufacturing of

cost and number of procedures involved from the moment the plaintiff files the lawsuit until payment is received. For additional details, see the Doing Business web page http://www.doingbusiness.org/

[7]The average and median levels of contract enforcement in the World in the period 2010-2013 are 60 and 60.4 respectively. The variance of the variable is 164.1 in the sample of all countries, and 55.9 in the CIS sample.

[8]In our data, also Moldova, Russia and Belarus present lower aggregate productivity in 2012 and 2013 with respect to 2008 and 2009 while Ukraine and Kazakhstan have higher aggregate productivity.

[9]Revealed comparative advantage is calculated using the Balassa index, Balassa [1965].

Table 3.1: Average contract enforcement in CIS, 2010-2013

	AVG contract enforcement DTF
Armenia	55.35
Belarus	79.90
Kazakhstan	68.02
Kyrgyzstan	64.63
Moldova	74.78
Russia	76.11
Tajikistan	67.76
Ukraine	67.19

Note: Averages over the period 2010-2013 of distances to the frontier of contract enforcement are reported. Higher values correspond to better institutions.

food and beverages and non-metallic mineral products have been accompanied by decreases in productivity. [10]

The examples of Armenia and Kyrgyzstan reported above are not definitive evidence of negative effects of trade in countries with weak institutions and we are not claiming any causal relationship. However, this simple empirical evidence suggests that the positive selection of firms triggered by trade liberalization is complex and depends on additional factors such as the quality of institutions.

3.3 The model

3.3.1 The economic environment

We consider two countries indexed by $k \in \{H, F\}$ that have similar economic structures. Each country has two sectors, S and A, producing differentiated goods under monopolistic competition and a numeraire sector, X, producing a homogenous good under perfect

[10] A weak negative correlation between changes in RCA and changes in TFP in countries with weak institutions can also be found in a wider sample of countries. We also run a simple OLS regression using data from all countries surveyed from the World Bank. Controlling for country-industry variables such as the share of imports of an industry in a country and the country share of world imports in an industry, time-, country-, and industry-fixed effects, the correlation between changes in RCA and changes in TFP is positive but not significant. However, the coefficient of an interaction term between changes in RCA and a dummy equal to one for weak institutions suggests that there is a negative significant correlation between the two variables in countries with weak institutions.

competition[11]. S and A produce respectively simple and advanced goods. The production of simple goods is characterized by a lower degree of complexity (properly defined later). Each country has a population of L workers and there is no mobility of workers across countries. Every worker is endowed with a fixed number of hours h. We first describe in detail the economic structure in country H.

Demand

We assume Cobb-Douglas utility across sectors and CES across varieties:

$$U = \mathbf{S}^{\alpha_S}\mathbf{A}^{\alpha_A}X^{\alpha_X}$$

where **S** and **A** are the standard aggregate consumption levels for simple and advanced goods defined as

$$\mathbf{S} := \left[\int_{\omega\in\Omega^S} c(\omega)^{\frac{\sigma-1}{\sigma}}\mathrm{d}\omega\right]^{\frac{\sigma}{\sigma-1}} \qquad \text{and} \qquad \mathbf{A} := \left[\int_{\omega\in\Omega^A} c(\omega)^{\frac{\sigma-1}{\sigma}}\mathrm{d}\omega\right]^{\frac{\sigma}{\sigma-1}} \qquad \text{with } \sigma > 1.$$

Ω^i stands for the set of available varieties for each sector with $i \in \{S, A\}$. We assume $\alpha_X, \alpha_S, \alpha_A > 0$ and $\alpha_X + \alpha_S + \alpha_A = 1$.

Supply: Final Firms and Suppliers

Simple and advanced goods have to be produced according to their degree of complexity, which is the size of the continuum of intermediate goods required for the final production. The production of a simple good requires fewer intermediate goods than the production of an advanced good. We denote by z^i the size of this continuum for $i \in \{S, A\}$, with $z^S < z^A$. For the sake of clarity we explicitly distinguish between final and intermediate goods, the former being the ones entering the consumption bundle. Moreover, we call *final firms* (or simply *firms*) the producers of the simple and advanced final goods. Intermediate goods instead are provided by *suppliers* (properly defined later).

For each sector, the problem of a final firm is to efficiently organize the production of all the intermediate goods across suppliers. We assume that a final firm is characterized by an exogenous, idiosyncratic level of productivity ϕ. The productivity of the final firm affects the productivity of its suppliers as well as the way suppliers are organized to produce the

[11]The presence of the numeraire allows us to pin down the wage level and to focus on the price effects of trade liberalization. The homogeneous numeraire good is produced under perfect competition. One unit of X requires one unit of labor to be produced, so that the wage in the numeraire sector is $w = 1$. At the equilibrium, within country labor mobility makes sure that the wage w_i is the same for the sectors $i \in \{S, A\}$. For the rest of the paper we denote w the wage for all the sectors and we will focus our discussion on the the two sectors S and A.

final good[12]. The parameter ϕ is distributed according to a probability density function g on the support $(0, +\infty)$. We denote with G the associated cumulative distribution function. We posit that g is the same for the two countries. Given productivity ϕ, a final firm will choose whether to produce and in which sector to do so. Contrary to most of the models with multi-sectors economies and a monopolistic competition (e.g. Bernard et al. [2007]), in our framework the final firms choose in which sectors to produce and are not ex-ante affiliated to one sector.

For simplicity, we assume that one supplier consists of one worker endowed with h working hours. For each intermediate good, the supplier has to first spend time learning how to produce it. Then, actual production happens through a linear technology. The productivity of a supplier depends on the productivity of the final firm. Consider a supplier that has to provide a certain number of intermediate goods for a final firm with a productivity ϕ. For each intermediate good the supplier needs $\frac{1}{\phi}$ hours to learn how to produce it and $\frac{1}{\phi}$ hours for the actual production of one unit of it. The higher the productivity of the final firm, the more productive to learn and to produce a supplier becomes.

Denote with $\mathbb{Y}(\phi)$ the number of final good's units u that a final firm with productivity ϕ plans to produce. The number of hours l necessary to learn and produce one intermediate good for the production of $\mathbb{Y}(\phi)$ units of the final variety are given by the following expression:

$$l := \int_{u \in \mathbb{Y}(\phi)} \frac{1}{\phi} \mathrm{d}u + \frac{1}{\phi} \tag{3.1}$$

The learning cost of one intermediate good and the marginal productivity of a supplier in a final firm with productivity ϕ are the same across sectors.

Final firms produce under monopolistic competition and face a fixed production cost $f > 0$. We assume that all the sector-specific intermediate goods have to be provided in order to produce one unit of any final variety[13].

Firms' Organization and Institutions

Our modeling strategy for the organization of the final firms follows closely the theoretical structure introduced by Costinot [2009].

Let us consider a final firm with productivity ϕ in sector i. Each unit of the final good that the firm wants to produce requires one unit of each intermediate good in $[0, z^i]$. The final firm has to choose the number of its suppliers - we posit that suppliers cannot produce intermediates for more than one final firm - and, most importantly, it has to allocate the provision of intermediate goods across them. The final firm pays a wage w to

[12] We can consider this productivity level as a final firm-specific knowledge or as the ability of its manager.

[13] This is analogous to the O-ring theory by Kremer [1993].

each chosen supplier, irrespectively of the actual provision of the intermediate goods. It can be shown that the final firm optimally partitions the interval $[0, z^i]$ into N identical ranges of intermediate goods and assigns each range to a different supplier. Moreover, it optimally assigns the same range to the same supplier across as many units of final goods as it takes to deplete the supplier's endowment of hours[14]. As a result, the suppliers chosen by the final firm are divided into groups of size N. Each member of a group is specialized in z^i/N intermediate goods: it spends $z^i/N\phi$ hours in learning how to produce them, and the remaining $h - z^i/N\phi$ hours of its endowment in producing them.

We crucially assume that the suppliers' activity can be hampered by institutional obstacles such as corrupted bureaucracies, unexpected taxation or violation of property rights[15]. The quality of institutions, therefore, determines the probability with which every single supplier is able to fulfill the provision of intermediates it has been assigned to. Formally, we define a successful provision indicator for a given supplier as

$$\mathbb{I}(supply) = \begin{cases} 1 & \text{with probability } e^{-\frac{1}{\theta}} \\ 0 & \text{with probability } 1 - e^{-\frac{1}{\theta}} \end{cases} \tag{3.2}$$

where $\theta > 0$ captures the quality of institutions. When $\mathbb{I}(supply) = 0$ the supplier fails the provision of all the intermediate goods it was responsible for. As a consequence, the final firm is not able to produce those units of the final good, which the supplier's provision was intended to contribute to. Low values of θ are associated with low probabilities of successful provision and therefore represent weak institutional frameworks. For θ going to $+\infty$ instead, the probability of successful provision tends to 1, minimizing the uncertainty in the production process of the final firm.

The optimal organization of a final firm coincides with the optimal choice of N, the number of suppliers for each group or, in other words, the degree of fragmentation of intermediates' provision across suppliers. The trade-off behind this optimal decision is intuitive: on the one hand, a higher fragmentation allows the final firm to leave its suppliers with a greater amount of hours for the actual production of intermediates (each supplier is specialized in a smaller range of intermediates and therefore has to allocate less hours into learning). On the other hand, a higher degree of fragmentation increases uncertainty in the production process of the final firm: a single supplier failing its provision compromises the production of units of final goods, independently on the provision of all the other members of its group.

In our model, institutions affect the organization of the final firms and their frontier of production. Moreover, the quality of institutions is the only parameter that differs

[14]Our framework takes as given many important intermediate results of the Cosinot theoretical structure. We provide a fully micro funded application in Appendix B.

[15]A complementary assumption would be the existence of imperfect contract enforcement. In this environment a supplier is able, with a certain probability, to shirk on the provision of intermediates that was assigned to it by a final firm.

across the two countries. If the two countries trade among each other, institutional heterogeneity is the source of comparative advantage and therefore it creates potential trade opportunities. Before turning to the analysis of trade regimes, we present our modeling framework and derive results for a country in autarky.

3.3.2 Equilibrium under autarky

The consumers' problem

We apply the two-stage budget procedure using the aggregate income $\mathcal{R}$ and the aggregate price indexes

$$P^i = \left[\int_{\omega\in\Omega^i} p(\omega)^{1-\sigma}\mathrm{d}\omega\right]^{\frac{1}{1-\sigma}} \qquad \forall i \in \{S, A\}$$

The Cobb-Douglas specification implies fixed expenditure shares for the two sectors: $P^S\mathbf{S} = \alpha_S\mathcal{R}$ and $P^A\mathbf{A} = \alpha_A\mathcal{R}$. In order to get rid of any demand side effects in determining the comparative advantage under free trade we assume $\alpha_S = \alpha_A = (1-\alpha_X)/2$.[16] We denote by α this parameter. In addition we take R as the aggregate income net of the expenditure for the numeraire good X, $R = (1-\alpha)\mathcal{R}$. For every sector, consumption across varieties is given by the following equations:

$$c(\omega) = \begin{cases} \mathbf{S}\big[p(\omega)/P^S\big]^{-\sigma} & \text{if } \omega \in \Omega^S \\ \mathbf{A}\big[p(\omega)/P^A\big]^{-\sigma} & \text{if } \omega \in \Omega^A \end{cases} \tag{3.3}$$

The firms' problem: optimal organization

The final firm chooses how to organize its production through the allocation of the intermediate-good production among the suppliers. The optimal organization strategy is a number of suppliers denoted by N (called degree of fragmentation) associated to an optimal allocation of intermediate goods for each supplier.

First, we denote by $y(\phi)$ the expected production given the initial plan of production $\mathbb{Y}(\phi)$ that is produced in case of no uncertainty. Given that all suppliers have the same probability to fail intermediates' provision, the expected production of the final firm is given by:

$$y(\phi) = \mathbb{P}(\mathbb{I}=1)^{N(\phi)} \int_{u\in\mathbb{Y}(\phi)} du \tag{3.4}$$

with $N(\phi)$ the number of suppliers in a team of a final firm with productivity ϕ. $\mathbb{P}(\mathbb{I} = 1)^{N(\phi)}$ defines the probability that all the suppliers successfully provide their range of intermediate goods such that the final good can be produced. Supplier level probabilities

[16] Krugman [1980] shows how the country with higher internal demand for a sector will develop a comparative advantage in the production of the sector specific varieties.

of failed provision are multiplied by each other because the final good is produced only if all the intermediate goods required to its production are supplied.

We can derive the production technology of a final firm of productivity ϕ in the sector with complexity $z \in \{z^S, z^A\}$ of a country with institutions θ and determine its optimal organization $N^*(\phi, z, \theta)$. Given the total mass S of suppliers working in in the final firm, its maximization problem can be written as[17]

$$\max_N \ pe^{-\frac{N}{\theta}} \frac{\phi}{z^i} S\Big(h - \frac{z^i}{\phi N}\Big) - w(S+f) \tag{3.5}$$

The optimal organization - or degree of fragmentation - of the final firm is given in the following

Proposition 3.3.1. *(Degree of fragmentation) The optimal number of suppliers for a final firm with productivity ϕ in the sector with complexity z in a country with institutions θ is:*

$$N^*(\phi, z, \theta) = \frac{z}{2h\phi}\left(1 + \sqrt{1 + \frac{4\theta h\phi}{z}}\right) \tag{3.6}$$

Proof. See Costinot [2009]. □

The final good is produced when each of the N suppliers have supplied their range of intermediate goods. The degree of fragmentation depends upon exogenous parameters as stated in the following

Observation 1. *(Comparative statics) N^* decreases in ϕ, increases in z and θ.*

This comparative static result tells us that higher productivity, lower complexity or worse institutions decreases the fragmentation of the production by the final firm. This comes from the trade-off explained in Costinot [2009] between the gains and costs of fragmentation. The learning cost for each intermediate good creates gains of fragmentation as a supplier with a smaller interval of goods can be more specialized and produce more. However the uncertainty in the supply of intermediates due to the poor quality of institutions creates costs of fragmentation of the final production.

