ABSTRACT

Title of dissertation: ESSAYS IN TRADE AND UNCERTAINTY

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Firms face uncertainty on many different dimensions: demand level, productivity and input prices, taxes and regulations. Furthermore, some argue that uncertainty is higher in recessions (cf. Bloom et al. (2012)) and one of the causes of the slow recovery during the recent Great Recession (cf. Stock and Watson (2012) and Baker et al. (2012)). However, most trade models assume uncertainty away by considering a deterministic framework or introduce uncertainty in a very limited way.

In this dissertation, I argue that uncertainty can be particularly important for two topics in international trade: (i) firms' global sourcing decisions and (ii) firms' exports decision when facing multiple sources of uncertainty. Firms' decisions to enter new foreign markets, exit from foreign markets that they are currently serving and whether to vertically integrate or outsource with foreign firms (i.e. their global sourcing decisions). Not only do these decisions require high sunk costs (cf. Roberts and Tybout (1997) and Antràs and Helpman (2004)) but they are also subject to an additional set of uncertain conditions, e.g. exchange rates, foreign market

conditions, and foreign policies. In particular, these potential multiple sources of uncertainty can work as an amplification mechanism, specially during recessions.

The first chapter discusses the key insights that motivates my dissertation. The second chapter develops a dynamic model of international trade with heterogeneous firms who endogenously decide when to start exporting to foreign markets, under which sourcing scheme, and when to exit foreign markets in a framework with foreign demand uncertainty. The third chapter focuses on empirically evaluating the theoretical model of the previous chapter using U.S. firm-level data. I find that integration reduces the probability that a firm exits by as much as 8%, while uncertainty increases this probability by 23%. The fourth chapter looks into the interaction between demand and policy uncertainty during the Great Trade Collapse and is joint work with Kyle Handley and Nuno Limao. We examine if the resulting change in policy uncertainty initially deepened the collapse and then helped reverse it, when the worst fears of protection were not realized.

ESSAYS IN TRADE AND UNCERTAINTY

by

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Dedication

Le dedico mi tesis a Capu, Panci y Adri, quienes hicieron esto posible.

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List of Abbreviations

AH	Antràs and Helpman (2004)
ASM	Annual Survey of Manufactures
BEA	Bureau of Economic Analysis
CES	Constant Elasticity of Substitution
GATT	General Agreement on Tariffs and Trade
CM	Census of Manufactures
DOC	Department of Commerce
EIN	Employer Identification Number
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GTC	Great Trade Collapse
HL	Handley and Limão (Forthcoming)
IMF	International Monetary Fund
LBD	Longitudinal Business Database
LPM	Linear Probability Model
NAICS	North American Industrial Classification System
OECD	Organization of States for Economic Development
PTA	Preferential Trade Agreement
TPU	Trade Policy Uncertainty
UNCTAD	United Nations Conference on Trade and Development
U.S.	United States of America
WTO	World Trade Organization

Chapter 1: Introduction

International trade takes place between firms that can either have an ownership relationship (i.e. related party trade) or not (i.e. arm's length trade). These alternative ways of trading imply differences in setup costs and in the degree of bargaining power between the trading parties, which in turn can affect how firms react to exogenous shocks. Despite the fact that trade between related parties represented 28.2% of U.S. exports and 50.2% of U.S. imports in 2012, most of the existing international trade models assume away these differences. Understanding both the determinants of global sourcing decisions (i.e. trade with a related party or at arm's length), and exploring whether different global sourcing schemes generate heterogeneous responses to shocks is particularly relevant in uncertain environments where shocks are frequent and/or large, such as the recent fall in international trade flows during the Great Recession (a phenomenon known as the Great Trade Collapse, GTC).

This paper makes the case that it is important to understand firms' sourcing decisions under uncertainty, an unexplored topic in the literature. First, uncertainty has played a central role in recent policy debates on the causes of the GTC: some argue that uncertainty is higher in recessions in general (cf. Bloom et al. (2012)), and that elevated uncertainty was one of the causes of the slow recovery during the recent Great Recession (cf. Stock and Watson (2012) and Baker et al. (2012)).[1] Second, uncertainty is more relevant if firms face significant sunk costs, as is the case for firms that engage in international trade in general (cf. Das, Roberts, and Tybout (2007)) and global sourcing strategies in particular (cf. Antràs and Helpman (2004)). Third, exporting firms are subject to additional sources of uncertainty, such as exchange rates and foreign market conditions. Fourth, the impact of uncertainty on sourcing decisions has yet not been explored in the literature. Fifth, heterogeneous responses to aggregate shocks across global sourcing strategies can potentially be important in terms of welfare and trade dynamics.

To address these issues, I first show that U.S. firms' adjustment to the GTC differs across sourcing schemes. Then, I develop a dynamic model with endogenous entry and *exit* combined with global sourcing decisions in which firms face demand uncertainty. Next, I construct a theory-based uncertainty measure and take the model predictions to U.S. firm-level exports data for the period 2002-2011, with special focus on the exit decision. Finally, I use the estimated results to quantify the role of uncertainty and sourcing decisions. In the counterfactual analysis, I find that if all firms behaved as related parties, the 2009 collapse of U.S. exports would have been 10% smaller. Also, the counterfactual analysis shows that reducing foreign demand uncertainty for all firms to the first tercile of the uncertainty would

[1] For example, in words of Olivier Blanchard, chief economist at the IMF *"[Uncertainty] is largely behind the dramatic collapse in demand. [...] Given the uncertainty, why build a new plant, or introduce a new product now? Better to pause until the smoke clears."* Similarly, John C. Williams, president of Federal Reserve Bank of San Francisco, remarks that *"There is pretty strong evidence that the rise in uncertainty is a significant factor holding back the pace of recovery now."*

have reduced the 2009 collapse in U.S. exports by 8%.

The data required to examine the impact of uncertainty on global sourcing decisions and the impact of sourcing on responses to shocks are highly demanding. In addition to requiring detailed information on U.S. firms' export and import transactions at high frequency, such a task requires information on the ownership relationships between U.S. trading firms and their foreign partners. This information is naturally scarce. However, U.S. firm-level international trade data is particularly well-suited for the task under consideration, because it is one of the few datasets that records the relationship between trading firms for *every* transaction, and thus avoids the need to limit the analysis to a subsample of firms or to impose other restrictive assumptions.[2] Moreover, to the best of my knowledge, this paper is the first to exploit this data in order to analyze the heterogeneity in the impact of shocks across sourcing strategies.

Uncertainty rose sharply during the GTC. Bloom et al. (2012) show that both microeconomic uncertainty and macroeconomic uncertainty show countercyclical behavior for the period 1972-2010. According to Bloom et al. (2012), microeconomic uncertainty increased by between 76% and 152% during the GTC, depending on the measure of uncertainty used, while macroeconomic uncertainty increased by 23%. These remarkable increases of uncertainty support the claim of policy makers that elevated uncertainty was a cause of the GTC. Given the significant role of uncertainty in policy debates and the evidence of its countercyclical behavior, it is striking that

[2]For example, Corcos et al. (2009) used a survey of manufacturing firms that have foreign affiliates and trade more than 1 million euros in 1999.

uncertainty has not been much explored as one of the potential factors behind the GTC in the academic trade literature. A notable exception is Carballo, Handley, and Limão (2013), who consider the impact of trade policy and economic uncertainty on the firm export decision. This current paper expands on their work by constructing a model where demand uncertainty plays a significant role. The interaction between uncertainty and global sourcing decisions is then examined. Finally, I quantify the impact of uncertainty and heterogeneity of responses by sourcing decision during the GTC.

Carballo, Handley, and Limão (2013) show that the extensive margin accounts for roughly one third of the collapse in U.S. exports during the GTC. Furthermore, the exit margin is the main force driving the adjustment along the extensive margin during this period. Most trade models are ill suited to understand the dynamics of episodes such as the GTC, since they are primarily focused on entry and disregard the exit decision. In order to overcome this limitation, I introduce an *endogenous* exit decision into a model where firms also make entry and sourcing decisions. Furthermore, I explore the impact of sourcing strategies on firms' exit decision and find that related party trade is more resilient to a large negative shock, such as the GTC.

As is standard in trade models, the model features heterogeneous firms that have to pay a sunk cost to start exporting (see Melitz (2003)). Following Antràs and Helpman (2004), I introduce incomplete contracts to model the sourcing decision and assume that integrating with a foreign firm requires to pay another sunk cost.[3] Firms also have to pay a fixed per period cost, which generates an endoge-

[3] Transaction costs and incentive system are alternative approaches used to model the integration

nous exit decision. Additionally, I impose that the final good is consumed in the foreign destination.[4] Finally, I introduce uncertainty by assuming that firms do not know the future foreign demand level. In this setting, I show that uncertainty leads firms to delay sunk investments, such as entry and integration, and makes them less responsive to demand level changes. Firms internalize that demand is going to change in the future, and thus they do not fully respond to the current demand level. I further prove that sourcing strategies affect the exit decision: related parties wait longer before leaving foreign markets. This impact arises due to the combination of uncertainty, additional sunk costs needed to export to a related party, and the higher profit flow associated with integration. Moreover, I prove that uncertainty generates heterogeneity on the impact of current demand changes across organizational forms and margins, therefore breaking the homogeneous impact of the deterministic framework. The reason behind this result is that in a deterministic framework, profits are log-separable in the current demand condition. However, this log-separability does not hold in a stochastic environment, wherein firms' response to changes in current demand level are affected by their sourcing strategy.

This work contributes to the literature studying multinationals broadly (see Antràs and Yeaple (2013) for a recent survey) and more specifically to the literature on multinationals and option value. Early work by Rob and Vettas (2003) focuses on the choice between FDI and exports when demand growth is uncertain. Fillat

decision in the international trade literature. See Grossman and Helpman (2004) for an incentive system approach and McLaren (2000) and Grossman and Helpman (2002) for a transaction costs approach.

[4] According to Antràs and Yeaple (2013) a very small fraction of output is exported from foreign affiliates back to the headquarter's country. Furthermore, Ramondo, Rappoport, and Ruhl (2011) show that most foreign affiliates sell all their output in their host country.

and Garetto (2010) analyze the relationship between stock market return and risk exposure of multinationals in a context of option value. More recently, Ramondo, Rappoport, and Ruhl (2013) consider the decision between FDI and exports in two period model with demand uncertainty. These papers focus on the choice between multinational production or exporting as substitutes. In contrast, my work allows for intra-firm exports and models firms' decisions between exporting through related parties or at arm's length. In this sense, this paper is closer to Irarrazabal, Moxnes, and Opromolla (2013), who consider multinational production with intra-firm trade in a static context.[5] However, they focus on geography and multinational production and do not have information on whether transactions take place through related parties or arm's length trade. Thus, this research adds to the literature by analyzing, for the first time, the role of demand uncertainty in global sourcing decisions using U.S. firm level export data for the period 2002-2011. The analysis is performed for the whole population of U.S. exporting firms, not just a sample, and without imposing any assumption on the organizational choice, since U.S. Census Bureau data provides the information about the type of relationship between trading firms.

This paper also contributes to the literature on the GTC in two ways.[6] First, this paper highlights differences across organizational forms in the dynamics of U.S. firm-level trade during the GTC and its recovery. Second, this research evaluates the contribution of uncertainty and its interaction with global sourcing decisions in explaining the dynamics of U.S. firms' exports during the GTC.

[5]See also Keller and Yeaple (2013) who consider multinational production with tangible and intangible intra-firm trade.

[6]See Bems, Johnson, and Yi (2013) for a survey of the literature studying the GTC.

1.1 Data and Descriptive Evidence

In this section, I use data on firms' exports and characteristics to present descriptive evidence on the recent Great Trade Collapse (GTC). I focus on differences in dynamics across organizational forms during this period. First, I present aggregate evidence about related parties and arm's length trade. Second, I show evidence from several decomposition exercises that highlights differences in margins of adjustment across organizational forms when firms respond to shocks in foreign markets.

1.1.1 Data Description

The main data sources I use are the Longitudinal Foreign Trade Transactions Database (LFTTD) and the Longitudinal Business Database (LBD) for the period 2002-2011. Both databases are from the U.S. Census Bureau. The LFTTD provides detailed information on U.S. firms' export transactions with product and destination disaggregation. The LFTTD has a longitudinal identifiers variable that allows me to track firms over time. The LBD, meanwhile, is constructed based on administrative data and provides firm-level information over time such as employment, age and sector of activity.

The paper focuses on the sourcing decisions of U.S. exporters. Hence information about the ownership relationship between trading parties is key. Importantly, the LFTTD has a variable that allows one to identify whether the U.S. exporter and the foreign firm involved in a transaction are related parties. According to the

Foreign Trade Regulations of the Department of Commerce, a related party export transaction is "*a transaction involving trade between a U.S. principal party in interest and an ultimate consignee where either party owns directly or indirectly 10 percent or more of the other party.*" (see Foreign Trade Regulations, 2013). This is mandatory information that should be included in the *automatic electronic system* data filing for export transactions (see Ruhl (2013)).[7] Thus, the LFTTD provides a complete picture on the sourcing decisions of U.S. exporters at high frequency and over time, and avoids the problems that other studies in the literature have faced when considering the sourcing decision of firms. For example, Corcos et al. (2009) use a small sample of 4,305 French firms from a 1999 survey to analyze the determinants of sourcing decisions.

Other sources of information used in the paper include uncertainty measures introduced by Baker and Bloom [2013] and the International Financial Statistics from the International Monetary Fund for country characteristics. Additionally, I use the product concordances for the Harmonized Schedule developed by Pierce and Schott (2009) in order to avoid capturing spurious changes along the extensive margin due to schedule changes.[8]

[7]This mandatory filing of the relationship between trading parties assures that the information covers virtually the whole universe of export transactions. The Census Bureau related parties data is very consistent when compared with the Bureau of Economic Analysis data on Multinational firms, which has been used more extensively in previous literature (see Ruhl (2013)).

[8]The U.S. harmonized product codes used to register import and export transactions are updated over time. Pierce and Schott (2009) developed an algorithm that matches revised codes to time-invariant identifiers to allow for following products over time.

1.1.2 Heterogeneous Responses during the GTC

The 2008-9 global recession and its associated trade contraction is known as the Great Trade Collapse in the literature. U.S. imports and exports begin falling in the third quarter of 2008. By the end of 2009, imports had fallen by 22.7% and exports by 19.0%, generating a 20.1% decrease in U.S. international trade. This sudden trade collapse is remarkable since U.S. GDP only dropped 1.7% over the same period while world GDP contracted by 1.1%. Interestingly, the overall drop in total exports differed somewhat between related parties and arm's length trade, at 16.92% and 18.74% respectively.[9] However, this difference across organizational forms is magnified when other dimensions of the collapse are considered, such as the number of firms and firm-varieties trading across organizational forms, or when the GTC collapse is decomposed into the extensive and intensive margins using U.S. firm level data distinguishing by organizational form.

Overall, the number of firms exporting fell by 12.16% during 2009. The number of firms trading to related parties fell by 8.51% in 2009, while for arm's length trade the collapse in the number of firms is significantly higher, at 12.52%. The fall in the number of firm-varieties traded by non-related parties during the GTC was almost double the fall for related parties. More specifically, at the peak of the collapse the number of related firm-varieties contracted by 5.73% while the contraction in the number of firm-varieties traded at arm's length reached the 11.38%. Moreover, the

[9]According to BEA data, the difference between related parties exports and arm's length trade is significantly bigger. More specifically, exports to affiliated foreign firms contracted only by 5.32% while exports to unaffiliated foreign firms contracted by 22.10% over this period.

number of firm-varieties for related parties recovered more quickly after the 2008-2009 GTC. For example, by the end of 2009 the number of related firm-varieties was actually 0.64% higher than its level in 2008. In contrast, the number of firm-varieties for arm's length trade at the end of 2009 was 5.07% lower than its peak level in 2008, and did not recover its respective pre-crisis level until almost a year later. Naturally, this difference in the evolution of the number of varieties traded across organizational forms translates into differences in the exit rate of firm-varieties. The exit rate for related parties is roughly two-thirds of the exit rate for arm's length trade at quarterly frequency during the GTC, at 42.7% and 62.2% respectively. Thus, although the overall drop in total exports during the GTC was similar between related parties and arm's length trade, the difference in the behavior of the number of varieties suggests that there is some heterogeneity in dynamics during the GTC across organizational form (See table 1.2 in the appendix for more details.). To further explore this heterogeneity, I decompose firm level trade into its intensive and extensive margins.

Specifically, I perform the following decomposition exercise using highly disaggregated U.S. data. First, I compute the midpoint growth rate of exports at the firm-product-country level, in order to isolate the evolution of the extensive and intensive margins of exports, and I do this separately for related parties and arm's length trade. I follow the literature on the GTC by working with data at quarterly frequency, motivated by the timing of the collapse, as annual data would mask many interesting dynamics(cf. Bricongne et al. (2012a), Behrens, Corcos, and Mion (2013) and Eaton et al. (2013)).

The midpoint decomposition breaks export growth into its intensive and extensive margins at the firm-country-product level. I then decompose each of these terms into positive and negative margins. Finally, growth rates computed at the firm level are aggregated to compute the aggregate midpoint growth rate. The aggregate mid-point growth rate of exports is defined as follows:

$$G(q) = \frac{X(q) - X(q-4)}{\frac{1}{2}[X(q) + X(q-4)]}$$

$$G(q) = \sum_i \sum_c \sum_k \underbrace{\frac{[x_{ick}(q) + x_{ick}(q-4)]}{[X(q) + X(q-4)]}}_{s_{ick}(q)} \times \underbrace{\frac{[x_{ick}(q) - x_{ick}(q-4)]}{\frac{1}{2}[x_{ick}(q) + x_{ick}(q-4)]}}_{g_{ick}(q)}$$

$$G(q) = \sum_i \sum_c \sum_k s_{ick}(q) \times g_{ick}(q)$$

where x denotes exports and i, c, k, q index firm, country, product and quarter respectively; $g_{ick}(q)$ is the midpoint growth rate of firm i exports of product k to country c in quarter q; and $s_{ick}(q)$ is the weight corresponding to $g_{ick}(q)$ in total exports.

Changes in exports at the firm-product-country level can be classified into: (i) extensive positive ("Entry") where $x_{ick}(q) > 0$ and $x_{ick}(q-4) = 0$; (ii) extensive negative ("Exit") where $x_{ick}(q) = 0$ and $x_{ick}(q-4) > 0$; (iii) intensive positive ("Growers") where $x_{ick}(q) > x_{ick}(q-4) > 0$; and (iv) intensive negative ("Shrinkers") where $x_{ick}(q-4) > x_{ick}(q) > 0$. Thus, the aggregate midpoint growth rate can be expressed as

$$G(q) = \sum_{i}^{NE_{ck}} \sum_{c} \sum_{k} [s_{ick}(q) \times g_{ick}(q)] + \sum_{i}^{NX_{ck}} \sum_{c} \sum_{k} [s_{ick}(q) \times g_{ick}(q)]$$
$$+ \sum_{i}^{CN1_{ck}} \sum_{c} \sum_{k} [s_{ick}(q) \times g_{ick}(q)] + \sum_{i}^{CN2_{ck}} \sum_{c} \sum_{k} [s_{ick}(q) \times g_{ick}(q)]$$

where $NE_{ck}, NX_{ck}, CN1_{ck}$ and $CN2_{ck}$ denote respectively the sets of entering, exiting, growing and shrinking firms exporting product k to country c. This decomposition also allows me to compute the net extensive and net intensive margins, by adding up both positive and negative components of each margin. Figures 1.1 and 1.2 present the evolution of the net extensive and net intensive margins for related parties and arm's length trade during the period surrounding the GTC.(See appendix for detailed tables 1.3 and 1.4.)

This decomposition exercise shows that the overall volume of related parties and arm's length trade followed a similar path during the GTC, but that their margin of adjustment differed substantially (see the appendix for detailed tables). In both cases, the intensive margin was the main margin of adjustment. However, the extensive margin took a more prominent role for arm's length trade than for related parties. More specifically, during 2009, the extensive margin for arm's length trade represented -9.90% points of growth on average, while for related parties the extensive margin contributed only -3.95% on average. Hence, the extensive margin contribution for arm's length trade was roughly two and a half times higher than the extensive margin contribution for related parties. The opposite holds true for the intensive margin, whose average contribution for related parties was 1.5 times the average intensive margin contribution for arm's length trade. Importantly, this pattern is robust to using lower frequency data and more aggregated firm-level data, in particular computing the decomposition using data at the half-yearly frequency and using firm-country exports aggregated over products. Furthermore, the differences between across related parties and arm's length trade are robust to controlling for firm size using employment level. When restricting the decomposition exercise to firms with more than 250 employees, I continue to find that arm's length trade adjusts significantly more through the extensive margin than related parties trade. Also, this result is robust to distinguishing between related-party and arm's length trade for both PTA partners and non-PTA partners. This robustness exercise is motivated by the fact that PTA agreements can protect firms from additional uncertainty as it is discussed in chapter 4.

1.1.3 Uncertainty and the Sourcing Decision

Demand uncertainty has not been considered in previous work as a determinant of the sourcing decision of whether to export to a related party or at arm's length. However, descriptive evidence suggests that there is a correlation between uncertainty and firms' decision regarding the organizational form of trade.Table 1.1 shows that U.S. firms export on average less via related parties to countries with high uncertainty, as measured by the volatility of GDP following Bloom (2014). More specifically, I classify countries as low uncertainty if the standard deviation of their GDP growth belongs to the first tercile, while I consider countries as having high uncertainty if the standard deviation of their GDP growth rate is in third tercile. Country categories are time-invariant over the sample period considered. The negative relationship holds both in terms of average total exports and the average number of products, and , more importantly in terms of the average share of related parties exports in total exports and the average ratio of the number of related parties products to the total number of product exported to that country.[10] , [11]

In this section, I present evidence that suggests that related parties and arm's length trade had different responses to the GTC in 2008/9. In particular, decomposition exercises show that arm's length exporters were more likely to exit foreign markets than related parties during the GTC. Thus, the exit decision is a key margin along which the organizational form affects the response of firms. This evidence on heterogeneous responses combined with the existing literature on uncertainty during the GTC and the descriptive evidence above on the relationship between uncertainty and the organizational form chosen by U.S. exporters are the key insights that motivate me to build a dynamic model with endogenous entry, exit and organizational choice when firms face demand uncertainty.

[10]Section 3.1 discuss a theory consistent measure of uncertainty. These patterns on the share of related party exports and uncertainty hold when I use this theory-consistent uncertainty measure.

[11]Figure 1.3 shows that this correlation between uncertainty and the way U.S. firms choose to serve a foreign market holds for the distribution of related party share in exports.

1.2 Tables

Table 1.1: Related Parties and Uncertainty (2002-2011 Average)

	Uncertainty		Total
	Low	High	
Related Exports	8,770.00	1,000.00	4,510
	[1,780]	[2,030]	[10,130]
Share of Related Exports	0.2331	0.1294	0.193
	[0.1268]	[0.118]	[0.1331]
Number of Related Products Exported	264.79	140.28	195.09
	[120.93]	[118.49]	[126.33]
Share of Related of Products Exported	0.6428	0.3877	0.5008
	[0.2385]	[0.2442]	[0.2551]
Observations	310	310	310

Means and standard deviations in brackets.
Low and High refer to the bottom and top tercile of the uncertainty measure.
Total includes the full sample at country level.

Table 1.2: Net Extensive Margin: Related-Party vs Arm's Length Trade

	Firm		
	Related-Party	Arm's Length Trade	Mid-point Difference
Fall at Trough	-11.11%	-15.47%	32.81%
Fall at Q4:2009	-6.86%	-8.92%	26.11%
Recovery Peak	0.01%	-0.53%	207.69%
Quarters until Recovery	13	>14	-7.41%
	Firm-Country-Product		
	Related-Party	Arm's Length Trade	Mid-point Difference
Fall at Trough	-7.2%	-12.64%	54.84%
Fall at Q4:2009	0.64%	-5.2%	256.14%
Recovery Peak	15.94%	7.6%	70.86%
Quarters until Recovery	4	8	-66.67%

Mid-point difference computes the mid-point difference rate between related-party and arm's length trade. More specifically, the formula is $(x^{RP} - x^{AL})/(0.5 * (x^{RP} + x^{AL}))$

Table 1.3: Midpoint Decomposition - 2006-2011 - Related Party Trade

Year	**Quarter**	**Intensive Margin**			**Extensive Margin**		
		Growers	Shrinkers	Net	Entry	Exit	Net
2007	1	0.238	-0.194	0.044	0.280	-0.241	0.039
2007	2	0.231	-0.200	0.031	0.277	-0.262	0.015
2007	3	0.236	-0.206	0.030	0.293	-0.278	0.015
2007	4	0.248	-0.205	0.043	0.317	-0.273	0.044
2008	1	0.216	-0.202	0.014	0.318	-0.263	0.055
2008	2	0.234	-0.232	0.002	0.338	-0.241	0.097
2008	3	0.232	-0.229	0.003	0.352	-0.238	0.114
2008	4	0.209	-0.278	-0.069	0.300	-0.284	0.016
2009	1	0.153	-0.368	-0.215	0.302	-0.335	-0.033
2009	2	0.154	-0.353	-0.199	0.284	-0.358	-0.074
2009	3	0.158	-0.290	-0.132	0.299	-0.378	-0.079
2009	4	0.203	-0.234	-0.031	0.350	-0.322	0.028
2010	1	0.285	-0.182	0.103	0.353	-0.271	0.082
2010	2	0.314	-0.170	0.144	0.344	-0.262	0.082
2010	3	0.272	-0.155	0.117	0.335	-0.260	0.075
2010	4	0.252	-0.173	0.079	0.316	-0.257	0.059
2011	1	0.246	-0.181	0.065	0.300	-0.230	0.070
2011	2	0.243	-0.197	0.046	0.304	-0.212	0.092
2011	3	0.237	-0.189	0.048	0.291	-0.218	0.073
2011	4	0.233	-0.208	0.025	0.302	-0.238	0.064

Midpoint decomposition of the quarterly log growth rate for U.S. firms exporting to related parties. See Section 2.2 for detailed formulas. Growers denotes the positive intensive margin and shrinkers denotes the negative intensive margin.

Table 1.4: Midpoint Decomposition - 2006-2011 - Arm's Length Trade

Year	**Quarter**	**Intensive Margin**			**Extensive Margin**		
		Growers	Shrinkers	Net	Entry	Exit	Net
2007	1	0.228	-0.197	0.031	0.439	-0.363	0.076
2007	2	0.235	-0.187	0.048	0.446	-0.370	0.076
2007	3	0.237	-0.183	0.054	0.453	-0.361	0.092
2007	4	0.257	-0.186	0.071	0.444	-0.362	0.082
2008	1	0.258	-0.168	0.090	0.458	-0.359	0.099
2008	2	0.252	-0.173	0.079	0.459	-0.347	0.112
2008	3	0.239	-0.182	0.057	0.473	-0.369	0.104
2008	4	0.185	-0.243	-0.058	0.436	-0.417	0.019
2009	1	0.142	-0.297	-0.155	0.396	-0.487	-0.091
2009	2	0.137	-0.292	-0.155	0.375	-0.528	-0.153
2009	3	0.162	-0.278	-0.116	0.373	-0.513	-0.140
2009	4	0.211	-0.212	-0.001	0.418	-0.433	-0.015
2010	1	0.260	-0.170	0.090	0.453	-0.369	0.084
2010	2	0.275	-0.157	0.118	0.457	-0.362	0.095
2010	3	0.257	-0.173	0.084	0.444	-0.353	0.091
2010	4	0.264	-0.171	0.093	0.427	-0.340	0.087
2011	1	0.254	-0.181	0.073	0.435	-0.334	0.101
2011	2	0.256	-0.175	0.081	0.435	-0.343	0.092
2011	3	0.260	-0.172	0.088	0.432	-0.342	0.090
2011	4	0.233	-0.200	0.033	0.410	-0.349	0.061

Midpoint decomposition of the quarterly log growth rate for U.S. firms exporting to related parties. See Section 2.2 for detailed formulas. Growers denotes the positive intensive margin and shrinkers denotes the negative intensive margin.

1.3 Figures

Figure 1.1: Decomposition Related Party

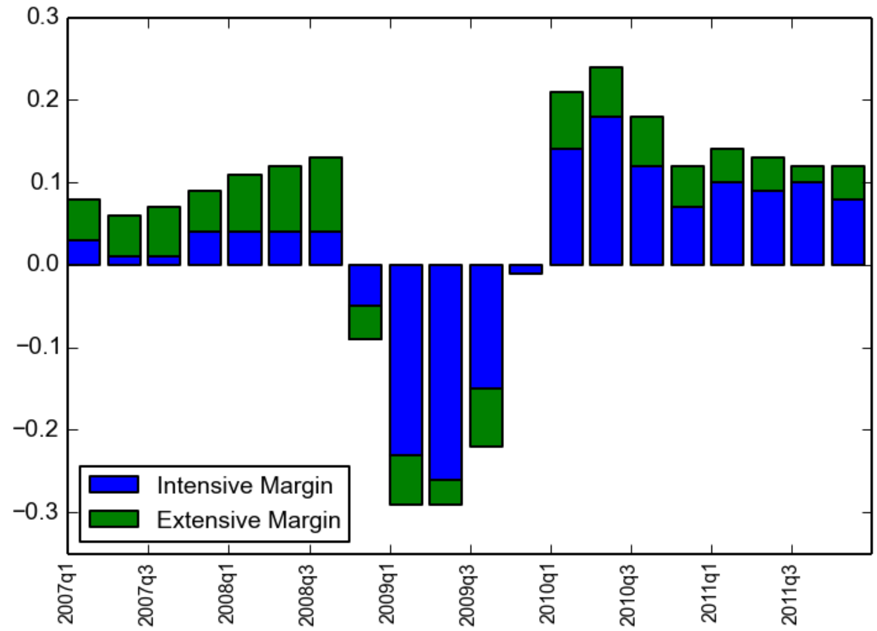


Figure 1.2: Decomposition Arm's Length

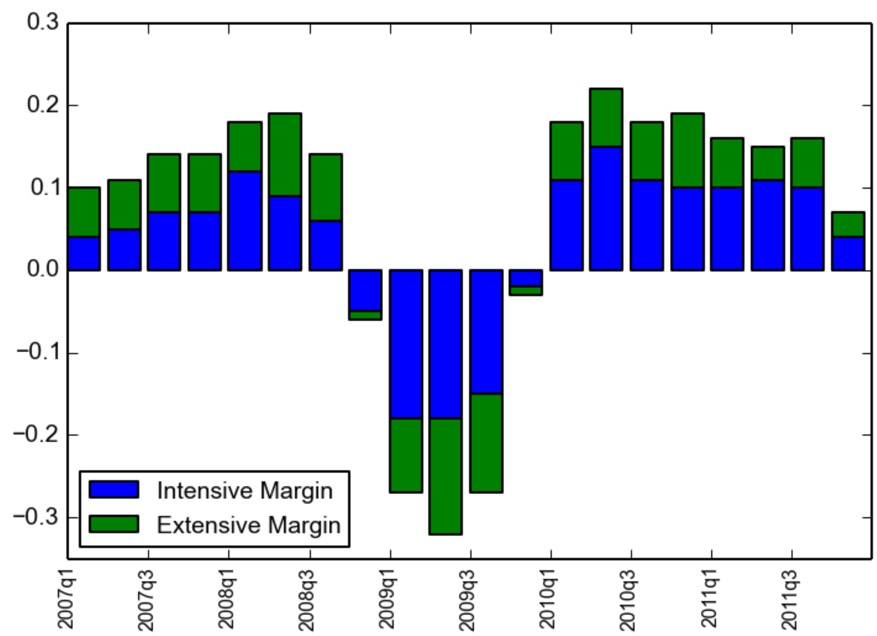
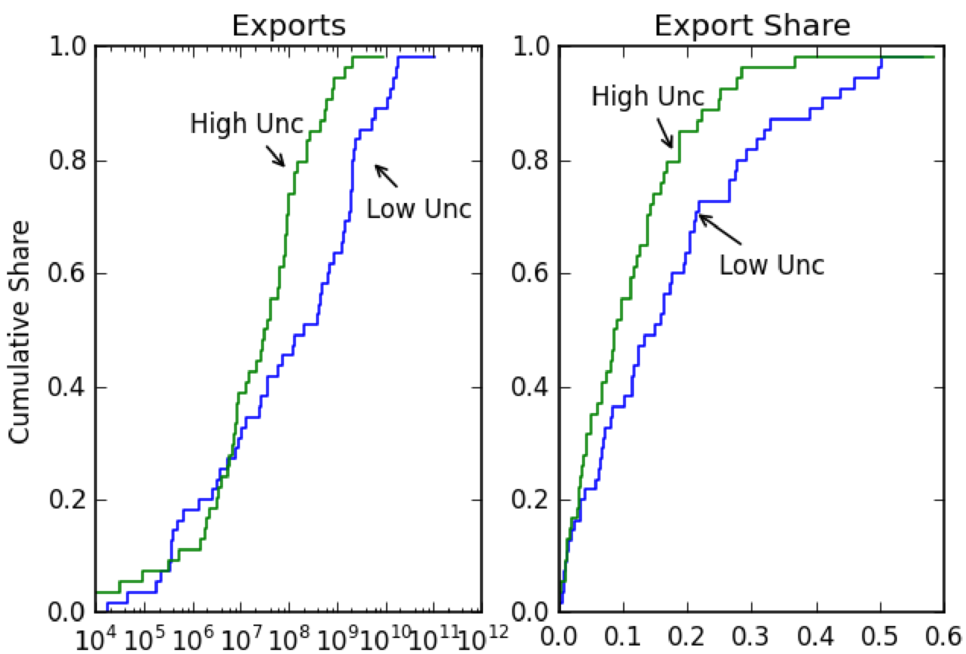


Figure 1.3: Related Party Exports and Uncertainty



Chapter 2: Global Sourcing and Uncertainty: Theory

This section develops a dynamic model with incomplete contracts in which firms endogenously choose when to start and stop exporting and make global sourcing decisions under demand uncertainty. The novel features of the model are the stochastic demand process and its interaction with the exit and global sourcing decisions. In the first section, I derive the basic elements of the model for exporting firms under incomplete contracts: optimal demand, supply, pricing and profits. Then I consider firms' entry, exit and global sourcing decisions under demand uncertainty.