A higher productivity decreases the learning cost per supplier but does not affect the uncertainty level due to the quality of institutions. The gains of fragmentation are reduced with a higher productivity and the final firm decreases its optimal degree of fragmentation. Second, a higher degree of complexity for the final good increases the number of intermediate goods to provide and the hours to be dedicated to the learning process. The gains of fragmentation increase with a higher degree of complexity and

[17] The computation is similar to Costinot [2009] and is detailed in the Annex. $e^{-\frac{N}{\theta}}$ is the probability for teams of N suppliers to get all the intermediate goods provided and $\left(h - \frac{z^i}{N\phi}\right)$ the number of hours left for production for each supplier after the learning process.

the final firm expands its optimal degree of fragmentation. Finally, a higher quality of institutions directly decreases the costs of fragmentation and the final firm increases its optimal degree of fragmentation. We provide a graphical illustration of the comparative statics result in Figure 3.2 and 3.3.[18]

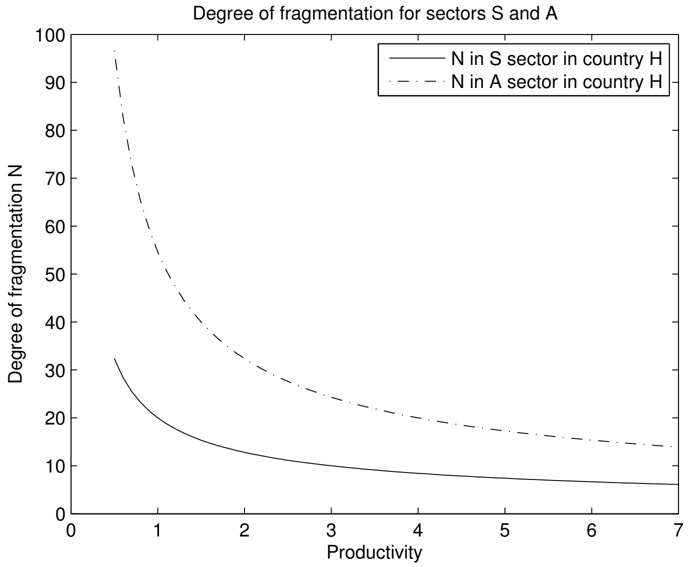

Figure 3.2: The degree of fragmentation N^* for the two sectors S and A in one country

The fragmentation of production directly affects production chains, outsourcing and the productivity of firms. One example is Fally [2012] that shows that fragmentation weighted by the value added of each range of intermediates has decreased over the last decades in the US. The explanation he gives is the increase of services in production that are usually not so fragmented and are provided close to the customers. Our model provides another mechanism for which a higher productivity of final firms, a lower complexity of final goods or a fall in the quality of institutions can also explain this fall of fragmentation.

The firms' problem: production and sector decision

In this subsection we derive the optimal pricing rule and the profit function for firms of productivity ϕ. We then determine which firms choose to produce and in which sector they do so. For the rest of the paper we denote by $N^i(\phi)$ the optimal organization of the final firm of productivity ϕ in sector $i \in \{S, A\}$ in a country with a quality of institutions θ, such that $N^i(\phi) = N^*(\phi, z^i, \theta)$.

Let us consider a final firm with a productivity level ϕ producing a variety in Ω^i under the institutional framework θ. The final firm chooses the optimal total mass of suppliers

[18] The general patterns shown in Figure 3.2 hold for any level of institutions. The general patterns in figure 3.3 hold for any level of complexity.

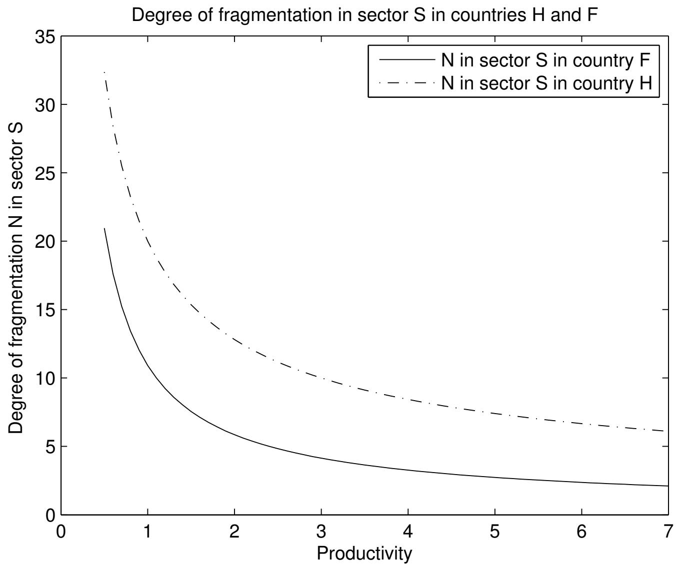

Figure 3.3: The degree of fragmentation N^* for two countries with different qualities of institutions θ^H and θ^F in one sector

$S^i(y)$ summing up all the suppliers required to produce y, the whole amount of final good:

$$S^i(y) = \frac{z^i}{\phi} e^{\frac{N^i(\phi)}{\theta}} \left(h - \frac{z^i}{\phi N^i(\phi)}\right)^{-1} y \tag{3.7}$$

Given optimal organization, we define the inverse of the marginal productivity of a final firm's supplier as[19]

$$\beta^i(\phi) := \frac{\partial S^i\big(y\big)}{\partial y} = e^{\frac{N^i(\phi)}{\theta}} \left[\frac{h\phi}{z^i} - \frac{1}{N^i(\phi)}\right]^{-1} \tag{3.8}$$

The maximization problem of the final firm can be written as

$$\max_y \; p^i(y)y - w\Bigg[S^i\big(y\big) + f\Bigg] \tag{3.9}$$

For the rest of the paper we set the wage w equal to 1. Following Dixit and Stiglitz [1977] we posit that the market share of each final firm is small enough in order to be neglected in the pricing decision of the others. This assumption (supported by the infinite number of firms in our set up) together with the constant elasticity of substitution gives us the following expression for the elasticity of demand faced by the final firm:

$$\epsilon^i(\phi) = \epsilon = \frac{1}{1-\rho} \quad \text{where} \quad \rho = \frac{\sigma - 1}{\sigma} \tag{3.10}$$

The pricing rule is defined by the standard mark-up over the marginal cost:

$$p^i(\phi) = \frac{\beta^i(\phi)}{\rho} \tag{3.11}$$

[19]This level of productivity differs from the initial distribution of productivity parameters ϕ and results form the optimal strategy of the firm to organize the production depending on the complexity of the goods.

The profit function is given by

$$\pi^i(\phi) = \frac{R}{2\sigma}\left[\frac{P^i\rho}{\beta^i(\phi)}\right]^{\sigma-1} - f \tag{3.12}$$

Let us begin our analysis of the profit function with the following

Observation 2. *(Properties of the profit function)* $\forall\phi, \forall i$ $\pi^i(\phi)$ *is continuous and monotonically increasing in* ϕ*. Moreover* $\lim_{\phi\to 0}\pi^i(\phi) = -f$ *and* $\lim_{\phi\to+\infty}\pi^i(\phi) = +\infty$.

The contribution of this paper is to allow final firms to be mobile across sectors. Each final firm optimally chooses in which sector to produce depending on the expected profits in each sector given its productivity. Optimal production and sector decision under autarky is given by the following

Proposition 3.3.2. *(Production and sector decision) If the autarky equilibrium (properly defined later) exists, (i) there exists one productivity threshold* ϕ^{SA} *such that* $\pi^S(\phi^{SA}) = \pi^A(\phi^{SA}) > 0$*; (ii) there exist two productivity thresholds* ϕ^{eS} *and* ϕ^{eA} *such that* $\pi^S(\phi^{eS}) = \pi^A(\phi^{eA}) = 0$ *and* $\phi^{eS} < \phi^{eA}$*; (iii) a final firm chooses whether and in which sector to produce according to the following scheme:*

- *if* $\phi < \phi^e$ *with* $\phi^e = \phi^{eS}$*, the firm does not produce any good,*
- *if* $\phi \in [\phi^e, \phi^{SA})$*, the firm produces a variety in sector S,*
- *if* $\phi \geq \phi^{SA}$*, the firm produces a variety in sector A.*

Proof. See Appendix C. □

Proposition 3.3.2 shows the existence of the two thresholds ϕ^{eS} and ϕ^{eA} from which a firm can make non negative profits. The threshold ϕ^{eS} is shown to be the lowest level of productivity that enables a firm to make non negative profits, we call it the *entry threshold* and we drop the S from its superscript. A firm that draws a productivity parameter below ϕ^e exits the market and never starts producing. The choice threshold ϕ^{SA} is defined as the productivity level for which a firm is indifferent between producing in one of the two sectors. We provide a graphical representation of the entry and choice thresholds in Figure 3.4 where we rely on a simplified representation of the profit functions for the two sectors.

Proposition 3.3.2 also states that for any quality of institutions, firms in the advanced sector are more productive than the firms in the simple sector. A firm with a productivity between ϕ^e and ϕ^{SA} produces a simple variety, and with a productivity above ϕ^{SA} an advanced variety. This important result is explained by the fact that the ratio of the marginal costs $\beta^S(\phi)/\beta^A(\phi)$ is increasing in the productivity. This implies that final firms are increasingly better at producing a variety in sector A relatively to a variety in sector

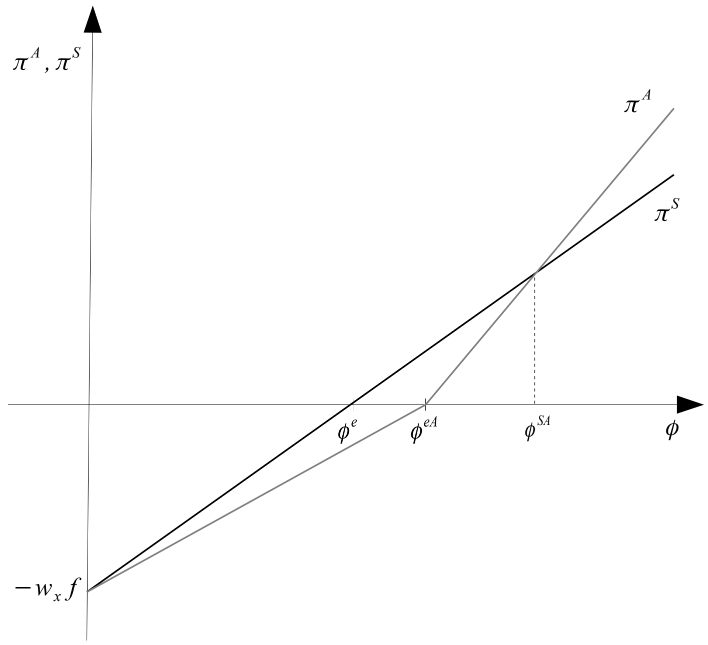

Figure 3.4: Profits as function of productivity

S. What matters here is the relative ratio, as more productive firms are always better (lower marginal costs) to produce a variety in each sector. However more productive firms are relatively better at producing a variety in sector A.

Aggregation: prices and profits

We define the average marginal costs $\tilde{\beta}^S$ and $\tilde{\beta}^A$ in the two sectors which is determined by the cutoff productivity levels ϕ^e and ϕ^{SA} as follows.

$$\tilde{\beta}^S = \tilde{\beta}^S(\phi^e, \phi^{SA}) = \left[\frac{1}{G(\phi^{SA}) - G(\phi^e)} \int_{\phi^e}^{\phi^{SA}} \left(\beta^S(\phi)\right)^{1-\sigma} g(\phi) \mathrm{d}\phi\right]^{\frac{1}{1-\sigma}}$$

and

$$\tilde{\beta}^A = \tilde{\beta}^A(\phi^{SA}) = \left[\frac{1}{1 - G(\phi^{SA})} \int_{\phi^{SA}}^{\infty} \left(\beta^A(\phi)\right)^{1-\sigma} g(\phi) \mathrm{d}\phi\right]^{\frac{1}{1-\sigma}}$$

Calling M the total mass of firms active either in S or in A, we can write the aggregate price indexes for the two sectors as

$$P^S = \left(M^S\right)^{\frac{1}{1-\sigma}} p^S\left(\tilde{\beta}^S\right) \quad \text{and} \quad P^A = \left(M^A\right)^{\frac{1}{1-\sigma}} p^A\left(\tilde{\beta}^A\right).$$

with $M^S = \left[\frac{G(\phi^{SA})-G(\phi^e)}{1-G(\phi^e)}\right] M$ and $M^A = \left[\frac{1-G(\phi^{SA})}{1-G(\phi^e)}\right] M$, denoting respectively the mass of firms producing a variety of the simple and the advanced goods. Finally, aggregate profits Π are given by the following expression:

$$\Pi = M\bar{\pi} = M\left[\frac{G(\phi^{SA}) - G(\phi^e)}{1 - G(\phi^e)}\bar{\pi}^S + \frac{1 - G(\phi^{SA})}{1 - G(\phi^e)}\bar{\pi}^A\right]$$

with $\bar{\pi}^S$ and $\bar{\pi}^A$ the average profits defined as

$$\bar{\pi}^S = \frac{\int_{\phi^e}^{\phi^{SA}} \pi^S(\phi)g(\phi)\mathrm{d}(\phi)}{[G(\phi^{SA}) - G(\phi^e)]} \quad \text{and} \quad \bar{\pi}^A = \frac{\int_{\phi^{SA}}^{\infty} \pi^A(\phi)g(\phi)\mathrm{d}(\phi)}{[1 - G(\phi^{SA})]}$$

Timing and free-entry condition

Following Melitz [2003] we model a process of firms' dynamics. Every period there is a mass M_e of potential entrants. At this stage the potential entrants are identical. In order to draw a productivity parameter from the distribution $g(\cdot)$ they have to pay a fixed entry cost f_e thereafter sunk. Once the firm knows its productivity, it decides whether to engage in production and in which sector to do so. Those decisions are taken anticipating optimal pricing behavior, which in turn embeds optimal organization determined taking prices as given.[20] Thus, only the potential new firms with a productivity level higher than ϕ^e finally enter the production process. Every period will be characterized by a mass M of active firms which is the sum of the firms active in the two sectors: $M = M^A + M^S$. For every active firm in every period, there is a positive probability δ of exogenous death. At the beginning of the period a proportion δ of the incumbent firms M_{-1} disappears. The dynamics is given by: $M = (1-\delta)M_{-1} + (1 - G(\phi^e))M_e$. We will focus on the steady states of this dynamic process, where $M = M_{-1}$ and $[1 - G(\phi^e)]M_e = \delta M$. The expected profits from drawing a productivity level has to be equal to the cost f_e of having a draw. From this we derive the firm entry condition:

$$V = \frac{[1 - G(\phi^e)]}{\delta}\bar{\pi} = f_e \tag{3.13}$$

with V the ex-ante utility of the firm over time and $\bar{\pi}$ the average ex-post profit in the economy. We use the expressions of the average profits to rewrite the free-entry condition as a function of the two thresholds (ϕ^e and ϕ^{SA}) and other exogenous variables:

$$V(\phi^e, \phi^{SA}) = \tfrac{f}{\delta}\Big\{[G(\phi^{SA}) - G(\phi^e)]\Big\{\Big[\tfrac{\tilde{\beta}^S(\phi^e,\phi^{SA})}{\beta^S(\phi^e)}\Big]^{1-\sigma} - 1\Big\} +$$
$$+ [1 - G(\phi^{SA})]\Big\{\Big[\tfrac{\tilde{\beta}^A(\phi^{SA})}{\beta^A(\phi^{SA})}\tfrac{\beta^S(\phi^{SA})}{\beta^S(\phi^e)}\Big]^{1-\sigma} - 1\Big\}\Big\} = f_e$$

Goods and labor markets

The goods market clearing condition requires that the share of revenues from a sector equals the share of expenditures into it:

$$R_S = \alpha_S R \quad \text{and} \quad R_A = \alpha_A R$$

[20] As in Dixit and Stiglitz [1977] we assume that the market shares of the firms are small enough not to trigger the strategic consideration of the opponents' pricing behavior.

Suppliers are used to enter the production process as well as to produce. S^e denotes the total number of suppliers used in the entry process (notice that S^e is not sector specific) and S_i^p denotes the number of suppliers used for production in sector i. Given our simplifying assumption of one worker for each supplier, the total number of suppliers is equal to the number of workers L.

The labor market clearing conditions is thus:

$$S^e + S^p = L \quad \text{with} \quad S^p = S_S^p + S_A^p$$

Equilibrium

Proposition 3.3.3. *(Autarky equilibrium) For each country, there exists an autarky equilibrium*

$$\{\phi^{e*}, \phi^{SA*}, P^{S*}, P^{A*}, M^*, p^{S*}(\phi), p^{A*}(\phi)\}$$

that verifies the optimal behavior of the consumers and producers, the labor market and good market conditions.

Proof. See Appendix C □

All the equilibrium endogenous variables can be pinned down from the vector of thresholds (ϕ^{e*}, ϕ^{SA*}). See Appendix C (Proof of Proposition 3.3.3) for a detailed derivation of the equilibrium under autarky

Observation 3. *(Institutions under autarky) Under the autarky equilibrium, (i) the entry and choice thresholds ϕ^{e*} and ϕ^{SA*} decrease in the quality of institutions; (ii) the marginal costs at both thresholds $\beta^S(\phi^{e*})$ and $\beta^A(\phi^{SA*})$ decrease in the quality of institutions; (iii) the average numbers of suppliers per team $\tilde{N}^S$ and $\tilde{N}^A$, i.e. the average degrees of fragmentation, decrease in the quality of institutions.*

Better institutions decrease the cost of production by reducing the uncertainty with which suppliers provide their range of intermediate goods. As a consequence, better institutions reduce the marginal production cost and allow firms with a low exogenous productivity to start producing (entry threshold decreasing in θ). A change in θ affects also the marginal cost $\beta^S(\cdot)$. Following an increase in the quality of institutions, the worst producing firm has a lower exogenous productivity but also a lower marginal cost. The same happens for the worst firm producing in the advanced sector. Finally, we define the average degree of fragmentation in the two sectors by:

$$\tilde{N}^S = \tilde{N}^S(\phi^e, \phi^{SA}) = \left[\frac{1}{G(\phi^{SA}) - G(\phi^e)} \int_{\phi^e}^{\phi^{SA}} \left(N^S(\phi)\right)^{1-\sigma} g(\phi) \mathrm{d}\phi\right]^{\frac{1}{1-\sigma}}$$

and

$$\tilde{N}^A = \tilde{N}^A(\phi^{SA}) = \left[\frac{1}{1 - G(\phi^{SA})} \int_{\phi^{SA}}^{\infty} \left(N^A(\phi)\right)^{1-\sigma} g(\phi) \mathrm{d}\phi\right]^{\frac{1}{1-\sigma}}$$

The average degree of fragmentation in both sectors increase in the quality of institutions. A lower uncertainty about the provision of the intermediate goods leads to higher equilibrium gains of fragmentation.

Figures 3.5, 3.6 and 3.7 provide a graphical representation of Observation 3 using the results from a numerical simulation of the equilibrium under autarky[21]. The figures plot equilibrium values of respectively the logarithm of the entry and choice thresholds, the marginal costs at the entry and choice thresholds and the average degrees of fragmentation as functions of the probability of successful provision $\mathbb{P}(\mathbb{I}=1)=e^{\frac{-1}{\theta}}$.

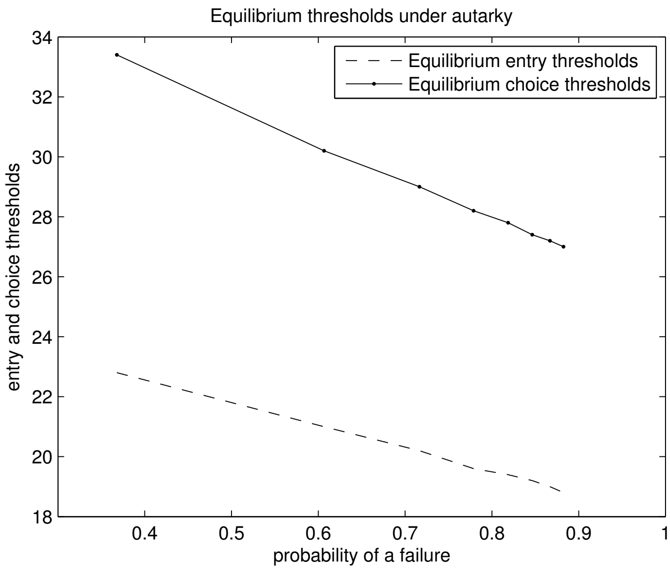

Figure 3.5: Entry and choice thresholds ϕ^{e*} and ϕ^{SA*} as functions of institutions $\mathbb{P}(\mathbb{I}=1)$

3.3.3 Equilibrium under free trade

In this section we allow countries to trade varieties of the two goods at no costs. The extension to costly trade has similar results and it is briefly discussed in section 3.3.4. We assume that countries only differ in their institutional qualities and that country H has better institutions ($\theta^H > \theta^F$). This difference creates a comparative advantage in one of the two sectors. Contrary to a simple Ricardian model with a single firm, the specialization might not be complete even in the case of no trade costs. Finally we assume that workers are not mobile across countries.

In the free trade equilibrium consumers of both countries have access to foreign varieties, i.e. $\forall k\ \forall i,\ \Omega^i_{FT,k} = \Omega^i_k + \Omega^i_{-k}$ where $-k$ is the trade partner country index. The

[21]The parametrization of our economic framework follows closely the numerical exercise in Bernard et al. [2007]: final firms' productivity is drawn from a Pareto distribution with scale parameter 1 and shape parameter 3.4; $\sigma = 3.8$, $f_e = 2$ and $f = 0.1$. Moreover we fix the hours endowment $h = 1$, number of workers $L = 100$, complexity parameters $z^S = 10$ and $z^A = 40$.

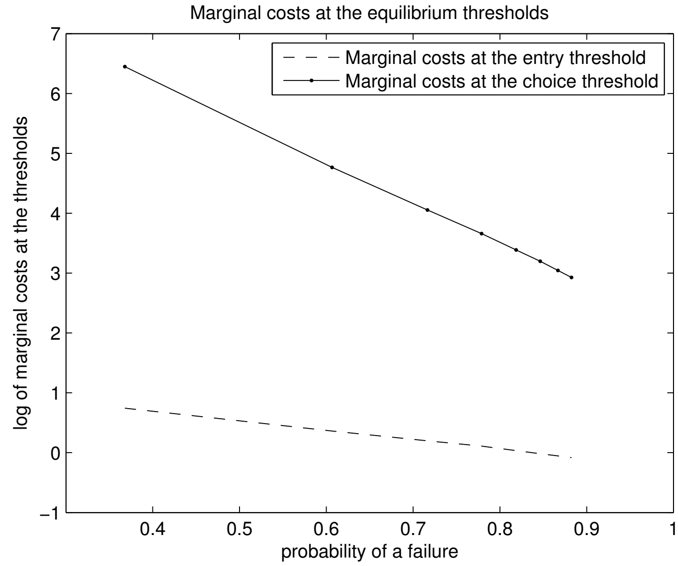

Figure 3.6: Marginal costs at the productivity thresholds $(\beta^S(\phi^{e*}), \beta^A(\phi^{SA*}))$ as functions of institutions $\mathbb{P}(\mathbb{I} = 1)$

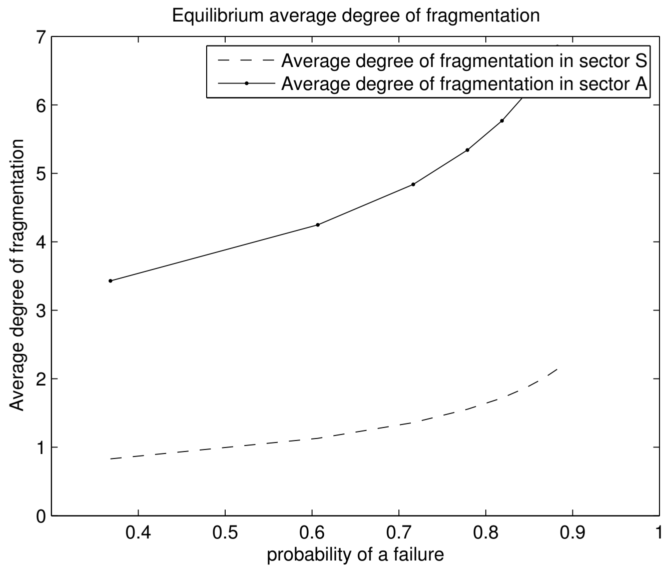

Figure 3.7: Average degrees of fragmentation $(\tilde{N}^S, \tilde{N}^A)$ as a function of institutions $\mathbb{P}(\mathbb{I} = 1)$

consumers' optimization does not change. Turning to firms, we notice that their optimal organization does not change either. Moreover, the free-trade standard result that all the firms that produce also export holds within our framework as well[22]. We can notice that two final firms with the same productivity level ϕ in different countries might not have the same behavior, i.e. the same optimal choice of sector and prices. Given the difference in institutional qualities, a firm with the productivity level ϕ has a marginal cost $\beta^i_H(\phi)$ in country H and $\beta^i_F(\phi)$ in country F. Given that country H has better institutions, the marginal cost of a firm with productivity ϕ is lower in country H for any variety in any of the two sectors.

The outcome of each final firm's production decision is thus a vector of prices, one for the domestic market (d) and the other for the export one (x). As a consequence of constant elasticity of demand across countries and no trade costs, the two pricing rules will be equal, i.e.

$$p^i_{k,d}(\phi) = p^i_{k,x}(\phi) = p^i_k(\phi) = \frac{\beta^i_k(\phi)}{\rho} \quad \forall\ k, i$$

Given that all firms export with the same price they charge on the domestic market, we have that the price indexes are equalized across countries:

$$P^i_H = P^i_F \quad \forall i$$

Denoting with $r_{k,d}$ the k firm's revenue from domestic sales, with $r_{k,x}$ the firm's revenue from exports and with R_k the consumers' total revenue, we can write the free trade revenues and profits of a final firm in k with productivity ϕ active in sector i respectively as

$$r^i_k(\phi) = r^i_{k,d}(\phi) + r^i_{k,x}(\phi) = \frac{R_k}{2}\left[\frac{P^i_k}{p^i_{k,d}(\phi)}\right]^{\sigma-1} + \frac{R_{-k}}{2}\left[\frac{P^i_{-k}}{p^i_{k,x}(\phi)}\right]^{\sigma-1} = r^i_{k,d}(\phi)\left[1 + \frac{R_{-k}}{R_k}\right]$$

$$\pi^i_k(\phi) = \frac{r^i_k(\phi)}{\sigma} - f$$

It is immediate to see that Proposition 3.3.2 still holds under free trade. Firms' sector-indifference condition defines the choice threshold ϕ^{SA}_k in both countries. The entry threshold ϕ^e_k is defined as the productivity level that makes profits in the S sector equal to 0 in country k. The entry and the choice thresholds give the expressions for average marginal costs which are identical to the autarky ones. Notice that the price aggregates are instead different from their autarky counterparts: in fact they take into account the varieties imported from the trading partner and can be written as follows

$$P^i_k = \left\{ M^i_k[p^i_k(\tilde{\beta}^i_k)]^{1-\sigma} + M^i_{-k}[p^i_{-k}(\tilde{\beta}^i_{-k})]^{1-\sigma} \right\}^{\frac{1}{1-\sigma}}$$

[22]This is an implication of consumers' love of variety and the assumption of no trade costs.

or

$$P_k^i = (M_k^i)^{\frac{1}{1-\sigma}} \frac{\tilde{\beta}_k^i}{\rho} + (M_{-k}^i)^{\frac{1}{1-\sigma}} \frac{\tilde{\beta}_{-k}^i}{\rho}$$

where

$$M_k^S = \frac{[G(\phi_k^{SA}) - G(\phi_k^e)]}{[1 - G(\phi_k^e)]} M_k \quad \text{and} \quad M_k^A = \frac{[1 - G(\phi_k^{SA})]}{[1 - G(\phi_k^e)]} M_k \tag{3.14}$$

Firms' dynamics is clearly unchanged with respect to autarky. Country k steady state stability and the firm entry condition are still

$$[1 - G(\phi_k^e)] M_k^e = \delta M_k$$

and

$$\begin{aligned} &\tfrac{f}{\delta}\Bigg\{ [G(\phi_k^{SA}) - G(\phi_k^e)] \Big\{ \Big[\tfrac{\tilde{\beta}_k^S(\phi_k^e, \phi_k^{SA})}{\beta_k^S(\phi_k^e)} \Big]^{1-\sigma} - 1 \Big\} + \\ &+ [1 - G(\phi_k^{SA})] \Big\{ \Big[\tfrac{\tilde{\beta}_k^A(\phi_k^{SA})}{\beta_k^A(\phi_k^{SA})} \tfrac{\beta_k^S(\phi_k^{SA})}{\beta_k^S(\phi_k^e)} \Big]^{1-\sigma} - 1 \Big\} \Bigg\} = f_e \end{aligned} \tag{3.15}$$

Goods' market clearing in country k requires that the expenditure share in each i sector equalizes the domestic revenue of k-owned firms producing an i variety plus the revenue made by foreign firms exporting an i variety to k. Mathematically

$$R/2 = R_{k,d}^i + R_{-k,x}^i \quad \forall\ k, i$$

Finally, labor market condition does not change with respect to autarky. We can now state the following

Proposition 3.3.4. *(Free trade equilibrium) The free trade equilibrium is defined through the vectors*

$$\{\phi_k^{e,FT}, \phi_k^{SA,FT}, P_k^{S,FT}, P_k^{A,FT}, M_k^{FT}, p_k^{S,FT}(\phi), p_k^{A,FT}(\phi)\} \qquad \text{for } k \in \{H, F\} \tag{3.16}$$

that verify the optimal behaviors of the consumers and the firms, the labor market and good market conditions in each country. The equilibrium under free-trade exists unique.