2.1 Incomplete Contracts

The incomplete contracts setting of the model follows the standard approach of Antràs and Helpman (2004), in which incompleteness affects how the revenue of a trading relationship is distributed between the firms involved. Interestingly, this setup simplifies the analysis because the optimal quantity and price decisions are invariant across global sourcing decisions. There are two countries, N and S, where S is the foreign country. I assume that wages are higher in N, $w^N > w^S$.

Preferences in the foreign country are represented by a Cobb-Douglas utility function over a homogeneous good, denoted x_0, and a CES sub-utility index defined over differentiated goods X with constant expenditure share μ, where $0 < \mu < 1$. The homogeneous good is the numeraire of the model and is freely traded. Formally,

$$U = x_o^{1-\mu} X^{\mu} \tag{2.1.1}$$

$$X = \left[\int x(i)^{\alpha} di\right]^{1/\alpha} \tag{2.1.2}$$

where $0 < \alpha < 1$. Optimal demand for variety i when aggregate income is equal to Y is given by $x(i) = \mu Y \left[\frac{p(i)}{P^{\alpha}}\right]^{-\frac{1}{1-\alpha}}$ where P denotes the price index and $p(i)$ is the price of the variety.

There are two types of agents in the economy, entrepreneurs (H) and manufacturers (M). Entrepreneurs provide headquarters services and are located only in N, while manufacturers are located in S and provide assembly services. For simplicity, firms in the North can only outsource or integrate with firms in the South.[1] The final good production is represented by $x(i) = \theta \left[\frac{h(i)}{\eta}\right]^{\eta} \left[\frac{m(i)}{1-\eta}\right]^{1-\eta}$, where $0 < \eta < 1$. θ is the productivity parameter, while functions $h(i)$ and $s(i)$ denote headquarters and assembly services respectively. As in Antràs (2014), headquarters services are meant to include high-tech manufacturing or assembly, while assembly services also encompass distribution, packaging or marketing services. Following Ramondo and Rodríguez-Clare (2013) and Antràs (2003), I assume that there is trade in intermediates but no trade in final goods and that the final good is consumed only in the foreign destination. This assumption is motivated by the fact that most foreign affiliates do not export back to their headquarters country (see Antràs and Yeaple (2013))

[1] Fernandes and Tang (2012) use the same assumption in the context of a static model.

and that most foreign affiliates do not export to third countries (see Ramondo, Rappoport, and Ruhl (2011)). The entrepreneur (i.e. the firm located in N) can choose either to integrate vertically with a firm located in S, or to outsource its demand for assembly services to a firm located in S. In this setup, an organizational form consists of an ownership structure $k \in \{Outsourcing\,(O), Vertical\,Integration\,(V)\}$.

As is standard in trade models, firms are required to pay a sunk cost to start exporting (cf. Melitz (2003)). More specifically, firms have to pay f_e in order to start exporting via outsourcing, which is the default option to start exporting. If firms want to integrate, they have to pay an additional sunk cost f_v as is the case in AH. All firms also must pay a fixed per period cost f_p to operate in the foreign market. This fixed per period cost allows me to consider the optimal decision to stop exporting. Finally, to preserve the symmetry of the model, I assume that firms have to pay a sunk cost f_x to exit the foreign market.[2]

Following AH, I assume that parties cannot write enforceable contracts contingent on outcomes. Instead the entrepreneur and manufacturer bargain over surplus from the relationship. Ex-post bargaining is modeled as a generalized Nash bargaining game, in which the entrepreneur obtains a fraction $\zeta \in (0, 1)$ of the ex-post gains from the relationship. Importantly, the ownership structure does not affect whether or not there is ex-post bargaining. More specifically, the space of contracts is independent of the ownership structure and the same is true for the ex-post bargaining process. In the incomplete contract setting, the outside options for the two parties determine the incentives that each party has ex-post. I assume that the outside

[2]Results do not depend on the sunk cost to exit, although this sunk cost simplifies the exposition.

option for the manufacturing firm is zero in all cases, while the outside option for the entrepreneur depends on the organizational form. In the case of outsourcing, the outside option is zero while under vertical integration, the entrepreneur H can seize a share of the final good δ, where $0 < \delta < 1$.

The mode of ownership is chosen at the beginning of the period by H to maximize its profits. The contract includes an up-front fee (positive or negative) that is paid by M in order to participate in the relationship. Under the assumption that the supply of M is infinitely elastic, in equilibrium M's profits from the relationship net of the participation fee should be equal to its outside option, zero. Under outsourcing, when parties reach an agreement ex-post, H gets $\zeta R(i)$ while M gets $(1-\zeta)R(i)$, where $R(i)$ denotes the potential revenue of the trade relationship.[3] If parties fail to reach an agreement, both parties get zero under outsourcing. In contrast, when parties fail to reach an agreement under vertical integration, H can sell an amount $\delta x(i)$ of output which yields revenue $\delta^\alpha R(i)$. Hence the ex-post gains from trade are $[1-\delta^\alpha]R(i)$. Accordingly, in the bargaining, H receives its outside option plus its share of the ex-post gains, or $\delta^\alpha R(i) + \zeta[1-\delta^\alpha]R(i)$. This implies that M receives $(1-\zeta)[1-\delta^\alpha]R(i)$. Hence, the fraction of revenue going to the entrepreneur under integration satisfies:

$$\zeta_V = \delta^\alpha + \zeta[1-\delta^\alpha] \geq \zeta_o = \zeta$$

In other words, H is able to appropriate a higher fraction of revenue under integra-

[3]The potential revenue of the trade relationship is $R(i) = (\mu Y)^{1-\alpha} P^\alpha \theta^\alpha \left[\frac{h(i)}{\eta}\right]^{\alpha\eta} \left[\frac{m(i)}{1-\eta}\right]^{\alpha(1-\eta)}$
.

tion than under outsourcing.

Given the nature of the contract, parties choose their quantities of inputs noncooperatively, since inputs are not contractible ex-ante. Thus, firms' problems conditional on organizational form k are

$$
\begin{aligned}
H: & \max_{h(i)} \zeta_k R(i) - w^N h(i) \\
M: & \max_{m(i)} (1-\zeta_k) R(i) - w^S m(i)
\end{aligned}
$$

After solving these two problems, I obtain the following expression for the total current period profit:

$$\pi_k(\mathcal{A}, \eta, \theta) = \mathcal{A}\theta^{\frac{\alpha}{1-\alpha}} \psi_k(\eta)$$

The profit function is the product of a term capturing the demand level ($\mathcal{A} = (\mu Y)P^{\frac{\alpha}{1-\alpha}}$), the modified productivity of the firm ($\theta^{\frac{\alpha}{1-\alpha}}$), a term capturing the impact of the incomplete contracts mechanism ($\psi_k(\eta) = \frac{(1-\alpha[\zeta_k\eta+(1-\zeta_k)(1-\eta)])}{\left(\frac{1}{\alpha}\left[\frac{w^N}{\zeta_k}\right]^{\eta}\left[\frac{w^S}{(1-\zeta_k)}\right]^{1-\eta}\right)^{\frac{\alpha}{1-\alpha}}}$) and the fixed per period costs $w^N f_p$.

The setup implies that H chooses the organizational form that maximizes $\pi_k(\theta, A, \eta)$. Operating profits for the two firms are:

$$
\begin{aligned}
\pi_{Hk} = & \zeta_k R(i) + t - w^N h(i) \\
\pi_{Mk} = & (1-\zeta_k) R(i) - t - w^S m(i)
\end{aligned}
$$

Given that the outside option for M is zero, then the fee t is set such that $\pi_{Mk} = 0$. Hence $\pi_{Hk} = R(i) - w^N h(i) - w^S m(i)$ and in a subgame-perfect equilibrium $\pi_{hk} = \pi_k(\theta, \mathcal{A}, \eta)$. As in AH, there are no means to commit ex-ante to a division rule of the surplus. The choice of ownership structure is the only instrument for affecting the division rule. The entrepreneur producer then can choose between $\zeta_k = \{\zeta_V, \zeta_0\}$ which determines whether the H receives $\pi_v(\theta, \mathcal{A}, \eta)$ or $\pi_o(\theta, \mathcal{A}, \eta)$. In general. $\pi_v(\theta, \mathcal{A}, \eta)$ and $\pi_o(\theta, \mathcal{A}, \eta)$ cannot be ranked without further assumptions on η (intensity of headquarters services).

Note that the division rule of the profit ζ_k affects the slope of the profits function with respect to the productivity parameter θ and the parameter capturing the demand level $\mathcal{A}$. Furthermore, note that $\zeta_v > \zeta_0$ is not enough to unequivocally determine whether $\psi_v(\eta)$ is greater or lower than $\psi_o(\eta)$. The intensity of headquarters services is key to determining which function $\psi_k(\eta)$ is larger. Intuitively, the incompleteness of contracts implies that neither party appropriates the full marginal return on its investments. Hence both H and M underinvest, although this underinvestment is ameliorated by the fraction of the surplus that they receive. Thus, ex ante efficiency requires that the higher the intensity of headquarters services (i.e. high η), the higher the fraction of the surplus that should be allocated to H. This relationship between the optimal ζ and η, combined with the assumption that ζ_k are fixed, implies that for η, sufficiently large higher values of ζ_k generate more profits. This, in turn, implies that for sufficiently large η, $\psi_v(\eta) > \psi_o(\eta)$ given that $\zeta_v > \zeta_o$. In contrast, for low enough η, $\zeta_o > \zeta_v$ implies that $\psi_v(\eta) < \psi_o(\eta)$. Note that given that vertical integration requires an additional sunk cost, $\psi_v(\eta) < \psi_o(\eta)$ is sufficient for outsourcing to be the optimal choice. In contrast, $\psi_v(\eta) > \psi_o(\eta)$ is not sufficient for vertical integration to be optimal given the additional sunk cost. In this case, firms with different θ will choose different organizational forms in equilibrium. Since this is the case I want to focus on, I will assume that η is sufficiently large enough so that $\psi_v(\eta) > \psi_o(\eta)$ whenever $\zeta_v > \zeta_o$. So far the setup of the model is standard and uncertainty has not played any role. This is due to the fact that uncertainty about current period state variables is resolved before firms take any decisions. In the next section, I discuss how uncertainty is incorporated into the setup.

2.2 Demand Uncertainty and Firms' Decisions

Firms face uncertainty when considering whether to enter or to exit a market and when choosing their ownership structure. More specifically, firms have to deal with uncertainty about foreign demand. Firms do not know next period's value of $\mathcal{A}$, and today's demand level is only partially informative about the future values of $\mathcal{A}$. This uncertainty is captured by a stochastic foreign demand process. The foreign demand level is a random variable with CDF $G(\mathcal{A})$, with shocks to the path of foreign demand arriving with probability $\gamma > 0$. Furthermore, I assume that the CDF $G(\mathcal{A})$ is stable across time and that the arrival of shocks implies that a new demand level is drawn from this stable underlying distribution. I also assume that $G(\mathcal{A})$ has support $[\underline{\mathcal{A}}, \bar{\mathcal{A}}]$.

This uncertainty implies that firms solve an optimal stopping problem. In a deterministic framework, firms make decisions by comparing the profit flows of each status with the cost of changing status. However, in a stochastic framework, this approach, called the *naive* approach by Dixit and Pindyck (1994), ignores the possibility of waiting. More specifically, comparing the flow of profits across states leaves out the possibility that the optimal decision may be to switch status in some future period when the environment has different conditions.

Firms in the model endogenously decide when to start exporting,, when to stop exporting and what ownership structure to employ. Thus, firms that currently only produce domestically must decide whether or not to enter exporting, and under what ownership structure. Firms that currently export via outsourcing must decide whether to continue, integrate or exit; and firms that currently export under integration must decide whether to continue or exit. In each transition from, firms compare the difference in value between each status with the cost of changing status. For example, non-exporting firms at the margin of considering exporting via outsourcing will compare the fixed cost of entry to the difference between the expected value of being an exporter and the expected value of being a non-exporter. It is worth noting that the expected value of not exporting in the current period includes the possibility of becoming an exporter in the future, because non-exporters in the current period could begin exporting in some future period when conditions improve. In other words, the value of not exporting implicitly includes the value of waiting. Similarly, the value of exporting via outsourcing includes the possibility that the firm integrates in the future. Formally, non-exporting firms solve:

$$V = \max\{V_o - f_e, V_v - f_e - f_v, V_w\}$$

where V_k denotes the value function of each possible status (o, exporting via outsourcing; v, integrated exporter; and w non-exporter). Note that this problem can be decomposed into two simpler problems, given the assumption that the profit flow from outsourcing is lower than the profit flow from integration conditional on the demand level.[4] More specifically, a non-exporting firm will prefer exporting via outsourcing to being a non-exporter if $V_o - f_e > V_w$. Hence, equalizing the value of exporting via outsourcing minus the sunk cost to the value of waiting implicitly defines a demand level that makes a firm with given productivity θ indifferent between these two options:

$$V_w(\mathcal{A}_o^e) = V_o(\mathcal{A}_o^e) - f_e \tag{2.2.1}$$

where $\mathcal{A}_o^e$ is the *demand entry threshold with outsourcing*. This condition, when evaluated at $\mathcal{A}_o^e$, implies that the difference in current period profits (note that when the firm is not exporting, the current period profits *of exporting* are zero) plus the difference in expected future value should be equal to the fixed cost of entering. Similarly, non-exporting firms will prefer exporting with integration to being a non-exporter as long as $V_v - f_e - f_v > V_w$. However, note that the condition

[4] This is due to the assumption that the sector is sufficiently intensive in headquarters services, which assures that $\pi_v > \pi_o$.

$V_v - f_e - f_v > V_w$ is not relevant to a firm's decision because for any demand level that fulfills this condition it is also true that $V_o - f_e > V_w$. Hence the optimal alternative to integration for a firm on the margin is to export via outsourcing than rather not exporting.

A firm exporting via outsourcing needs to consider whether to continue, integrate or exit the market. Formally, firms exporting via outsourcing solve:

$$V = \max\{V_o, V_v - f_v, V_w - f_x\}$$

which can be separated into two decisions, whether or not to integrate and whether or not to exit. Each of these decisions determines a threshold demand level. A firm that currently exports via outsourcing will integrate if $V_v - f_v > V_o$. Hence the following equation determines the demand integration threshold $\mathcal{A}_v^e$:

$$V_o(\mathcal{A}_v^e) = V_v(\mathcal{A}_v^e) - f_v \tag{2.2.2}$$

Similarly, a firm that is currently exporting via outsourcing will stop exporting if $V_o > V_w - f_x$. The exit with outsourcing demand threshold $\mathcal{A}_o^x$ is determined by

$$V_o(\mathcal{A}_o^x) = V_w(\mathcal{A}_o^x) - f_x \tag{2.2.3}$$

Finally, a firm currently exporting under vertical integration will solve the following problem:

$$V = \max\{V_o - f_o, V_v, V_w - f_x\}$$

Note that since $V_v > V_o$ for all demand levels, it is never optimal for a currently integrated firm to switch to outsourcing. Thus, the relevant decision for an integrated firm is whether or not to continue, which will be optimal if $V_v > V_w - f_v$. Then the exit with integration threshold $\mathcal{A}_v^x$ is determined by

$$V_v(\mathcal{A}_v^x) = V_w(\mathcal{A}_v^x) - f_x \tag{2.2.4}$$

In summary, firms can be in one of three states in the model: non-exporter, exporting via outsourcing and exporting via integration. These three states imply four relevant margins along which firms can be indifferent: (i) switching from being a non-exporter to exporting via outsourcing, (ii) switching from exporting via outsourcing to integration, (iii) switching from exporting under integration to being a non-exporter and (iv) switching from exporting via outsourcing to being a non-exporter.[5] These four conditions determine four demand thresholds $(\mathcal{A}_o^e, \mathcal{A}_v^e, \mathcal{A}_o^x, \mathcal{A}_v^x)$ for each firm that completely describe the firm's policy function. The next step is solve the value functions for each of the possible states. Figure 2.1 shows all the

[5]The other two potential margins that are left out are (v) switching from exporting with integration to exporting via outsourcing and (vi) switching from being a non-exporter to exporting with integration. The former is irrelevant because exporting with integration is always more profitable than exporting via outsourcing ex-post, and, hence no firm will optimally do this transition. The latter is irrelevant because the following holds. In order to integrate, the non-exporter firm needs that $V_v - f_e - f_v > V_w$ and $V_v - f_e - f_v > V_o - f_e$ but since for any demand level satisfying $V_v - f_e - f_v > V_w$ it is also true that $V_o - f_e > V_w$ so that the two initial conditions collapse to $V_v - f_v > V_o$ which is the same comparison for the transition (ii).

transitions across states in the model with their respective demand thresholds.

Starting with the value of exporting via outsourcing, note that the firm perceives a current profit from exporting equal to $\pi_o(\mathcal{A}_t) - f_p$ and a continuation value that depends on the optimal decision for the next period. Formally, the value function for a firm with productivity θ_i that exports with outsourcing is:

$$V_o(\mathcal{A}, \theta_i) = \pi_o(\mathcal{A}, \theta_i) - f_p + \beta \mathbb{E} \max\{V_v(\mathcal{A}', \theta_i) - f_v, V_o(\mathcal{A}', \theta_i), V_W(\mathcal{A}', \theta_i) - f_x\}$$

where V_k is the expected value with respect to the demand level conditional on $\mathcal{A}$ and β is the assumed discount factor of the firm. From now on, I will drop the productivity level for simplicity. Exploiting the structure of the stochastic demand process and the threshold demand levels defined above, the value function can be expressed as follows:

$$\begin{aligned} V_o(\mathcal{A}) = & \pi_o(\mathcal{A}) - f_p + \underbrace{\beta(1-\gamma)V_o(\mathcal{A})}_{no\, shock} + \underbrace{\gamma G(\mathcal{A}_o^x)\beta[\mathbb{E}V_w(\mathcal{A}' < \mathcal{A}_o^x) - f_x]}_{shock\, below\, exit} \\ & + \underbrace{\gamma[G(\mathcal{A}_v^e) - G(\mathcal{A}_o^x)]\beta\mathbb{E}V_o(\mathcal{A}_o^x < \mathcal{A}' < \mathcal{A}_v^e)}_{shock\, between\, o\, and\, v} \\ & + \underbrace{\gamma[1 - G(\mathcal{A}_v^e)]\beta[\mathbb{E}V_v(\mathcal{A}' > \mathcal{A}_v^e) - f_v]}_{shock\, above\, v} \end{aligned} \tag{2.2.5}$$

where the value of exporting via outsourcing is equal to current profits, plus the value of remaining in the same status if no shock arrives, which happens with probability $(1-\gamma)$, plus the value if a shock arrives. Note that the latter can be decomposed into three terms involving demand thresholds. With probability $\gamma G(\mathcal{A}_o^x)$, a shock arrives such that the new demand level is below the exit threshold, and the optimal decision is to pay the sunk cost, f_x, and exit. With probability $\gamma[1-G(\mathcal{A}_v^e)]$, a shock arrives such that $\mathcal{A}'$ is greater than the integration threshold and the firm decides to integrate after paying the sunk cost f_v. Finally, with probability $\gamma[G(\mathcal{A}_v^e) - G(\mathcal{A}_o^x)]$ the shock is between the exit threshold and the integration threshold, and the optimal decision is to remain an exporter with outsourcing.

Similarly, the value of exporting with integration can be expressed as follows:

$$\begin{aligned} V_v(\mathcal{A}) =& \pi_v(\mathcal{A}) - f_p + \underbrace{\beta(1-\gamma)V_v(\mathcal{A})}_{no\,shock} + \underbrace{\beta\gamma G(\mathcal{A}_v^x)[\mathbb{E}V_W(\mathcal{A} < \mathcal{A}_v^x) - f_x]}_{shock\,below\,exit} \\ &+ \underbrace{\beta\gamma[1-G(\mathcal{A}_v^x)]\mathbb{E}V_v(\mathcal{A} > \mathcal{A}_v^x)}_{shock\,above\,exit} \end{aligned} \tag{2.2.6}$$

Note that in this case, there are only two possible choices conditional on the arrival of a demand shock. As discussed above, this is because once a firm has paid the sunk cost to integrate, it is never optimal to go back to outsourcing.

Finally, I consider the value of a non-exporting firm. In this case, the firm does not earn profits in the current period from exporting, and the value of being in this status stems from the possibility that the demand level changes in the future, so that the firm would find it profitable to start exporting. Formally, the value of waiting as a non exporter is:

$$V_w(\mathcal{A}_t) = \underbrace{\beta(1-\gamma)V_w(\mathcal{A}_t)}_{no\,shock} + \underbrace{\beta\gamma G(\mathcal{A}_o^e)\mathbb{E}V_w(\mathcal{A}_t)}_{shock\,below\,entry} \tag{2.2.7}$$
$$+ \underbrace{\beta\gamma[G(\mathcal{A}_v^e) - G(\mathcal{A}_o^e)][\mathbb{E}V_o(\mathcal{A}_o^e < \mathcal{A} < \mathcal{A}_v^e) - f_e]}_{shock\,between\,o\,and\,v}$$
$$+ \underbrace{\beta\gamma[1 - G(\mathcal{A}_v^e)][\mathbb{E}V_v(\mathcal{A} > \mathcal{A}_v^e) - f_e - f_v]}_{shock\,above\,v}$$

Note that this is a flexible formulation in which firms are allowed to start exporting via outsourcing or as an integrated firm. Thus, I am are not imposing any assumption of sequential entry to export markets.

2.2.1 Entry and Organizational Choice

Equations (2.2.5), (2.2.6) and (2.2.7) are a linear system in the value functions that can be solved for each value function. After some manipulations, I obtain an implicit solution for the entry threshold for a firm exporting via outsourcing, $\mathcal{A}_o^e$:[6]

$$f_e = \frac{\pi_o(\mathcal{A}_o^e) - f_p}{1 - \beta\tilde{\lambda}_o^x} + \frac{\beta\gamma}{1 - \beta\tilde{\lambda}_o^x}\int_{\mathcal{A}_o^x}^{\mathcal{A}_o^e} \frac{[\pi_o(\mathcal{A}) - \pi_o(\mathcal{A}_o^e)]dG}{1 - \beta + \beta\gamma} - \frac{\beta\gamma G(\mathcal{A}_o^x) f_x}{1 - \beta\tilde{\lambda}_o^x} \tag{2.2.8}$$

where $\tilde{\lambda}_o^x \equiv [1 - \gamma G(\mathcal{A}_o^x)]$ represents the probability that the firm remains an active exporter in the next period. Hence at $\mathcal{A}_o^e$, the entry sunk cost is equal to the discounted flow of current profits (as in the deterministic case) plus two additional terms.[7] The first additional term is the discounted difference in profits resulting from

[6]For a detailed derivation, see Appendix A.2, in general, and A.2.4, in particular.

[7]Note, however, that in the deterministic framework, the discount factor is $(1-\beta)$ while in this stochastic framework, the discount factor is $(1 - \beta\tilde{\lambda}_o^x)$. It is evident that $\tilde{\lambda}_o^x < 1$.

the arrival of demand shocks below the entry threshold but above the exit threshold, such that the firm continues as an exporter via outsourcing. The second term reflects the discounted cost of exit when the new shock is below the exit threshold.

Notice that the increased flow of profits from future demand shocks above the entry threshold does not show up in the condition. This is the *bad news principle* in action: gains from realizations above the entry threshold also accrue to the firm that waits to become an exporter. Also, note that since firms can opt to stop exporting in the case that a very bad realization arrives (i.e. a realization such that $\mathcal{A} < \mathcal{A}_o^x$), profits under these realizations are replaced by the sunk cost of exit.

Finally, comparing (2.2.8) with the entry condition in the deterministic framework, I show in the appendix (see A.2.4) that $\mathcal{A}_o^e > \mathcal{A}_o^{eD}$ because $\pi_o(\mathcal{A}_o^e) > \pi_o(\mathcal{A}_o^{eD})$. Thus, a firm requires a higher demand realization to be willing to pay the cost of exporting via outsourcing when there is demand uncertainty.

Considering the decision to integrate, after some algebra I obtain an implicit solution for the integration threshold for a firm currently exporting via outsourcing, $\mathcal{A}_v^e$:

$$\begin{aligned} f_v =& \frac{\Delta_{vo}\pi(\mathcal{A}_v^e)}{1-\beta\tilde{\lambda}_v^{:x}} + \frac{\beta\gamma}{1-\beta\tilde{\lambda}_v^{:x}} \int_{\mathcal{A}_o^x}^{\mathcal{A}_v^e} \frac{[\Delta_{vo}\pi(\mathcal{A}) - \Delta_{vo}\pi(\mathcal{A}_v^e)]}{1-\beta+\beta\gamma} dG \\ &+ \frac{\beta\gamma}{1-\beta\tilde{\lambda}_v^{:x}} \int_{\mathcal{A}_v^x}^{\mathcal{A}_o^x} \frac{[\pi_v(\mathcal{A}) - \pi_o(\mathcal{A}_o^x)] - \Delta_{vo}\pi(\mathcal{A}_v^e)}{1-\beta+\beta\gamma} dG \end{aligned} \tag{2.2.9}$$

where $\Delta_{vo}\pi(\mathcal{A}) \equiv \pi_v(\mathcal{A}) - \pi_o(\mathcal{A})$ is the difference in profits between integration and outsourcing for a given demand level $\mathcal{A}$ (See Appendix A.2.5 for derivation). This condition implies that the integration sunk cost must be equal to the discounted difference in the flow of current profits between the two organizational forms, plus two additional terms that capture differences in the impact of future shocks below the integration threshold. The first additional term captures the discounted value of the difference between organizational forms from changes in profits due to the arrival of shocks in the inaction band $[\mathcal{A}_o^x, \mathcal{A}_v^e]$. The second term captures the discounted value of losses under integration due to the arrival of shocks that trigger exit under outsourcing but not integration. Note that the integration condition is similar to the entry condition (2.2.8) with the key difference that in (2.2.9), firms earn profits in both states, which explains why the differences and double differences show up in the condition. Since I allow firms to exit directly from integration, severe negative shocks (below the threshold for exit for integration) do not show up in the integration condition, since such shocks would trigger exit under both integration and outsourcing. Meanwhile, in accordance with the bad news principle, realizations above the integration threshold are also irrelevant for the decision to integrate.

Following the same strategy as before, I show in the appendix (see A.2.5) that $\mathcal{A}_v^e > \mathcal{A}_v^{eD}$ for all firms (or more precisely, for all productivity levels). Under uncertainty, therefore, firms delay the decision to integrate because of the possibility that the demand level will change in the future.

2.2.2 Exit from Foreign Destinations

Up to now I have considered the decision to start exporting and the choice of organizational form. The next step is to examine the exit decision for both integrated exporters and firms exporting via outsourcing. Starting with the latter, note that the exit threshold for firms exporting via outsourcing depends on the difference between the value of exporting and the value of being a non-exporter, similar to the entry threshold. In this case, the expression that explicitly defines the exit threshold for firms exporting via outsourcing is similar to (2.2.8).[8] In particular:

$$f_x = -\frac{\pi_o(\mathcal{A}_o^x) - f_p}{1-\beta\tilde{\lambda}_o^{\bar{A}e}} - \frac{\beta\gamma}{1-\beta\tilde{\lambda}_o^{\bar{A}e}}\int_{A_o^x}^{\mathcal{A}_o^e}\frac{[\pi_o(\mathcal{A}) - \pi_o(\mathcal{A}_o^x)]dG}{1-\beta+\beta\gamma} - \frac{\beta\gamma[1-G(\mathcal{A}_o^e)]f_e}{1-\beta\tilde{\lambda}_o^{\bar{A}e}} \tag{2.2.10}$$

where $\tilde{\lambda}_o^{\bar{A}e} \equiv [1-\gamma(1-G(\mathcal{A}_o^e)]$ represents the probability that the firm remains an non-exporter in the next period. This equation shows that at the exit threshold demand level, the sunk cost of exiting should be equal to the present discounted value of current flow losses (where losses are the per period fixed cost minus the flow variable profits), minus the potential profits that the firm gives up in the case that a shock between the entry and exit triggers arrives, minus the cost of reentering the export market in the case that a shock above the entry trigger arrives in some future period. When there is no uncertainty, the last two terms disappear and the discount factor becomes $(1-\beta)$.

Equation (2.2.10) has no counterpart in Handley and Limão (Forthcoming), since their model focuses only on the entry side of the extensive margin. However, this exit condition is qualitatively similar to the one obtained for the entry decision. The first two terms in (2.2.10) are identical in form to their counterparts in (2.2.8),

[8](See Appendix A.2.6 for derivation)

while the third term takes into account the sunk cost of entering instead of the corresponding cost of exit. In addition, the discount factor is different in the exit decision, since it takes into account the probability that a shock arrives above the entry threshold. Note also that a *good news principle* applies to the exit decision. Bad shocks with respect to the exit threshold, i.e. shocks below $\mathcal{A}_o^x$, are not included in the expected losses, since firms that do not exit today retain the option of exiting in the future.

Note that since $f_x \geq 0$ and the second and third terms are negative, it has to be the case that $\pi_o(\mathcal{A}_o^x) - f_p < 0$.[9] Thus, firms earn negative profits at the exit threshold and will earn negative flow profits throughout the entire demand interval $[\underline{\mathcal{A}}, \mathcal{A}_o^x]$. Hence the exit option allows firms to discard a part of the demand support, where flow profits are negative.