Proof. See Appendix C. □

The first step for the analysis of the free trade equilibrium consists in the derivation of the pattern of comparative advantage which is given in the following

Proposition 3.3.5. *(Comparative advantage) Under free trade, the country with better institutions (H) has a comparative advantage in producing varieties in the advanced sector (A).*

Proof. See Appendix C. □

Reallocation of resources

A novelty of our paper is the assumption that final firms are mobile across sectors. In fact, not only final firms choose whether to produce, but they also decide which good to produce. The ability of firms to chose their sector introduces a new mechanism through which resources can be reallocated across firms and sectors.

The reallocation towards more productive firms of resources that were used in autarky by the least productive firms that exit in free-trade, what we call "Melitz effect", is the only channel for the reallocation of resources in papers such as Melitz [2003] and Bernard et al. [2007]. In Melitz [2003] resources are limited and reallocated towards better firms and so aggregate productivity increases. In Bernard et al. [2007] resources are reallocated within and across industries. In each sector, firms choose whether to produce but do not choose their sector. The "Melitz effect" takes place in both sectors, and is magnified in the sector with the comparative advantage.

What allows us to have different results with respect to Bernard et al. [2007] is the assumption that the free-entry condition is not a condition per sector but a condition for the whole economy.[23] In our model, new export opportunities do not necessarily lead to a higher entry threshold.

The reallocation of resources depends on whether firms exit or enter the production process compared to autarky, which in turns crucially depends on which good the active final firms choose to produce. In general, if the free trade equilibrium entry threshold increases with respect to autarky, resources are reallocated to more productive firms, the so-called "Melitz effect". A decrease in the equilibrium entry threshold instead leads to a decrease in the whole aggregate productivity and this is what we call an "anti Melitz effect".

The sector choice introduces another dimension to the analysis of the effects of trade on productivity, both at the sector and at the aggregate level. The comparative advantage dynamics, through changes in the relative price, drives the choice of sector. If the equilibrium choice threshold decreases, firms that were producing in the simple sector in autarky now produce in the advanced sector and resources are reallocated from the simple to the advanced sector. We start looking at the advanced sector, where the effect of trade on productivity depends solely on the movements of the choice threshold. This effect is described in the following

Proposition 3.3.6. *(Aggregate productivity in A) The free trade aggregate productivity in the advanced sector (A) decreases in the country with the comparative advantage in the*

[23] The free-entry condition is the expression that drives the results in Melitz [2003] and Bernard et al. [2007]. This condition requires the average profit to be equal to the entry cost. The intuition of the result is that higher profit opportunities due to exports lead to a higher entry threshold that reduces the average price in equilibrium.

advanced sector, and increases in the other country compared to autarky.

Proof. See Appendix C. □

We provide a graphical representation of Proposition 3.3.6 in Figure 3.8 and Figure 3.9.

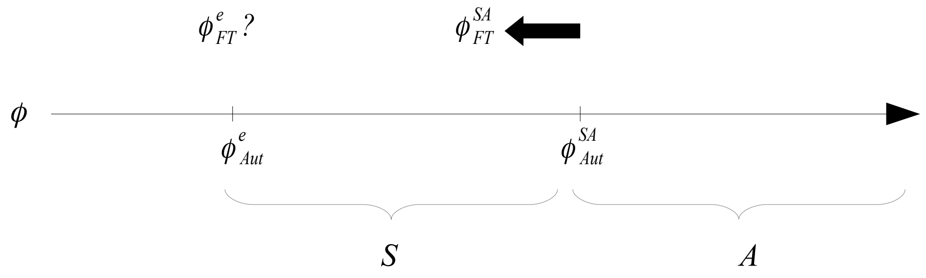

Figure 3.8: Change in thresholds for the country with good institutions

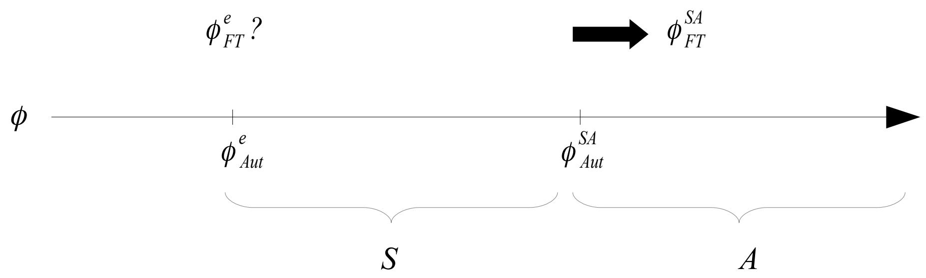

Figure 3.9: Change in thresholds for the country with poor institutions

The result from Proposition 3.3.6 is driven by the choice of firms to produce in one of the two sectors. This choice depends on the comparative advantage of the country. The country with the good institutions has a comparative advantage in the advanced sector and the relative price of the advanced good increases. Firms that were previously producing in the simple sector decide to produce in the advanced sector and get higher profits, and firms with lower productivity ϕ thus enters the advanced sector. In the other country, the opposite happens and some firms that were previously producing in the advanced sector decide to produce in the simple sector. Firms with higher productivity ϕ thus decides to produce in the simple sector.

What are the implications of this result for the productivity in the simple sectors and, most importantly, for the aggregate productivity of the two countries? Due to the complexity of our modeling framework we are not able to derive an analytical answer to this question and we need to rely upon a numerical simulation of the equilibrium. Nevertheless, Proposition 3.3.6 reveals a mechanism that will guide our economic intuition.

Consider country H with good institutions. The pattern of comparative advantage attracts the final firms into the advanced sector and therefore there are firms that would have produced the simple goods under autarky but produce the advanced goods under free trade. Ceteris paribus, higher complexity of the good calls for higher 'consumption' of resources (higher fragmentation of production). Moreover, final firms in this bigger advanced sector benefit from the highest export opportunities, this again calls for higher 'consumption' of resources. Given inter industry reallocation of final producers, the final firms above the free trade entry threshold are consuming more resources than what they would have done under autarky. This mechanisms suggests that the resources available for the firms below the free trade choice threshold could be less than what they would have been under autarky. There are other general equilibrium mechanisms that affect the movement of the entry threshold and that we are not able to capture analytically, but the result in Proposition 6 are consistent with an increase in the entry threshold for country H or, in other words, with a "Melitz effect".

When instead the pattern of comparative advantage attracts firms into the simple sector (in the country with weak institutions), free trade has the opposite effects on resources allocation. On the one hand, all final firms can export and this calls for a higher consumption of resources. On the other hand, the pattern of comparative advantage is such that under free trade there are firms that would have produced an advanced variety under autarky but produce a simple one under free trade. The reduced complexity decreases the degree of fragmentation and, ceteris paribus, the consumption of resources. Those two effects on total resources consumption have opposite sign. In the case of country F, the result in Proposition 6 suggests an ambiguous movement of the entry threshold, or in other words, a possible "anti-Melitz effect".

Numerical analysis of the Free-Trade Equilibrium

Due to the analytical complexity of the model it is not possible to explicitly characterize the key components of the tree-trade Equilibrium. We thus turn to a parametric version of the equilibrium. This exercise has two purposes. First, it allows us to get additional results in terms of aggregate productivity and welfare. Second, it enables us to assess the role of institutional proximity on production, sector choices, and trade. The parametrization of the equilibrium follows the numerical exercise in Bernard et al. [2007], and we check our main results for a large range of complexity and institutional parameters[24]. For the following exercise, we assume that country H has the best institutions ($\theta^H > \theta^F$).

Relative prices

[24] All the details of our parametrization are reported in Appendix D.

Result 1. *The gap between the autarky relative prices and the free-trade relative price decreases in the institutional proximity.*

This result is an illustration of the comparative advantage dynamics and its effect on relative price convergence. Figure 3.10 shows the equilibrium relative price P^S/P^A as a function of the ratio θ_H/θ_F which we interpret as an indicator of *institutional proximity*[25]. Institutional heterogeneity is a source of comparative advantage and the country with the best institutions develops a comparative advantage in the advanced sector. Figure 3.10 shows that the difference between the autarky relative prices in the two countries decreases with the institutional proximity. The middle line represents the free-trade relative price. For large gaps between the autarky relative price and the free-trade price, more firms change sectors. In country H, the relative price of the advanced good increases so more firms choose to produce the advanced good whereas in country F the relative price of the simple good increases so more firms choose to produce the simple good.

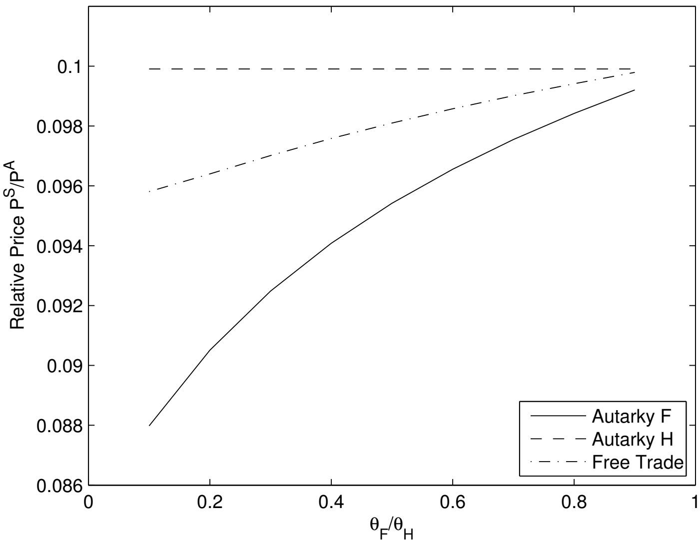

Figure 3.10: Relative price P^S/P^A

Aggregate productivity

Proposition 3.3.6 only gives results for the aggregate productivity in the advanced sector. Our parametrization delivers numerical results for changes in the two thresholds, the entry and the choice, and for changes in aggregate productivity in the two sectors going from autarky to free-trade. The left diagram of Figure 3.11 plots on the vertical

[25]Variation in θ_H/θ_F is obtained fixing θ_F and letting θ_H increase. By construction, our measure of institutional proximity is also a function of the parameter θ_F and therefore has to be interpreted as conditional on the fixed value of θ_H that we choose for our numerical exercise.

axis the *entry ratio*, defined as the entry threshold under autarky over the entry threshold under free trade ($\phi^e(Aut)/\phi^e(FT)$), for both countries. The right diagram instead shows the *choice ratio*, defined as the ratio between the choice threshold under autarky and the choice threshold under free trade ($\phi^{SA}(Aut)/\phi^{SA}(FT)$).

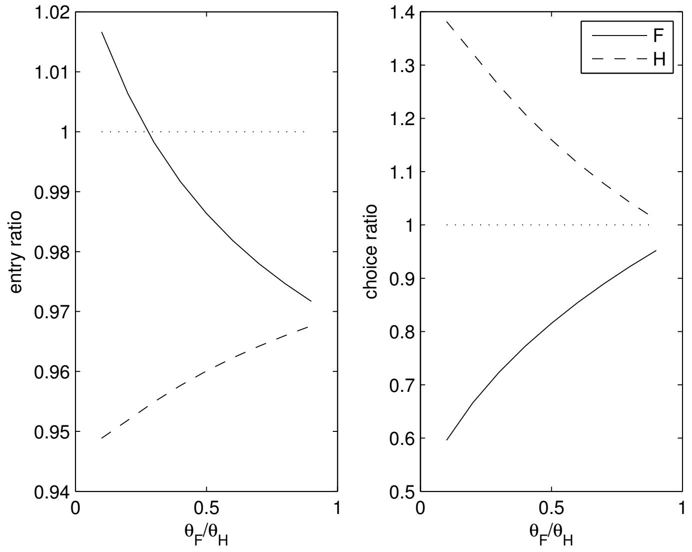

Figure 3.11: Entry and choice ratio

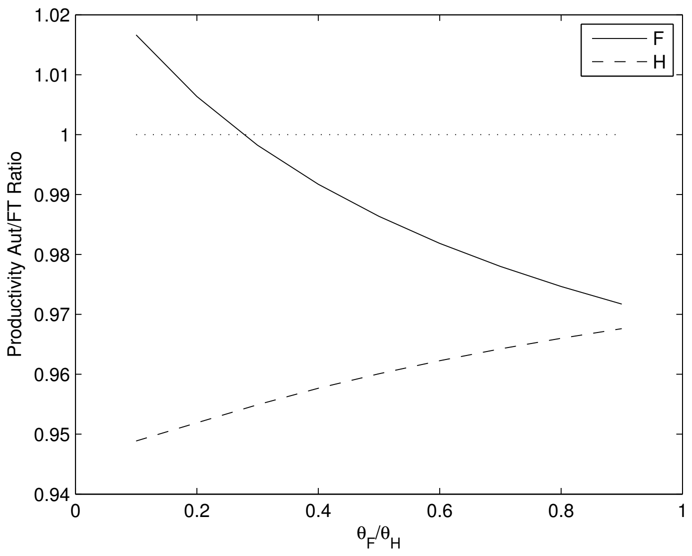

Figure 3.12: Aggregate productivity (Autarky/Free Trade ratio)

Result 2. *In the country with the best institutions, and the comparative advantage in the advanced sector, the aggregate productivity in the advanced sector (A) decreases but the whole aggregate productivity increases.*

In the country with good institutions, for any level of institutional proximity, the free-trade entry threshold increases. This is consistent with the pro-competitive effect of trade liberalization from Melitz [2003] and Bernard et al. [2007]. Export opportunities and the reallocation of firms across sectors increase the average profit. Indeed country H has a comparative advantage in sector A, more firms decide to produce in sector A and the aggregate productivity of sector A decreases (Proposition 3.3.6). This implies that the aggregate price of sector A increases and the profits of the new firms in this sector as well as the profits of the previous ones increase. Using the free-entry condition, profits of firms in sector S decrease at the equilibrium. In the free trade equilibrium, the least productive firms do not produce any more compared to autarky, and the aggregate price of good S decreases.

Result 3. *In the country with the worst institutions, and the comparative advantage in the simple sector, the aggregate productivity in the advanced sector (A) increases but the whole aggregate productivity decreases (increases) for a low (high) institutional proximity.*

Contrary to country H, there exist institutional parameters for which the entry threshold decreases, what we denoted "the anti-Melitz effect". Figure 3.11 shows that a low institutional proximity leads to a decrease in the entry threshold. In other words, if the quality of institutions in country F is too low compared to the quality of institutions in country H, free-trade decreases the whole aggregate productivity in country F but increases the whole aggregate productivity in country H compared to autarky. The reasoning is similar to the one for country H. First new export opportunities increase the average profit. Second country F has a comparative advantage in sector S, more firms decide to produce in sector S and the aggregate productivity of sector A increases (Proposition 3.3.6). This implies that the aggregate price of sector A decreases and the profits of the firms in this sector decrease. The equilibrium effect on prices in sector S is undetermined and depend on the institutional proximity. When countries are similar the variation of the relative price is lower, and fewer firms change sectors. When countries are very different in terms of institutional quality a lot of firms change sectors, and the average profit in sector A decreases a lot. If the fall is sharp enough, the equilibrium effect is to get increasing profits in sector S. This implies a higher aggregate price in sector S and explains why low-productivity firms start producing. In that case free-trade leads worst firms to start producing and some resources are reallocated from more productive firms towards these new firms.

Welfare of Consumers

In a simple Ricardian framework, trade and the comparative advantage dynamics benefit both countries. Adding heterogeneous firms and reallocation of firms across sectors challenges this result, and creates cases for which welfare, measured here as the real consumption wage, decreases in free-trade compared to autarky.[26]

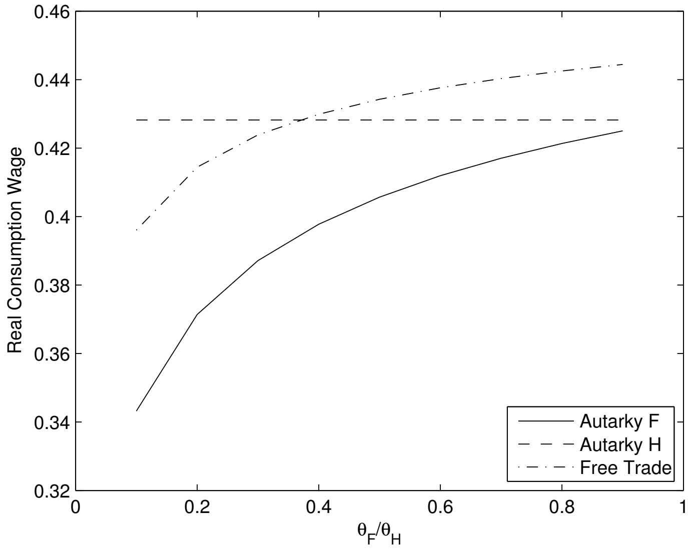

Figure 3.13: Real Consumption Wage

Result 4. *(i) In the country with the best institutions, and the comparative advantage in the advanced sector, the real wage decreases compared to autarky when the institutional proximity is low. (ii) In the country with the worst institutions, the real wage always increases compared to autarky.*

First the real wage is the same for both countries in free-trade by construction. Then Figure 3.13 shows that the real wage in the country with the worst institutions (country F) in free-trade is always higher than the real wage in autarky. Consumers in country F benefit from the opening to trade. The fall in aggregate productivity in country F is compensated by access to cheap varieties from country H. On the contrary, the real wage in country H in free-trade is either higher or lower than the real wage in autarky. It is lower for low institutional proximity values. Thus the fall in aggregate productivity in country F directly affects the aggregate price of imports in country H due to the comparative advantage dynamics and the preference for diversity. When the institutional proximity is low, the specialization due to comparative advantage is strong and consumers in country H buy a lot of varieties of good S from country F. Consumers from country H do not always benefit from free-trade in terms of real wage.

[26]In the derivation of these results, we do not take into account the love for diversity of consumers.

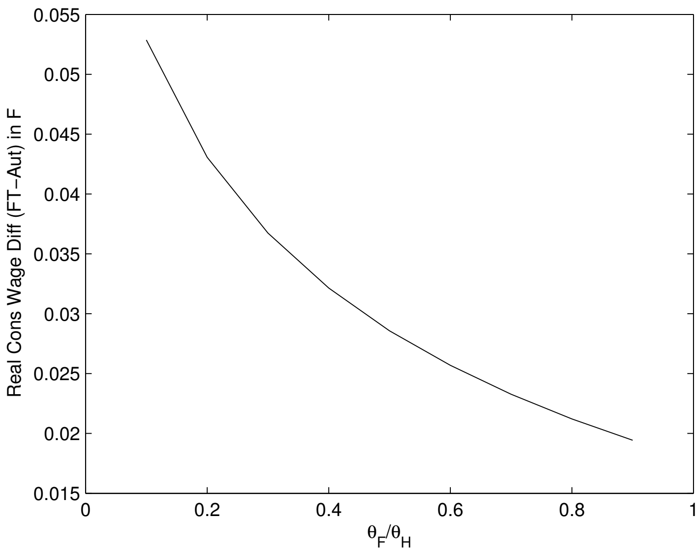

Figure 3.14: Free Trade Welfare effect in country H

Result 5. *In the country with the worst institutions, the welfare gains in terms of real wages are always positive but decrease in the institutional proximity.*

Figure 3.14 shows that the difference between the free-trade real wage and the autarky real wage decreases in the institutional proximity. When we only focus on real wage, the welfare impact depends more on the comparative advantage dynamics than on the access to more varieties. When the institutional proximity is low, the potential gains from the specialization due to comparative advantage are high (large differences in relative prices) and country F benefits a lot from this specialization.

One limit to this analysis of the real wage is our assumption of a fixed wage due to the standard homogeneous good assumption that freezes the wage channel in the free-trade general equilibrium.

Institutional proximity and industrial composition

A nice feature of our model with institutional heterogeneity and endogenous production choices is that we can study the impact of institutional convergence on the production structure of both countries in autarky and free-trade. Figure 3.15 presents the results of this comparative statics exercise.

Result 6. *In the country with the best institutions, (i) the relative mass of firms in the* advanced *sector and the relative production are always higher in free-trade but decrease in the institutional proximity, (ii) the relative average profit in the* advanced *sector is lower in free-trade but the relative total profits are higher.*

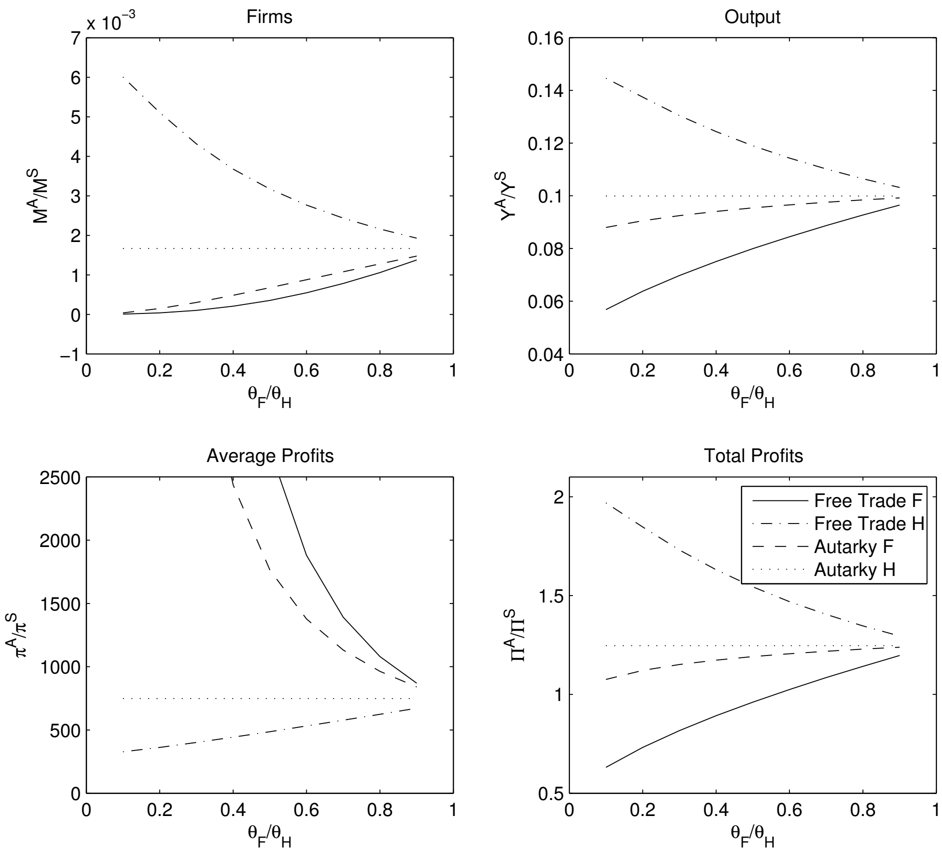

Figure 3.15: Industrial composition

Result 7. *In the country with the worst institutions, (i) the relative mass of firms in the* simple sector *and the relative production are always higher in free-trade but decrease in the institutional proximity, (ii) the relative average profit in the* simple *sector is lower in free-trade but the relative total profits are higher.*

All results of this section are symmetric for each country depending on their comparative advantage sector. Figure 3.15 shows that the sector with the comparative advantage is relatively the largest in terms of mass of firms, production and total profits. The differences in the characteristics of sectors are amplified when countries are very different and the gains from specialization potentially high. The results of the average profits follows from Proposition 3.3.6 that states that the aggregate productivity decreases in sector A in country H whereas it increases in country F. Thus the relative average profit in sector A increases in free-trade in country F but decreases in country H.

When the countries are similar, trade is not driven by specialization due to their comparative advantage. Consumers' love for diversity is the engine of trade and becomes characterized mainly by intra-industry trade. Figure 3.16 shows an output-weighted average of the Grubel Lloyd industry indexes, denoted as WGL[27]. Not surprisingly, trade is driven by specialization when differences between countries are high, and increasingly becomes intra-industry the higher the institutional proximity between the two countries.

3.3.4 Costly trade

All the results and simulations above have been assuming that exporting does not require any additional cost. As an extension, we also derived the main propositions when exporting firms have to pay a variable and a fixed costs to export. The results are very similar to the free trade case with a few caveats.[28]

Compared to the free-trade equilibrium, the presence of fixed costs to export imply that not all the firms export. Therefore, the costly trade equilibrium can be defined similarly to the free trade equilibrium with the addition of two new thresholds that define the productivity thresholds for the exporting firms.

The pattern of comparative advantage under costly trade is also the same as in free trade, i.e. the country with the best (worst) institutions has a comparative advantage in the advanced (simple) sector. However, the specialization is somewhat more extreme:

[27] We computed a weighted version of the Grubel-Lloyd index (see Grubel and Lloyd [1975]) as

$$WGL_k = \sum_{i \in \{S,A\}} \frac{EX_k^i + IM_k^i - |EX_k^i - IM_k^i|}{EX_k^i + IM_k^i} \times \frac{Y_k^i}{Y_k}$$

where weights are the ratio of incomes $\frac{Y_k^i}{Y_k}$.

[28] Since the main results still hold, here we only highlight the differences between free and costly trade. A formal definition of the equilibrium and the complete derivation of the results is available upon request.

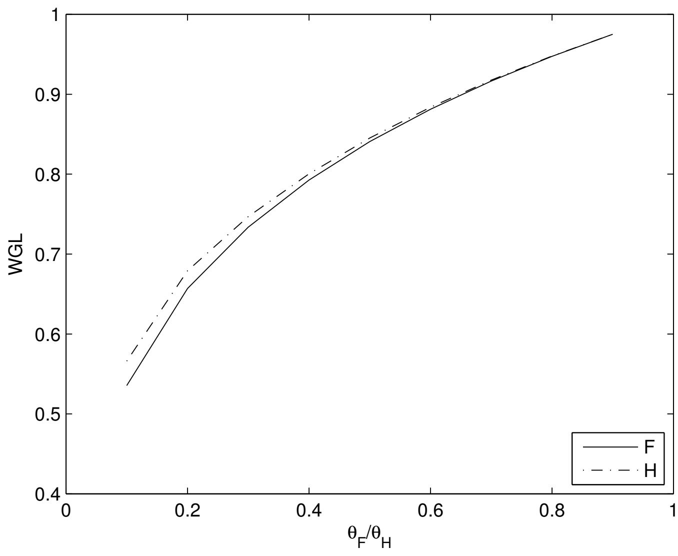

Figure 3.16: Intra-industry trade

the country with a comparative advantage in the advanced sector only exports in the advanced sector whereas the other country exports in both sectors.

On the other hand, the asymmetric effect of trade on productivity is more nuanced. While the aggregate productivity in the country with the best institutions increases, the effect of trade opening on the aggregate productivity in the country with weak institutions is ambiguous.

3.4 Conclusion

The empirical trade literature has recently suggested that the benefits of free trade depend on the existence of other non-trade distortions. We provide a theoretical framework in which weak institutions create distortions and hamper the creation of gains from trade in terms of aggregate productivity and welfare.

This is certainly not the first paper that studies the role of institutions in intentional trade. However we introduce some novelties in the theoretical framework that allow to derive original implications regarding the effects of trade in countries with weak institutions.

We propose a monopolistic competition model with heterogeneous firms where comparative advantage are determined by the quality of the business environment. Moreover we allow firms to endogenously choose whether to produce a simple or a complex good, if any.