Next, I consider the exit decision for an integrated firm. Note that in this case, firms compare the difference between the value of exporting with integration and the value of being a non-exporter. After finding an expression for this difference (see Appendix A.2.3), I plug it into (2.2.4) and get the following implicit solution

[9] Notice that this result does not stem from the sunk exit costs. Even in the absence of sunk cost to exit, current profits at the exit threshold have to be negative in order to compensate for the expected cost of reentering. However, the sunk exit cost does create more incentives for the firm to sustain negative profits before making the decision to exit.

for the demand exit threshold for an integrated exporter, $\mathcal{A}_v^x$:

$$f_x = -\frac{\pi_v(\mathcal{A}_v^x) - f_p}{1-\beta\tilde{\lambda}_v^{\bar{A}e}} - \frac{\beta\gamma}{1-\beta\tilde{\lambda}_v^{\bar{A}e}}\left[\int_{\mathcal{A}_v^x}^{\mathcal{A}_v^e}\frac{\pi_v(\mathcal{A}) - \pi_v(\mathcal{A}_v^x)}{1-\beta+\beta\gamma}dG - \int_{\mathcal{A}_o^e}^{\mathcal{A}_v^e}\frac{\pi_o(\mathcal{A}) - \pi_o(\mathcal{A}_o^e)}{1-\beta+\beta\gamma}dG\right] \tag{2.2.11}$$

$$-\frac{\beta\gamma[1-G(\mathcal{A}_v^e)][f_v+f_e]}{1-\beta\tilde{\lambda}_v^{\bar{A}e}}$$

Note that this condition implies that firms sustain negative profits before deciding to exit, since the last two terms are negative, and this implies that $\pi_v(\mathcal{A}_v^x) - f_p < 0$. Then, the exit decision allows firms to avoid states where profits are negative. Note also that expected profits from exporting via outsourcing appear in this condition. This is because the firm is comparing the future profits of remaining as an integrated exporter with the future profits that accrue in the case that a demand shock above the entry threshold for outsourcing ($\mathcal{A}_o^e$) arrives after the firm has exited, where the optimal decision in that case would be to pay the sunk cost to start exporting again.

A visual inspection of the exit conditions for each organizational structure shows clearly that the organizational form impacts the exit decisions. Furthermore, I prove in the appendix (see A.2.8) that

$$\pi_o(\mathcal{A}_o^x) - \pi_v(\mathcal{A}_v^x) > 0$$

which implies that $\mathcal{A}_o^x > \mathcal{A}_v^x$ since $\pi_v > \pi_o$. Thus, integrated firms wait longer to exit than firms that outsource; this is true even conditional on the productivity level. Furthermore, I show in the appendix that for a given productivity level θ_i all demand threshold can be ranked as follows: $\mathcal{A}_v^x < \mathcal{A}_o^x < \mathcal{A}_o^e < \mathcal{A}_v^e$. Note that this ranking hold conditional on productivity.

Summing up, firms optimally choose when to start exporting, how to export (integrated or outsourcing) and when to stop exporting. All of these decisions are completely described by the four demand thresholds $\mathcal{A}_v^e$, $\mathcal{A}_v^x$, $\mathcal{A}_o^e$, $\mathcal{A}_o^x$ and the current status of the firm.

2.3 Impact of Uncertainty at Industry Level

The previous section derives implicit expressions for the demand thresholds that describe the policy function at the firm level. The next step is to use these conditions to describe behavior at the industry level. My approach is to start from a realization of industry demand and then determine the productivity level of the marginal firm for each decision. This parametrization will allow me to perform key comparative statics exercises and will also allow me to compare industry behavior in the stochastic framework with the deterministic framework.[10]

In the stochastic framework, after some manipulations (see A.4.1 for the detailed derivation), I get the following expression for the productivity cutoff for entry with outsourcing:

$$\theta_o^e = \Psi_o^e \theta_o^{eD} > \theta_o^{eD} \tag{2.3.1}$$

[10] A.2.8 solves the corresponding deterministic framework to the model.

where

$$\Psi_o^e = \left[1 + \frac{\beta\gamma G(\mathcal{A}_t\xi_o^x)[f_x + f_e]}{(1-\beta)f_e + f_p}\right]^\rho / \left[1 + \frac{\beta\gamma\Delta_{\mathcal{A}}(\mathcal{A}_t, \mathcal{A}_t\xi_o^x)/\mathcal{A}_t}{1-\beta+\beta\gamma}\right]^\rho \tag{2.3.2}$$

and ξ_k^m denotes the parameters relating $\mathcal{A}_t$ with the $m \in \{e, x\}$ from the $k \in \{O, V\}$ threshold and $\Delta_{\mathcal{A}}(\mathcal{A}_i, \mathcal{A}_j) = \int_{\mathcal{A}_j}^{\mathcal{A}_i} (\mathcal{A} - \mathcal{A}_i) dG$ is a function capturing the expected difference in profits between the specific demand realization $\mathcal{A}_i$ and potential new realizations over the interval $(\mathcal{A}_j, \mathcal{A}_i)$. In this case $\Delta_{\mathcal{A}}(\mathcal{A}_t, \mathcal{A}_t\xi_o^x) < 0$, and this term reflects the loss if the new demand level is below the entry threshold but high enough not to force the firm to exit.

Ψ_o^e captures the ratio between the sunk costs of entry and exit when a bad shock arrives, on the one hand, and the profits lost relative to profits at the entry threshold in case that a shock in the inaction band arrives. Intuitively, Ψ_o^e compares the cost of becoming an exporter and exiting in the future, i.e. the sunk cost that the firm has to pay in the case a new shock arrives forcing the firm to exit, with the *relative* cost of exporting when a shock arrives in the inaction band, i.e. the profit loss relative to profits at the entry threshold. Firms with productivity $\theta_i > \theta_o^e$ will find it profitable to pay the sunk costs to start exporting. $\Psi_o^e > 1$ since the numerator is greater than 1, while the denominator is less than 1 because the second term in the denominator is negative but less than 1 in absolute value. Uncertainty, therefore, delays firms' decision to start exporting via outsourcing. Note that in the absence of demand uncertainty, Ψ_o^e collapses to 1 and $\theta_o^e = \theta_o^{eD}$.

Similarly, an expression for the productivity cutoff for exit from outsourcing can be derived in the stochastic framework in terms of the respective deterministic productivity cutoff (see A.4.2):

$$\theta_o^x = \Psi_o^x \theta_o^{xD} < \theta_o^{xD} \tag{2.3.3}$$

where $\Psi_o^x = [1 - \frac{\beta\gamma[1-G(\mathcal{A}_t\xi_o^e)][f_e+f_x]}{f_p-[1-\beta]f_x}]^\rho / [1 + \frac{\beta\gamma\Delta_\mathcal{A}(\mathcal{A}_t\xi_o^e,\mathcal{A}_t)/\mathcal{A}_t}{1-\beta+\beta\gamma}]^\rho$. Outsourcing firms with $\theta_i \leq \theta_o^x$ will exit and firms with $\theta_i > \theta_o^x$ will keep exporting. Ψ_o^x captures the ratio between the sunk cost of entry, on the one hand, and exit in the case that a shock arrives above the entry threshold, and the profits gained if a shock arrives in the inaction band, where $\Delta_\mathcal{A}(\mathcal{A}_t\xi_o^e, \mathcal{A}_t) > 0$. I show that $\Psi_o^x < 1$ in the appendix. Thus, compared to the deterministic framework, firms wait longer before exiting the foreign market in the stochastic framework.

Next, I derive the following expression for the productivity cutoff for entry with integration under the stochastic framework (see A.4.3):

$$\theta_v^e = \Psi_v^e \theta_v^{eD} > \theta_v^{eD} \tag{2.3.4}$$

where $\Psi_v^e = \left[1 + \frac{\beta\gamma G(\mathcal{A}_t\xi_v^x)}{1-\beta}\right]^\rho / \left[1 + \frac{\beta\gamma}{1-\beta+\beta\gamma}\frac{\Delta_\mathcal{A}(\mathcal{A}_t,\mathcal{A}_t\xi_o^x)}{\mathcal{A}_t} + \frac{\psi_o}{\psi_v-\psi_o}\frac{\beta\gamma}{1-\beta+\beta\gamma}\frac{\Delta_\mathcal{A}(\mathcal{A}_t\xi_o^x,\mathcal{A}_t\xi_v^x)}{\mathcal{A}_t}\right]^\rho$. Ψ_v^e captures the ratio between the cost of exiting in the case a bad shock arrives, and the profit loss in the case that a shock arrives in the inaction band for integrated firms. Note that the profit loss takes into account that the alternative optimal decision in the inaction band may either be integration or outsourcing, depending on the realization of the demand level. In the appendix, I show that $\Psi_v^e > 1$. Hence demand uncertainty delays the decision to integrate. I also show in the appendix that $\theta_o^e < \theta_v^e$, since I am focusing on sectors with high headquarters intensity where $\pi_v(\mathcal{A}) > \pi_o(\mathcal{A})$ for all $\mathcal{A}$. Thus, only relatively productive firms, i.e. firms with $\theta_i > \theta_o^e$ will export, and only the most productive of these will integrate, the ones with $\theta_i > \theta_v^e$.

The respective expression for the exit productivity cutoff for integrated exporters is as follows (see A.4.4):

$$\theta_v^x = \Psi_v^x \theta_v^{xD} < \theta_v^{xD}$$

where $\Psi_v^x = \left[1 - \frac{\beta\gamma[1-G(\mathcal{A}_t\xi_v^e)][f_v+f_e+f_x]}{f_p-[1-\beta]f_x}\right]^\rho \Big/ \left[1 + \frac{\beta\gamma}{1-\beta+\beta\gamma}\frac{\Delta_{\mathcal{A}}(\mathcal{A}_t\xi_v^e,\mathcal{A}_t)}{\mathcal{A}_t} - \frac{\psi_o}{\psi_v}\frac{\beta\gamma}{1-\beta+\beta\gamma}\frac{\Delta_{\mathcal{A}}(\mathcal{A}_t\xi_v^e,\mathcal{A}_t\xi_o^e)}{\mathcal{A}_t}\right]^\rho$ and $\Psi_v^x < 1$ (see Appendix). Thus, integrated exporters with $\theta_i < \theta_x^v$ will exit. Since $\theta_v^x < \theta_v^{xD}$, firms wait longer to exit foreign markets under uncertainty. This difference is due to the fact that firms internalize that with some probability, things will improve in the future. Furthermore, I show in the appendix that $\theta_v^x < \theta_o^x$ (see A.4.5). Hence the productivity level needed to keep exporting with integration is lower than the productivity required to keep exporting via outsourcing. Thus, firms characterized by $\theta_i \in [\theta_v^x, \theta_o^x]$ will keep exporting if they are already exporting with integration but will stop exporting if they are exporting via outsourcing. The following propositions summarize the results for the productivity cutoffs:

Proposition 1. *(Exit and Organizational Choice under Uncertainty) Under foreign demand uncertainty $\mathcal{A}$, the productivity exit cutoffs are (i) proportional to the corresponding deterministic cutoffs by an uncertainty factor, $\theta_k^x = \Psi_k^x \theta_k^{xD}$ where*

$k \in \{V, O\}$ and (ii) lower than their deterministic counterparts, $\theta_k^x < \theta_k^{xD}$; (iii) cutoffs are specific to organizational form, where the vertical integration cutoff is lower than the outsourcing cutoff, $\theta_v^x < \theta_o^x$, and (iv) differences across organizational choice are higher than in the deterministic setting, $(\theta_o^x - \theta_v^x) > (\theta_o^{xD} - \theta_v^{xD})$

Proof. See appendix. □

Proposition 2. *(Entry and Integration under Uncertainty) Under foreign demand uncertainty, the entry and integration productivity cutoffs are (i) proportional to the deterministic cutoffs by an uncertainty factor, $\theta_k^e = \Psi_k^e \theta_k^{eD}$ where $k \in \{V, O\}$ and (ii) higher than their deterministic counterparts, $\theta_k^e > \theta_k^{eD}$; (iii) the vertical integration cutoff is higher than the outsourcing cutoff, $\theta_v^e > \theta_o^e$.*

Proof. See appendix. □

The results derived so far consider the impact of demand uncertainty on productivity cutoffs compared to the deterministic framework. Additionally, I am interested in uncovering how the introduction of uncertainty modifies the responses of these productivity cutoffs to changes in the key parameters of the model. The following propositions discuss the effect of uncertainty on the productivity cutoffs.

Proposition 3. *(Delay) A higher arrival rate of demand shocks increases the productivity cutoff for entry ($\frac{\partial \ln \theta_o^e}{\partial \gamma} > 0$) and decreases the productivity cutoff for exit from outsourcing ($\frac{\partial \ln \theta_o^x}{\partial \gamma} < 0$). An increase in the arrival rate of demand shocks increases the entry productivity cutoff ($\frac{\partial \ln \theta_v^e}{\partial \gamma}|_{\gamma=0} > 0$) and decreases the exit productivity cutoff ($\frac{\partial \ln \theta_v^x}{\partial \gamma}|_{\gamma=0} < 0$) for exporting with integration when evaluated around* *the deterministic case, i.e. $\gamma = 0$. Moving away from $\gamma = 0$, a compensating factor, the impact of uncertainty on the productivity cutoff for outsourcing, kicks in and ameliorates the effect on integration productivity cutoffs.*

Proof. See appendix. □

This proposition implies that firms facing more uncertainty are more likely to delay their entry and exit decisions. Note that this result refers to one of the elements used to model uncertainty in this framework, namely the demand shock arrival rate, holding fixed the other component of the demand stochastic process, namely the cumulative distribution function. In the case of the integration productivity cutoffs , the first order effect of higher γ is to delay entry and exit.

Proposition 4. *(Heterogeneity in the responses by organizational form) The entry and exit cutoffs for exporting via outsourcing are more elastic to demand changes than the respective cutoffs for exporting with integration, i.e.* $(|\frac{\partial \ln \theta_o^e}{\partial \ln \mathcal{A}_t}| - |\frac{\partial \ln \theta_v^e}{\partial \ln \mathcal{A}_t}| > 0)$ *and* $(|\frac{\partial \ln \theta_o^x}{\partial \ln \mathcal{A}_t}| - |\frac{\partial \ln \theta_v^x}{\partial \ln \mathcal{A}_t}| > 0)$.

Proof. See appendix. □

The intuition for these results is that sunk costs dampen the response of the productivity cutoffs to shocks. Since integration requires higher sunk costs compared to outsourcing, it follows that demand elasticities for outsourcing cutoffs are higher (in absolute value). This higher elasticity of productivity cutoffs for outsourcing than integration sharply contrasts with the deterministic framework. In the deterministic framework, elasticities are similar both within organizational form and across organizational form. The reason is that all productivity cutoffs in the deterministic framework are log-separable in the demand realization. This log-separability does not hold in the stochastic framework since the current demand realization affects the expected gains and losses of potential future changes in demand conditions. These differences by organizational form in the elasticity to demand level are potentially interesting, because productivity is the only reason for differences in the behavior between integrated and non-integrated firms in the deterministic framework. In the stochastic framework, however, demand uncertainty and partially irreversible costs create another channel to explain the differences in the margin of adjustment between integrated and non-integrated firms.

Recall that demand uncertainty is modeled as a two component stochastic process: the demand shock arrival rate and the underlying demand distribution. Thus, comparative statics in terms of the arrival rate do not capture all of the possible effects of uncertainty in the model. Another approach to analyze the effect of uncertainty in the model is to consider changes in the distribution function $G(\mathcal{A})$. For example, a perceived worsening of demand conditions can be parametrized as a shift in mass towards the left tail of the distribution $G(\mathcal{A})$. The following propositions consider different scenarios in which I am able to identify the direction of the effect of changes in $G(\mathcal{A})$ on firms' decisions.

Proposition 5. *(Bad News I) Suppose that the distribution of demand $G(\mathcal{A})$ changes such that the new distribution $G'(\mathcal{A})$ is first order stochastic dominated by the initial distribution $G(\mathcal{A})$. Then productivity cutoffs for entry with outsourcing, integra-*

tion, exit from outsourcing and exit from integration are higher under $G'(\cdot)$ That is, $\theta_k^m(G') > \theta_k^m(G)$ where $k \in \{V, O\}$and $m \in \{e, x\}$.

Proof. See appendix. □

Proposition 6. *(Bad News II) Suppose that the distribution of demand $G(\mathcal{A})$ changes such that $G'(\mathcal{A})$ is a mean-preserving spread of $G(\mathcal{A})$ such that $G(\mathcal{A})$ and $G'(\mathcal{A})$ cross only once at $\tilde{\mathcal{A}}$. Then the exit cutoff increases, $\theta_k^x < \theta_k^{x\prime}$, for current realizations below $\tilde{\mathcal{A}}$ and declines, $\theta_k^x > \theta_k^{x\prime}$, above this threshold. Also, the entry cutoff increases, $\theta_k^e > \theta_k^{e\prime}$, for current realizations below $\tilde{\mathcal{A}}$ and decreases , $\theta_k^e > \theta_k^{e\prime}$, above this threshold.*

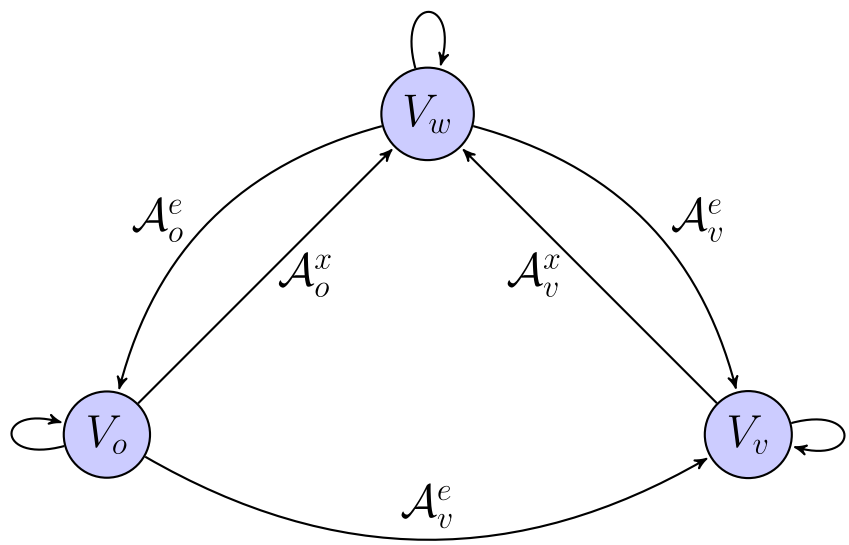
Proof. See appendix. □

These propositions imply that even when the current demand conditions remain constant, a change in the underlying demand distribution can lead firms to either enter, exit or change their organizational form. The is because an improvement in the demand distribution implies an increase of the expected gains of exporting. Therefore some firms -those that had been waiting for good news before beginning to export - decide to stop waiting and start exporting. Similarly, some firms that were considering integration will decide to stop waiting, because their expected profits from a new shock are higher than before. This result, interpreted from the perspective of episodes such as the Great Trade Collapse, implies that shocks that change not only the current demand condition but also the underlying distribution in the same direction would have stronger impacts than shocks to the current realization only. This proposition can also provide a potential explanation for recoveries after a negative shock through an improvement of the underlying demand distribution even if current conditions are unchanged.

To summarize, this section shows theoretically that uncertainty affects both entry, exit and organizational form decisions via both the threshold levels and the marginal response of these thresholds to shocks. This suggests that uncertainty can play a significant role in episodes characterized by high and changing uncertainty such as the GTC. The next section presents the steps I follow to test the model empirically and to quantify the role of uncertainty in the GTC.

2.4 Figures

Figure 2.1: Transitions and Demand Thresholds



Chapter 3: Global Sourcing and Uncertainty: Empirical Evaluation

The model developed in the previous sections has several predictions. In this section, I focus on key predictions to test the model and to provide insights on heterogeneous responses of firms across organizational choice. I focus on the decision to exit from foreign markets for several reasons. First, the exit decision has not been explored in detail by the trade literature. Second, the exit decision is a key margin that highlights the differences between related parties and arm's length trade, which played a key role during the GTC. Third, the exit decision provides a better setting than entry to identify the impact of uncertainty, as no assumption is needed to know the level of uncertainty to which the firm is exposed. More specifically, since it is not known a priori which foreign destination a firm would enter, it is not straightforward to measure uncertainty in the case of entry.

Based on the theoretical results and the propositions in the previous section, I expect the following: (i) related parties should survive longer following negative aggregate shocks, (ii) an increase in foreign demand uncertainty, as measured by the share of GDP that would be lost if a severe shock arrives, should induce firms to exit, and (iii) the difference in exit thresholds between related parties and arm's length trade should be bigger during times of higher uncertainty. The first testable prediction is based on proposition 1 and the result that even conditional on firm productivity the demand threshold to exit from vertical integration is lower than the exit threshold for outsourcing, $\mathcal{A}_v^x < \mathcal{A}_o^x$. The second prediction is based on proposition 5, which is applicable given the definition of uncertainty that I construct. The third testable prediction comes from the fact that introducing uncertainty into the model expands the differences in the exit cutoff between vertical integration and outsourcing.

A straightforward approach to testing these predictions is to build a duration model where the probability that the firm stops exporting in the next period is modeled using a hazard function that depends on independent variables such as measures of uncertainty and organizational form, including firm and destination characteristics in order to control for potential differences across firms.

3.1 Uncertainty Measure

In order to test the model, the first step is to compute a measure of uncertainty. In the model, firms are uncertain about the future value of $\mathcal{A}$ where $\mathcal{A} = \mu \times Y(t+1) \times P(t+1)^{\frac{\alpha}{1-\alpha}}$ and $Y(t+1)$ is the income of the foreign country. Therefore, I compute uncertainty by modeling the stochastic process for destination countries' Gross Domestic Product. More specifically, I assume that $\ln gdp_c(t)$ for country c follows an AR(1) process in differences with a Gaussian distributed error term:

$$\Delta \ln gdp_c(t+1) = a_c + \rho_c \Delta \ln gdp_c(t) + \epsilon_c(t+1)$$

After estimating this AR(1) process for all countries with at least 20 annual observations in the 1988-2011 period, I then compute the uncertainty measure as the share of GDP that a country will lose in the next period if a bad shock arrives.

$$unc_c(t) = 1 - \frac{\exp(\ln gdp_c(t) + \hat{\rho}_c \Delta \ln gdp_c(t) + \hat{\epsilon}_{c,0.05})}{gdp_c(t)}$$

This uncertainty measure assumes that firms base their decision to exit by forming an expectation of how much profit would be lost if a severe shock arrives. In the theoretical model, changes in foreign GDP are the only factor affecting $\mathcal{A}$. In reality, there are many other sources of uncertainty specific to destinations besides GDP; however, destination GDP is surely one important factor about which exporting firms are uncertain. Implicitly, the measure is approximating the expected profit loss using a two state process, involving GDP today and a bad shock at the 0.05 percentile of the distribution. This approach simplifies the construction of the measure and highlights the role of severe shocks, such as the GTC, in firms' decisions. Note that the country-specific uncertainty measure is varying over time. However, most of variation comes from the country dimension compared to the time dimension. More specfically, country is the source of around 90% of the variation while time accounts for the remaining variation.

As an alternative, I follow the literature on uncertainty at the macro level and use stock market volatility in the foreign market as my measure of uncertainty (cf. Bloom et al. (2012)). In particular, I use yearly stock market volatility in the destination market, as constructed by Baker and Bloom (2013).

3.2 Survival Approach

The standard approach in duration analysis when working with annual data is to use a discrete time model.[1] A discrete time model has the advantage that unobserved factors which may affect the estimation can be controlled for relatively easily. These factors, such as firm productivity and other unobserved firms characteristics, are controlled by introducing a "frailty" term that varies at the firm level. Formally, the hazard function is:

$$h_{ipc}(t) = Prob[exit \in [t-1,t] | survive > t-1]$$

where $h_{ipc}(t)$ is the probability that firm i exporting product p to country c stops exporting in period t. Under the proportional hazard assumption, the hazard function becomes:

$$h_{ipc}(t) = 1 - \exp\left(-\exp\left(X_{ipc}(t)\beta + j_t + \nu_{ipc}\right)\right)$$

where $X_{ipc,t}$ is a set of covariates that includes: (i) a dummy variable for related parties, (ii) an uncertainty measure, (iii) the interaction of uncertainty and the related parties dummy, and (iv) additional controls. j_t is the non-parametric baseline hazard and ν_{ipc} is assumed to follow a normal distribution, which implies that the individual effect is distributed log-normal. The assumption of log-normality is par-

[1] In the duration literature it also common to use the Cox proportional hazard estimator. The Cox proportional hazard model has the disadvantage of assuming that time is continuous and that failures can occur at any point. This is clearly not the case when using annual frequency data.

ticularly appealing for modeling the productivity of the firm, since there is evidence that at least the right tail of firm productivity follows a log-normal distribution (see Head, Mayer, and Thoenig (2014)).

As described in section 1.1, I use the LFTTD and LBD databases from the U.S. Census Bureau as the main source of information. The LFTTD provides detailed information on all U.S. export transactions at the firm level disaggregating by product, destination and ownership relationship between the trading firms. The LBD collects firm characteristics that I use as controls in the regression analysis. The unit of analysis is firm-destination-product-year and the period is 2002-2011.[2]

According to the model predictions discussed above, a dummy variable capturing whether firms engage in related party trade should have a negative impact on the hazard function, while uncertainty should have a positive impact. Additionally, uncertainty and GDP in the destination country should have a heterogeneous impact across organizational form. More specifically, related party trade should be less affected by uncertainty and the same level of GDP should have a stronger impact on the reduction of the probability of exiting. These heterogeneous effects imply that interactions between the related party indicator and the respective covariate should be negative for both cases.

The set of control variables includes firm and market characteristics. Firm age, size and previous export levels are introduced to control for firm productivity and export history, since previous studies show that more productive and more experi-

[2]The period of analysis is determined by the data availability since 2011 is the last year for which data on export transactions are available at the Census Bureau.

enced firms survive longer (see e.g. Dunne, Roberts, and Samuelson (1988), Mata and Portugal (1994), Pérez, Llopis, and Llopis (2004) and Volpe Martincus and Carballo (2009)). Also, control variables are motivated by the results on determinants of intra-firm imports for a sample of French firms by Corcos et al. (2013). They show that importing from a related-party firm is more probable for more productive firms, firms more capital and skill intensive. Also, they show that French firms are more likely to import through related-party from countries with better judicial systems. First, the individual effects captures firms' constant characteristics and in doing so control for the constant component of skill intensity, capital intensity and firm productivity. Second, employment size controls at least partially for time-varying productivity. Also, in the robustness section I perform several exercises that further control for these determinants.[3]. Destination country GDP is also included to control for current demand conditions.

Results are presented in Table 3.1 in the exponential form as is standard in duration model. These coefficients in exponential form should be interpreted using 1 as the reference. Coefficients lower than one reduce the probability of exiting while coefficients above one increase it. The results confirm the prior predictions. The indicator for related party trade is lower than 1 and significant in all specifications. This implies that related parties firms have a lower probability of exiting compared to arm's length trade. In the specification where all controls are included, the presence of related parties implies a reduction of 5.6% of the baseline exit hazard.

[3] First, I introduce firm TFP for a sample of manufacturing firms. Second, I introduce industry-specific baseline hazard that control for capital intensity and skill intensive differences across industries. Third, I add measures for country rule of law to control for the quality of judicial system. Results are robust to introduce all these controls.

Note that the controls have the expected effects; bigger firms in terms either of exports or employment are less likely to stop exporting and a higher GDP in the foreign destination also reduces this probability.

Table 3.1: Firms' Survival in Export Markets and Related Parties

Depvar: Exit	**(1)**	**(2)**	**(3)**
Related Party	0.791***	0.807***	0.946***
	(0.001)	(0.001)	(0.001)
GDP (log)		0.957***	0.963***
		(0.001)	(0.001)
Employees (log)			0.955***
			(0.001)
Age (log)			1.006***
			(0.001)
Exports (log)			0.747***
			(0.001)
Individual Effect	Yes	Yes	Yes
Observations (rounded)	17,600,000	17,600,000	17,600,000

Clustered standard errors at firm-destination-product in parentheses
Hazard function is non-parametric.
Coefficients are presented in their exponential form.
$***p < 0.01$, $**\ p < 0.05$, $*p < 0.10$

The results from estimating the impact of uncertainty on the firm decision to exit are presented in Table 3.2. The measure of uncertainty used is the expected GDP loss if a bad shock arrives, as we explain above. The impact of uncertainty is significantly higher than 1, as it increases the probability of exiting in the next period by 20% in the preferred specification in which all covariates and controls are included. Note that the impact of trading to related parties remains negative and significant when we control for uncertainty and also a dummy capturing whether the year corresponds to the GTC.

Results presented in the previous tables show that uncertainty has a negative

Table 3.2: Firms' Survival in Export Markets and Uncertainty

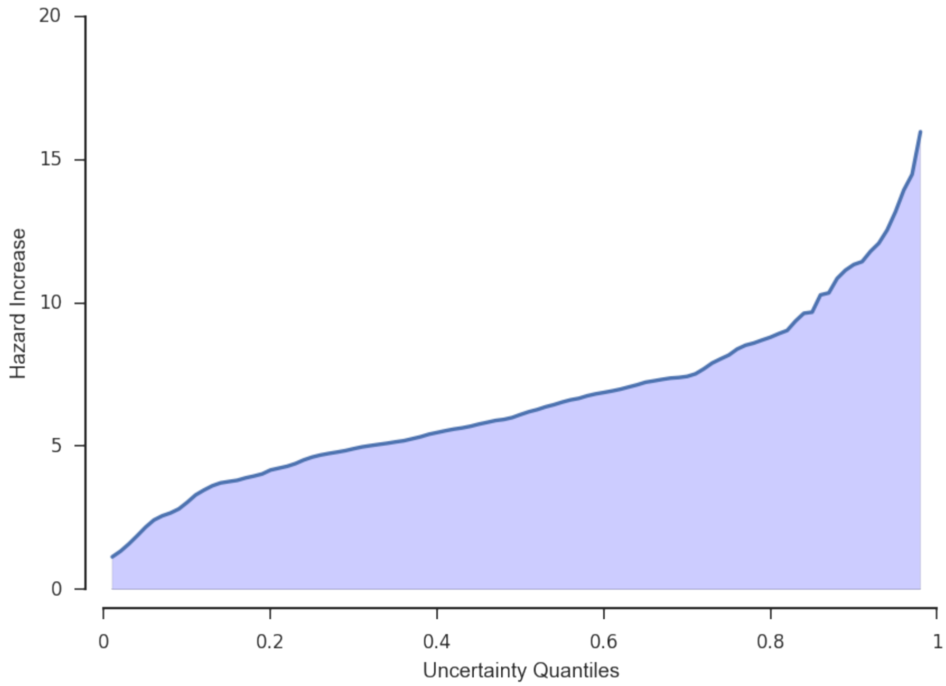
Dep var: Exit	**(1)**	**(2)**	**(3)**
Related Party	0.804***	0.889***	0.917***
	(0.001)	(0.001)	(0.001)
Uncertainty AR(1)	1.046***	1.080***	1.232***
	(0.004)	(0.005)	(0.004)
Crisis (2009)	1.082***	1.084***	1.099***
	(0.001)	(0.001)	(0.001)
GDP (log)		0.957***	0.968***
		(0.001)	(0.001)
Employees (log)			0.965***
			(0.001)
Age (log)			1.009***
			(0.001)
Exports (log)			0.777***
			(0.001)
Individual Effect	Yes	Yes	Yes
Observations (rounded)	14,300,000	14,300,000	12,700,000

Clustered standard errors at firm-destination-product in parentheses
Hazard function is non-parametric.
Coefficients are presented in their exponential form.
$***p < 0.01$, $**\ p < 0.05$

impact on firms' survival. However they do not provide with a measure of how much uncertainty increases the probability of exiting. Hence, I estimate the marginal impact of uncertainty for the full sample of firms. Figure 3.1 plots the marginal effect for the full distribution of firms exporting in 2005. I find that for at least 50% of firm-destination-product flows, uncertainty increases the probability of exiting by at least 5 percentage points and that for the upper tail of the distribution the increases is higher than 10 percentage points.