We first show that most productive firms always choose to produce the more complex good. This result, together with the pattern of comparative advantage triggered by differences in institutions, determine the reallocation of resource when moving from autarky to free trade which ultimately affect the distribution of the gains from trade.

Our paper confirms a positive effect of trade on the aggregate productivity in the country with good institutions. However the effects of trade in a country lacking in business friendly institutions can be negative. Moreover, the asymmetric effects are amplified when the difference in institutions is very high and trade mainly happens across industries.

The complexity of the model prevents us from deriving all the results analytically, thus we need to rely on numerical simulations. Moreover, we exploit numerical simulations also for the analysis of the industrial composition of the two countries. Finally, the main results are shown to be qualitatively the same in costly trade.

Appendix

A Data and methodology

Productivity and trade data

In order to construct measures of productivity, we exploit the data from the World Bank Enterprise Survey. Starting in 2002, the World Bank collects firm level data in its Enterprise Survey dataset. The Enterprise Survey is a firm-level survey of a representative sample of an economy's private sector. The survey covers more than 130 developing and emerging countries in different years between 2002 and 2014. The survey provides detailed information about firms' activity such as sales and other economic variables allowing us to construct a measure of productivity for each firm. Information about the industry in which each firm operates is available at the division level (two digits) of the International Standard Industrial Classification (ISIC Rev. 3).

An additional advantage of the Enterprise Survey is that most of the countries had been surveyed at least twice, therefore we can look at the evolution of aggregate industry productivity across time. In particular, all CIS countries except Tajikistan have been surveyed at least twice by the World Bank. For our purposes we use the 2008 and 2013 surveys for Belarus and Ukraine, 2009 and 2013 for Armenia, Kazakhstan, Kyrgyzstan and Moldova and 2009 and 2012 for Russia. All these surveys a part from Russia in 2012 fall before or after the year of entry into force of the CIS-FTA.

We construct a measure of firms' productivity using the methodology outlined in the paper by Saliola and Seker [2012]. Essentially we estimate a firm's total factor productivity (TFP) as the residual of a Cobb-Douglas production function with capital, labor and intermediate goods as factor of production. The regression we run is

$$log(Y) = \beta_1 log(K) + \beta_2 log(L) + \beta_3 log(I) + \delta + \epsilon \tag{17}$$

where Y is the output of a firm operating in an industry in a country in a particular year, K represents firm's capital, L is labor used by the firm and I are intermediate goods employed by the firm in the production. The World Bank Enterprise Survey provides firm level information that can be associated to output and these factor of production. In particular, output is measured as firms' sales, capital is the replacement value of machinery, vehicles and equipment, labor is the total compensation of workers including wages, and intermediate goods are measured as the cost of raw and intermediate materials.

In our baseline regression, we run a pooled regression including all available manufacturing firms in all available countries.[29] In order to control for unobservable variables we

[29]The World Bank surveys also services firms. However we restrict our analysis to manufacturing firms in order to match firm level data with trade data.

include a set δ of fixed effects at the country, industry and year level. For each variable in the regression, we exclude the outliers that are more than three standard deviation away from the mean value of the country as in Saliola and Seker [2012].

Using simple OLS we estimate equation 17 and interpret the residuals ϵ as the TFP of each firm.[30] Productivity at the firm level, is then averaged in order to construct the average productivity of the available industries in each country.[31]

In order to match with firm level data, we retrieve export data at the 2-digits ISIC Rev. 3 from the UN COMTRADE database. For each industry, country and year we construct the revealed comparative advantage (RCA) index (Balassa [1965]) considering only manufacturing goods.[32]

Complexity

In order to classify industries according to complexity, we constructed the PRODY index as defined in Hausmann et al. [2007]. The PRODY index gives a sense of the "revealed" technology content of an industry. We calculated the PRODY index using a sample of 133 countries for which we have consistent and reliable trade and GDP data. Trade data is from COMTRADE at the 2 digits ISIC Rev.3 level and GDP per capita is from the World Development Indicators published by the World Bank. Table A.1 shows the industries with the largest and smallest values of the index.[33]

B Final firms' organization: a framework for a fully micro-funded application of Costinot' theory

Final firms are indexed with the letter j, suppliers with s and intermediate goods with I. The production of a firm j active in sector i of country k is organized as follows:

- every firm j partitions the sector-specific intermediate goods' space $[0, z^i]$ into N_j^i different product ranges (denote the resulting partition $R_j^i = \{R_{k,j}^i\}_{k=1}^{N_j^i}$), i.e. sets of intermediate goods whose provision is to be assigned to suppliers;

[30]Given the survey design of the data, we use the sampling weights directly provided by the World Bank. For more information refer to the Methodology page of the Enterprise Survey website: http://www.enterprisesurveys.org/methodology

[31]In order to calculate the average productivity of the industry we weigh each firm using the share of output of a firm on the total output of the industry in a given year.

[32]This corresponds to industries from 15 to 40 in the ISIC Rev 3.

[33]We averaged the PRODY index in 2006, 2007 and 2008. The full list of 2 digit ISIC industries is available upon request.

Table A.1: Smallest and largest PRODY values

	Product Code	ISIC Rev. 3 Product Description	Average PRODY
Smallest	19	Tanning And Dressing Of Leather; Manufacture Of Luggage, Handbags, Saddlery, Harness And Footwear	8637.316
	15	Manufacture Of Food Products And Beverages	9130.748
	16	Manufacture Of Tobacco Products	10410.57
	10	Manufacture Of Wood And Of Products Of Wood And Cork, Except Furniture; etc.	10411.58
	27	Manufacture Of Basic Metals	12063.41
Largest	32	Manufacture Of Radio, Television And Communication Equipment And Apparatus	23177.29
	30	Manufacture Of Office, Accounting And Computing Machinery	23603.89
	29	Manufacture Of Machinery And Equipment N.E.C.	23785.39
	33	Manufacture Of Medical, Precision And Optical Instruments, Watches And Clocks	24530.68
	23	Manufacture Of Coke, Refined Petroleum Products And Nuclear Fuel	25920.47

- the firm selects a subset of suppliers, $L_j^i \subset [0, L_k]$. We assume that every supplier can be selected by one firm only. The firm then pays w_k to the supplier irrespectively of the actual provision of intermediate goods;

- for every selected supplier $n \in L_j^i$ and for each unit of the final good $u \in \mathbb{R}^+$, the firm specifies which range R of intermediate goods - if any - has to be provided by that particular supplier for the that particular unit of the final good. Formally the firm designs the mapping

$$O_j^i(\cdot,\cdot) : L_j^i \times \mathbb{R}^+ \rightrightarrows \{R_{1,j}^i, \ldots, R_{N_j^i,j}^i, \emptyset\}$$

From the mapping $O_j^i(\cdot,\cdot)$ we can identify the units of the final-good-variety produced by firm j in sector i for which supplier n provides the intermediate good I. Calling the set of such units $\mathbb{U}_j^i(n, I)$ we have that

$$\mathbb{U}_j^i(n, I) = \{u \in \mathbb{R}^+ \mid \exists\, t \text{ such that } I \in R_{t,j}^i \wedge R_{t,j}^i \in O_j^i(n, u)\}$$

The successful provision indicator is given by

$$S_{k,j}^i(n, I, u) = \begin{cases} 1 & \text{with probability } e^{-\frac{1}{\theta_k}} \\ 0 & \text{with probability } 1 - e^{-\frac{1}{\theta_k}} \end{cases} \tag{18}$$

for every $n \in L_k$ and for every pair (u, I) such that $u \in \mathbb{U}_j^i(n, I)$. $S_{k,j}^i(n, I, u) = 1$ means that supplier n is able to provide the intermediate good I for the production of the u^{th} unit of the final good produced by j.

We make the following assumptions:

- a supplier that fails the provision of one intermediate good, fails also in the provision of all the others intermediate goods it was responsible for;

- the firm's organization applies to all the units of the final good;

- the firms cannot assign more than one supplier to one range of intermediate goods;

- suppliers do not interact among each others.

From this framework we can replicate the following important results that we take as given in the body of the paper.

Result Optimal organization implies that each supplier selected by a final firm provides one and only one range of intermediate goods for every final good?s unit it is responsible for.

Result Each final firm optimally allocates the same number of intermediate goods across ranges.

The proofs of these results consist of the same identical steps of the analogous results in Costinot [2009] and therefore we omit them here.

C Proofs

Proof of Proposition 3.3.2

(i) We need to show that the two sector profit functions cross each other once and only once, and that this happens for a positive value of profits. In equilibrium there must be production in both sectors to clear demand. Therefore there must exist two different productivity values ϕ_1 and ϕ_2 such that $\pi^S(\phi_1) > \pi^A(\phi_1) > 0$ and $\pi^A(\phi_2) > \pi^S(\phi_2) > 0$. Given observation 2 we just need to check the sign of the second derivative of the profit functions with respect to productivity. We remove the i index since our computations hold for both industries.

$$\pi'(\phi) = \frac{R}{2\sigma}(\sigma - 1)\Big[\frac{P\rho}{w\beta(\phi)}\Big]^{\sigma-2} \times \frac{-w\,\overbrace{\beta'(\phi)}^{<0}\,P\rho}{[w\beta(\phi)]^2} > 0$$

$$\pi''(\phi) = \frac{R}{2\sigma}(\sigma - 1)\Bigg\{(\sigma-2)\Big[\frac{P\rho}{w\beta(\phi)}\Big]^{\sigma-3}\Big[\frac{-w\beta'(\phi)P\rho}{[w\beta(\phi)]^2}\Big]^2 + \\ + \Big[\frac{P\rho}{w\beta(\phi)}\Big]^{\sigma-2}\Big[\overbrace{\frac{P\rho\{2[\beta'(\phi)]^2 - \overbrace{\beta''(\phi)}^{>0}\beta(\phi)\}}{[w\beta(\phi)]^3}}^{>0}\Big]\Bigg\} > 0 \quad (19)$$

Given that profit functions are both always convex it must be that if they cross they cross only once.

(ii) Existence in equilibrium of ϕ^e and ϕ^{eA} such that $\pi^S(\phi^e) = \pi^A(\phi^{eA}) = 0$ is a trivial corollary of Observation 2. We want to prove that $\phi^e < \phi^{eA}$. Assume by contradiction that $\phi^e > \phi^{eA}$. Then, $\forall\ \phi^+ > \phi^{SA}$ we have that $\pi^S(\phi^+) > \pi^A(\phi^+)$. Using the profit expression and after some algebra we get the following

$$\pi^S(\phi^+) > \pi^A(\phi^+) \iff \frac{P^S}{P^A} > \frac{\beta^S(\phi^+)}{\beta^A(\phi^+)} \quad (20)$$

Analogously, $\forall\ \phi^- < \phi^{SA}$ we have that $\pi^S(\phi^-) < \pi^A(\phi^-)$. As before

$$\pi^S(\phi^-) < \pi^A(\phi^-) \iff \frac{P^S}{P^A} < \frac{\beta^S(\phi^-)}{\beta^A(\phi^-)} \quad (21)$$

Combining the two conditions (20) and (21) we get

$$\frac{\beta^S(\phi^-)}{\beta^A(\phi^-)} > \frac{\beta^S(\phi^+)}{\beta^A(\phi^+)} \quad (22)$$

Defining the function $B(\phi) := \frac{\beta^S(\phi)}{\beta^A(\phi)}$ we can show that $B'(\phi) > 0$. This contradicts condition (22) and completes the proof.

(iii) From (i), (ii) and profit maximization.

Proof of Proposition 3.3.3

Detailed derivation of the Autarky equilibrium conditions

Average profits as functions of the entry and choice thresholds The average profits in the two sectors are defined by the following expressions:

$$\bar{\pi}^S = \frac{\int_{\phi^e}^{\phi^{SA}} \pi^S(\phi)g(\phi)\mathrm{d}\phi}{[G(\phi^{SA}) - G(\phi^e)]}$$

$$\bar{\pi}^A = \frac{\int_{\phi^{SA}}^{\infty} \pi^A(\phi)g(\phi)\mathrm{d}\phi}{[1 - G(\phi^{SA})]}$$

We can now derive average profits as functions of the productivity cutoffs:

$$\bar{r}^S = \underbrace{r^S(\tilde{\beta}^S(\phi^e, \phi^{SA}))}_{\text{or } r^S(\tilde{\beta}^S)} = \left[\frac{\tilde{\beta}^S(\phi^e, \phi^{SA})}{\beta^S(\phi^e)}\right]^{1-\sigma} \underbrace{r^S(\beta^S(\phi^e))}_{\text{or } r^S(\phi^e)} \tag{23}$$

$$\bar{r}^A = \underbrace{r^A(\tilde{\beta}^A(\phi^{SA}))}_{\text{or } r^A(\tilde{\beta}^A)} = \left[\frac{\tilde{\beta}^A(\phi^{SA})}{\beta^A(\phi^{SA})}\right]^{1-\sigma} \underbrace{r^A(\beta^A(\phi^{SA}))}_{\text{or } r^S(\phi^{SA})}$$

and

$$\bar{\pi}^S = \pi^S(\tilde{\beta}^S) = \left[\frac{\tilde{\beta}^S(\phi^e, \phi^{SA})}{\beta^S(\phi^e)}\right]^{1-\sigma} \frac{r^S(\phi^e)}{\sigma} - f$$

$$\bar{\pi}^A = \pi^A(\tilde{\beta}^A) = \left[\frac{\tilde{\beta}^A(\phi^{SA})}{\beta^A(\phi^{SA})}\right]^{1-\sigma} \frac{r^A(\phi^{SA})}{\sigma} - f$$

We still need an expression for $r^S(\phi^e)$ and $r^A(\phi^{SA})$ to reach our goal. We use the definitions of ϕ^e and ϕ^{SA}:

$$\pi^S(\phi^e) = 0 \iff r^S(\phi^e) = \sigma f$$

$$\pi^S(\phi^{SA}) = \pi^A(\phi^{SA}) \iff r^S(\phi^{SA}) = r^A(\phi^{SA})$$

Moreover, we notice that the revenue ratio of any two firms ϕ and ϕ' in sector i becomes

$$\frac{r^i(\phi)}{r^i(\phi')} = \left(\frac{\beta^i(\phi')}{\beta^i(\phi)}\right)^{(\sigma-1)} \tag{24}$$