The third testable prediction is the heterogeneity in the impact of uncertainty and GDP across organizational form. More specifically, uncertainty has a smaller impact on the probability of exiting for related party exports according to the model.

Figure 3.1: Uncertainty Impact



Similarly, related party exports respond less to changes in GDP and have a lower cutoff of exiting given a demand level in the foreign destination. In order to test this, I reestimate the model allowing for an interaction between uncertainty and related parties. The specification in the case of allowing for heterogeneity in the impact of uncertainty is as follows:

$$h_{ipc}(t) = 1 - \exp(-\exp(\beta_{unc} unc_c(t) + \beta^{R}_{unc} unc_c(t) \times R + \beta_R R + X_{ipc}(t)\beta + j_t + \nu_{ipc}))$$

The approach for the case of GDP is similar to this where I introduce an interaction between GDP and related parties. Table 3.3 presents the results of estimating these heterogeneous impact across organizational forms for uncertainty and GDP.

Results show that trading to related parties rather than arm's length reduces

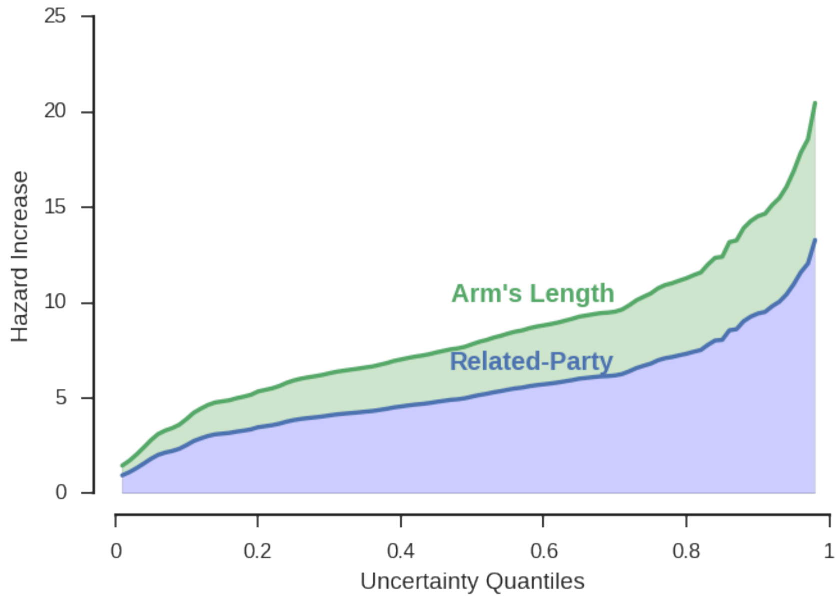
Table 3.3: Heterogeneity in Firms' Survival in Export Markets

Depvar: Exit	**(1)**	**(2)**
Related Party (β_R)	0.972***	0.976***
	(0.00876)	(0.0053)
Uncertainty AR(1) (β_{unc})	1.307***	1.152***
	(0.0305)	(0.0102)
RP x Uncertainty AR(1) (β^R_{unc})	0.910***	
	(0.0113)	
GDP (log) (β_{gdp})	0.956***	0.957***
	(0.007)	(0.007)
RP x GDP (log) (β^R_{gdp})		0.988***
		(0.00225)
Firms Characteristics	Yes	Yes
Individual Effect	Yes	Yes
Observations (rounded)	14,300,000	14,300,000

Clustered standard errors at firm-destination-product in parenthesis
Hazard function is non-parametric.
$***p < 0.01$, $**\ p < 0.05$

the impact of uncertainty on the probability from a 30.7% increase to a 18.9% increase. This represent a reduction of the effect of almost 40%. In the case of the GDP, trading to related parties implies an additional reduction on the probability of exiting of 2.68%. Note this is inline with the fact that at the same level of GDP related firms obtain higher profits and hence the probability of exiting is smaller. However, this also implies that the impact of GDP is stronger for related parties and, thus, this result contradicts the ranking of demand elasticity of the productivity cutoffs across organizational form. To further explore the heterogeneity in the impact of uncertainty, I compute the marginal effect for the full sample under analysis and plot the impact for percentiles of the uncertainty distribution. Figure 3.2 shows that the difference in the increase of the hazard between related parties and arm's length trade increases as uncertainty increases. For example, uncertainty increases the probability of exiting by 5 percentage points or more for more than 80% of firms trading at arm's length but only 50% of firms trading with related parties.

Figure 3.2: Heterogeneous Uncertainty Impact



Note that the identified effects correspond to the average industries. However, industries are heterogeneous in their production process. From the perspective of the model, the η parameter is the one capturing this heterogeneity. According to it, the impact of trading to related parties should be stronger the higher the η parameter is, i.e. the more relevant headquarters services are in the production process. In the robustness section, I introduce industry-specific hazard rates that control for these potential differences as long as they are constant over time.

A key assumption of the model is that the final good is consumed in the foreign destination. However, firms may have a multi-stage production process involving several countries. In particular, U.S. firms may be more likely to have a multi-stage production involving countries such as Canada and Mexico, due to NAFTA integration, or China, where the wage differential is higher. Unfortunately, it is not possible to track multi-country production process given the information available. However, I control for this potential issue by dropping these countries from the sample. In the robustness section, I show that this does not affect the main results.

3.3 Quantification

To explore the economic significance of the mechanisms highlighted by the model, I quantify the impact of trading with related parties and the role of uncertainty in the exit decision. The first counterfactual analysis considers the role of trading with related parties. More specifically, I compute how many additional exports would result if all firms had traded with related parties in 2009. Under this scenario, all firms originally trading at arm's length would have a lower probability of exiting in 2009, which in turns generates additional exports. I assume that these additional surviving firms have exports similar to average firms exporting to non-related firms in 2009. As an alternative scenario, I assume that these firms experience the average contraction in exports experienced by firms exporting to related parties. Results from performing this counterfactual analysis show that the 2009 contraction in U.S. exports would have been between 10% and 12% smaller under this scenario.

The second counterfactual analysis assumes that uncertainty in 2009 drops to its first tercile for all firms with uncertainty above the third tercile. In this scenario, all firms facing uncertainty above the third tercile have a higher probability of surviving, and this in turns generates additional exports. I assume that additional firms surviving in this scenario have the average export level of all firms exporting to their respective country in 2009. Results indicate that the contraction of exports in 2009 would have been reduced by 8% under this scenario.

3.4 Robustness Exercises

There are a number of potential concerns about these results. The main concern is whether these results are specific to the uncertainty measure used. In order to test this, I use the annual average stock market volatility in the foreign destination over the period as an alternative measure of uncertainty. The results, reported in Table 3.4, confirm that uncertainty increases the exit probability. A one standard deviation increase of stock market volatility increases the probability of exiting by 2.5% for the average firm while moving from the 5th percentile to the 75th percentile increases this probability by 4.4%.

Second, a key identification assumption is that the final good is consumed in the foreign country, so that uncertainty over the foreign country demand affects the firm's decision to export through related parties or at arm's length. If instead U.S. firms export via related parties to a foreign country with the intention to ship back the good, then foreign demand conditions in general, and uncertainty in particular, are irrelevant to the organizational choice. Note than if reshipment is more likely for related parties than arms-length trade, the impact of uncertainty would be higher than the one estimated above. Such a multi-stage production process involving U.S. exports is more probable for exports within NAFTA or China. Hence, I reestimate the model taking out exports to NAFTA and China from the sample. Results are reported in Table 3.5. These regressions confirm all previous results; moreover, the impact of uncertainty is stronger when I eliminate all export flows to Canada, Mexico and China.

Third, a potential concern is whether the estimated impact of uncertainty is driven solely by the 2008-9 recession (GTC), with no impact of uncertainty before 2008. However, reestimating the model for the 2002-2007 period, before the GTC started, confirms the baseline results and shows that uncertainty plays a significant role in firms' exit decisions even in periods of relative stability, see Table 3.6 for detailed results.

Fourth, results may depend on unobserved factors, such as productivity and other firm's characteristics. Controlling for a timer-varying firm-level TFP measure, as computed by the Census Bureau, does not affect previous findings.[4] This result is reported in the first column of Table 3.7; the other columns include other firm characteristics such as whether the firm is importing and total domestic sales. All results and conclusions remain the same after introducing these controls. Similarly,

[4]The TFP index measure is constructed using the following formula:

$$\ln TFP_e(t) = \ln Q_e(t) - \alpha_K \ln K_e(t) - \alpha_L \ln L_e(t) - \alpha_M \ln M_e(t)$$

where Q is real output, K is real capital, L is labor input, M is real materials, α denotes factor elasticities, the subscript e denotes individual establishments and t denotes time. Factor elasticities are industry-level cost shares for each input. See more details in Foster, Grim, and Haltiwanger (2014).

results may be affected by unobserved characteristics at the industry or destination level. In order to control for these unobserved characteristics, I reestimate the model using industry and country-specific baseline hazards, where industries are defined using the 2-digits harmonized classification. These industry-specific and country-specific baseline hazards incorporate permanent characteristics of industries and destinations. Results are reported in 3.8 and are robust to incorporating these additional controls. Note that country-specific hazard rates allow to control for the impact of PTA agreements on the probability of exiting.

Fifth, results may be affected by firms reentering in the future. Empirically, this does not seem to be the case, as most firms exit permanently. Moreover, adding a dummy for previous spells to control for this reentry behavior does not change results. Additionally, results could depend on the frequency of the data or the estimator used. However, results are robust to using data at the semi-annual frequency and to using the Cox proportional hazard model, instead of the discrete approach followed in the main specification; results are reported in Table 3.9.

Sixth, the empirical analysis uses firm-destination-product as it level of analysis. However, firms do not take decision independently across destinations and markets. In order to control for this, I run several robustness exercises: first, I included a dummy to check whether the firm is exiting in another foreign market; second, I allowed standard errors to be clustered at firm-level to account for common shocks at firm level; third, I included domestic sales as a control in the regression to include information about the domestic market. In all cases, the results remain the same qualitatively.

3.5 Conclusions

I examine how firms' global sourcing strategies affect their responses to economic crises such as the 2008-2009 recession. I model firms' entry, exit and sourcing decisions (integrated production or outsourcing) under demand uncertainty. Uncertainty increases the option value of waiting, resulting in less integration as well as less entry and exit. Additionally, I show that trade decisions of integrated firms are less sensitive to uncertainty shocks. These heterogeneous responses to shocks highlight the role of sourcing strategies in the way firms adjust and contrast with the homogeneous responses predicted by the deterministic model.

I develop a theory-consistent measure of foreign demand uncertainty following closely the model. Then, I use U.S. firm-level export data for the 2002-2011 period to test the predictions of the model for the exit decision. In doing so, I exploit the fact that U.S. customs data is one of the few databases that records the ownership relation between trading parties for every transaction. I find that integration reduces the probability that a firm exits by as much as 8%, while uncertainty increases this probability by as much as 22%. Quantifying the impact of these results, I find that if all firms traded to related parties, the 2009 collapse in exports would have been reduced by between 10% and 12%. Also, if uncertainty was reduced to the first tercile for all firms, the reduction on exports of 2009 would have been 8% smaller.

3.6 Tables

Table 3.4: Firms' Survival and Alternative Uncertainty Measures

Dep var: Exit	**(1)**	**(2)**	**(3)**	**(4)**
Related Party	0.804***	0.917***	0.799***	0.914***
	(0.001)	(0.001)	(0.001)	(0.001)
Crisis (2009)	1.082***	1.099***	1.079***	1.05***
	(0.001)	(0.001)	(0.002)	(0.002)
GDP (log)	0.959***	0.968***	0.974***	0.974***
	(0.001)	(0.001)	(0.001)	(0.001)
Uncertainty AR(1)	1.046***	1.232***		
	(0.004)	(0.004)		
Stock Market Volatility			1.027***	1.041***
			(0.003)	(0.001)
Stock Market Return			0.9539**	0.856***
			(0.021)	(0.009)
Observations (rounded)	15,300,000	12,700,000	12,700,000	11,900,000
Firms characteristics	No	Yes	No	Yes

Clustered standard errors at firm-destination-product in parentheses
Hazard function is non-parametric.
Coefficients are presented in their exponential form.
$***p < 0.01$, $**\ p < 0.05$

Table 3.5: Estimation without China and NAFTA

Dep var: Exit	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Related Party	0.845***	0.913***	0.934***	0.841***	0.908***	0.932***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
GDP (log)	0.969***	0.966***	0.98***	0.98***	0.974***	0.98***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Uncertainty AR(1)	1.046***	1.076***	1.252***			
	(0.003)	(0.004)	(0.004)			
Crisis (2009)	1.06***	1.062***	1.081***	1.055***	1.052***	1.032***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Employees (log)		0.963***	0.973***		0.964***	0.975***
		(0.001)	(0.001)		(0.001)	(0.001)
Age (log)		1.016***	1.004***			1.009***
		(0.001)	(0.001)			(0.001)
Exports (log)			0.803***			0.803***
			(0.001)			(0.001)
Stock Market Volatitly				1.016***	1.02***	1.025***
				(0.001)	(0.001)	(0.001)
Stock Market Return				0.89***	0.896***	0.811***
				(0.009)	(0.009)	(0.009)
Observations (rounded)	8,130,000	8,130,000	8,130,000	7,030,000	7,030,000	7,030,000

Clustered standard errors at firm-destination-product in parentheses
Hazard function is non-parametric.
Coefficients are presented in their exponential form.
$***p < 0.01$, $**\ p < 0.05$

Table 3.6: Estimation without GTC

Dep var: Exit	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Related Party	0.824***	0.904***	0.932***	0.814***	0.896***	0.924***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
GDP (log)	0.963***	0.961***	0.97***	0.979***	0.974***	0.99***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Uncertainty AR(1)	1.05***	1.046***	1.183***			
	(0.006)	(0.006)	(0.006)			
Employees (log)		0.956***	0.969***		0.956***	0.97***
		(0.001)	(0.001)		(0.001)	(0.001)
Age (log)		1.018***	0.994***		1.018***	0.993***
		(0.001)	(0.001)		(0.001)	(0.001)
Exports (log)			0.79***			0.787***
			(0.001)			(0.001)
Stock Market Volatility				1.012***	1.033***	1.065***
				(0.00179)	(0.00184)	(0.00179)
Stock Market Return				0.884***	0.848***	0.887***
				(0.0119)	(0.0123)	(0.0121)
Observations (rounded)	7,822,000	7,822,000	7,822,000	6,568,000	6,568,000	6,568,000

Clustered standard errors at firm-destination-product in parentheses
Hazard function is non-parametric.
Coefficients are presented in their exponential form.
$***p < 0.01$, $**\ p < 0.05$

Table 3.7: Additional Firms' Characteristics

Dep var: Exit	**(1)**	**(2)**	**(3)**
Related Party	0.92***	0.92***	0.919***
	(0.003)	(0.003)	(0.003)
GDP (log)	0.973***	0.973***	0.98***
	(0.001)	(0.001)	(0.001)
Uncertainty AR(1)	1.155***	1.156***	1.156***
	(0.010)	(0.010)	(0.010)
Crisis	1.08***	1.08***	1.079***
	(0.003)	(0.003)	(0.003)
Employees (log)	0.974***	0.974***	0.971***
	(0.001)	(0.001)	(0.001)
Age (log)	0.993***	0.993***	0.992***
	(0.002)	(0.002)	(0.002)
Exports (log)	0.776***	0.776***	0.776***
	(0.001)	(0.001)	(0.001)
TFP (log)	0.982***	0.982***	0.982***
	(0.002)	(0.002)	(0.002)
Importer		0.9933**	0.985***
		(0.003)	(0.003)
Domestic Sales (log)			0.988***
			(0.001)
Observations (rounded)	7,822,000	7,822,000	7,822,000

Clustered standard errors at firm-destination-product in parentheses
Hazard function is non-parametric.
Coefficients are presented in their exponential form.
$***p < 0.01$, $**\ p < 0.05$

Table 3.8: Estimation using Industry-specific Baseline Hazard

Dep var: Exit	**(1)**	**(2)**	**(3)**
Related Party	0.885***	0.926***	0.936***
	(0.003)	(0.003)	(0.003)
GDP (log)	0.965***	0.961***	0.98***
	(0.001)	(0.001)	(0.001)
Uncertainty AR(1)	1.033***	1.055***	1.138***
	(0.009)	(0.009)	(0.009)
Crisis	1.031***	1.042***	1.061***
	(0.002)	(0.002)	(0.002)
Employees (log)		0.965***	0.977***
		(0.001)	(0.001)
Age (log)		1.013***	0.988***
		(0.002)	(0.002)
Exports (log)			0.792***
			(0.001)
Observations (rounded)	14,300,000	14,300,000	12,700,000

Clustered standard errors at firm-destination-product in parentheses
Hazard function is non-parametric.
Coefficients are presented in their exponential form.
$***p < 0.01$, $**\ p < 0.05$

Table 3.9: Estimation using Cox Proportional Hazard

Dep var: Exit	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Related Party	0.919***	0.953***	0.964***	0.916***	0.951***	0.963***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
GDP (log)	0.986***	0.985***	0.99***	0.99***	0.988***	0.99***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Uncertainty AR(1)	1.025***	1.036***	1.097***			
	(0.002)	(0.002)	(0.002)			
Crisis (2009)	1.025***	1.026***	1.033***	1.03***	1.027***	1.015***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Employees (log)		0.982***	0.987***		0.981***	0.988***
		(0.001)	(0.001)		(0.001)	(0.001)
Age (log)		1.006***	0.997***			0.995***
		(0.001)	(0.001)			(0.001)
Exports (log)			0.89***			0.887***
			(0.001)			(0.001)
Stock Market Volatility				1.01***	1.072***	1.016***
				(0.001)	(0.001)	(0.001)
Stock Market Return				0.967***	0.971***	0.942***
				(0.004)	(0.004)	(0.004)
Observations (rounded)	14,300,000	14,300,000	12,700,000	12,700,000	12,700,000	11,900,000

Clustered standard errors at firm-destination-product in parentheses
Hazard function is non-parametric.
Coefficients are presented in their exponential form.
$***p < 0.01$, $**\ p < 0.05$

Chapter 4: Trade Collapse: The Role of Economic and Policy Uncertainty in the Great Recession

Note: This chapter is coauthored with Kyle Handley and Nuno Limão

4.1 Overview

Firms face uncertainty about future conditions affecting their costs, demand, and profitability. Sources of uncertainty range from purely economic shocks - such as productivity or tastes - to policy shocks - such as monetary and fiscal innovations, tax and regulatory reforms. These uncertainties about future conditions are especially important when firms must decide on costly irreversible investments such as, adopting a new technology, producing or selling in a new market, or the decision to close a plant or abandon a market outright.

The recent "Great Recession" and slow recovery renewed concerns about the impact of uncertainty on economic activity. Existing frameworks used to study such impacts focus on uncertainty from purely economic shocks but generally ignore other sources such as uncertainty about future policy. However, uncertainty about future taxes, regulatory reforms, and other policies can be quite important and in fact some prominent policy makers and economists believe that policy uncertainty helps to explain the weak recovery in the U.S.[1] Furthermore, available models are usually not able to encompass multiple sources of uncertainty, and less so how these multiple sources interact. Moreover, it can argued that uncertainty about trade policy also increased during this recession. For example, the G-20 repeatedly pledged that "We will not repeat the historic mistakes of protectionism of previous eras." which shows that the fear of a trade war, similar to the one in the 1930's, was widespread.[2] Despite these concerns among policy makers about the impact of policy uncertainty, there is relatively little firm evidence about its economic impacts and how it interacts with economic uncertainty.

The impact of uncertainty on certain firm investments is theoretically understood (cf. Bernanke (1983); Dixit (1989)) and there is some empirical evidence linking the two (Bloom, Bond, and Reenen (2007); Bloom (2009)). The empirical evidence is particularly scarce when it comes to policy uncertainty, even though thousands of firms worldwide rank it as an important business constraint (World Bank (2004)). Furthermore, studies that consider multiple sources of uncertainty are virtually nonexistent. The scarce evidence is in part due to the fact that it is hard to measure policy uncertainty, identify its causal impact on specific investment decisions (Bloom, Bond, and Reenen (2007)), and unbundle it from other sources of uncertainty, such as economic uncertainty. The international trade setting provides an ideal framework to overcome these problems. First, firms' entry to an export

[1] See for example, "Minutes of the Federal Open Market Committee," August 9, 2011, < http://federalreserve.gov/monetarypolicy/fomcminutes20110809.htm >; "Uncertainty and the Slow Recovery," Wall Street Journal, January 4, 2010. Becker, Gary S., Steven J. Davis and Kevin M. Murphy

[2] G-20 Communique, April 9, 2009. http://www.londonsummit.gov.uk/en/summit-aims/summit-communique/

market involves a sunk cost (cf. Roberts and Tybout (1997)) and once firms are operating in a foreign market, they are subject to additional policy uncertainty (e.g. the threat of trade wars). Unlike many other activities, firms' international transactions have to be registered, thus generating very detailed firm-level data that allows to identify market entry (and its associated investments) as well as other export outcomes . Furthermore, this detailed information is available at a high frequency, a key feature to identify the impact of uncertainty. Finally, the institutional setting for international trade, mainly trade agreements, the WTO and tariffs levels, provides variation in policy uncertainty over countries and products as well as a good way to measure policy uncertainty.[3]

The trade setting is also extremely interesting in its own right. First, global integration and the increasing share of exports in firms' sales have considerably increased exposure to foreign policy uncertainty. Second, while a significant portion of trade analysis assumes policy is fixed, Handley (2014) and Handley and Limão (Forthcoming) show that policy can be quite uncertain, which has direct effects on exporting and also makes current tariff changes less credible, attenuating their impact on investment and trade even in context of low economic uncertainty. Third, the impact of trade policy uncertainty during a high economic uncertainty period has not been explored.

During the most recent economic downturn, the so called "Great Recession", worldwide trade experienced the greatest contraction since World War II, as world

[3]Moreover, trade policy is one of the main concern for exporting firms. For example, Japanese firms ranked trade policy first in terms of the uncertainty they face and second in terms of the impact on their management decisions among the sources of policy uncertainty (see Morikawa (2013)).

exports decreased by 12 percent in 2009. The collapse affected many different countries and the U.S. was no exception. U.S. export and import volumes dropped 18.0 percent and 25.9 percent respectively in 2009 (see U.S. Census Bureau (2015)). A collapse of international trade of such magnitude attracted a lot of attention, especially since the contraction in GDP was milder.[4] Several hypotheses to explain it have emerged: (i) changes in the composition of demand (Eaton et al. (2013)); (ii) the collapse of trade credit (Chor and Manova (2012)); (iii) the disintegration of international supply chains (Bems, Johnson, and Yi (2011)); (iv) the inventory cycles of firms (Alessandria, Kaboski, and Midrigan (2010)); and (v) economic uncertainty (Novy and Taylor (2014)). The overall consensus in the literature is that these explanations cannot account for the bulk of the "Great Trade Collapse" (GTC). Moreover, proposed explanations focus on the contraction but ignore the subsequent fast recovery of international trade. U.S. exports grew more than 31% from the 4th quarter of 2009 to the 4th quarter of 2010.[5] Hence, explanations of the GTC not only need to account for the contraction but must also be consistent with such a recovery.

These facts lead us to explore a different explanation of the GTC and the recovery: changes in uncertainty about other countries' policies combined with economic uncertainty. Our main motivation for this hypothesis is the widespread fear of a return to protection not seen since the trade wars of the 1930s. Three factors lent credibility to an increase in the risk of protectionism. First, there was large

[4]For example, according to the World Bank U.S. GDP contracted only 2.04% during 2009 while U.S. international trade decreased a 22.8%.

[5]Furthermore, the growth from the trough of the recession to the end of 2010 in U.S. exports was a remarkable 68% in 6 quarters

scale government intervention to stimulate markets but prevent free-riding of foreign countries. For example, the "buy American" clause in the US stimulus bill discriminated against foreign firms (Eichengreen and Irwin (2010)). Second, unilateral liberalization by several countries before the crisis implied that more than 30% of applied tariffs worldwide were well below binding ceilings negotiated at the WTO (Foletti et al. (2011)). This meant that the potential scale of WTO-legal tariff increases was large. Third, the world trade system had not been tested in a coordinated downturn of this magnitude since the 1930's, which is one reason for the repeated assurances to eschew protectionism.

Despite these fears of a return to protectionism, the WTO and other organizations monitored increases in applied protection and ultimately found only limited increases.[6] But in our framework, a backslide to protectionism need not actually occur to affect real activity. Only that firms expect a trade war with a higher probability during the GTC is required.[7] Traces of uncertainty-related trade frictions were evident. First, the decline in trade was larger for consumer durable and capital goods, which require larger fixed investments (Bems, Johnson, and Yi (2011)). Second, the IMF (2010) found the exports of crisis countries to non-crisis ones can be explained by contemporaneous changes in income and other covariates, whereas their imports cannot. This suggests a higher perceived likelihood of protection in

[6] WTO, OECD and UNCTAD 2010, "Report on G20 Trade and Investment Measures." Kee, Neagu, and Nicita (2013) find increases in applied protection accounted for a small share of the collapse, but there is heterogeneity across countries.

[7] More specifically, Kee, Neagu, and Nicita (2013) find that the increase in protectionism affected only 1% of traded products and 2% of the trade collapse. This is in sharp contrast with the Great Depression of 1930, where increases in barriers affected 35% of tariff schedule lines and accounted for a large fraction of the trade contraction (see Madsen (2001)).

crisis relative to non-crisis countries. Moreover, in those products that were directly targeted by protection, trade declines were large, which suggests that expectations of large losses conditional on a policy shock were warranted. Third, Bown and Crowley (2013) show evidence of negative correlation between economic shocks and barriers to trade before 2008-9 recession. Hence firms' expectations before the GTC naturally include some positive probability of a policy amplification channel in the case of a recession in the foreign destination. However, when this backslide to protectionism did not take place, uncertainty declined and helped foster the recovery of international trade.

More specifically, we address the following questions in this chapter: Did uncertainty play a role during the GTC? What was the role of economic and policy uncertainty in the collapse and subsequent recovery? Our approach to answering these questions is first, to document the trade dynamics of U.S. firms during the GTC and second, to empirically assess the role of economic uncertainty and trade policy uncertainty (TPU) in the collapse, guided by a theoretical model that encompasses both economic and policy uncertainty and allows us to unbundle both sources of uncertainty.

In order to explore the dynamics of U.S. exporting firms during the GTC, we use, for the first time in the literature, confidential detailed firm-level from the Census Bureau.[8] The descriptive exploration of these data highlights three key

[8]Our main source of information for firms export transaction is the Longitudinal Firm Trade Transaction Database (LFTTD). This database links trade transactions to the firms that make them and allows us to track firms over time. Importantly, this dataset records for each trade transactions the product classification, the value and quantity shipped, the date of the shipment, and the destination country, among other things. This detailed information allows us to track firms' export dynamics across countries, products and over time.

findings: First, the collapse was strong but was followed by a quick recovery. The collapse started in the fourth quarter of 2008 and reached its trough in the second quarter of 2009. Most of the export variables recovered by the end of 2010 and 2011. Second, the intensive margin -adjustment of existing trade flows- played a central role but the extensive margin -the creation/destruction of trade flows- represented a significant share of the contraction in the U.S., in sharp contrast to other countries. We find that the extensive margin represented around 40% in terms of values and that around 13% of U.S. firms stopped exporting during the GTC; also, it took more than 8 quarters for the number of U.S. firms exporting to get back to their level before the recessions. Third, heterogeneity across product, firms and destinations show significant differences in the adjustment Importantly, trade institutions affected significantly the margin of adjustment of U.S. firms during the GTC. Firms exporting to countries with preferential trade agreements (PTA) adjust significantly less through the extensive margin than firms exporting to non-PTA countries.[9] This difference in the adjustment margin is consistent with firms assigning a positive probability of trade wars during the GTC.

We then develop a dynamic model of heterogeneous firms that face policy and economic uncertainty to guide our estimation approach. We build on Handley and Limão (Forthcoming) and generalize it in two ways that are central for the analysis of the GTC. First, we focus on demand uncertainty, which allows us to capture both trade policy uncertainty (TPU) (as in Handley and Limão (Forthcoming)) but also

[9]PTAs are agreements among a countries that involves a preferential treatment of trade among members of PTA relative to non-members. Free trade agreements (FTA) are the most common form of PTAs. In general, PTAs implies a commitment to lower trade barriers and to no trade barriers in the case of FTAs.

economic uncertainty. Second, while Handley and Limão (Forthcoming) focus on entry, we examine the dynamics of exporting more broadly, including re-entry. To capture these central elements in a tractable way that permits estimation using firm-level data we abstract from certain general equilibrium effects, such as the impacts of entry on the price index analyzed by Handley and Limão (2013) in the context of China's export boom to the U.S.[10] Firms have to pay a sunk cost to start exporting. This sunk cost combined with the uncertainty in the demand level generates an option value of waiting to enter a foreign market.

As a first step, we model demand uncertainty originating from trade policy and the aggregate income under the assumption that shocks to both variables arrive at the same time (i.e. when a shock arrives both the policy and the income level draw a new value). In this setting an increase in uncertainty reduces entry and also reduces re-entry. Introducing a correlation between the policy realization and the economic realization increases or decreases the impact on entry depending on the sign of the correlation. A negative correlation, low income is associated with high tariffs and vice-versa, between the sources of uncertainty decreases entry even more because firms internalize that a recession in their foreign market increases the probability that a future policy shock hurts profits even more. Next, we incorporate the fact that the persistences of economic and policy shocks are different. More specifically, we allow for different arrival rates of shocks by assuming that an economic shock is a necessary condition for a policy shock but it is not sufficient. In the theory section,

[10] Handley and Limão (2013) show that allowing for general equilibrium effects in the context of a model with uncertainty generates an attenuation of the uncertainty effect, which under certain general assumptions does not dominate the partial equilibrium effect.

we show that the impact of uncertainty on firms' export decisions is summarized by a multiplicative factor that captures the expected profit loss if economic conditions get worse than the current realization. This factor is the key of the empirical analysis since it captures the role of demand uncertainty in firms' decisions. Thus, in order to empirically assess the role of uncertainty we need a measure of this expected profit losses if conditions worsen in some future period. Our approach to measure this uncertainty factor is to compute the expected contraction of nominal GDP in the foreign destination if a bad economic shock arrives.

In order to unbundle the economic and policy uncertainty, we proceed in two steps. First, we interact our uncertainty GDP measure with an indicator that captures whether the foreign destination has a PTA with the U.S., since having a trade agreement lowers significantly the probability of a trade war. Second, following Broda, Limao, and Weinstein (2008) we exploit the fact that countries during a trade war would increase their tariffs heterogeneously across products and that foreign destination market power in the industry is a key driver of this heterogeneity. This strategy allows us to unbundle the effect of multiple sources of uncertainty by comparing the impact of economic uncertainty with and without policy uncertainty (PTA countries vs non-PTA countries) and the impact of economic uncertainty depending on the level of a policy threat that could take place (high market power vs low market power). We then estimate a flexible specification to identify the impact of demand uncertainty and disentangle economic and policy uncertainty. We allow for time-varying impact of uncertainty in order to avoid imposing a particular timing on the GTC. Importantly, we use quarterly frequency data, since using annual frequency can mask some of the characteristic of the GTC. Additionally, we control for changes in GDP in the foreign destination and include several fixed effects at the country, industry, and quarter-year level to control for other potential factors affecting export outcomes.

We find that uncertainty has a negative impact on the number of varieties exported and that its effect increased during GTC compared to the baseline period 2002-2008. The negative impact of uncertainty reaches its peak during the first four quarters of the GTC and then decreases. After estimating the empirical model, we disentangle the sources of uncertainty by computing the difference in export outcomes across PTA and non-PTA partners and using comparing industries with high and low market power. We find that the negative impact of uncertainty during the GTC and the subsequent recovery is stronger for partners without a PTA, until the end of 2010 when the differences became insignificant. This suggests that firms assigned some probability of a trade war -additional policy uncertainty- at the beginning of GTC but that at some point around the end of 2010 firms dropped this expectation, fueled by the lack of changes in policy variables in foreign destinations. Disentangling economic and policy uncertainty with market power confirms that the impact of uncertainty is stronger when the threat of bad policy shocks stronger (i.e. higher market power in the foreign destination) and this difference only manifests for non-PTA partners. In the quantification exercises, we find that uncertainty is responsible for around 50% of the GTC and a similar magnitude for the recovery. Furthermore, the reduction of the impact of uncertainty played an important role fostering the recovery. The recovery in net entry during 2010 would have been 81%

smaller if the uncertainty impact had remained at the level observed during the first four quarters of the GTC.

The chapter is organized as follows: the next section focuses on the descriptive analysis of the GTC. In the third section, we build a theoretical model that incorporates the key elements from the descriptive evidence and introduces multiple sources of uncertainty. Finally in the fourth section we take our model and main predictions to the data and evaluate the impact of uncertainty during the GTC.

4.2 Firm-level Anatomy of the Great Trade Collapse

The 2008 financial crisis was followed by the Great Recession and a remarkable collapse in international trade. According to the WTO, world trade fell by 12% in 2009 while world GDP fell only by 2.7%. This is the greatest contraction of world trade since World War II. The Great Trade Collapse (GTC) showed a remarkable synchronization across countries (see Antonakakis (2012) and Martins and Araújo (2009)) but its depth was heterogenous across countries. The declines were particularly large for certain developed countries such as the U.S., where in 2009 imports decreased by 22.7% and exports contracted by 14.2% (Census Bureau, 2011). This collapse is more remarkable given that U.S. GDP contracted only by 3.5% in 2009 (Worldbank, 2012). The depth and speed of the collapse has been examined for some specific countries including the U.S. (see Bems, Johnson, and Yi (2013) for a survey). However, previous work for the U.S. has employed aggregate data and has therefore not examined the dynamics of U.S. trade at the firm and product level, which is crucial to understand the causes and consequences of the collapse.

The strong collapse of 2008-9 was followed by a relatively fast recovery. This recovery has not received much attention. U.S. quarterly exports were 25% higher on average in 2010 compared to the same quarter of 2009 and U.S. exports in the fourth quarter of 2010 were 34% higher than the same quarter in 2008. Therefore, our contribution in this section is to provide a detailed anatomy of U.S. firms' trade dynamics in the GTC by employing detailed customs transaction data and information on firms. Due to the timing of the crisis, starting in the last quarter of 2008, we focus on quarterly frequency data, as does most of the work on the GTC does.

4.2.1 Aggregate Exports

Total exports of goods to a particular country can be decomposed into the number of firms exporting, the number of products exported, how much these firm-products trade in each transaction and the number of transactions. Thus, we start by looking at the evolution of each of these components in order to provide a first approximation to the trade dynamics during the Great Trade Collapse.

Aggregate U.S. exports reached their pre-crisis peak in the second quarter of 2008 after several quarters of sustained growth. One year later, in the second quarter of 2009, aggregate exports were only 73% of that peak value. The recovery started in the third quarter of 2009 and annual exports in 2009 were about 81% of their total in 2008. However, it was not until the last quarter of 2010 that total exports in any given quarter exceeded the pre-crisis peak. Total exports in 2010 were roughly the same nominal value as the total in 2008.

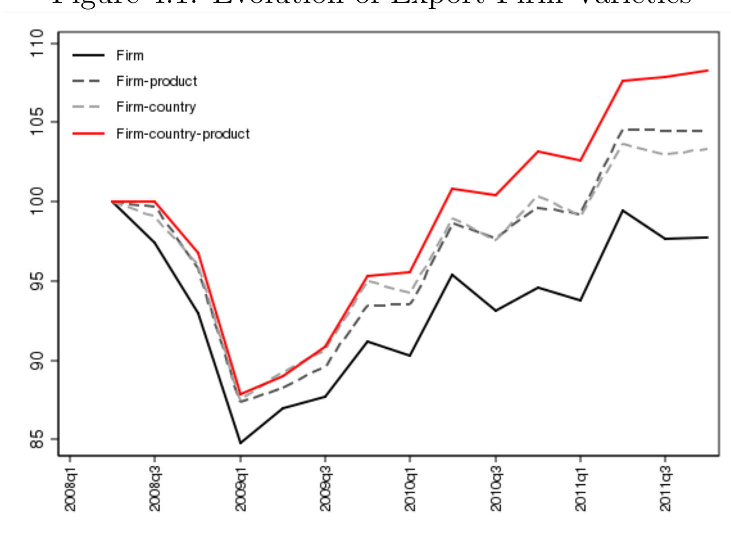
The number of export transactions followed a similar pattern to exports but with a faster recovery. More specifically, the number of transactions returns to its pre-crisis level in the last quarter of 2009, a full year before the recovery of total exports. This implies that the average value of transactions dropped during 2010.

The number of both exporting firms and varieties reached their peaks in the third quarter of 2008. Relative to this point, in the second quarter of 2009 there were 13% fewer exporting firms and 11% fewer varieties (where the latter varies slightly depending on the definition of a variety: firm-destination, firm-product, firm-product-destination), as we can see in figure 4.1 below. This is particularly striking given that the number of firms and varieties prior to the crisis had been growing at an annual average rate of 3.8% and 5.5% respectively. This strong fall during the GTC in the number of varieties exported from the U.S. points to a significant action in the destruction of trade flows, henceforth the exit margin.

The collapse in the number of U.S. exporting firms is much stronger than that reported for the few other countries where such information has been analyzed. Between October 2008 and April 2009 the number of exporters in France declined by 7.6% (Bricongne et al. (2012b)) while the corresponding number was almost double for the US, 13%. The comparison with Belgium is even more striking: Behrens, Corcos, and Mion (2013) find an increase in exporting firms of about 1% between the first semester of 2008 and that of 2009, while in the U.S. there was a decrease of 12% in the same period.

While the drop for the number of firms and number of varieties was similar, their recovery pattern was very different. Varieties recovered to their pre-crisis levels by the end of 2010, but in 2011 the number of firms exporting was still below its pre-crisis level. This suggests that firms that survived the GTC expanded their export baskets in terms of products, countries or both, and by 2011 this increase was enough to compensate for the firms that stopped exporting during the GTC. As we will show below this substitution is reflected in Table 4.3, which shows that the intensive margin contributed on average 50% to total export growth prior to the crisis but 70% starting in 2010 (and continuing in 2011).

Figure 4.1: Evolution of Export Firm Varieties



All numbers of varieties are indexed to their value in the third quarter of 2008. A firm variety is defined as a unique combination of firm and the corresponding level of disaggregation.

4.2.2 Decomposing the GTC

In order to better understand firm export dynamics over the GTC, we decompose total exports into their margins. We do so by exploiting customs data at the firm-product-destination level, henceforth variety level. First, we compute the midpoint growth rate of exports and distinguish between the evolution of its extensive margin (i.e. the creation and destruction of firm-country-destination flows in a given quarter) and intensive margin (i.e. changes in the export value of continuing varieties). Second, we explore whether there are heterogeneous responses during the GTC by repeating the decompositions for mutually exclusive subsamples defined in terms of different characteristics of either firms, products and/or destinations.[11]

The aggregate mid-point growth rate between a quarter, q, and the previous year, $q-4$, is defined as follows

$$G(q) = \frac{X(q) - X(q-4)}{\frac{1}{2}[X(q) + X(q-1)]}$$

As we show in the appendix (eq. B.1.1) this can be re-written as a weighted average of midpoint growth rates at the variety level as:

$$G(q) = \sum_{i,c,k} s_{ick}(q) \times g_{ick}(q)$$

where i, c, k index firm, destination and product respectively; $g_{ick}(q)$ is the midpoint

[11]In order to avoid capturing spurious extensive margin changes during 2006-2011 due to classification changes in the U.S. custom schedule we applied the concordance developed by Pierce and Schott (2009) to have a stable product classification.

growth rate for firm i's exports of product p to country c in quarter q; and $s_{ick}(q)$ is its share in total exports in q.

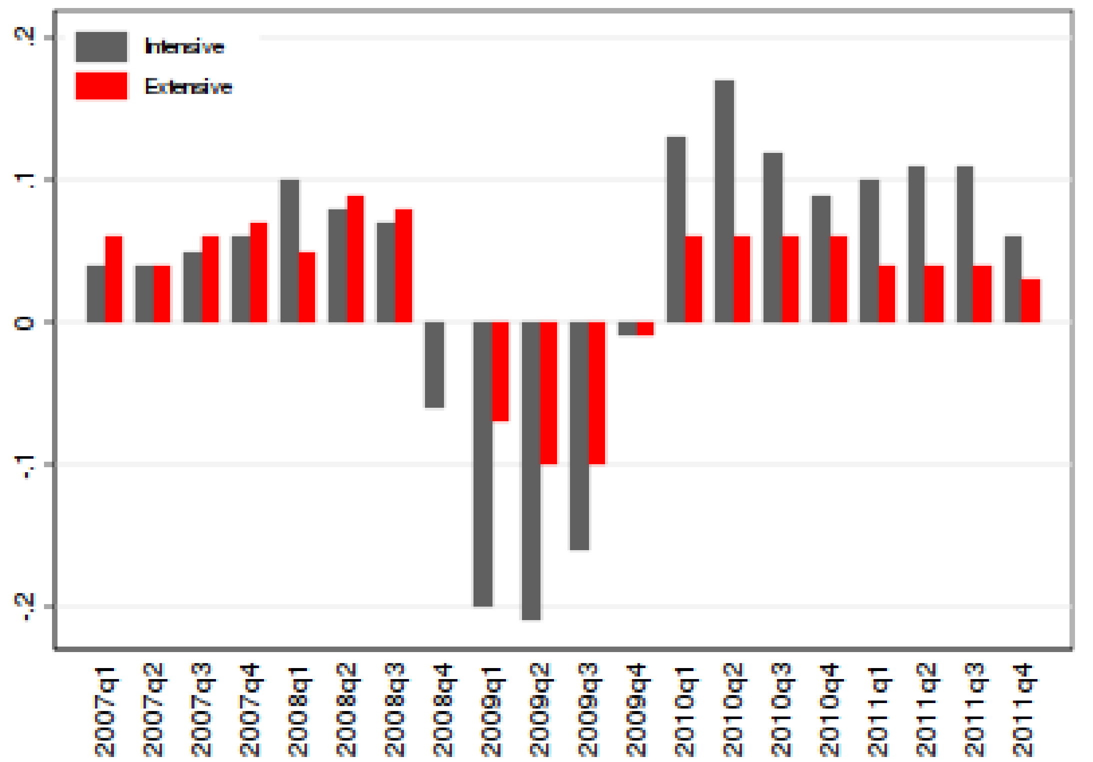
We then decompose the growth into an intensive and extensive margin (at firm-destination-product level) by defining four sets of flows indexed by m. The extensive margin is decomposed into (i) Entry ($x_{ick}(q) > 0$ and $x_{ick}(q-4) = 0$) and (ii) Exit ($x_{ick}(q) = 0$ and $x_{ick}(q-4) > 0$), while the intensive margin is decomposed into (i) Growers ($x_{ick}(q) > x_{ick}(q-4) > 0$) and (ii) Shrinkers ($x_{ick}(q-4) > x_{ick}(q) > 0$). Denoting $I_m = 1$ if a flow belongs to group m we can then write the aggregate midpoint growth rate as the sum across these mutually exclusive groups

$$G(q) = \sum_{i,c,k} \sum_{m} I_m \times s_{ick}(q) \times g_{ick}(q) \tag{4.2.1}$$

for $m = EN_{ick}, EX_{ick}, GR_{ick}, SH_{ick}$ This decomposition allows us to compute the net extensive and net intensive margin by adding up the positive and negative components of each respective margin as we can see in the above expression.

Figure 4.2 presents the evolution of the net extensive and net intensive margin computed according to (4.2.1). This figure shows that intensive and extensive margins followed a similar path in terms of their signs during the great collapse. The decline in the intensive margin was faster and more pronounced than the extensive margin. One potential explanation for this difference in the behavior across margins is the fact that adjustments through the extensive margin usually require paying, or at least taking into account, fixed costs or sunk costs or both, and these costs could dampen firms' responses.

Figure 4.2: Evolution of Export Net Margins

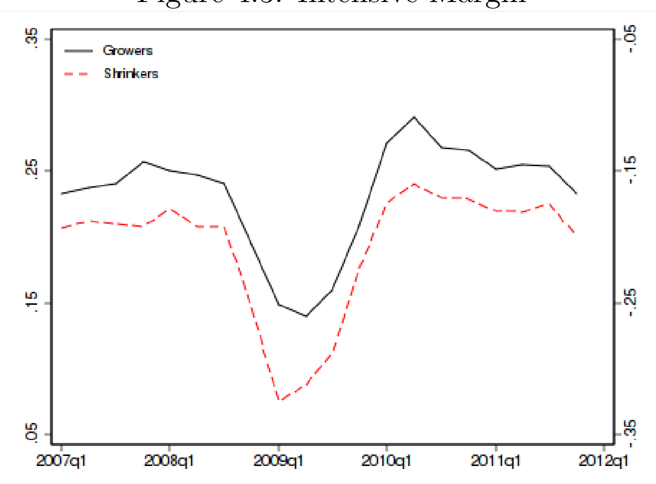


This decomposition also shows the importance of the extensive margin in the recent evolution of U.S. exports. Before the crisis the extensive margin accounted for about half of US export growth, 55% and 53% in the third quarter of 2007 and 2008, respectively. One year later, in the third quarter of 2009, it accounted for 38% of the observed decline, less than the intensive share but quite large still. After exports started to grow again the extensive margin contributed positively, but a substantially smaller share than prior to the crisis, e.g. 33% in the third quarter of 2009 (see Table in 4.3 appendix for details). In countries such as France the contribution of the extensive margin was considerably smaller.[12]

[12] Bricongne et al. (2012b) report that on average for 2006 and 2007 the net extensive margin represented 32 % of the growth rate at quarterly frequency for France. This share dropped to 10% during the GTC period of September 2008 and April 2009. Our results are not directly comparable

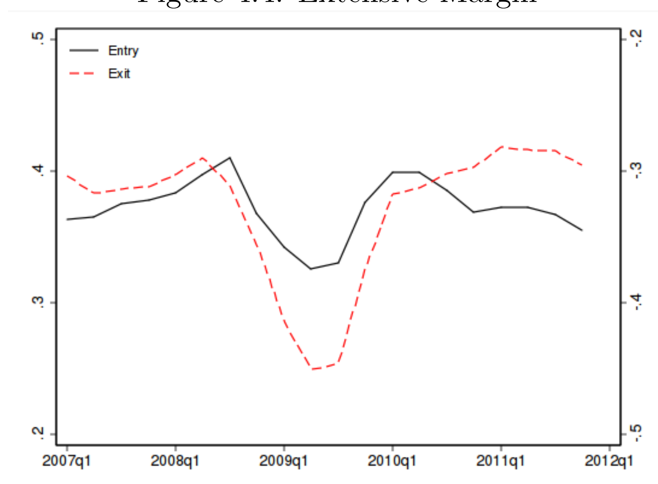
In figure 4.4 we decompose the net extensive margin into its components. In the last quarter of 2008 and the first quarter of 2009, both the entry and exit margins changed by similar amounts relative to $q-4$, but exit fell twice as much in the second quarter of 2009 (about 13 percentage points). Thus, exit was more important in shaping the net extensive margin during the GTC. In contrast to the extensive margin, both components of the intensive margin showed similar magnitudes during 2009 (see figure 4.3).

Figure 4.3: Intensive Margin



Growers scale corresponds to the left axis while Shrinkers scale corresponds to the right axis.

Figure 4.4: Extensive Margin



Entry scale corresponds to the left axis while Exit scale corresponds to the right axis.

Summing up, midpoint decompositions show that (i) the extensive margin played an important role in the recent evolution of U.S. exports, and accounted for around 40% of the GTC; (ii) the intensive margin collapse (and recovery) was somewhat faster and stronger than the extensive margin; and (iii) the exit margin played a more important role than entry during the collapse. In the next subsection

to the ones reported by Behrens, Corcos, and Mion (2013) for Belgium since they use a more broad definition of the intensive margin that includes all product-country adding, switching and dropping at firm level.

we exploit detailed information about firms, products and destination to explore heterogeneous responses.

4.2.2.1 Firm Heterogeneity

Related Parties and the GTC: Related Parties trade represents a significant part of U.S. international trade. For example, in 2006 around 47% of U.S. total imports and 35% of U.S. total exports were between related parties. Hence exploring whether there are differences in the evolution of the extensive and intensive margins between related parties and arm's length trade compared to the overall behavior may potentially provide a better understanding of GTC. Applying the decomposition for firms trading to related parties, we observe differences in the margin contributions as well as in the timing with respect to the overall pattern (see figure 1.1 in the appendix of chapter 1) In the related parties case, the intensive margin takes a more prominent role and the collapse of this margin starts earlier than in the full sample. The opposite is true for the extensive margin for the related parties sample compared to the full sample. As expected, these differences are more striking if we compare related parties with arms length trade (see figure 1.2 in the appendix of chapter 1). At its peak, the drop in the extensive margin for arms length trade is more than double the one corresponding to related parties, while the opposite holds for the case of the intensive margin, as the drop in the intensive margin is higher for related parties than for arms length trade. Previous chapters explore the role of uncertainty in the organization of trade and how organizational choice affects firms' responses to changes in their environment.

Age and Size: Firms are heterogeneous in several dimensions, such as productivity, age, size and location, and potentially these heterogeneities can affect how firms respond to shocks such as the GTC. In order to explore whether this is the case, we run decompositions splitting the sample of firms according to firm age and employment size. In the case of employment size we split the sample of firms in five categories: 1-49 employees, 50-249 employees, 250-999 employees, 1000-2499 employees and 2500 and more employees. Results clearly indicate that bigger firms in terms of employment adjust more through the intensive margin while small and medium firms adjust similarly across margins. This implies that bigger firms weathered the GTC while remaining active in foreign markets while a significant number of smaller and medium firms exited foreign markets. This is in line with models that highlight the role of firm productivity in export activities since firm productivity is directly related to firm's employment size.

In the case of age, we define the follow four categories for firm age: 1-4 years, 5-9 years, 10-19 years and 20 or more years. We find that younger firms adjust almost exclusively through the extensive margin, while old firms adjust through the intensive margin. Furthermore, the decompositions for the other age categories show a monotone relationship between age and the role of the intensive margin. This relationship between age and the intensive margin role suggests that firms go through a learning and selection process that matters for their response to shocks.

4.2.2.2 Destination Heterogeneity

Free Trade Agreements: The GTC fueled a fear of increased protectionism and trade wars as a response to the collapse in domestic activity. One argument for free trade agreements is that they can provide insurance against such trade wars (c.f. Perroni and Whalley (2000)). If that is the case then all else equal, we should find that the crisis had less of a negative impact on exports to PTA partners. We explore this in the econometric section guided by our theoretical model. As a first step, we provide some aggregate and firm-level descriptive evidence that suggests this may be the case. First, we can see in figure 4.5 that the share of US exports to PTA countries underwent a steep decline from 45% in 2003 to 40% in the third quarter of 2008. But starting in the first quarter in 2009 that decline halted and the share started to increase. By 2011 it had stabilized around 41%.

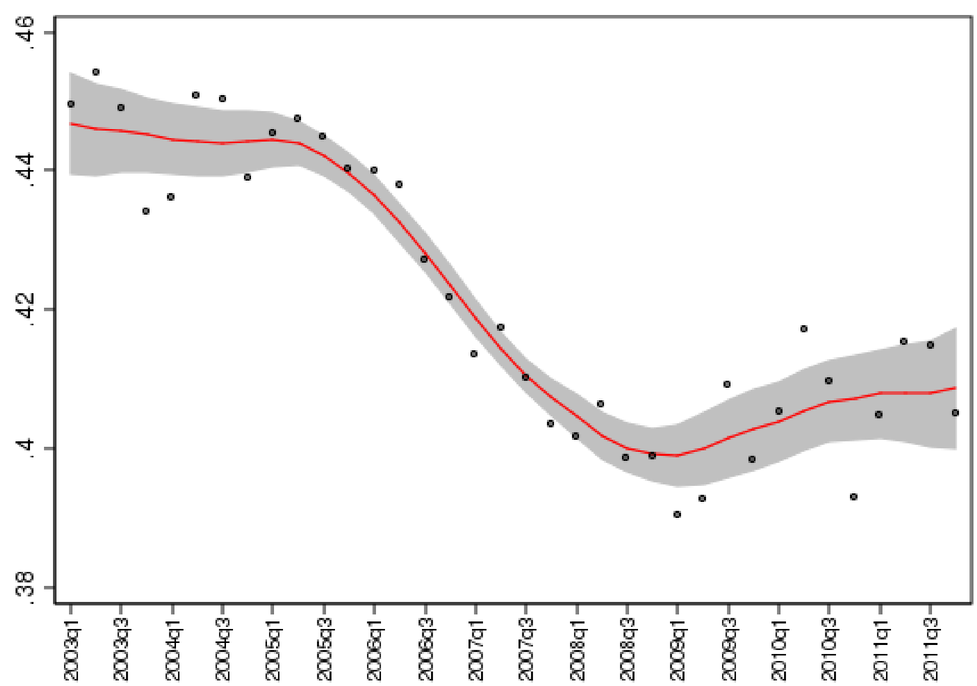
We then decompose the margins of export growth for PTA partners vs. other countries.[13] Figures 4.6 and 4.7 show a clear difference in the role of the extensive margin. Exports towards PTAs around the GTC are more strongly affected by the decline in the intensive margin than the extensive one (left hand side of figure), while for non-PTAs the contribution of both margins is closer (right hand side figure).[14]

More specifically, we see that for PTAs the extensive margin accounted for between 46% and 80% of the total growth in the pre-crisis quarters. In contrast, during the strong contraction from the third quarter of 2008 to the third quarter of

[13]Note that we left outside of these exercises those countries that change categories between 2007 and 2011 in order to avoid any contamination.

[14]See Tables 4.4 and 4.5 in the appendix for details.

Figure 4.5: Share of U.S. Exports to PTA Countries



2009, the extensive margin accounted only 28% of the total decline. For non-PTA countries the extensive margin share of the contraction during the same period was 43%. Furthermore, the contribution of the extensive margin for non-PTA countries was higher in each quarter of the GTC.

Figure 4.6: PTA Countries

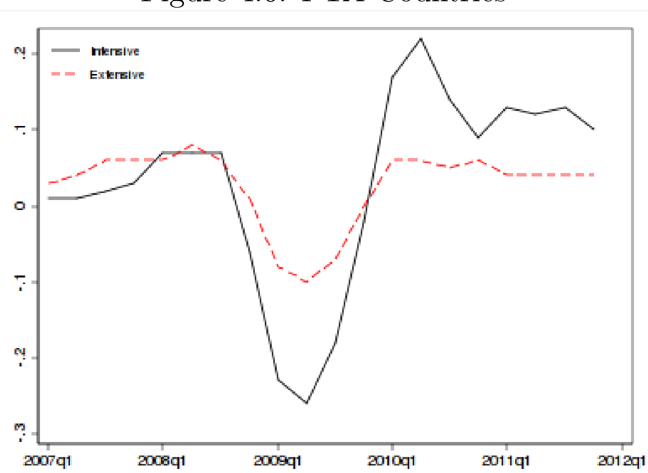
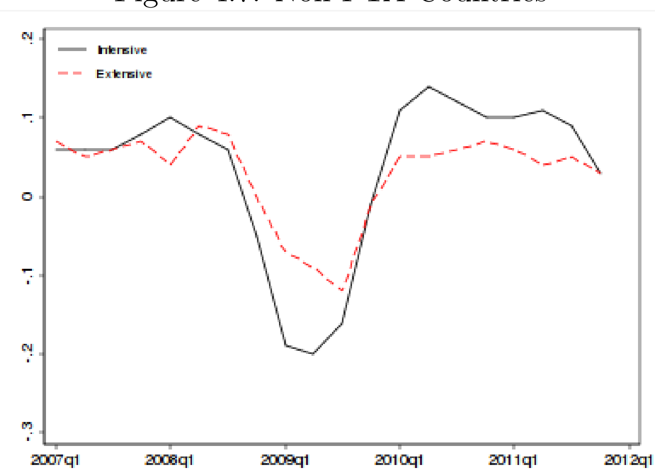


Figure 4.7: Non PTA Countries

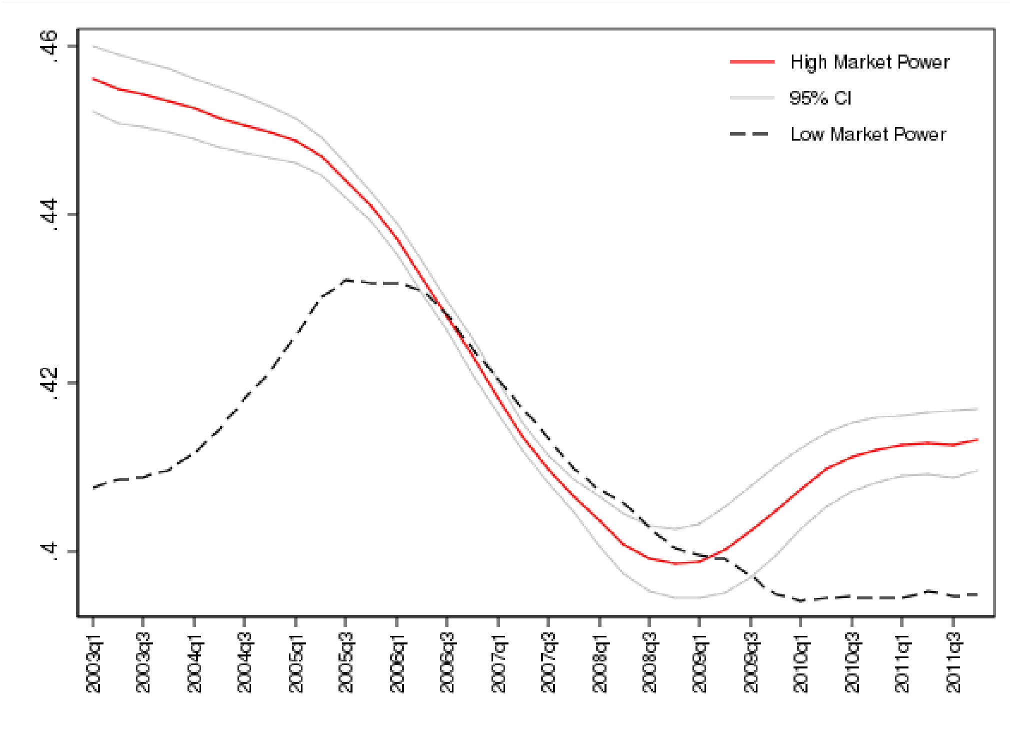


In sum, U.S. firms responded to the crisis relatively more by lowering export values rather than exiting in PTA than in non-PTA countries. This is consistent with the possibility that U.S. exporters to countries with PTAs assigned a relatively lower increase in the probability of a "bad" policy shock in PTA markets as foreign economic conditions worsened.

4.2.2.3 Product Heterogeneity

High importer market power: If a trade war did break out then countries would increase their protection differentially across products. Evidence in Broda, Limao, and Weinstein (2008) shows that, as predicted by several theoretical models, protection in goods that are not regulated by trade agreements is higher in industries where importers have more market power. They measure market power by estimating the inverse foreign export supply elasticity faced by an importer and find that across a range of countries market power tends to be concentrated in a particular set of industries. We thus use their classification of goods with high (or medium) market power and examine if the aggregate PTA pattern we described above is particularly strong for such goods. Recall that previously we found that the decline in PTA share was reversed during the crisis. In figure 4.8, we find that pattern is also present for high market power goods. The share declined steeply from the start of the sample period, stabilized in the first quarter of 2009 and then increased. Moreover, the PTA share for low market power goods, represented by the dashed line, also declined starting in 2006 but did so more slowly, and continue to decline through the start of the crisis; this share stabilized later at a lower average share than for high market power industries.

Figure 4.8: Share of U.S. Exports to PTA Countries by Market Power



Durable Goods and the GTC: Several papers in the literature studying the GTC highlight the role of durable in the contraction of international trade (see e.g. Bricongne et al. (2012b) and Levchenko, Lewis, and Tesar (2010) among others). The explanation is that durable goods consumption is more volatile cyclically than the consumption of non-durable goods, and since the share of durable goods is higher in international trade than in GDP (see Engel and Wang (2010)), a negative demand shock to durable goods would translate into a higher contraction of international trade than GDP (see Levchenko, Lewis, and Tesar (2010)). To examine this, we perform the decomposition separately for durable and non-durable goods according to the classification used by Engel and Wang (2010). First, results show that the collapse is stronger for U.S. firms exporting durable goods in line with the results in the literature for other countries and for U.S. at aggregate data. The average contraction during the first four quarters of the GTC was 24 points for durable goods and this contraction was 17% higher than the overall contraction and 55% higher than the contraction for non-durable goods. Second, the intensive margin was the more important margin in the GTC for durable goods and it took a slightly bigger share of the contraction than in the benchmark. However, the extensive margin still showed significant action during the GTC. For example, the extensive margin represented almost a quarter of the average contraction during the first year of the GTC.

This section explores U.S. exporting firms dynamics during the GTC and later recovery, exploiting disaggregated firm-level data from the Census Bureau. First, we find that the intensive margin played a central role but that the extensive margin also took a significant share, in contrast to other countries such as France (see Bricongne et al. (2012b)) and Belgium (see Behrens, Corcos, and Mion (2013)). This significant role of the extensive margin is mostly due to an increase in the exit margin, as we observe when we compare the extensive margin components and track the number of U.S. firms exporting over time. Second, heterogeneities across product, firms and destinations show significant differences in their adjustment during the GTC. Notably, PTAs significantly reduce the adjustment through the extensive margin in the GTC. This reduction in the destruction of trade flows to PTAs is aligned with firms assigning some positive probability of a trade war, assuming that PTAs provide safeguard from protectionism. A potential issue with these descriptive results is whether the frequency and/or aggregation level affect some of the main findings. In order to check this, we perform the same set of exercises modifying both the frequency of the data and the aggregation level considered. More specifically, we repeat the decompositions using monthly and half-yearly frequency and change the aggregation from firm-country-product to firm-country. In both cases, all the main findings are robust to these exercises. Motivated by these findings and the role of uncertainty during the recession, we build a stochastic framework of international trade in the next section that not only incorporates economic uncertainty but also policy uncertainty and explores how these sources may interact.

4.3 A Theory of Export Dynamics under Multiple Sources of Uncertainty

We now develop a dynamic model of firm export decisions under multiple sources of uncertainty that will guide the estimation of the impact of uncertainty during the GTC. We generalize Handley and Limão (Forthcoming) in several directions. First, we introduce uncertainty in the foreign demand level, encompassing both trade policy uncertainty (as in Handley and Limão (Forthcoming)) and economic uncertainty. We do this in two steps. Initially, we impose that both sources of uncertainty have a unique arrival rate so both shocks - economic and policy - arrive at the same time. Then, we generalize the demand regime to allow for heterogeneity in the persistence across sources of uncertainty. More specifically, we incorporate the fact that policy shocks arrive less frequently than economic shocks. Second, we examine the dynamics of exporting more broadly than Handley and Limão (Forthcoming), by including entry, re-entry and allowing export capital to depreciate with a certain probability in each period. In order to extend the framework in these dimensions, we abstract from some general equilibrium effects of uncertainty that are explored by Handley and Limão (2013) in the context of China's export boom to the U.S and its accession to the WTO.