Using the revenue ratio (24) we can substitute $r^S(\phi^{SA})$ with $r^S(\phi^e)[\beta^S(\phi^e)/\beta^S(\phi^{SA})]^{\sigma-1}$. Rearranging and substituting $r^S(\phi^e) = \sigma f$ we get

$$r^A(\phi^{SA}) = \left[\frac{\beta^S(\phi^{SA})}{\beta^S(\phi^e)}\right]^{1-\sigma} \sigma f$$

Eventually we can write average profits as

$$\bar{\pi}^S = f\left\{\left[\frac{\tilde{\beta}^S(\phi^e, \phi^{SA})}{\beta^S(\phi^e)}\right]^{1-\sigma} - 1\right\} \tag{25}$$

$$\bar{\pi}^A = f\left\{\left[\frac{\tilde{\beta}^A(\phi^{SA})}{\beta^A(\phi^{SA})}\frac{\beta^S(\phi^{SA})}{\beta^S(\phi^e)}\right]^{1-\sigma} - 1\right\}$$

Threshold (ϕ^{SA}) The choice threshold ϕ^{SA} is defined as the level of productivity that makes a final firm indifferent across sectors, i.e. such that

$$\pi^S(\phi^{SA}) = \pi^A(\phi^{SA})$$

which, using the expression for profits, becomes

$$\left\{\frac{P^S}{\beta^S(\phi^{SA})}\right\}^{\sigma-1} = \left\{\frac{P^A}{\beta^A(\phi^{SA})}\right\}^{\sigma-1}$$

using the aggregate price expressions and substituting the sectoral mass of firms we get

$$\left\{\frac{\tilde{\beta}^S(\phi^e,\phi^{SA})}{\beta^S(\phi^{SA})}\right\}^{\sigma-1}\frac{[1-G(\phi^e)]}{M[G(\phi^{SA})-G(\phi^e)]} = \left\{\frac{\tilde{\beta}^A(\phi^{SA})}{\beta^A(\phi^{SA})}\right\}^{\sigma-1}\frac{[1-G(\phi^e)]}{M[1-G(\phi^{SA})]}$$

and rearranging

$$\frac{\tilde{\beta}^S(\phi^e,\phi^{SA})^{\sigma-1}}{G(\phi^{SA})-G(\phi^e)} = \left[\frac{\beta^S(\phi^{SA})}{\beta^A(\phi^{SA})}\right]^{\sigma-1}\frac{\tilde{\beta}^A(\phi^{SA})^{\sigma-1}}{1-G(\phi^{SA})} \qquad (\phi^{SA})$$

The free-entry condition (FE) Given the firms dynamics as described in Melitz [2003] we derive the firm entry condition:

$$V = \frac{[1-G(\phi^e)]}{\delta}\bar{\pi} = f_e \qquad (26)$$

with V being the ex-ante (before the productivity realization) utility of the final firm, $\bar{\pi}$ the average ex-post profit in the economy and f_e the fixed cost that has to be paid initially to draw a productivity level. Decomposing the aggregate average profits we can rewrite the LHS of the above equation:

$$\frac{1}{\delta}\Big[[G(\phi^{SA})-G(\phi^e)]\bar{\pi}^S + [1-G(\phi^{SA})]\bar{\pi}^A\Big] = f_e \qquad (27)$$

Using the expressions for average profits (25) and (C) in the two sectors we have:

$$\begin{aligned}&\tfrac{f}{\delta}\Bigg\{[G(\phi^{SA})-G(\phi^e)]\left\{\left[\tfrac{\tilde{\beta}^S(\phi^e,\phi^{SA})}{\beta^S(\phi^e)}\right]^{1-\sigma} - 1\right\} + \\ &+[1-G(\phi^{SA})]\left\{\left[\tfrac{\tilde{\beta}^A(\phi^{SA})}{\beta^A(\phi^{SA})}\tfrac{\beta^S(\phi^{SA})}{\beta^S(\phi^e)}\right]^{1-\sigma} - 1\right\}\Bigg\} = f_e\end{aligned} \qquad (28)$$

We use equation (ϕ^{SA}) to derive an expression for $\left\{\frac{\tilde{\beta}^A(\phi^{SA})\beta^S(\phi^{SA})}{\beta^A(\phi^{SA})}\right\}^{1-\sigma}$, in particular we get

$$\left\{\frac{\tilde{\beta}^A(\phi^{SA})\beta^S(\phi^{SA})}{\beta^A(\phi^{SA})}\right\}^{1-\sigma} = \frac{[G(\phi^{SA})-G(\phi^e)]}{[1-G(\phi^{SA})]}\left\{\tilde{\beta}^S(\phi^e,\phi^{SA})\right\}^{1-\sigma} \qquad (29)$$

We get:

$$\frac{f}{\delta}\Bigg\{[G(\phi^{SA})-G(\phi^{e})]\Big\{\Big[\frac{\tilde{\beta}^S(\phi^e,\phi^{SA})}{\beta^S(\phi^e)}\Big]^{1-\sigma}-1\Big\}+$$
$$+[1-G(\phi^{SA})]\Big\{\frac{[G(\phi^{SA})-G(\phi^e)]}{[1-G(\phi^{SA})]}\Big[\frac{\tilde{\beta}^S(\phi^e,\phi^{SA})}{\beta^S(\phi^e)}\Big]^{1-\sigma}-1\Big\}\Bigg\}=f_e$$

$$\Longleftrightarrow \quad \frac{f}{\delta}\Bigg\{2[G(\phi^{SA})-G(\phi^{e})]\Big[\frac{\tilde{\beta}^S(\phi^e,\phi^{SA})}{\beta^S(\phi^e)}\Big]^{1-\sigma}$$
$$-[G(\phi^{SA})-G(\phi^{e})]-[1-G(\phi^{SA})]\Bigg\}=f_e$$

$$\Longleftrightarrow \quad \frac{G(\phi^{SA})-G(\phi^e)}{\tilde{\beta}^S(\phi^e,\phi^{SA})^{\sigma-1}}=\frac{1}{2}\Big[\delta f_e/f+1-G(\phi^e)\Big]\beta^S(\phi^e)^{1-\sigma} \qquad (FE)$$

The labor market condition We first solve the number of workers/suppliers needed at the equilibrium for the sector X. Given the technology in this sector, $S_x = X = \frac{\alpha_x \mathcal{R}}{p_x}$. With p_x normalized to 1 we have

$$S_x = \alpha_x \mathcal{R} = \alpha_x w L$$

Labor is used to enter the production process as well as to produce. The economy has a population of L workers. S^e denotes the total amount of suppliers used in the entry process which is not sector specific and S_i^p denotes the total amount of suppliers used for production in sector i. The labor market clearing conditions are:

$$S^e + S^p = L - S_x = (1-\alpha_x)L \quad \text{with} \quad S^p = S_S^p + S_A^p$$

Every period, each firm in sector i, with a productivity level ϕ needs f plus $\beta^i(\phi)y^i(\phi)$ suppliers to produce the quantity $y^i(\phi)$ of goods. Total production-labor demand in sector i would be

$$S_i^p = M^i \bar{S}_i^p \quad \forall i$$

where L_i^p denotes average production-labor demand in sector i whose expression is

$$\bar{S}_S^p = \frac{1}{[G(\phi^{SA})-G(\phi^e)]}\left[\int_{\phi^e}^{\phi^{SA}} \beta^s(\phi)y^s(\phi)g(\phi)d\phi + f\right]$$

$$\bar{S}_A^p = \frac{1}{[1-G(\phi^{SA})]}\left[\int_{\phi^{SA}}^{\infty} \beta^A(\phi)y^A(\phi)g(\phi)d\phi + f\right]$$

Given the following expressions for supply and number of final firms

$$y^i(\phi) = \frac{r^i(\phi)}{p^i(\phi)} = \frac{R}{2}\Big[\frac{\rho}{\beta^i(\phi)}\Big]^{\sigma}(P^i)^{\sigma-1}$$

$$M^S = \frac{[G(\phi^{SA})-G(\phi^e)]}{[1-G(\phi^e)]}M \quad M^A = \frac{[1-G(\phi^{SA})]}{[1-G(\phi^e)]}M$$

the final labor market clearing condition is:

$$\Big(\rho\Big)^{\sigma}\frac{M\mathcal{R}}{[1-G(\phi^e)]}\Big[\alpha_S\int_{\phi^e}^{\phi^{SA}}\frac{(P^S)^{\sigma-1}}{\beta^S(\phi)^{\sigma}}g(\phi)d(\phi)+$$

$$+\alpha_A\int_{\phi^{SA}}^{\infty}\frac{(P^A)^{\sigma-1}}{\beta^A(\phi)^{\sigma}}g(\phi)d(\phi)\Big]+Mf+M_ef_e=(1-\alpha_x)L$$

L is exogenously given as the total number of workers in the economy.

Body of the proof

The equilibrium thresholds solve the following system of equations:

$$\begin{cases} (FE) \qquad V(\phi^{e*},\phi^{SA*})=f_e \\ (\text{def } \phi^{e*}) \qquad \pi^S(\phi^{e*})=0 \\ (\text{def } \phi^{SA*}) \qquad \pi^S(\phi^{SA*})=\pi^A(\phi^{SA*}) \\ \text{labor and good market clearing conditions} \end{cases} \tag{30}$$

All the equilibrium endogenous variables can be pinned down from the vector of thresholds (ϕ^{e*},ϕ^{SA*}). In particular, the number of firms entering and exiting production is given by the stationary equilibrium equation and pined down by the labor market condition.

We need to show that the following system has at least one solution (ϕ^e_*,ϕ^{SA}_*)

$$\begin{cases} (\phi^{SA}) \qquad \frac{\tilde{\beta}^S(\phi^e,\phi^{SA})^{\sigma-1}}{G(\phi^{SA})-G(\phi^e)}=\Big[\frac{\beta^S(\phi^{SA})}{\beta^A(\phi^{SA})}\Big]^{\sigma-1}\frac{\tilde{\beta}^A(\phi^{SA})^{\sigma-1}}{1-G(\phi^{SA})} \\ (FE) \qquad \frac{G(\phi^{SA})-G(\phi^e)}{\tilde{\beta}^S(\phi^e,\phi^{SA})^{\sigma-1}}=\frac{1}{2}\Big[\delta f_e/f+1-G(\phi^e)\Big]\beta^S(\phi^e)^{1-\sigma} \end{cases} \tag{31}$$

Define the right hand side (RHS) of (ϕ^{SA}) as $h:\phi^{SA}\longrightarrow h(\phi^{SA})$. Consider the following:

i. $\Big[\frac{\beta^S(\phi^{SA})}{\beta^A(\phi^{SA})}\Big]^{\sigma-1}$ is strictly increasing in ϕ^{SA};

ii. $\frac{\tilde{\beta}^A(\phi^{SA})^{\sigma-1}}{1-G(\phi^{SA})}=1/\int_{\phi^{SA}}^{\infty}\beta^A(\phi)^{1-\sigma}g(\phi)\mathrm{d}\phi$ is strictly increasing in ϕ^{SA}.

We conclude that $h'(\phi^{SA})>0$.

Define the RHS of (FE) as $m:\phi^e\longrightarrow m(\phi^e)$. If a solution of (31) exists it has to satisfy the following equation

$$h(\phi^{SA})=\frac{1}{m(\phi^e)} \tag{32}$$

Given the strict monotonicity of h we can use (32) to write the equilibrium value of ϕ^{SA} as a function of ϕ^e:

$$\phi^{SA}=h^{-1}\left(\frac{1}{m(\phi^e)}\right)=:H(\phi^e). \tag{33}$$

We will now show that (31) admits at least one solution of the kind $(\phi^e_*, H(\phi^e_*))$. Consider (FE) and rewrite it as an equation in the only unknown ϕ^e using (33)

$$k(\phi^e) := \int_{\phi^e}^{H(\phi^e)} \beta^S(\phi)^{1-\sigma} g(\phi)\mathrm{d}\phi - m(\phi^e) = 0 \tag{34}$$

The following properties hold:

i. $k(\cdot)$ is continuous on its domain $[0, +\infty)$;

ii. $\lim_{\phi^e \to 0} k(\phi^e) \geq 0$;

iii. $\lim_{\phi^e \to \infty} k(\phi^e) = -\infty$.

We conclude that (34) has at least one solution applying the intermediate value theorem to $k(\cdot)$. This implies that also (ϕ^{SA}) admits at least a solution of the kind $(\phi^e_*, H(\phi^e_*))$:

$$(\phi^{SA}) \iff 1/\int_{\phi^e}^{H(\phi^e)} \beta^S(\phi)^{1-\sigma} g(\phi)\mathrm{d}\phi = h(H(\phi^e))$$

This completes the proof.

Proof of Proposition 3.3.4

Detailed derivation of the Free-Trade equilibrium conditions for one country

Average profits as functions of the entry and choice thresholds The same as under autarky.

Threshold (ϕ^{SA}) The choice threshold ϕ^{SA} is defined as the level of productivity that makes a final firm indifferent across sectors, i.e. such that

$$\pi^S(\phi^{SA}) = \pi^A(\phi^{SA})$$

which, using the expression for profits, becomes

$$\left\{\frac{P^S}{\beta^S(\phi^{SA})}\right\}^{\sigma-1} = \left\{\frac{P^A}{\beta^A(\phi^{SA})}\right\}^{\sigma-1} \tag{$\phi^{SA,FT}$}$$

The free-entry condition (FE) Given the firms dynamics as described in Melitz [2003] we derive the firm entry condition:

$$V = \frac{[1 - G(\phi^e)]}{\delta}\bar{\pi} = f_e \tag{35}$$

with V being the ex-ante (before the productivity realization) utility of the final firm, $\bar{\pi}$ the average ex-post profit in the economy and f_e the fixed cost that has to be paid initially to draw a productivity level. Decomposing the aggregate average profits we can rewrite the LHS of the above equation:

$$\frac{1}{\delta}\Big[[G(\phi^{SA})-G(\phi^{e})]\bar{\pi}^{S}+[1-G(\phi^{SA})]\bar{\pi}^{A}\Big]=f_e$$

Using the expressions for average profits (25) and (C) in the two sectors we have:

$$\begin{aligned}&\tfrac{f}{\delta}\Bigg\{[G(\phi^{SA})-G(\phi^{e})]\Big\{\Big[\tfrac{\tilde{\beta}^{S}(\phi^{e},\phi^{SA})}{\beta^{S}(\phi^{e})}\Big]^{1-\sigma}-1\Big\}+\\&+[1-G(\phi^{SA})]\Big\{\Big[\tfrac{\tilde{\beta}^{A}(\phi^{SA})}{\beta^{A}(\phi^{SA})}\tfrac{\beta^{S}(\phi^{SA})}{\beta^{S}(\phi^{e})}\Big]^{1-\sigma}-1\Big\}\Bigg\}=f_e\end{aligned}\qquad (FE,FT)$$

The labor market condition We first solve the number of workers needed at the equilibrium for the sector X. Given the technology in this sector, $S_X=X=\frac{\alpha_X\mathcal{R}}{p_X}$. With p_X normalized to 1 we have

$$S_X=\alpha_X\mathcal{R}=\frac{\alpha_X R}{1-\alpha_X}$$

Moreover the amount of workers needed for the pre-production stage is by construction

$$S^e=M_e f_e$$

where M_e will be given by steady state stability.