4.3.1 Economic Environment

We start by deriving the operating profit for a monopolistically competitive firm that exports a differentiated good, denoted by v, to country i. In order to focus on the export decision as the only one subject to uncertainty, we assume that in each period t the firm can observe all relevant information before making its production and pricing decisions for that period. This assumption, and the absence of any adjustment costs, implies that, after entry with a particular technology, firms simply maximize operating profits, π_{ivt}, period by period. Thus, π_{ivt} can be derived similarly to monopolistic competition models in standard deterministic settings.

There are $V + 1$ industries; one produces a homogeneous, freely traded good, the numeraire, and the remaining V industries produce differentiated goods. Total expenditure on goods in country i is denoted by Y_i with a fixed exogenous fraction ε_V spent on each industry V and $1 - \Sigma\varepsilon_V$ on the numeraire. Consumers have constant elasticity of substitution preferences over goods in each industry V with

$\sigma = 1/(1-\rho) > 1$. A firm v faces the standard optimal demand in country i at time t,

$$q_{ivt} = \underbrace{\left[D_{iVt}\left(\tau_{iVt}\right)^{-\sigma}\right]}_{a_{iVT}} p_{ivt}^{-\sigma} \tag{4.3.1}$$

where D_{iVt} can be interpreted as the demand parameter in country i for the industry V that v belongs to. The consumer price is equal to the producer price, p_{ivt}, times the advalorem tariff policy factor in industry V, $\tau_{iVt} \geq 1$. From the individual firm's perspective, the compound demand term, a_{iVT}, is exogenous and summarizes all payoff relevant information for the current period. Thus for now, we assume that the firm observes only a_{iVT}. When we unbundle the sources of demand uncertainty we will return to the determination of D_{iVt} and τ_{iVt} and whether there is any informational value for the firm to know each independently.

The supply side is also standard in trade models. There is a single factor, labor, which has constant marginal productivity in the numeraire sector, so the wage is normalized to unity. Differentiated goods are produced with a constant marginal cost, characterized by a labor coefficient of c_v, which is heterogeneous across firms. As we noted above, at the start of each period firms observe the demand conditions before pricing and know their productivity and σ. Therefore they choose prices to maximize operating profits in each period, $\pi_{ivt} = (p_{ivt} - c_v)\, q_{ivt}$, leading to the standard mark-up rule over cost, $p_v = c_v/\rho$. Using the optimal price and demand we obtain the export revenue received by the producer, and the associated gross operating profit:

$$p_{ivt}q_{ivt} = a_{iVt}c_v^{1-\sigma}\tilde{\sigma}\sigma \tag{4.3.2}$$

$$\pi_{ivt} = a_{iVt}c_v^{1-\sigma}\tilde{\sigma} \tag{4.3.3}$$

where $\tilde{\sigma} \equiv (1-\rho)\,\rho^{\sigma-1}$.[15] Given the environment we can analyze firm decisions in any given industry-export market separately so below we omit the industry subscript; unless otherwise stated all the variables except c_v vary by industry-export market.

4.3.2 Exporters Dynamics

We now examine firms' export dynamics. We focus on export, rather than domestic, entry decisions by assuming there are no entry costs for the domestic market and there is a constant mass of domestic firms in each industry. This implies that the number of domestic firms active in their domestic market is constant and that an endogenous subset of these exports, which we now determine. Given that all firms already produce domestically, they face no uncertainty about their productivity when deciding whether to enter into exporting. Firms face foreign demand uncertainty about the path of a_t, which they take as given. We also assume that the mass of exporters relative to domestic producers is sufficiently small that their entry

[15] We can extend the framework to allow for upgrades and downgrades of technology; for now (4.3.3) represents the gross exporting profit of a firm that drew a technology c_v and observed demand conditions in importer i industry V of a_{iVt}.

decisions have a negligible impact on the price index in the importing country.[16]

To start exporting a firm must incur a sunk cost, K. Given the current conditions it will be optimal to enter if the expected value of exporting, Π_e, net of K is at least as high as the expected value of waiting. So the marginal entrant is the firm with cost equal to the cutoff, c_t^U, defined by

$$\Pi_e \left(a_t, c_t^U, r\right) - K = \Pi_w \left(c_t^U, r\right). \tag{4.3.4}$$

Before entering the firm can observe the current conditions in the market, a_t, and uses this along with information about the demand "regime" defined below to form expectations regarding future profits. Firms believe that a demand shock in the following period occurs with probability γ and when it does the new demand parameter, a', is drawn from some distribution $H(a)$. Firms take the *demand regime* $r = \{\gamma, H\}$ as given and time-invariant. One advantage of this characterization is that it allows for persistent demand but it is still tractable. Moreover, different regimes can encompass different settings, e.g. when $\gamma = 0$ there is no uncertainty about demand and when it is unity demand is i.i.d; alternatively when $\gamma \in (0, 1)$ there are imperfectly anticipated shocks of uncertain magnitude. When we unbundle demand uncertainty we will describe the regime in terms of more fundamental

[16]It is well known that under this structure $D_{iVt} = \varepsilon_V Y_{it} \left(P_{iVt}\right)^{\sigma-1}$ where P_{iVt} is the standard CES price aggregator over varieties in each V sold in i. The standard assumption that we also make is that monopolistically competitive firms are sufficiently small relative to the total number (measure) of firms in industry V available in country i to take into account any effect that they may have on the price index or aggregate goods' expenditure. To this we add a "small" exporter assumption which allows us to provide sharper results by focusing on the direct effects of the demand uncertainty on operating profits rather than indirect general equilibrium effects. Handley and Limão (2013) allow for general equilibrium effects of policy uncertainty via impacts on the price index. Doing so introduces adjustment dynamics, as the price index adjusts to entry and exit, and tends to attenuate, rather than overturn, the direct effects of tariff policy on entry decisions.

economic and policy processes.

We can generalize certain results to allow for period fixed costs, export participation in any given period after entry and endogenous exit. However, because of data limitations we will not be able to distinguish between certain types of decisions. For example, if firms can exit and then repay the sunk cost to enter then we will be unable to distinguish this from non-participation decisions because of low demand in a given period, because we do not observe capital expenditures on particular export decisions. Thus, the theory will focus on a simple setting where firms have no per period fixed cost, so that after entry they always optimally choose to export. However, we allow a firm's entry capital to depreciate, and when it does so fully the firm can only export if it pays a sunk cost, which is independent of whether or not it previously exported. The depreciation process is very simple: at the end of each period the export capital either fully depreciates or remains intact. The firm correctly expects this to occur with a fixed probability d. This process generates exit from exporting without firm death, to be consistent with the data. We also allow for re-entry, which is again observed in the data, provided the firm decides to pay K again. Given the setup, the entry decision is independent of whether a firm will ever be able to re-enter that market or not after re-paying the cost, provided we use an effective discount rate that reflects the probability that the capital survives. We prove this in the appendix (see B.2.6). However, the intuition should be clear: the re-entry decision of any given firm is independent of its past export status if it has lost all its export capital (there is no other measure of experience or presence in the market that is relevant for exporting); and so each entry decision can be made independently of future re-entry. This implies that we can solve the dynamic entry decision problem *as if* the firm had only one possibility to enter and had to choose when to do so, and then note that if it ever loses its capital (with probability d) it will again be in the position to make another entry decision unless the firm as a whole dies (probability δ) so the firm's effective discount rate used to value future payoffs is $\beta = (1-\delta)(1-d) < 1$.[17]

The expected value of starting to export at time t conditional on observing current market conditions a_t is

$$\Pi_e(a_t, c, r) = \pi(a_t, c) + \beta[\underbrace{(1-\gamma)\Pi_e(a_t, c, r)}_{\text{No Shock}} + \underbrace{\gamma \mathbb{E}\Pi_e(a', c, r)}_{\text{Shock}}]. \tag{4.3.5}$$

which includes current operating profits upon entering and the discounted future value. Without a shock the firm value next period is still $\Pi_e(a_t, c, r)$. If a shock arrives then a new demand is drawn with some value, a'. So the third term is the *ex-ante* expected value of exporting following a shock, where $\mathbb{E}$ denotes expectation over the H distribution. This is simply $\mathbb{E}\Pi_e(a', c, r) = \mathbb{E}\pi(a', c)/(1-\beta)$, which is time invariant.[18] The conditional mean of a and the expected value of exporting, $\Pi_e(a_t, c, r)$, vary over time since they depend on current conditions.

We then compute the expected value of waiting as

[17] Since there is a fixed probability of death, δ, there is an equal probability of new firms being born to replace those that die, which maintains a constant mass of firms.

[18] The reason is simple: the distribution of future conditions *after a shock*, $H(a')$, is time invariant so even if there is a new a at $t+1$ this provides no additional information at time t about future conditions.

$$\Pi_w(c,r) = 0 + \beta \underbrace{(1-\gamma+\gamma H(\bar{a}))\Pi_w(c,r)}_{\text{Wait}} + \beta \underbrace{\gamma(1-H(\bar{a}))(\mathbb{E}\Pi_e(a' \geq \bar{a}, c, r) - K)}_{\text{Enter}} \tag{4.3.6}$$

A non-exporter at time t receives zero profits from that activity today. In the following period the continuation value is still Π_w if either demand is unchanged, with probability $1-\gamma$, or changes but goes to some level that is not sufficiently high, with probability $\gamma H(\bar{a})$. If demand changes and is above some endogenous trigger level, $a' \geq \bar{a}$, then we obtain the third term, reflecting the expected value of exporting net of the sunk cost, K, conditional on the new demand level being heigh enough to trigger entry. The conditional expected value of exporting if $a' \geq \bar{a}$ is given by

$$\mathbb{E}\Pi_e(a' \geq \bar{a}, c, r) = \mathbb{E}\pi(a' \geq \bar{a}, c, r) + \beta(1-\gamma)\mathbb{E}\Pi_e(a' \geq \bar{a}, c, r) + \beta\gamma\mathbb{E}\Pi_e(a', c, r) \tag{4.3.7}$$

This equation is structurally the same as (4.3.5), but it is time invariant because profit flows are evaluated *ex-ante* at the conditional expected value of exporting for a firm that enters following a sufficiently favorable demand shock.

We can determine a threshold demand level $a_{c_v} = \bar{a}(c_v)$ such that a firm with costs c_v would be indifferent between starting to export or wait. Instead, we characterize which firms will invest and enter at any observed current demand.

We can do so since a is common to all firms exporting to a given market in a given industry and the marginal cost is the only source of heterogeneity among such firms. Assuming a continuum of firms in any given industry with productivity that can be ranked according to a strictly increasing CDF, we can find the marginal export entrant for any a_t. Such a firm has marginal cost equal to the c_t^U that satisfies $a_t = \bar{a}\left(c_t^U\right)$. We find this cutoff by using the entry condition in (4.3.4) and the value functions in (4.3.5), (4.3.6) and (4.3.7), and the expression for $\mathbb{E}\Pi_e$. As will be clear, if a firm has costs equal to this threshold then in that period all other firms with lower costs would also be exporters. The closed form expression for c_t^U generalizes the result in Handley and Limão (Forthcoming) to allow for uncertainty in demand rather than only on tariff policy.

Solving the system of equations, we obtain the following expression:

$$\begin{aligned} K =& \frac{\pi(a_t, c_t^U)}{1-\beta(1-\gamma)} + \frac{\beta\gamma}{1-\beta}\frac{\mathbb{E}\pi(a', c_t^U)}{1-\beta(1-\gamma)} \\ &+ \frac{\beta\gamma\left(1-H(a_t)\right)}{1-\beta}\frac{\pi(a_t, c_t^U) - \mathbb{E}\pi\left(a' \geq a_t, c_t^U\right)}{1-\beta(1-\gamma)} \end{aligned} \tag{4.3.8}$$

The intuition for this equation is that the three terms in the right hand side should cover at least the sunk cost of entry. In the special case where $\gamma = 0$, there is no demand uncertainty and the marginal entrant in this deterministic demand case would have a marginal cost satisfying $K = \frac{\pi(a_t, c_t^D)}{1-\beta}$, which yields

$$c_t^D = \left[\frac{a_t\tilde{\sigma}}{(1-\beta)K}\right]^{\frac{1}{\sigma-1}} \tag{4.3.9}$$

When demand conditions can change in future periods, then current profit is discounted at a higher rate that captures the probability that a demand shock will arrive, so K must now cover the value of profits until the policy changes (first term) plus the ex-ante present value of expected profits following a shock (second term), and the present value of the expected loss of entering today, given that demand conditions will eventually improve (third term). This last term is negative and captures the option value of waiting.

By combining this expression with the operating profit function, we solve directly for c_t^U as a function of the current demand. We obtain

$$c_t^U = \underbrace{\left[\frac{1-\beta+\beta\gamma\omega\left(a_t\right)}{1-\beta+\beta\gamma}\right]^{\frac{1}{\sigma-1}}}_{=U_t}\underbrace{\left[\frac{a_t\tilde{\sigma}}{(1-\beta)K}\right]^{\frac{1}{\sigma-1}}}_{=c_t^D} \tag{4.3.10}$$

Thus, the cutoff under uncertainty is lower than the deterministic cutoff whenever the uncertainty term, denoted by U_t, is lower than unity. From this equation we see that demand uncertainty makes entry more stringent if and only if $\omega\left(a_t\right)-1 \leq 0$. In the appendix (see B.2.1), we derive this term as

$$\omega\left(a_t\right)-1 = -H(a_t)\frac{a_t-\mathbb{E}(a' \leq a_t)}{a_t} \leq 0 \tag{4.3.11}$$

This is the proportional reduction in operating profits expected to occur if we start at a_t and a shock occurs that (with probability $H(a_t)$) worsens conditions. As usual with this type of framework, even though a shock can generate higher or lower demand levels, it is only the latter possibility that affects the entry decision, since the benefits of demand levels above the entry trigger also accrue to waiting firms.

We will refer to increases in γ as increases in demand uncertainty, since they imply that demand is more likely to be subject to a shock and a new draw from the distribution. Note that increases in γ lower entry for *any* a_t. This occurs even though increases in γ can increase the conditional mean of demand if a_t is below its long-run mean (or decrease it if a_t is above it). We can neutralize the first moment component of this effect by examining shocks to γ when demand is at its long-run mean, i.e. $a_t = \mathbb{E}(a')$, such that $\mathbb{E}(a_T|a_t) = \mathbb{E}(a')$ for all T is independent of γ. We will refer to the latter as pure risk γ shocks and note that they too lower entry.[19]

Another type of pure risk shock is a mean-preserving spread (MPS) in H, the underlying demand distribution. This shock leaves the long-run mean, $\mathbb{E}(a')$, unchanged by definition and also implies that the conditional mean, $\mathbb{E}(a_T|a_t)$ for all T, is unchanged. Moreover, we can show the following

Remark 1: If$\gamma > 0$, then a mean-preserving spread in $H(a)$ reduces entry for all $a_t < a^{\max}$.

We prove this remark in the appendix (see B.2.2). The basic intuition is that H affects entry only via $\omega(\cdot)$ (see expression 4.3.11). A MPS in H adds weight to both tails, but the one that is relevant for ω is the bad news, which lowers the expected profit loss term conditional on worsening conditions. For the MPS (or any other factor that works via ω) to affect entry it is obvious we require $\gamma > 0$ and any such effect is increasing in γ, since $\frac{\partial}{\partial\gamma}\frac{\partial c_t^U}{\partial\omega} > 0$.

[19] In this case HL show that $\mathbb{E}_t(a_T|a_t) = \mathbb{E}(a')$ for all T and that any increases in γ impart a mean-preserving spread in the distribution of future a.

4.3.3 Economic and Policy Sources of Demand Uncertainty

We now unbundle demand uncertainty into two of its fundamental components: economic and policy uncertainty. We examine how each of these components affects firm decisions and how the two interact.

While a is the only payoff relevant variable for firms, it may not be directly observable. However, if firms can observe its underlying components then they can form expectations about a to make dynamic decisions. We first assume that the economic and policy shocks arrive simultaneously and firms know their distribution. Subsequently, we examine the impact of different arrival rates to allow for different degrees of persistence across sources of uncertainty. All variables below can vary by importer i so we omit the subscript. Under this model's structure, $D_{Vt} = \varepsilon_V Y_t (P_{Vt})^{\sigma-1}$ where P_{Vt} is the standard CES price aggregator over varieties in each V sold in a country at period t. Given our assumptions regarding small exporters and the fixed mass and productivity of domestic firms, we have a fixed P_V. The aggregate price index for a country is then $\tilde{P} = \prod (P_V)^{\varepsilon_V}$ so we can rewrite the demand term as follows:

$$a_{VT} = \varepsilon_V \frac{Y_t}{\tilde{P}} / \frac{P_V}{\tilde{P}} \left(\frac{\tau_{Vt}}{P_V} \right)^{\sigma} = y_t \times \varsigma_{Vt} \tag{4.3.12}$$

where ε_V denotes the expenditure share in V, $y_t = Y_t/\tilde{P}$ is real income effect, and $\varsigma_{Vt} = \frac{P_V}{\tilde{P}} \left(\frac{\tau_V t}{P_V} \right)^{\sigma}$ is the policy price effect. This formulation allows us to focus on the aggregate real income effect, y_t, and policy effect, ς_{Vt}. The latter can be interpreted as a price substitution effect. When the relative price of a taxed good increases then there is substitution within the industry at a rate $\sigma > 1$ and between this industry and others industries at a unit elasticity. Given the structure of the model, the source of exogenous shocks we consider for the policy effect are tariffs, and for real income the labor endowment.

Firms know ε_V and believe that conditional on a shock, real income and the policy effect have a joint density $f(y, \varsigma)$. Let the corresponding CDF for a be denoted by H, as before, and note that now $H(a_t) = \int_{\varsigma=0}^{\varsigma^{\max}} \int_0^{y=a_t\varsigma/\varepsilon_V} f(y, \varsigma)\, dy d\varsigma$.

To illustrate the points clearly we assume $f(y, \varsigma)$ is a bivariate log normal distribution with correlation η and mean and variance denoted by μ_x and Σ_x^2 respectively for $x \in \{y, \varsigma\}$. Then conditional on a shock the distribution of a in any given industry is $a_t = \varepsilon y_t/\varsigma_t \sim \ln N(\mu, \Sigma^2)$, where the parameters are directly related to the underlying distributions, as we show below. To match risk shocks to the data we now focus on an **increase in risk of** $\ln x$, defined as a MPS of its marginal distribution conditional on a shock, i.e. a MPS of $N(\mu_x, \Sigma_x^2)$, which is equivalent to an increase in Σ_x^2.

Proposition 7. ***(Sources of demand risk and interaction effects)*** *Suppose that the income and policy shocks, $x \in \{y, \varsigma\}$ arrive simultaneously at rate $\gamma > 0$. Conditional on a shock these variables have correlation η and follow a bivariate $\ln N(\mu_x, \Sigma_x^2)$ and the demand is distributed $a = \varepsilon y/\varsigma \sim \ln N(\mu, \Sigma^2)$. Then for any $a_t \in (0, \exp(\mu)]$ and for some $a_t > \exp(\mu)$ we obtain the following:*

(a) an increase in risk in either component increases risk in $\ln a$ if and only if

$\eta \in [-1, \frac{\Sigma_x}{\Sigma_{\neq x}}]$ *and lowers export entry.*

(b) a decrease in η *increases risk in* $\ln a$ *and lowers export entry. Moreover this effect is increasing in the risk of either component.*

(c) if $\eta < 0$ *then increases in risk in (ln) income and (ln) policy are complementary in increasing risk in* $\ln a$*, i.e.* $\frac{\partial^2 \Sigma_a^2}{\partial (\Sigma_{\neq x})^2 \partial \Sigma_x^2} > 0$*, and lowering entry.*

(d) All the effects in (a)-(c) are increasing in γ*.*

Proof. Given $f(y, \varsigma)$ is a bivariate log normal and the definition of a we have $a = \varepsilon y/\varsigma \sim \ln N(\mu = \ln \varepsilon + \mu_y - \mu_\varsigma, \Sigma^2 = \sum_x \Sigma_x^2 - 2\eta \Sigma_y \Sigma_\varsigma)$ where $x \in \{y, \varsigma\}$. None of the shocks considered affect μ so we need only check they increase Σ^2 as stated. We then show when this increase in Σ^2 lowers entry.

(a) An increase in risk in either $\ln x$ is equivalent to an increase in either Σ_x^2, which increases risk in $\ln a$ if and only if $\frac{\partial \Sigma^2}{\partial \Sigma_x^2} > 0$, i.e. if and only if $\eta \in (-\frac{\Sigma_x}{\Sigma_{\neq x}}, 1]$.

(b) A decrease in η implies an increase in risk in $\ln a$ since $-\frac{\partial \Sigma^2}{\partial \eta} = 2\Sigma_y \Sigma_\varsigma$, which is clearly increasing in risk in either $\ln x$

(c) $\frac{\partial^2 \Sigma^2}{\partial (\Sigma_{\neq x}^2) \partial \Sigma_x^2} = -\frac{\eta}{\Sigma_x \Sigma_{\neq x}} > 0$ if and only if $\eta < 0$.

(d) At a given a_t an increase in the risk of $\ln a$ affects entry only by lowering ω and $\frac{\partial}{\partial \gamma} \frac{\partial c_t^U}{\partial \omega} > 0$ as shown in previous section.

To prove that an increase in risk in $\ln a$ (i.e. an increase in Σ^2), lowers entry when $\gamma > 0$ and $a_t \in (0, \exp(\mu)]$ and some $a_t > \exp(\mu)$ we need only show that the new distribution of a, denoted by $M(a)$, implies a lower ω. Recall from the previous result that

$$\omega - \omega_M = \frac{1}{a_t} \int_0^{a_t} [M(a) - H(a)]\, da$$

so we need only show that there are a_t such that $\int_0^{a_t} M(a)\,da \geq \int_0^{a_t} H(a)\,da$ with equality at some critical $\bar{a} > \exp(\mu)$. If $a_t = \exp(\mu)$ then the inequality holds strictly since two log normal variables with the same μ and different Σ^2 have a single crossing at their *common* median $\exp(\mu)$. So $M(\exp(\mu)) = H(\exp(\mu)) = 1/2$ and M crosses from above if it has higher Σ^2. Therefore there is some $\delta > 0$ such that $\omega > \omega_M$. □

It is natural to evaluate the risk shocks to $\ln a$ at its geometric mean, which is also the median a_t, such that *at that point* when the shock hits the new probability of a shock that worsens conditions is the same as before and equal to 1/2. However, the proposition shows that the results also hold for all lower a_t and some above it. The reason it may not hold for all a_t is that we are considering geometric mean preserving spreads of the variables and so the riskier distributions will give rise to higher arithmetic means.

Corollaries: Suppose that preferential trade agreements lower Σ_m. Then for $a_t \in (0, \exp(\mu)]$ and for some $a_t > \exp(\mu)$

1. Agreements increase entry for any $\eta \in (-\frac{\Sigma_x}{\Sigma_{\neq x}}, 1]$.

2. Agreements have a stronger impact on export entry in countries with higher Σ_y if $\eta < 0$.

3. An increase in exporter (ln) income risk will have a smaller negative effect on export entry to PTA countries if $\eta < 0$.

4. An increase in the arrival rate of shocks will have a smaller impact on entry

of PTA countries if $\eta < 0$.

5. For non-PTA importers, an increase in the arrival rate of shocks will have a larger impact for countries-industries with higher Σ_{ς}^2 such as those with higher market power.

The interaction of risks depends on the parameter η that captures the correlation between sources of uncertainty. High tariffs are positively correlated with recessions as long as $\eta < 0$ and this is plausible since protection often increases during downturns (c.f. Bown and Crowley (2013)).

After considering this setting where both economic and policy shocks arrive at the same time, we now turn to the case where there is heterogeneity in the arrival rates across sources of uncertainty.

4.3.4 Heterogeneous Shock Persistence

When both income and policy shocks to demand arrive simultaneously and their subsequent realizations are independent of their previous values, firms only need to know a_t and $H(\cdot)$ to make optimal decisions. However, the income and policy shocks are likely to follow different processes. In this section, we capture one key difference between processes: the higher persistence of policy relative to income. More specifically, we assume that firms believe that an economic shock is necessary but not sufficient for a policy shock. We could allow for more general processes at the cost of tractability. Our approach captures two reasonably important features of the relationship between these shocks: the difference in the persistence as we mentioned before and the fact that a policy change requires a change in the economic conditions. Given that these processes now have different persistence, we must rederive the optimal entry decision.

Let γ denote the arrival of y shocks and γ_τ the probability of arrival of a policy shock *conditional* on the arrival of an economic shock. So our initial approach is a special case where $\gamma_\tau = 1$, and when $\gamma_\tau = 0$ there is no uncertainty in policy. As we did in our initial approach, we need to find expressions for $\Pi_e\left(a_t, c_t^U, r\right)$ and $\Pi_w\left(a_t, c_t^U, r\right)$ that solve (4.3.4) in this generalized demand regime $r = \{\gamma, \gamma_\tau, H\}$. Note that now firms need to know not only a_t but also its components y_t and τ_t in order to compute $\Pi_e(\cdot)$ and $\Pi_w(\cdot)$. The functional form of the expected value of starting to export at time t conditional on observing current market conditions $a_t(y_t, \tau_t)$ is still given by (4.3.5), but now the term when shocks arrive must be modified. This leads to the following expression:

$$\Pi_e(a_t, c, r) = \pi(a_t, c) + \beta \underbrace{(1-\gamma)\Pi_e(a_t, c, r)}_{\text{No Shock}} + \beta\gamma[\underbrace{(1-\gamma_\tau)\mathbb{E}_y\Pi_e(a'|\tau_t, c, r)}_{\text{Economic Shock Only}} + \underbrace{\gamma_\tau\mathbb{E}_a\Pi_e(a(y', \tau'), c, r)}_{\text{Economic \& Policy Shocks}}] \tag{4.3.13}$$

where now the shock term is split in two components. The second component is similar to our previous approach since both shocks arrive jointly in this case. Hence, this term is the *ex-ante* expected value of exporting following both shocks, where $\mathbb{E}_a$ denotes expectation over the H distribution. Again, this is simply $\mathbb{E}_a\Pi_e(a', c, r) = \mathbb{E}\pi(a', c, r)/(1-\beta)$. The first component refers to the *ex-ante* value of exporting when only the economic shock takes place, where $\mathbb{E}_y$ denotes the expectation over the distribution H holding $\tau = \tau_t$. This value of exporting is $\mathbb{E}_y\Pi_e(a'|\tau_t, c, r) = \mathbb{E}_y\pi(a'|\tau_t, c, r)/(1-\beta(1-\gamma\gamma_\tau))+\beta\gamma\gamma_\tau\mathbb{E}\pi(a', c, r)/((1-\beta)(1-\beta(1-\gamma\gamma_\tau))$. Note that $\mathbb{E}_y\Pi_e(a'|\tau_t, c, r)$ depends on current market conditions, thus it varies over time. This contrasts with $\mathbb{E}\Pi_e(a', c, r)$, which is time invariant in the initial demand regime.

Now the generalized expression for the value of waiting is:

$$\begin{aligned}\Pi_w(a_t, c, r) =& 0 + \beta(1-\gamma)\Pi_w(a_t, c, r) \\ &+ \beta\gamma(1-\gamma_\tau)\underbrace{H(\bar{a}|\tau_t)\mathbb{E}_y\Pi_w(a < \bar{a}|\tau_t, c, r)}_{\text{Wait-Economic shock}} + \\ &+ \beta\gamma(1-\gamma_\tau)\underbrace{(1-H(\bar{a}|\tau_t))(\mathbb{E}_y\Pi_e(a > \bar{a}|\tau_t, c, r) - K)}_{\text{Enter-Economic shock}} \\ &+ \beta\gamma\gamma_\tau[\underbrace{H(\bar{a})\mathbb{E}_a\Pi_w(a < \bar{a}, c, r)}_{\text{Wait-Economic \& Policy shocks}} + \underbrace{(1-H(\bar{a}))(\mathbb{E}_a\Pi_e(a > \bar{a}, c, r) - K)}_{\text{Enter-Economic \& Policy shocks}}]\end{aligned} \tag{4.3.14}$$

A non-exporter receives zero profit from exporting today. If no shock arrives, which occurs with probability $(1-\gamma)$, the continuation value remains the same $\Pi_w(a_t, c, r)$. With probability $\gamma(1-\gamma_\tau)H(\bar{a}|\tau_t)$ a pure economic shock arrives that is not sufficiently high to trigger entry given the policy level τ_t, hence the continuation value is $\mathbb{E}_y\Pi_w(a < \bar{a}|\tau_t, c, r)$. In case that the economic shock is high enough to trigger entry, which occurs with probability $\gamma(1-\gamma_\tau)(1-H(\bar{a}|\tau_t))$, then we get a term that is the expected value of exporting conditional on $a' > \bar{a}|\tau = \tau_t$ minus the sunk cost to start exporting. The last case when both shocks arrive is similar to what we discussed in the initial demand regime for (4.3.6). Both the conditional value of exporting if $a' > \bar{a}$, $\mathbb{E}_a\Pi_e(a' > \bar{a})$, and the conditional value of exporting if $a' > \bar{a}|\tau = \tau_t$, $\mathbb{E}_y\Pi_e(a' > \bar{a}|\tau = \tau_t)$, follow the same structure as (4.3.13). Note that now the value of waiting depends on the current realization of a_t because shocks to y and τ may not arrive jointly, while in our initial demand regime this was not the case.

Solving for the marginal entrant for any given $a_t(y_t, \tau_t)$, we obtain an expression for K which is a generalized version of (4.3.8), and we verify that the latter is obtained by setting $\gamma_\tau = 1$ (see appendix B.2.3 for the details). Then we solve for the expression for c_t^U:

$$c_t^U = U_t \times c_t^D \tag{4.3.15}$$

$$U_t = \left[1 - \frac{\beta\gamma(\gamma_\tau \omega(a_t) + (1-\gamma_\tau)\omega(a_t|\tau_t)\phi(a_t,\gamma))}{1-\beta+\beta\gamma(1-(1-\gamma_t)H(a_t))}\right]^{\frac{1}{\sigma-1}} \tag{4.3.16}$$

This generalized demand regime with different arrival rates for economic and policy shocks generates a lower cutoff than the deterministic setting as long as $U_t < 1$, as was the case when both shocks arrive at the same time (see (4.3.10)). The difference between these expressions is that now we have two terms instead of one capturing the proportional reduction in operating profits expected to occur if we start at a_t since two different types of shocks can arrive. More specifically, these terms correspond to conditions worsening due to only an economic shock arriving, $\omega(a_t|\tau_t)$, or both economic and policy shocks arriving, $\omega(a_t)$. These terms are defined as

$$\omega(a_t) = -H(a_t)\frac{\mathbb{E}_a(a < a_t) - a_t}{a_t} \in (0,1)$$

$$\omega(a_t|\tau_t) = -H(a_t|\tau_t)\frac{\mathbb{E}_y(a < a_t|\tau_t) - a_t}{a_t} \in (0,1)$$

and $\phi(a_t, \gamma) = \frac{1-\beta(1-\gamma(1-H(a_t)))}{1-\beta(1-\gamma)}$ adjusts for the fact that economic shocks alone have a different discount factor. Note that $\omega(a_t)$ and $\omega(a_t|\tau_t)$ cannot be ranked without information about τ_t. In the appendix, we show that $U_t < 1$. Hence, introducing uncertainty under ageneralized demand regime that allows for different arrival rates of economic and policy shocks makes it harder for firms to start exporting.

Remark 2: An increase in the economic shock arrival rate reduces entry while an increase in the policy shock arrival rate reduces entry when τ_t is sufficiently low.

We show in the appendix that an increase in the arrival rate of economic shocks reduces entry for $a_t > a_{min}, \frac{\partial \ln c^U}{\partial \ln \gamma} < 0$. In contrast, the effect of an increase in the arrival rate of policy shocks depends on the difference between $\omega(a_t)$ and $\omega(a_t|\tau_t)$. If the profit reduction with only economic shocks is smaller than the profit reduction with both economic and policy shocks, then $\omega(a_t) > \omega(a_t|\tau_t)$ and an increase in γ_τ reduces entry. On the contrary, if $\omega(a_t|\tau_t) > \omega(a_t)$ then an increase in the arrival rate of policy shock will induce entry. The intuition is that if the current realization of the policy variable is good (i.e. below the average), a higher arrival rate increases the probability of a bad policy realization and reduces entry; while a bad current realization of the policy variable combined with a higher arrival rate of policy shocks induces entry because there is a lower probability of getting a bad shock that reduces the profits.

Remark 3: Under the generalized demand regime when $\gamma > 0$, a mean-preserving spread in $F(y)$ reduces entry if $F(y)$ and $G(\varsigma)$ are independent and $F_{MPS}(y_t) \leq F(y_t)$.

The intuition is similar to our result when shocks arrive jointly. A mean-preserving spread adds more weight to the tails and since the entry decision focuses on the left tail (i.e. smaller realizations of income), then a MPS reduces entry. The independence assumption is used to simplify the proof.

Thus we show that uncertainty reduces entry even allowing for differences in the arrival rates of shocks. The entry condition shows that firms now compute two uncertainty terms that measure the expected profits loss when both shocks arrives and when only an economic shock arrives. This guides our empirical implementation to disentangle the sources of uncertainty.

4.4 Estimation

We now employ this model to estimate the impact of uncertainty during the GTC. More specifically, we focus on unbundling the impact of economic uncertainty and the impact of policy uncertainty during the recent trade collapse. Our empirical implementation follows closely the model which allows for different arrivals for economic and policy shocks.

The model focuses on the marginal cost cutoff as a function of the demand regime and current demand shifter, and this allows us to express the number of firms exporting to destination i in an industry V, N_{tVi}, as the mass of domestic producers in the industry with marginal cost below the cutoff. Assuming that N_v is the total mass of domestic producers in industry V, $N_{tVi} = G(c^U_{tVi}) \times N_V$ where $G(c)$ is the cumulative distribution function of marginal cost. Assuming that firm productivity follows a Pareto distribution such that $G(c) = (c/c_V)^k$ where $k > 0$, then $\ln N_{tVi} = k \ln c^U_{tVi} - k \ln c_V + \ln N_V$. Differencing over time, we obtain

$$\Delta \ln N_{tVi} = k \Delta \ln c^U_{tVi} \tag{4.4.1}$$

under the assumption that the mass of domestic producers and the location parameter of the Pareto distribution are time invariant. In order to obtain an estimation equation, we approximate the cutoff $\ln c^U_{tVi}$ in (4.4.1) around $x = x_o$, $\gamma = g > 0$ and $\gamma_\tau = 0$ where x denotes the other variables that affect entry independently of policy and economic uncertainty. Note that we are approximating the equation around a point where there is an initial level of economic uncertainty and no policy uncertainty, a scenario that describes the initial period. We obtain the following estimation equation:

$$\begin{aligned} \Delta \ln N_{tVi} = & a_x \Delta x_{tVi} + b^1_y \frac{\omega(a_{t-1}|\tau_{t-1})}{b^2_y + b^3_y \left(1 - \omega(a_{t-1}|\tau_{t-1})\right)} \\ & + b^1_{\mathrm{w}} \frac{\omega(a_{t-1})}{b^2_{\mathrm{w}} + b^3_{\mathrm{w}} \left(1 - \omega(a_{t-1}|\tau_{t-1})\right)} + u_{tVi} \end{aligned} \tag{4.4.2}$$

where a_x, b^j_y and b^j_{w} for $j \in \{1, 2, 3\}$ summarize the parameters, x_{tVi} denotes the demand shifter and u_{tVi} is a random term capturing measurement error.[20] Parameters $b^1_y(\gamma_t, \gamma_{\tau,t})$ and $b^1_{\mathrm{w}}(\gamma_{\tau,t})$ allow us to separate the impact of economic uncertainty alone and combined economic and policy uncertainty. Importantly, these parameters embed the arrival rates of economic and policy shocks at time t and the arrival

[20] Formally, $a_x = k \frac{\partial \ln c^d}{\partial x}$, $b^1_y = \frac{\beta k}{\sigma - 1} \frac{(1-\beta(1-g)) g \gamma_{\tau,t}}{1-\beta(1-H_0 g)} - \frac{\beta k}{\sigma - 1} \frac{(1-\beta)(\gamma_t - g)}{1-\beta(1-g)}$, $b^1_w = \frac{\beta k}{\sigma - 1} \frac{1-\beta(1-g)}{1-\beta(1-H_0 g)} \gamma_{\tau,t}$, $b^2_y = b^2_{\mathrm{w}} = 1 - \beta$, $b^3_y = b^3_w = \beta g$

rate of economic shocks alone at time t, respectively. Therefore, these parameters are potentially changing over time as these arrival rates change. In order to accommodate this possibility, we use a flexible specification that allows these parameters to change over time.

The observables are Δx_{tVi}, the uncertainty measure for economic shocks only, $\omega(a_{t-1}|\tau_{t-1})$, and the uncertainty measure for both shocks, $\omega(a_{t-1})$. Several terms are embodied in the demand shifter change, Δx_{tVi}. We control directly for changes in nominal income (GDP), $\Delta \ln y_{ti}$. Changes in applied tariffs are small over the time period we consider and previous research has shown they changed little over the financial crisis period (see e.g. Bown and Crowley (2013)). We also introduce industry effects to absorb industry expenditure shares, α_V, and country fixed effects to control for the trend growth in the price index, α_i. Also, we include quarter-year fixed effects to control for changes in the general worldwide conditions.

The key variables to model empirically are the following: (i) the conditional expected value of a bad economic shock combined with a bad policy shock, $\omega\left(a_{t-1}\right) = H(a_{t-1}) \times \frac{a_{t-1} - \mathbb{E}(a' \leq a_{t-1})}{a_{t-1}}$ where $H(a_t)$ is the joint distribution of policy and income conditional on an income shock, and (ii) the conditional expected value of a bad economic shock alone, $\omega\left(a_{t-1}|\tau_{t-1}\right) = H(a_{t-1}|\tau_{t-1}) \frac{a_{t-1} - \mathbb{E}(a' \leq a_{t-1}|\tau_{t-1})}{a_{t-1}}$ where $H(a_t|\tau_{t-1})$ is the distribution of policy and income conditional on an income shock only. To model the income component, we compute the marginal distribution of *economic uncertainty over future income* from the expected value of GDP. We estimate an AR(1) model in log changes from 1991 to 2001 for each country separately at quarterly frequency.[21] We then compute the expected proportional change in the level of GDP for each country if a bad shock happens. We use the 5th percentile of the empirical GDP distribution as our definition of a bad shock, letting $unc_{Yi} = \left(Y_t - \mathbb{E}[Y_{t+1}^{0.05}|Y_{t+1} < Y_t]\right)/Y_t$ for fixed $t = 2001$ (see appendix B.3.1 for details). Thus, economic uncertainty, unc_{Yi}, is constant over time and varies across countries.

To measure the conditional expected value of the combination of a bad economic and policy shock, we start with our measure of economic uncertainty and add a bad policy shock. Hence, we approximate $\omega\left(a_{t-1}\right) \approx unc_{Yi} \times \zeta(\varsigma^{threat})$ where $\zeta(\varsigma^{threat})$ is a factor that captures the additional loss due to the policy shock on top of the economic shock measured by unc_{Yi}. Our first step to capture $\zeta(\varsigma^{threat})$ is to allow for a differential impact of economic uncertainty between PTA and non-PTA partners. This captures the fact that PTAs reduce or eliminate the ability of foreign governments to worsen the policy level, e.g. increase tariffs.[22] This approach implicitly assumes that the main source of variation in policy uncertainty is destination-specific and that there is not much variation in the policy threat across industries conditional on a destination. In a second step, we allow the policy threat level to be a function of the market power of destination i in industry V, $\zeta(\varsigma^{threat}; mktpwr_{Vi})$ where $mktpwr_{Vi}$ denotes the market power of industry V at destination i. Note here that we are not limiting what is the policy variable that

[21] Specifically, we model $\Delta\tilde{y}_{t+1} = a + \rho\Delta\tilde{y}_t + \epsilon_{t+1}$, where $\epsilon \sim \mathcal{N}(0, \sigma^2)$ and $\Delta\tilde{y}_{t+1} \sim \mathcal{N}(a + \Delta\tilde{y}_t, \sigma^2)$.

[22] In the period under analysis U.S. has PTAs with the following countries: Israel, Canada, Mexico, Jordan, Australia, Chile, Singapore, Bahrain, Morocco, Oman, Peru, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and the Dominican Republic.

the foreign government is using. This policy variable can be either optimal tariffs, tariff bindings, or non-trade barriers. The only assumption is that each of these policy variables are set by the foreign government according to the market power of the industry V.

Rewriting the estimation equation (4.4.2) for the case that the heterogeneity across PTA and non-PTA partners captures all the variation in the policy threat, we have:

$$\Delta \ln N_{tVi} = \frac{\tilde{b}_1 \times unc_{Yi}}{b_y^2 + b_y^3 (1 - unc_{Yi})} + \frac{\tilde{b}_2 \times PTA_{it} \times unc_{Yi}}{b_y^2 + b_y^3 (1 - unc_{Yi})} + a_x \Delta x_{tVi} + u_{tVi} \quad (4.4.3)$$

where $\tilde{b}_1 = b_y^1 + b_{\mathrm{w}}^1 \times \zeta(\varsigma^{threat})$ and $\tilde{b}_2 = \left(-b_{\mathrm{w}}^1 \times \zeta(\varsigma^{threat})\right)$. Note that $\tilde{b}_1$ and $\tilde{b}_2$ are potentially changing over time since they are functions of the arrival rates of economic and policy shocks.

We then estimate the following specification

$$\begin{aligned}\Delta \ln N_{tVi} = & \underbrace{\left(\sum_{p=2008}^{2010} b_p \times Q_p\right) \times unc_{Yi}}_{Econ\,\&\,Pol\,Unc} + \underbrace{\left(b_{PTA} + \sum_{p=2008}^{2010} b_p^{PTA} \times Q_p\right) \times unc_{Yi} \times PTA_{it}}_{Econ\,Unc} \\ & + a_0 + \left(a_{PTA} + \sum_{p=2008}^{2010} a_p^{PTA} \times Q_p\right) \times PTA_{it} + a_2 \times \Delta PTA_{it} \\ & + (c_0 + c_1 \times PTA_{it}) \times \Delta \ln y_{it} + \alpha_t + \alpha_i + \alpha_V + u_{iVt}\end{aligned}$$

The first line captures the impact of uncertainty and its evolution over time. Q_p denotes a dummy for each period of four quarters starting in the fourth quarter of year p until the third quarter of year $p+1$. $\sum_{p=2008}^{2010} b_p \times Q_p$ captures the difference in the impact of both economic and policy uncertainty in period p with respect to our baseline period, from the first quarter of 2002 to the third quarter of 2008. $b_{PTA} + \sum_{p=2008}^{2010} b_p^{PTA} \times Q_p$ measures changes in the impact of uncertainty due to turning off policy uncertainty in the baseline period , b_{PTA}, and over time relative to the initial period. The second line captures the differences between PTA and non-PTA partners in terms of the intercept and changes in the potential impact of PTAs over the periods. We include these terms to control for potential factors affecting the PTA vs Non-PTA comparison that may bias our estimates of the impact of uncertainty. Finally, the third line captures the impact of the demand shifter and several fixed effects to control for potential issues that we mentioned before. Estimation results are presented in Table 4.7. In order to unbundle the impact of economic uncertainty and policy uncertainty and their changes over time, however, looking at the estimated coefficients is not enough and we need to test different linear combinations of coefficients capturing the impact of uncertainty.

For countries without a PTA, the expected change in the number of varieties between the initial period and, the crisis period, between the fourth quarter of 2008 to the third quarter of 2009, due to uncertainty equals the coefficient of uncertainty interacted with the period dummy times the average uncertainty level. That is, $\mathbb{E}\Delta \ln N_{08Q4Vi}|^{Non-Pta} = (b_{408} \times u\bar{n}c)$. This expected change in the number of varieties captures the change in the combined impact of economic and policy uncertainty. Note that the baseline effect of uncertainty is absorbed by the country fixed effect. Similarly, the expected change in the number of varieties for PTA partners combines coefficients interacted with the period dummy for the overall effect of uncertainty and the reduction that arises due to shutting down the policy channel through a PTA with the change in the intercept for PTA countries in the period. That is, $\mathbb{E}\Delta \ln N_{08Q4Vi}|^{Pta} = \left([b_{408} + b_{408}^{PTA}] \times u\bar{n}c\right) + a_{408}^{Pta}$. In order to explore whether multiple sources of uncertainty matter for the expected change in the number of varieties, we test if $\mathbb{E}\Delta \ln N_{pVi}|^{Non-Pta}$ and $\mathbb{E}\Delta \ln N_{pVi}|^{Pta}$ are significantly different from each other. Note that these tests are double differences: the first difference is between the period p and the baseline period within each group, for PTA and non-PTA countries; and the second is the difference between the differences across PTA versus non-PTA countries. Table 4.1 shows the result of computing each of the expected changes in the number of varieties for all four-quarter periods p after the start of the GTC.

Table 4.1: Uncertainty impact on Variety Growth - PTA vs Non-PTA Countries

	non-PTA	PTA	Difference
	$b_p \cdot \overline{unc}_{Yi}$	$\left(b_p^{PTA} + b_p\right) \cdot \overline{unc}_{Yi} + a_p^{PTA}$	
Q408-Q309	-8.1%	2.3%	-10.4%*
Q409-Q310	-2.4%	7.2%	-9.6%***
Q410-Q311	-4.4%	-5.5%	1.1%

Notes: Conditional on country, time, industry FEs, and income.

$***p < 0.01$, $**\ p < 0.05$, $*p < 0.10$

Results shows that between 2008-q4 and 2010-q3 there are significant differences in the expected change in the number of varieties between countries with PTAs and countries without PTAs. More specifically, the expected change in the number of varieties for PTA countries is 9.6% and 10.4% higher for countries with a PTA, during the first two year of the GTC, respectively. In the final period, changes in varieties are not significantly different between PTAs and non-PTAs. This timing of the difference between PTA and non-PTA countries suggests that at the beginning of the GTC firms believed that an additional policy shock might arrive, worsening their expected profits in the foreign destination if the firms was exporting to a non-PTA partner. This remained true until the end of 2010, after which the difference between the PTA and non-PTA countries is not significant. This suggests that firms after 2010 stopped worrying about a potential policy shock, given the lack of changes in actual policy. This difference in the impact of uncertainty across PTA and non-PTA partners is in line with our descriptive evidence that trade to PTA countries adjusted more through the intensive margin and less through the extensive margin compared to non-PTA countries (see Figures 4.6 and 4.7).[23]

The results based on the difference across PTA and non-PTA countries capture the additional negative impact of economic uncertainty due to the possibility of an additional negative policy shock. However, this approach ignores how foreign countries set their policy variables and also ignores heterogeneities across industries in these potential new policy levels. In case of a trade war, countries would set tariffs

[23] This is also consistent with the fact that the share of trade to PTA countries stopped decreasing in 2008 and stabilized during the 2008-2011 period, as shown in Figure 4.5.

to maximize their unilateral objective functions. There is theoretical and empirical evidence showing this optimal unilateral tariff is proportional to a country's import market power (Broda, Limao, and Weinstein (2008)). Thus, we classify industries at the 2-digit HS level as high market power if the elasticity measure estimated in Broda, Limao, and Weinstein (2008) is above the upper tercile and low market otherwise.

Formally, we estimate the following specification:

$$\begin{aligned}
\Delta \ln N_{tVi} = &\left(\sum_{p=2008}^{2010} b_p \times Q_p \right) \times unc_{Yi} + \left(b_{PTA} + \sum_{p=2008}^{2010} b_p^{PTA} \times Q_p \right) \times unc_{Yi} \times PTA_{it} \\
&+ \left(f(b_M; Q_{2008}^{2010}) \times M_{Vi} + f(b_M^{PTA}; Q_{2008}^{2010}) \times M_{Vi} \times PTA_{it} \right) \times unc_{Yi} \\
&+ a_0 + \left(a_{PTA} + \sum_{p=2008}^{2010} a_p^{PTA} \times Q_p \right) \times PTA_{it} + a_2 \times \Delta PTA_{it} \\
&+ a_M \times M_{Vi} + a_M^{PTA} \times M_{Vi} \times PTA_{it} \\
&+ (c_0 + c_1 \times PTA_{it}) \times \Delta \ln y_{it} + \alpha_t + \alpha_i + \alpha_V + u_{iVt}
\end{aligned}$$

where $f(b_X; Q_{2008}^{2010}) = b_X + \sum_{p=2008}^{2010} b_p^X \times Q_p$ and M_{Vi} is an indicator if country i has low market power in industry V. In this specification, we identify the effect of high market power uncertainty on non-PTA partners through b_M and the heterogenous effect for PTA partners through b_M^{PTA}, and estimate how these effects change over time through the period indicators. Results are presented in Table 4.8. Given our flexible specification, in order to unbundle the impact of economic and policy uncertainty we need to test for differences in the expected change in the number of varieties across high and low market power industries. We focus on countries without a PTA, since having a PTA reduces how much foreign countries can adjust their policy variables. In the case of low market power industries, the expected change in the number of varieties is captured by $\left([b_p + b_p^M] \times u\bar{n}c\right)$ for non-PTA countries, where we evaluate this effect at the average level of uncertainty. Since this is a difference between the base period and period p for low market power industries, the coefficient that captures the specific intercept is dropped in the difference. The expected change in the number of varieties for high market power industries is captured by the baseline impact of uncertainty, $b_p \times u\bar{n}c$. Results of testing the difference in the impact of uncertainty on the expected change of varieties between high and low market power industries, $\mathbb{E}\Delta \ln N_{pVi}|_{HM}^{Non-Pta} - \mathbb{E}\Delta \ln N_{pVi}|_{LM}^{Non-Pta}$, are presented in Table 4.2.

Table 4.2: Uncertainty impact on Variety Growth - Market Power

	Non-PTA			PTA
	High Market Power	Low Market Power	Difference	Difference
	$b_p \cdot \overline{unc}_{Yi}$	$\left(b_p^M + b_p\right) \cdot \overline{unc}_{Yi}$		
Q408-Q309	-5.6%	-2.4%	-3.2%***	0.9%
Q409-Q310	-2.0%	1.5%	-3.5%***	-0.35%
Q410-Q311	-4.6%	-2.3%	-2.3%**	6.9%***

Notes: Conditional on country, time, industry FEs, and income.

$***p < 0.01$, $**\ p < 0.05$, $*p < 0.10$

Table 4.2 shows that the impact of uncertainty on the expected change in the number of varieties during the GTC is stronger for industries where the foreign destination has a higher market power and this is the case only for countries without a PTA with the U.S., as theory suggests should be the case given that market power captures how much profits can deteriorate if a bad policy shock arrives. Note that this heterogeneous impact of uncertainty is significant after conditioning on several fixed effects and allowing for period-varying intercepts for low market power industries. Furthermore, if we compare the difference between high and low market power for PTA and non-PTA countries the differences are even higher.

Summarizing, demand uncertainty has a strong negative impact on the number of varieties exported to the foreign destination. The baseline effect of uncertainty is on average -4.9% for net entry between the fourth quarter of 2008 and the third quarter of 2011. The first four quarters of the GTC show the strongest impact of uncertainty, -8.1%. Unbundling the sources of demand uncertainty, we find that turning off the policy source of uncertainty reduces the impact of demand uncertainty significantly. This is the case whether we use PTAs or market power to unbundle the sources of uncertainty. For example, the difference in the impact of uncertainty on the expected change of the number of varieties between PTA and non-PTA countries is -10.4% in the beginning of the GTC. When we use heterogeneity in the market power of the foreign destination-industries, to unbundle the sources of demand uncertainty, we find that economic uncertainty has a stronger impact on industries where destinations have a higher market power, but only for countries without PTAs with the U.S.

4.4.1 Quantification

After exploring the role of demand uncertainty and distinguishing between policy uncertainty and economic uncertainty, we now turn to quantify the impacts of uncertainty on aggregate export dynamic. We do that by exploiting our flexible specification that allows us to perform several quantifications. First, we turn off the uncertainty effect during the GTC and compute the counterfactual path of U.S. exports. We do this by predicting the dependent variable at country-industry level for each quarter using our empirical model without allowing the impact of uncertainty to change during the GTC, and then aggregating the predicted values to obtain an aggregate measure for each quarter. Note that the effect of uncertainty during the baseline period (2002:Q1 to 2008:Q3) is absorbed by the set of extensive fixed effects that we include in the regression. Hence this first quantification evaluates whether the change in the impact of uncertainty during the GTC matters for the dynamic observed path of exports,

Figure 4.9: Quantifying the Role of Uncertainty - Number of Varieties

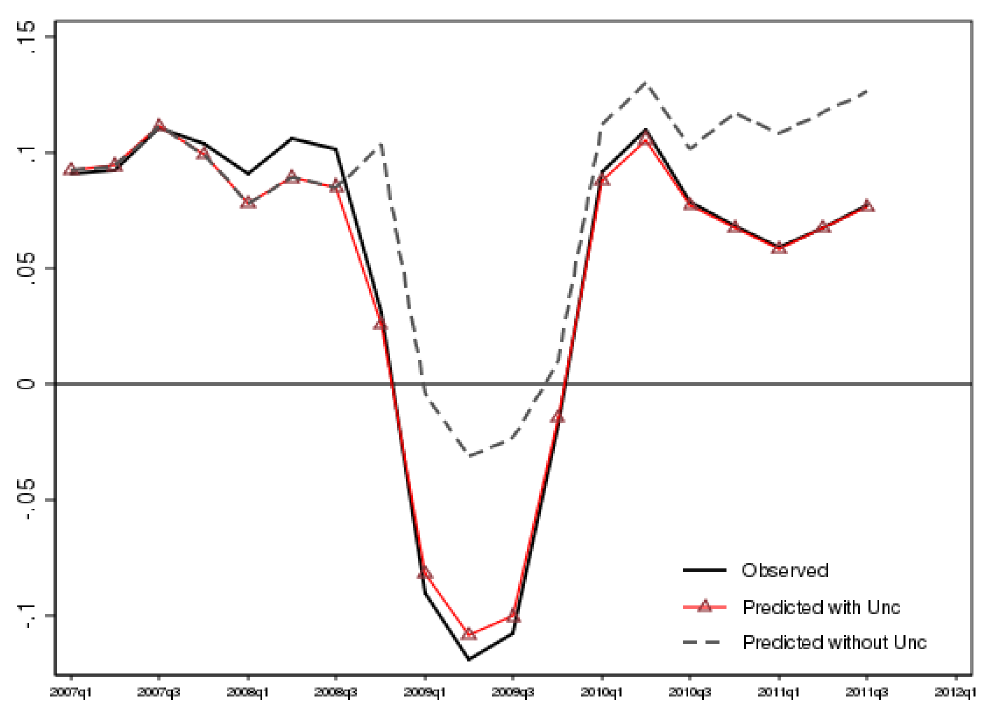


Figure 4.9 shows the results of this first quantification. More specifically, the figure plots the observed aggregate growth rate of number of varieties and the predicted growth rates with and without allowing for the impact of uncertainty to change after the onset of the GTC. A clear pattern emerges from this figure, since turning off the change in the impact of uncertainty after the fourth quarter of

2008 implies a significant underestimate of the contraction and overestimate of the recovery. In contrast, allowing for a time-varying impact of uncertainty generates a prediction that is almost equal to the observed value for each quarter. Moreover, the observed net entry growth rate drops around 22.5 points from its pre-crisis level to its trough in the second quarter of 2009, and uncertainty represents almost 10.5 points of this total contraction.

Figure 4.10: Quantifying the Role of Uncertainty - Number of Varieties for non-PTA Partners

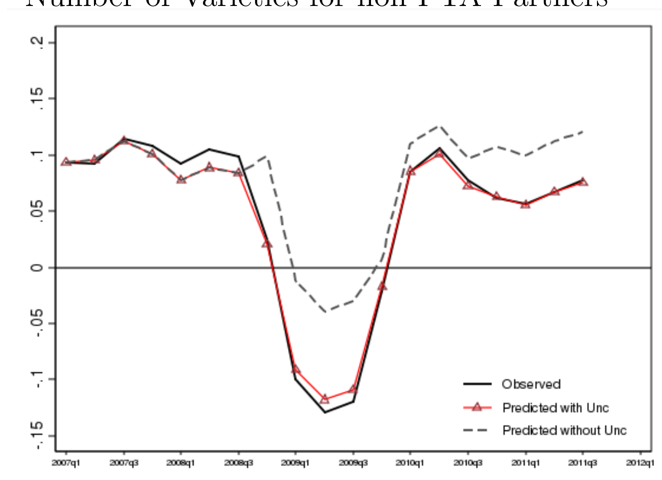
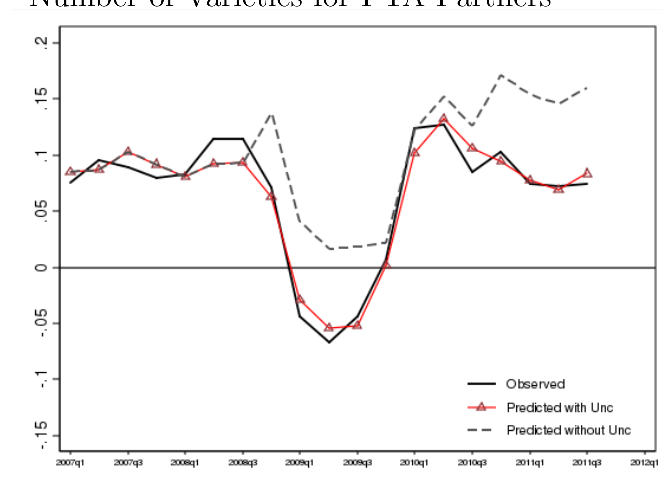


Figure 4.11: Quantifying the Role of Uncertainty - Number of Varieties for PTA Partners



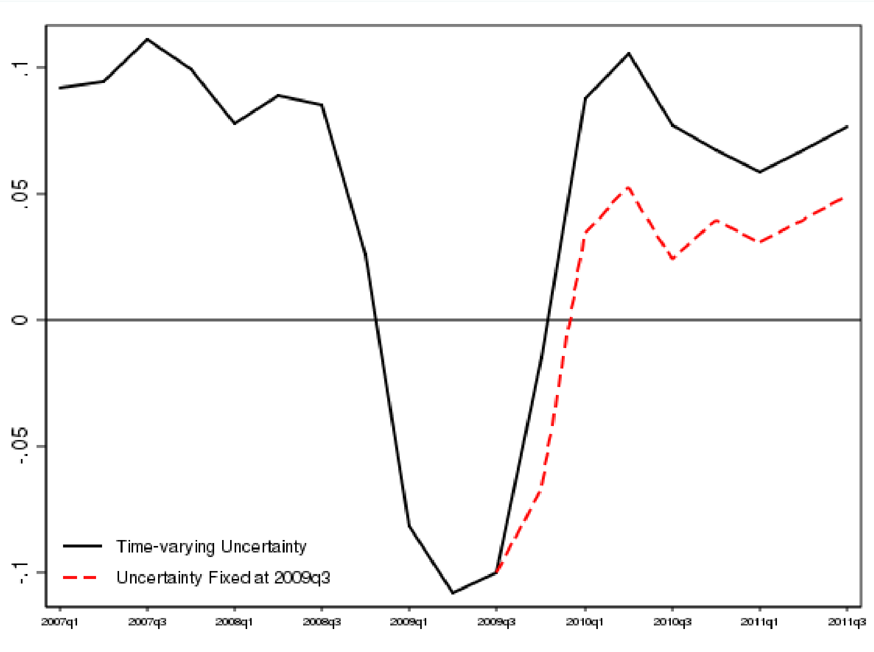
When we break this quantification between PTA partners and non-PTA partners, we observe first that the contraction on the number of varieties is almost 30% stronger for non-PTA partners. In both cases, the time-varying impact of uncertainty represents a significant share of the contraction, around 10 points of the total contraction.

Performing the quantification for total exports confirms the key role of uncertainty. For example, the growth rate of exports dropped to -31.22% at the trough of the GTC but this contraction reaches only -17.30% without allowing a time-varying impact of uncertainty. Hence -13.98% of the collapse corresponds to uncertainty (see Figure 4.15 in the Appendix). When distinguishing between PTAs and non-PTAs partners, we find that the contraction during the GTC was 10 points higher for non-PTAs partners in the second quarter of 2009 and that in both cases the time varying effects represented at least 12 points of the total contraction in the same quarter (see Figures 4.16 and 4.17 in the Appendix).

Our second quantification exercise explores the role of the reduction in uncertainty in the recovery after the GTC reached it trough. In this quantification, we keep the impact of uncertainty at its level of 2008:Q4-2009:Q3 and construct the counterfactual aggregate growth rate of the number of varieties exported. Figure 4.12 plots the results from this quantification exercise. The red dashed line denotes the predicted aggregate net entry if the impact of uncertainty had remained fixed at its level during the first four quarters of the GTC. The solid line shows the predicted aggregate net entry when allowing for time-varying impact of uncertainty. The difference between the two lines shows that the reduction in the impact of uncertainty during 2010 and 2011 played a significant role in the recovery. The average growth rate of net entry during 2010 is 6.5 points and the reduction on the impact of uncertainty accounts for 5.3 points.

In this second quantification, distinguishing between PTA partners and non-PTA partners we observe that time-varying effect of uncertainty is more important for non-PTA partners. More specifically, the reduction on the time-varying effect of uncertainty represent around 88% of the recovery for non-PTA partners, while it represents about 58% for PTA partners during the 2010. This difference is more

Figure 4.12: Time-varying Impact of Uncertainty - Number of Varieties



striking during 2011 where the reduction on the impact of uncertainty represents 52% of the recovery for non-PTA partners while its represents nothing for PTA partners. Note that this difference in time patterns across PTA and non-PTA partners is consistent with the PTA partners not subject to additional policy uncertainty.

Figure 4.13: Time-varying Impact of Uncertainty - Number of Varieties for non-PTA partners

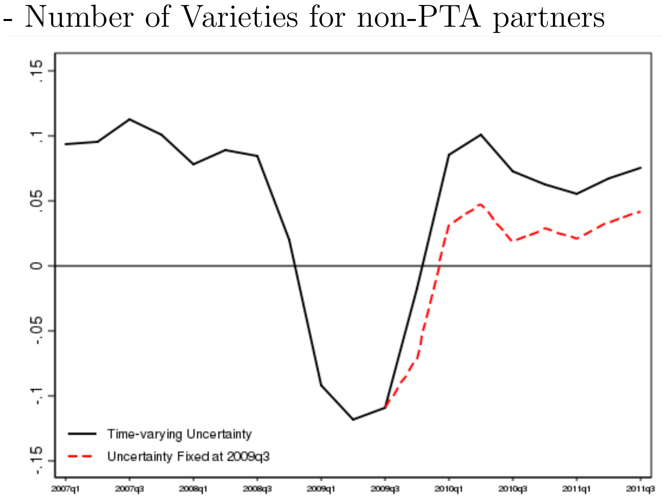
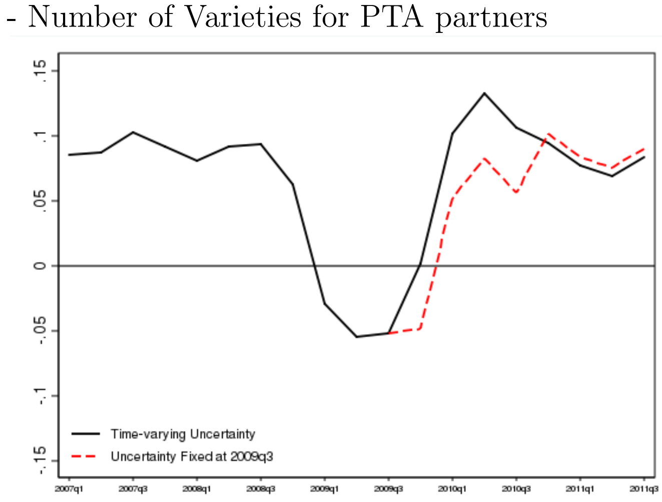


Figure 4.14: Time-varying Impact of Uncertainty - Number of Varieties for PTA partners



When repeating the quantification for exports, we find that the recovery would have been 30% smaller in the 2010 and 2011 on average if the impact of uncertainty have remained at the initial level during the GTC. (See Figure 4.18 in the Appendix). Repeating the exercises distinguishing between PTA and non-PTA partners, we observe that the role of time varying uncertainty is important for both cases but actually the time-varying impact of uncertainty accounts for a higher share of the recovery for the PTA partners (See Figures 4.19 and 4.20 in the Appendix).