The labor market clearing conditions is thus:

$$L=S^e+S^p+S_X\quad\text{with}\quad S^p=S^p_S+S^p_A$$

Every period, each firm in sector i, with a productivity level ϕ needs f plus $\beta^i(\phi)y^i(\phi)$ production units to produce the quantity $y^i(\phi)$ of goods. Total production-labor demand in sector i would be

$$S^p_i=M^i\bar{S}^p_i\quad\forall i$$

where $\bar{L}^p_i$ denotes average production-labor demand in sector i whose expression is

$$\bar{S}^p_S=\frac{1}{[G(\phi^{SA})-G(\phi^{e})]}\left[\int_{\phi^e}^{\phi^{SA}}\beta^s(\phi)y^s(\phi)g(\phi)\mathrm{d}\phi+f\right]$$

$$\bar{S}^p_A=\frac{1}{[1-G(\phi^{SA})]}\left[\int_{\phi^{SA}}^{\infty}\beta^A(\phi)y^A(\phi)g(\phi)\mathrm{d}\phi+f\right]$$

Given the following expressions for supply and number of firms

$$y^i(\phi)=\frac{r^i(\phi)}{p^i(\phi)}=\frac{R}{2}\Big[1+\frac{R_{-k}}{R}\Big]\Big[\frac{\rho}{w}\Big]^{\sigma}(P^i)^{\sigma-1}[\beta^i(\phi)]^{-\sigma}$$

$$M^S=\frac{[G(\phi^{SA})-G(\phi^{e})]}{[1-G(\phi^{e})]}M\quad M^A=\frac{[1-G(\phi^{SA})]}{[1-G(\phi^{e})]}M$$

we can write

$$S_S^p = \frac{M}{[1-G(\phi^e)]}\left[\int_{\phi^e}^{\phi^{SA}} \beta^s(\phi)\frac{R}{2}\Big[1+\frac{R_{-k}}{R}\Big]\Big[\frac{\rho}{w}\Big]^{\sigma}(P^S)^{\sigma-1}[\beta^S(\phi)]^{-\sigma}g(\phi)\mathrm{d}\phi + f\right]$$

$$= \frac{M}{[1-G(\phi^e)]}\left[\frac{R}{2}\Big[1+\frac{R_{-k}}{R}\Big]\Big[\frac{\rho}{w}\Big]^{\sigma}(P^S)^{\sigma-1}\int_{\phi^e}^{\phi^{SA}}[\beta^s(\phi)]^{1-\sigma}g(\phi)\mathrm{d}\phi + f\right]$$

$$= \frac{M}{[1-G(\phi^e)]}\left[\frac{R}{2}\Big[1+\frac{R_{-k}}{R}\Big]\Big[\frac{\rho}{w}\Big]^{\sigma}(P^S)^{\sigma-1}[\tilde{\beta}^S(\phi^e,\phi^{SA})]^{1-\sigma}[G(\phi^{SA})-G(\phi^e)] + f\right]$$

$$= \frac{Mf}{[1-G(\phi^e)]} + \frac{M}{[1-G(\phi^e)]}\frac{R}{2}\Big[1+\frac{R_{-k}}{R}\Big]\Big[\frac{\rho}{w}\Big]^{\sigma}(P^S)^{\sigma-1}[\tilde{\beta}^S(\phi^e,\phi^{SA})]^{1-\sigma}[G(\phi^{SA})-G(\phi^e)]$$

Analogously

$$S_A^p = \frac{Mf}{[1-G(\phi^e)]} + \frac{M}{[1-G(\phi^e)]}\frac{R}{2}\Big[1+\frac{R_{-k}}{R}\Big]\Big[\frac{\rho}{w}\Big]^{\sigma}(P^A)^{\sigma-1}[\tilde{\beta}^A(\phi^{SA})]^{1-\sigma}[1-G(\phi^{SA})]$$

Thus

$$S_S^p + S_A^p = \frac{2Mf}{[1-G(\phi^e)]} + \frac{M}{[1-G(\phi^e)]}\frac{R}{2}\Big[1+\frac{R_{-k}}{R}\Big]\Big[\frac{\rho}{w}\Big]^{\sigma}\times$$

$$\times\Big\{\Big[\frac{P^S}{\tilde{\beta}^S(\phi^e,\phi^{SA})}\Big]^{\sigma-1}[G(\phi^{SA})-G(\phi^e)] + \Big[\frac{P^A}{\tilde{\beta}^A(\phi^{SA})}\Big]^{\sigma-1}[1-G(\phi^{SA})]\Big\}$$

Moreover in equilibrium

$$R = w_k(L - S_X)$$

which plugging the expression for L_X and rearranging becomes

$$R = \Big(\frac{1-\alpha_X}{1-\alpha_X+w_k\alpha_X}\Big)w_k L$$

Given our assumptions on the parameters we have that R is the same in both countries. We can thus simplify our production-labor demand expressions

$$S_S^p + S_A^p = \frac{2Mf}{[1-G(\phi^e)]} + \frac{M}{[1-G(\phi^e)]}\Big(\frac{1-\alpha_X}{1-\alpha_X+w\alpha_X}\Big)wL\Big[\frac{\rho}{w}\Big]^{\sigma}\times$$

$$\times\Big\{\Big[\frac{P^S}{\tilde{\beta}^S(\phi^e,\phi^{SA})}\Big]^{\sigma-1}[G(\phi^{SA})-G(\phi^e)] + \Big[\frac{P^A}{\tilde{\beta}^A(\phi^{SA})}\Big]^{\sigma-1}[1-G(\phi^{SA})]\Big\}$$

Using the fact that in equilibrium $w = 1$ we have

$$S_S^p + S_A^p = \frac{2Mf}{[1-G(\phi^e)]} + \frac{M(1-\alpha_X)L}{[1-G(\phi^e)]}(\rho)^{\sigma}\times$$

$$\times\Big\{\Big[\frac{P^S}{\tilde{\beta}^S(\phi^e,\phi^{SA})}\Big]^{\sigma-1}[G(\phi^{SA})-G(\phi^e)] + \Big[\frac{P^A}{\tilde{\beta}^A(\phi^{SA})}\Big]^{\sigma-1}[1-G(\phi^{SA})]\Big\}$$

The final labor market clearing condition for country k is:

$$L - \alpha_X L - M_e f_e = \frac{2Mf}{[1-G(\phi^e)]} + \frac{M(1-\alpha_X)L}{[1-G(\phi^e)]}(\rho)^\sigma \times$$
$$\times\left\{ \left[\frac{P^S}{\tilde{\beta}^S(\phi^e,\phi^{SA})}\right]^{\sigma-1}[G(\phi^{SA}) - G(\phi^e)] + \left[\frac{P^A}{\tilde{\beta}^A(\phi^{SA})}\right]^{\sigma-1}[1 - G(\phi^{SA})]\right\} \qquad (LMC)$$

This equation contains the following unknowns: M, M_e, ϕ^e, ϕ^{SA} and the two price aggregates. We can easily replace M_e with M using the steady state stability condition.

Body of the proof

Given the above derivations, all the equilibrium quantities can be derived from a system of 8 equations in the following 8 unknowns $\{\phi^e_H, \phi^e_F, \phi^{SA}_H, \phi^{SA}_F, P^S, P^A, M_H, M_F\}$. The 8 equations are given by $(\phi^{SA,FT})$, (FE, FT) and (LMC) for both countries plus the expression aggregate price indexes for both sectors (they are equal across countries). The system admits one and only one solution.

Proof of Proposition 3.3.5

We assume that country H has the best institutions. By definition of the choice threshold $\phi^{SA,k}$ in country k $\in \{H, F\}$, we have:

$$\pi^S_k(\phi^{SA}_k) = \pi^A_k(\phi^{SA}_k) \Rightarrow \frac{P^S_k}{P^A_k} = \frac{\beta^S_k(\phi^{SA}_k)}{\beta^A_k(\phi^{SA}_k)}$$

The marginal cost ratio $(\beta^S(\phi)/\beta^A(\phi))$ is increasing in ϕ and in θ as shown in the following steps:

$$\frac{\partial(\beta^S/\beta^A)}{\partial\phi} = \frac{\frac{\partial\beta^S}{\partial\phi}\beta^A - \frac{\partial\beta^A}{\partial\phi}\beta^S}{(\beta^A)^2}$$

$$\frac{\partial(\beta^S/\beta^A)}{\partial\phi} > 0 \iff \frac{\partial\beta^S}{\partial\phi}\beta^A - \frac{\partial\beta^A}{\partial\phi}\beta^S > 0 \iff \frac{\partial\beta^S}{\partial\phi}/\beta^S > \frac{\partial\beta^A}{\partial\phi}/\beta^A$$

and by the chain rule, given that β^i takes only real, strictly positive values

$$\iff \frac{\partial \ln\beta^S}{\partial\phi} > \frac{\partial \ln\beta^A}{\partial\phi} \qquad (36)$$

Given that a strictly increasing transformation does not change the behavior of the derivative's sign we have that $\frac{\partial\beta^i}{\partial\phi} < 0$ implies $\frac{\partial ln\beta^i}{\partial\phi} < 0$. Moreover,

$$\frac{\partial \ln \beta^i}{\partial \phi \partial z^i} = \frac{-2\phi h\theta - z^i - z^i\sqrt{1+\frac{4\phi h\theta}{z^i}}}{2\phi^2 h\theta z^i\sqrt{1+\frac{4\phi h\theta}{z^i}}} < 0$$

We conclude that inequality (36) is verified. Analogously we can show that (β^S/β^A) is increasing in θ, given that

$$\frac{\partial \ln \beta^i}{\partial \theta \partial z^i} = \frac{-2\phi h\theta - z^i + z^i\sqrt{1+\frac{4\phi h\theta}{z^i}}}{2\phi h\theta^2 z^i\sqrt{1+\frac{4\phi h\theta}{z^i}}} < 0$$

Given this intermediate result on the marginal cost ratio we have the following inequality under the autarky equilibrium

$$\frac{\beta_S^H(\phi_H^{SA*})}{\beta_A^H(\phi_H^{SA*})} > \frac{\beta_S^F(\phi_F^{SA*})}{\beta_A^F(\phi_F^{SA*})}$$

Consequently we get $\frac{P_H^S}{P_H^A} > \frac{P_F^S}{P_F^A}$ for the autarky equilibrium. This defines a comparative advantage for country H to produce varieties of the advanced sector (A) and therefore completes the proof.

Proof of Proposition 3.3.6

Compared to the autarky choice thresholds ϕ^{SA*}, we can show that the free-trade choice threshold $\phi^{SA,FT}$ decreases in the country with the comparative advantage in the advanced sector and increases in the other country. We keep assuming that country H has the best institutions and therefore the comparative advantage in sector A. Proposition 3.3.5 gives us the following condition

$$\frac{P_F^{S*}}{P_F^{A*}} < \frac{P^{S,FT}}{P^{A,FT}} < \frac{P_H^{S*}}{P_H^{A*}}$$

We use the equality of profits at the choice thresholds in autarky ϕ^{SA*} and in free-trade $\phi^{SA,FT}$ for each country

$$\pi_k^S(\phi_k^{SA*}) = \pi_k^A(\phi_k^{SA*}) \quad \Rightarrow \quad \frac{P_k^{S*}}{P_k^{A*}} = \frac{\beta_k^S(\phi_k^{SA*})}{\beta_k^A(\phi_k^{SA*})}$$

$$\pi_k^S(\phi_k^{SA,FT}) = \pi_k^A(\phi_k^{SA,FT}) \quad \Rightarrow \quad \frac{P^{S,FT}}{P^{A,FT}} = \frac{\beta_k^S(\phi_k^{SA,FT})}{\beta_k^A(\phi_k^{SA,FT})}$$

and the result that the function β^S/β^A is strictly increasing to get the following implications

$$\frac{P^{S,FT}}{P^{A,FT}} < \frac{P_H^{S*}}{P_H^{A*}} \quad \Rightarrow \quad \frac{\beta_H^S(\phi_H^{SA,FT})}{\beta_H^A(\phi_H^{SA,FT})} < \frac{\beta_H^S(\phi_H^{SA*})}{\beta_H^A(\phi_H^{SA*})} \quad \Rightarrow \quad \phi_H^{SA,FT} < \phi_H^{SA*}$$

The choice threshold is proved to decrease in the country with the comparative advantage in the advanced sector. We use a similar reasoning for the other country.

D Technical details for the numerical exercise about the free-trade equilibrium

Given the many similarities of our modeling framework to that in Bernard et al. [2007], our choice of parameters follows closely the numerical exercise in that paper. We assume a Pareto distribution for ex-ante productivity with shape parameter equal to 3.4 and scale parameter equal to 1. We set elasticity of substitution $\sigma = 3.8$, sunk entry costs $f_e = 2$, fixed production cost $f = 0.1$ and probability of exogenous firm death $\delta = 0.025$. Moreover, we posit equal consumers' expenditure share across sectors, which, given the presence in our model of a technical homogeneous good sector, implies $\alpha = 1/3$. We assume the working hours endowment $h = 1$ and the total number of suppliers/workers $L = 100$. In terms of sector complexity we choose $z^A = 40$ and $z^S = 5$. Our results are robust across other levels of complexity proximity across sectors. Finally, we set the level of institutions in the less fragile country F, $\theta_H = 100$. We perform our simulation across values of the θ_F in the closed interval $[10, 90]$. Our results are robust across other levels of institutions, for instance $\theta_H = 10$ and θ_F varying in the interval $[1, 9]$.

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