4.4.2 Robustness

In this section, we perform several robustness checks to our main findings on the impact of demand uncertainty and its sources. Our benchmark estimation compares the growth rate of the number of varieties, defined as the number of firms at country-industry level per quarter. As a first robustness check, we compute the mid-point growth rate of the number of varieties instead of the standard growth rate. The mid-point growth rate allows us to include observations both for entry and exit, in contrast to the standard growth rate that requires flows to be present for at least two periods in order to be included into the computation. The results of the estimation using mid-point growth rates are presented in Tables 4.7 and 4.8 and confirm the negative impact of uncertainty and the additional negative impact of policy uncertainty, either following the PTA or the market power approach to identify the impact of policy uncertainty. For example, turning off the policy uncertainty channel reduces the negative impact of uncertainty on mid-point growth rate by -5.90% on average after the start of the GTC, a very similar magnitude to the impact we find using the standard growth rate.

More disaggregated trade flows can generate additional entry and exit dynamics and in doing so can capture stronger impacts for time-varying covariates. Hence we reestimate our benchmark estimation (4.4.3) aggregating trade flows up to the country level, where there is one observation of the number of firms or firm-product varieties exporting per country-quarter. Table 4.9 presents the results of estimating our benchmark specification at this more aggregated level. Results confirms that demand uncertainty has a negative impact on the number of varieties and the number of firms. Furthermore, the difference in the expected change in the number of varieties due to uncertainty between PTA and non-PTA countries is on average -7.16%, slightly above the difference in our benchmark specification.

To determine if the results are robust to the presence of outliers we run robust regressions that downweight outliers. These robust regressions start by computing Huber weights and then use Bi-weights after convergence has been achieved. Results are presented in 4.10 and confirm the negative impact of uncertainty and its growing importance during the GTC.

Previous chapters focus on the role of related-party for trade adjustment to uncertainty. Our empirical analysis does not include related-party trade controls explicit. However, the impact of related-party trade and its variation across industry and country is captured by country and industry fixed effects that absorb the constant component across the sample.[24]

[24] In future work we may explicitly control for this.

4.5 Conclusions

We assess the impact of demand uncertainty for U.S. exports during the "Great Trade Collapse" using a model of heterogeneous firm export dynamics with multiple sources of demand uncertainty. We show that uncertainty reduces entry in export markets and that multiple sources of uncertainty have a stronger impact on firms' export decisions. We use the model to explore an alternative explanation for the Great Trade Collapse and its subsequent recovery: the combination of economic uncertainty and heightened uncertainty about other countries' policies. Initially, firms feared an increased in protectionism fueled by the recession, and this contracted trade even more. After this return to protectionism did not materialize, demand uncertainty declined, helping the fast recovery.

Guided by the model developed, we construct theory-consistent measures of demand uncertainty and disentangle economic and policy uncertainty. We then estimate the impact of uncertainty during the GTC. We find that uncertainty reduced the number of varieties exported significantly and that turning off the policy uncertainty reduces the impact of uncertainty by 5.5% on average during the GTC. Uncertainty alone accounted for around 50% of the contraction from the pre-crisis level to the trough of the recession. Additionally, our quantifications show that if uncertainty had remained constant at its level prevailing during the first four quarters of the GTC, then the recovery would have been around half of the observed growth rate. Our findings suggest that policy and economic uncertainty played a significant role during the Great Trade Collapse, and that preferential trade agreements reduce the impact of economic uncertainty by reducing policy uncertainty.

4.6 Tables

Table 4.3: Decomposition of U.S. Exports Growth (2007-2011)

	Intensive Margin			**Extensive Margin**			**Total Growth Rate**
	Growers	**Shrinkers**	**Net**	**Entry**	**Exit**	**Net**	
2007:Q1	0.25	-0.21	0.04	0.28	-0.22	0.06	0.10
2007:Q2	0.25	-0.21	0.04	0.28	-0.24	0.04	0.08
2007:Q3	0.26	-0.21	0.05	0.3	-0.24	0.06	0.11
2007:Q4	0.27	-0.21	0.06	0.31	-0.24	0.07	0.13
2008:Q1	0.28	-0.18	0.10	0.29	-0.24	0.05	0.15
2008:Q2	0.27	-0.19	0.08	0.30	-0.21	0.09	0.17
2008:Q3	0.27	-0.20	0.07	0.30	-0.22	0.08	0.15
2008:Q4	0.21	-0.27	-0.06	0.27	-0.27	0.00	-0.06
2009:Q1	0.16	-0.36	-0.2	0.24	-0.31	-0.07	-0.27
2009:Q2	0.15	-0.36	-0.21	0.24	-0.34	-0.10	-0.31
2009:Q3	0.17	-0.33	-0.16	0.23	-0.33	-0.10	-0.26
2009:Q4	0.24	-0.25	-0.01	0.26	-0.27	-0.01	-0.02
2010:Q1	0.31	-0.18	0.13	0.29	-0.23	0.06	0.19
2010:Q2	0.34	-0.17	0.17	0.28	-0.22	0.06	0.23
2010:Q3	0.30	-0.18	0.12	0.27	-0.21	0.06	0.18
2010:Q4	0.28	-0.19	0.09	0.27	-0.21	0.06	0.15
2011:Q1	0.28	-0.18	0.10	0.26	-0.22	0.04	0.14
2011:Q2	0.29	-0.18	0.11	0.26	-0.22	0.04	0.15
2011:Q3	0.29	-0.18	0.11	0.26	-0.22	0.04	0.15
2011:Q4	0.26	-0.2	0.06	0.26	-0.23	0.03	0.09

Mid-point growth rate decomposition defined at firm-country-product level.
Intensive margin refers to flows that exist in quarters q and $q-4$ where growers and shrinkers correspond to flows with a positive and negative growth, respectively.
Extensive margin refers to flow without positive value in both q and $q-4$ quarters where entry corresponds to flows that exist in q only while exit corresponds to flow that exist in $q-4$ only.
See B.1.1 for mode details.

Table 4.4: Decomposition of U.S. Exports Growth - PTA countries (2007-2011)

	Intensive Margin			**Extensive Margin**			**Total Growth Rate**
	Growers	**Shrinkers**	**Net**	**Entry**	**Exit**	**Net**	
2007:Q1	0.23	-0.22	0.01	0.23	-0.20	0.03	0.04
2007:Q2	0.22	-0.21	0.01	0.24	-0.20	0.04	0.05
2007:Q3	0.23	-0.21	0.02	0.26	-0.20	0.06	0.08
2007:Q4	0.25	-0.22	0.03	0.27	-0.21	0.06	0.09
2008:Q1	0.25	-0.18	0.07	0.25	-0.19	0.06	0.13
2008:Q2	0.27	-0.20	0.07	0.26	-0.18	0.08	0.15
2008:Q3	0.27	-0.20	0.07	0.25	-0.19	0.06	0.13
2008:Q4	0.21	-0.27	-0.06	0.23	-0.22	0.01	-0.05
2009:Q1	0.15	-0.38	-0.23	0.20	-0.28	-0.08	-0.31
2009:Q2	0.15	-0.41	-0.26	0.19	-0.29	-0.10	-0.36
2009:Q3	0.17	-0.35	-0.18	0.19	-0.26	-0.07	-0.25
2009:Q4	0.24	-0.26	-0.02	0.21	-0.21	0.00	-0.02
2010:Q1	0.34	-0.17	0.17	0.25	-0.19	0.06	0.23
2010:Q2	0.37	-0.15	0.22	0.24	-0.18	0.06	0.28
2010:Q3	0.30	-0.16	0.14	0.22	-0.17	0.05	0.19
2010:Q4	0.27	-0.18	0.09	0.23	-0.17	0.06	0.15
2011:Q1	0.29	-0.16	0.13	0.21	-0.17	0.04	0.17
2011:Q2	0.29	-0.17	0.12	0.21	-0.17	0.04	0.16
2011:Q3	0.29	-0.16	0.13	0.20	-0.16	0.04	0.17
2011:Q4	0.28	-0.18	0.10	0.21	-0.17	0.04	0.14

Mid-point growth rate decomposition defined at firm-country-product level.
Intensive margin refers to flows that exist in quarters q and $q-4$ where growers and shrinkers correspond to flows with a positive and negative growth, respectively.
Extensive margin refers to flow without positive value in both q and $q-4$ quarters where entry corresponds to flows that exist in q only while exit corresponds to flow that exist in $q-4$ only.
See B.1.1 for mode details.

Table 4.5: Decomposition of U.S. Exports Growth - Non-PTA countries (2007-2011)

	Intensive Margin			**Extensive Margin**			**Total Growth Rate**
	Growers	**Shrinkers**	**Net**	**Entry**	**Exit**	**Net**	
2007:Q1	0.26	-0.20	0.06	0.30	-0.23	0.07	0.13
2007:Q2	0.27	-0.21	0.06	0.30	-0.25	0.05	0.11
2007:Q3	0.27	-0.21	0.06	0.31	-0.25	0.06	0.12
2007:Q4	0.29	-0.21	0.08	0.32	-0.25	0.07	0.15
2008:Q1	0.29	-0.19	0.10	0.30	-0.26	0.04	0.14
2008:Q2	0.27	-0.19	0.08	0.31	-0.22	0.09	0.17
2008:Q3	0.27	-0.21	0.06	0.32	-0.24	0.08	0.14
2008:Q4	0.22	-0.27	-0.05	0.29	-0.29	0.00	-0.05
2009:Q1	0.17	-0.36	-0.19	0.25	-0.32	-0.07	-0.26
2009:Q2	0.15	-0.35	-0.20	0.26	-0.35	-0.09	-0.29
2009:Q3	0.17	-0.33	-0.16	0.24	-0.36	-0.12	-0.28
2009:Q4	0.24	-0.25	-0.01	0.28	-0.29	-0.01	-0.02
2010:Q1	0.30	-0.19	0.11	0.30	-0.25	0.05	0.16
2010:Q2	0.32	-0.18	0.14	0.30	-0.25	0.05	0.19
2010:Q3	0.31	-0.19	0.12	0.29	-0.23	0.06	0.18
2010:Q4	0.29	-0.19	0.10	0.29	-0.22	0.07	0.17
2011:Q1	0.28	-0.18	0.10	0.29	-0.23	0.06	0.16
2011:Q2	0.29	-0.18	0.11	0.28	-0.24	0.04	0.15
2011:Q3	0.28	-0.19	0.09	0.29	-0.24	0.05	0.14
2011:Q4	0.25	-0.22	0.03	0.28	-0.25	0.03	0.06

Mid-point growth rate decomposition defined at firm-country-product level.
Intensive margin refers to flows that exist in quarters q and $q-4$ where growers and shrinkers correspond to flows with a positive and negative growth, respectively.
Extensive margin refers to flow without positive value in both q and $q-4$ quarters where entry corresponds to flows that exist in q only while exit corresponds to flow that exist in $q-4$ only.
See B.1.1 for mode details.

Table 4.6: Decomposition of U.S. Exports Growth - Durable and Non-durable (2007-2011)

	Durable Goods			**Non-Durable Goods**		
	Intensive Margin	**Extensive Margin**	**Total**	**Intensive Margin**	**Extensive Margin**	**Total**
2007:Q1	0.02	0.05	0.07	0.09	0.05	0.14
2007:Q2	0.03	0.05	0.08	0.07	0.03	0.10
2007:Q3	0.03	0.07	0.10	0.08	0.06	0.14
2007:Q4	0.04	0.05	0.09	0.08	0.06	0.14
2008:Q1	0.06	0.03	0.09	0.11	0.07	0.18
2008:Q2	0.04	0.06	0.10	0.12	0.06	0.18
2008:Q3	0.01	0.05	0.06	0.12	0.05	0.17
2008:Q4	-0.09	0.02	-0.07	-0.02	-0.02	-0.04
2009:Q1	-0.23	-0.06	-0.29	-0.14	-0.07	-0.21
2009:Q2	-0.25	-0.10	-0.35	-0.14	-0.04	-0.18
2009:Q3	-0.17	-0.08	-0.25	-0.11	-0.08	-0.19
2009:Q4	-0.05	-0.02	-0.07	0.01	0.02	0.03
2010:Q1	0.12	0.03	0.15	0.11	0.08	0.19
2010:Q2	0.19	0.05	0.24	0.11	0.04	0.15
2010:Q3	0.14	0.06	0.20	0.09	0.04	0.13
2010:Q4	0.08	0.05	0.13	0.09	0.04	0.13
2011:Q1	0.11	0.02	0.13	0.08	0.03	0.11
2011:Q2	0.09	0.03	0.12	0.10	0.05	0.15
2011:Q3	0.08	0.05	0.13	0.10	0.02	0.12
2011:Q4	0.07	0.03	0.10	0.04	0.01	0.05

Mid-point growth rate decomposition defined at firm-country-product level.
Goods classified in durable and non-durable according to classification by Engel and Wang (2010).
Intensive margin refers to flows that exist in quarters q and $q-4$ where growers and shrinkers correspond to flows with a positive and negative growth, respectively.
Extensive margin refers to flow without positive value in both q and $q-4$ quarters where entry corresponds to flows that exist in q only while exit corresponds to flow that exist in $q-4$ only.
See B.1.1 for mode details.

Table 4.7: Impact of Uncertainty on Growth of U.S. Exported Varieties (2003-2011)

	Net Entry	Net Entry (Entry-Exit) (midpoint growth)	Entry	Exit
Uncertainty (no PTA)				
Uncertainty*Q408	-0.354***	-0.210**	-0.0707	0.140***
	(0.097)	(0.086)	(0.046)	(0.051)
Uncertainty*Q409	-0.105	-0.0499	0.0557	0.106**
	(0.067)	(0.075)	(0.038)	(0.050)
Uncertainty*Q410	-0.193***	-0.175***	0.0196	0.195***
	(0.050)	(0.051)	(0.041)	(0.033)
Uncertainty (PTA)				
PTA*Uncertainty*Q408	1.754***	1.442***	0.697***	-0.746**
	(0.498)	(0.490)	(0.239)	(0.298)
PTA*Q408	-0.299***	-0.238***	-0.125***	0.112***
	(0.064)	(0.067)	(0.036)	(0.037)
PTA*Uncertainty*Q409	1.586***	1.534***	1.004***	-0.530**
	(0.371)	(0.325)	(0.227)	(0.215)
PTA*Q409	-0.269***	-0.255***	-0.181***	0.0741*
	(0.070)	(0.061)	(0.041)	(0.041)
PTA*Uncertainty*Q410	0.00211	-0.136	-0.0222	0.113
	(0.281)	(0.281)	(0.237)	(0.191)
PTA*Q410	-0.0113	0.0153	-0.0217	-0.037
	(0.052)	(0.052)	(0.044)	(0.033)
PTA*Uncertainty	-1.319*	-1.187*	-0.978**	0.21
	(0.774)	(0.704)	(0.439)	(0.406)
PTA	0.267**	0.239**	0.197**	-0.0425
	(0.132)	(0.117)	(0.080)	(0.062)
Change in PTA	-0.0153	-0.0133	-0.0119	0.00138
	(0.026)	(0.024)	(0.010)	(0.015)
Change in GDP	0.282***	0.246***	0.103***	-0.143***
	(0.041)	(0.041)	(0.023)	(0.023)
PTA*Change in GDP	-0.134	-0.0924	-0.0273	0.065
	(0.106)	(0.098)	(0.049)	(0.065)
Number of Observations	166,933	185,853	185,853	185,853
R-squared	0.03	0.03	0.099	0.082
Aggregation Level	Country-Hs2	Country-Hs2	Country-Hs2	Country-Hs2
Country Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Quarter-Year Fixed Effects	Yes	Yes	Yes	Yes

Clustered standard errors in parenthesis (country).
We use uncertainty estimates from AR(1) country-specific regressions. See details on document.
The number of observations in midpoint growth specifications is higher because they allow for zeros at the start or end of each period.
*,**,*** Sig. different from 0 at 10%,5% and 1

Table 4.8: Impact of Uncertainty on Growth of U.S. Exported Varieties (2003-2011) with Market Power

	Net Entry	Net Entry (Entry-Exit) (midpoint growth)	Entry	Exit
Uncertainty (no PTA)				
Uncertainty*Q408	-0.212*	-0.104	-0.0187	0.0849*
	(0.109)	(0.090)	(0.050)	(0.050)
Uncertainty*Q408*Market Power	-0.188***	-0.148***	-0.0735**	0.0744***
	(0.053)	(0.040)	(0.030)	(0.024)
Uncertainty*Q409	0.0165	0.064	0.0857*	0.0216
	(0.070)	(0.077)	(0.047)	(0.047)
Uncertainty*Q409*Market Power	-0.161***	-0.157***	-0.0438	0.113***
	(0.054)	(0.043)	(0.027)	(0.032)
Uncertainty*Q410	-0.0982	-0.102	0.0549	0.157***
	(0.064)	(0.061)	(0.047)	(0.034)
Uncertainty*Q410*Market Power	-0.124**	-0.102**	-0.0510*	0.0511
	(0.050)	(0.043)	(0.027)	(0.032)
Uncertainty*Market power	0.162***	0.143***	0.170***	0.0266
	(0.018)	(0.018)	(0.040)	(0.035)
Uncertainty (PTA)				
PTA*Uncertainty*Q408	1.701***	1.409***	0.616**	0.793***
	(0.488)	(0.500)	(0.275)	(0.275)
PTA*Uncertainty*Q408*Market Power	0.0488	0.0393	0.121	0.0821
	(0.171)	(0.159)	(0.111)	(0.087)
PTA*Q408	-0.296***	-0.237***	-0.125***	0.111***
	(0.064)	(0.067)	(0.036)	(0.037)
PTA*Uncertainty*Q409	1.586***	1.534***	0.957***	-0.577**
	(0.392)	(0.347)	(0.233)	(0.233)
PTA*Uncertainty*Q409*Market Power	-0.0303	-0.0152	0.071	0.0861
	(0.108)	(0.092)	(0.057)	(0.063)
PTA*Q409	-0.266***	-0.254***	-0.181***	0.0725*
	(0.069)	(0.061)	(0.041)	(0.041)
PTA*Uncertainty*Q410	-0.229	-0.341	-0.214	0.127
	(0.286)	(0.297)	(0.220)	(0.203)
PTA*Uncertainty*Q410*Market Power	0.326***	0.299***	0.287***	-0.0125
	(0.089)	(0.085)	(0.066)	(0.054)
PTA*Q410	-0.00922	0.0161	-0.0217	-0.0378
	(0.052)	(0.052)	(0.044)	(0.033)
PTA*Market power	0.0264	0.0125	0.0861	0.0736
	(0.018)	(0.018)	(0.068)	(0.079)
PTA*Uncertainty	-1.154	-1.055	-0.53	0.525
	(0.710)	(0.651)	(0.507)	(0.353)
PTA*Uncertainty*Market Power	-0.250**	-0.202*	-0.677	-0.475
	(0.114)	(0.110)	(0.406)	(0.466)
PTA	0.249**	0.231**	0.14	-0.0914
	(0.123)	(0.110)	(0.090)	(0.065)
Change in PTA	-0.0153	-0.0133	-0.0119	0.00142
	(0.026)	(0.024)	(0.010)	(0.015)
Change in GDP	0.282***	0.246***	0.103***	-0.143***
	(0.041)	(0.041)	(0.023)	(0.023)
PTA*Change in GDP	-0.134	-0.092	-0.0268	0.0651
	(0.106)	(0.098)	(0.049)	(0.065)
Number of Observations	166,933	185,853	185,853	185,853
R-squared	0.03	0.03	0.1	0.083
Aggregation Level	Country-Hs2	Country-Hs2	Country-Hs2	Country-Hs2
Country Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Quarter-Year Fixed Effects	Yes	Yes	Yes	Yes

Clustered standard errors in parenthesis (country).
We use uncertainty estimates from AR(1) country-specific regressions. See details on document.
Number of observations in midpoint growth specifications is higher since they allow for zeros at the start or end of each period.
*,**,*** Sig. different from 0 at 10%, 5% and 1% respectively.

Table 4.9: Impact of Uncertainty on Growth of U.S. Varieties and Firms (2003-2011)

	Varieties	**Firms**	**Exports**
Uncertainty (no PTA)			
Uncertainty*Q408	-0.349***	-0.379***	-0.178
	(0.118)	(0.130)	(0.430)
Uncertainty*Q409	-0.0602	-0.0352	0.1
	(0.126)	(0.105)	(0.418)
Uncertainty*Q410	-0.0990**	-0.0935***	-0.282
	(0.041)	(0.029)	(0.250)
Uncertainty (PTA)			
PTA*Uncertainty*Q408	1.823***	1.869***	-0.683
	(0.490)	(0.440)	(2.049)
PTA*Q408	-0.289***	-0.286***	0.0341
	(0.085)	(0.069)	(0.313)
PTA*Uncertainty*Q409	0.788***	0.594**	-1.203
	(0.283)	(0.290)	(1.219)
PTA*Q409	-0.129**	-0.0841	0.264
	(0.055)	(0.054)	(0.207)
PTA*Uncertainty*Q410	0.105	0.392	-2.384
	(0.339)	(0.255)	(1.607)
PTA*Q410	-0.0156	-0.0618	0.344
	(0.060)	(0.045)	(0.287)
PTA*Uncertainty	-1.112	-0.902	-1.176
	(0.831)	(0.610)	(2.883)
PTA	0.224	0.179*	0.286
	(0.137)	(0.100)	(0.479)
Change in PTA	-0.0108	0.00341	0.0433
	(0.014)	(0.013)	(0.064)
Change in GDP	0.330***	0.305***	0.358**
	(0.063)	(0.060)	(0.151)
PTA*Change in GDP	-0.17	-0.132	-0.154
	(0.106)	(0.113)	(0.216)
Number of Observations	2,387	2,387	2,387
R-squared	0.529	0.527	0.189
Aggregation Level	Country	Country	Country
Country Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	No	No	No
Quarter-Year Fixed Effects	Yes	Yes	Yes

Clustered standard errors in parenthesis (country).
We use uncertainty estimates from AR(1) country-specific regressions. See details on document.
Number of observations in midpoint growth specifications is higher since they allow for zeros at the start or end of each period.
*,**,*** Sig. different from 0 at 10%, 5% and 1% respectively.

Table 4.10: Impact of Uncertainty on Growth of U.S. Exports (2003-2011) - Robust Regression

	OLS	**Robust**
Uncertainty (no PTA)		
Uncertainty*Q408	-0.531**	-0.384***
	(0.201)	(0.056)
Uncertainty*Q409	-0.329**	-0.321***
	(0.150)	(0.054)
Uncertainty*Q410	-0.133	-0.139***
	(0.114)	(0.053)
Uncertainty (PTA)		
PTA*Uncertainty*Q408	0.417	0.355
	(0.814)	(0.667)
PTA*Q408	-0.115	-0.105
	(0.099)	(0.107)
PTA*Uncertainty*Q409	1.881*	1.799***
	(0.959)	(0.639)
PTA*Q409	-0.341*	-0.297***
	(0.180)	(0.106)
PTA*Uncertainty*Q410	0.181	0.0344
	(0.443)	(0.631)
PTA*Q410	-0.0572	-0.0295
	(0.078)	(0.105)
PTA*Uncertainty	-0.939	-1.221*
	(01.161)	(0.701)
PTA	0.259	0.296**
	(0.191)	(0.118)
Change in PTA	-0.0102	0.01
	(0.038)	(0.018)
Change in GDP	0.481***	0.413***
	(0.074)	(0.022)
PTA*Change in GDP	-0.322	-0.286***
	(0.226)	(0.074)
Number of Observations	166,933	166,933
R-squared	0.024	0.044
Aggregation Level	Country-Hs2	Country-Hs2
Country Fixed Effects	Yes	Yes
Industry Fixed Effects	Yes	Yes
Quarter-Year Fixed Effects	Yes	Yes

Clustered standard errors in parenthesis (country).
We use uncertainty estimates from AR(1) country-specific regressions. See details on document.
The number of observations in midpoint growth specifications is higher because they allow for zeros at the start or end of each period.
*,**,*** Sig. different from 0 at 10%, 5% and 1% respectively

4.7 Figures

Figure 4.15: Quantifying the Role of Uncertainty - Exports

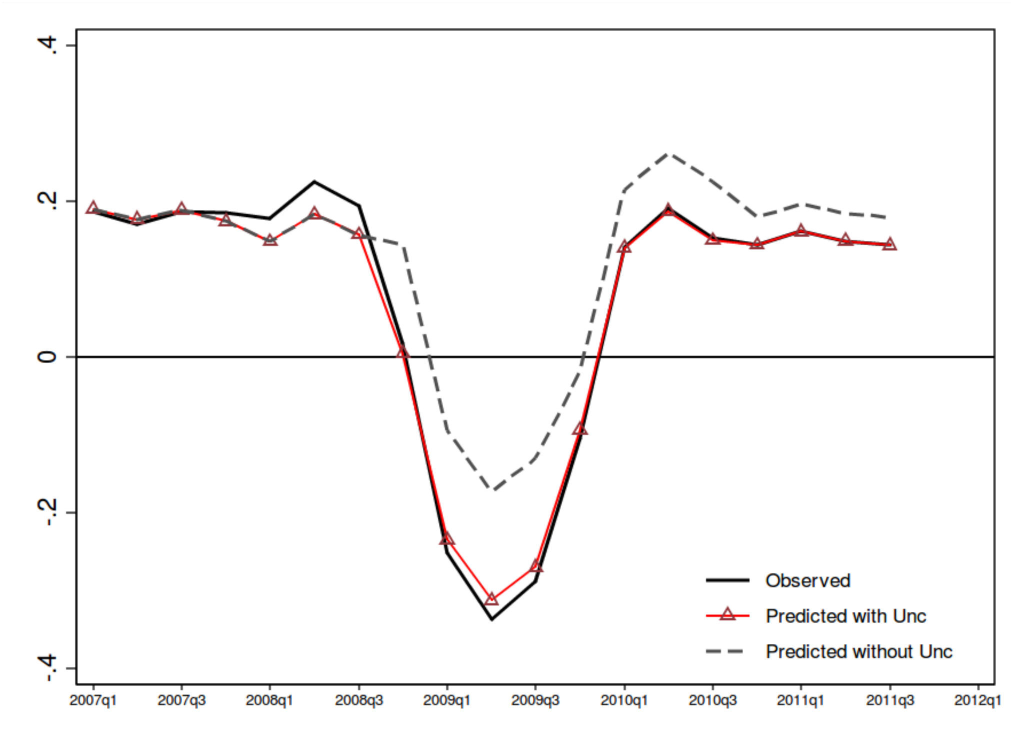


Figure 4.16: Quantifying the Role of Uncertainty - Exports for non-PTA partners

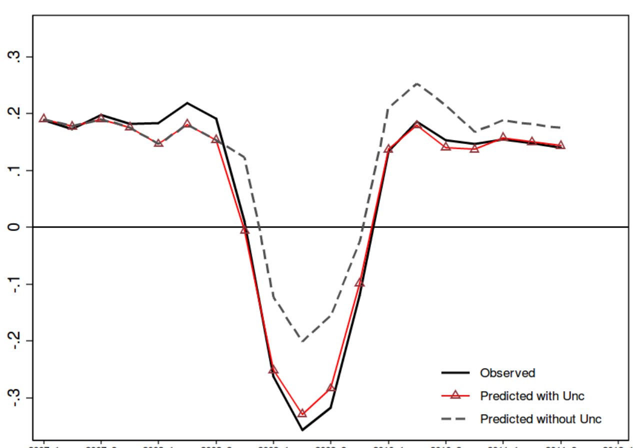


Figure 4.17: Quantifying the Role of Uncertainty - Exports for PTA partners

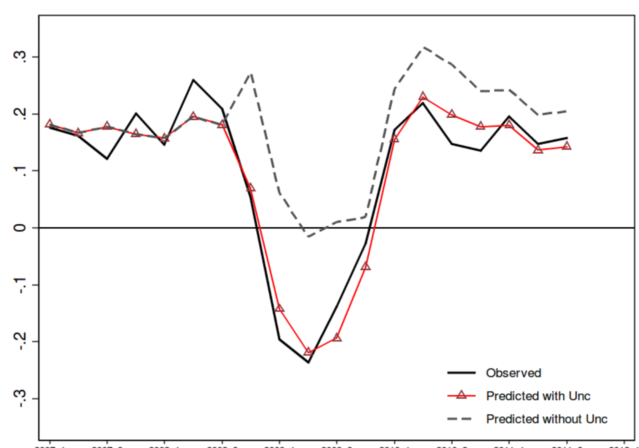


Figure 4.18: Time-varying Impact of Uncertainty - Exports

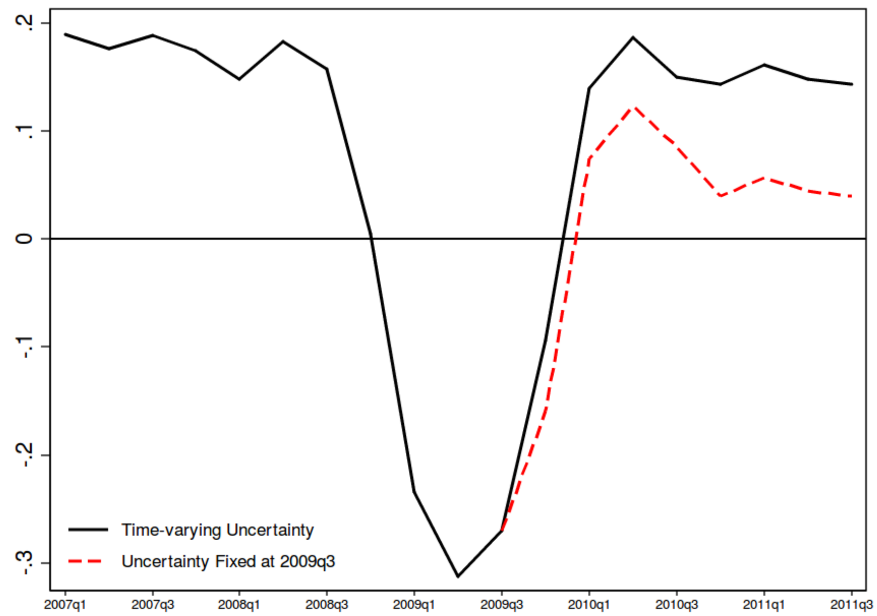


Figure 4.19: Time-varying Impact of Uncertainty - Exports to non-PTA partners

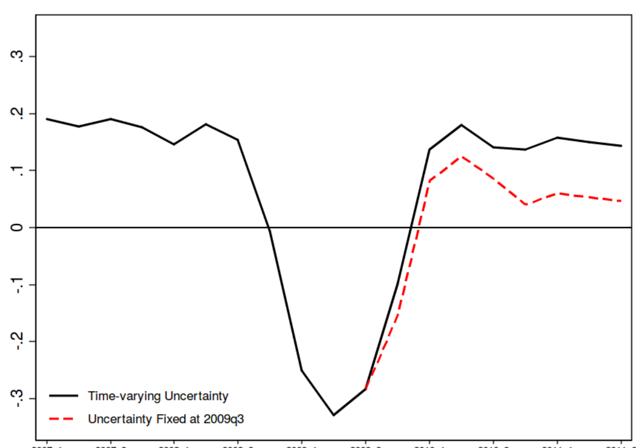
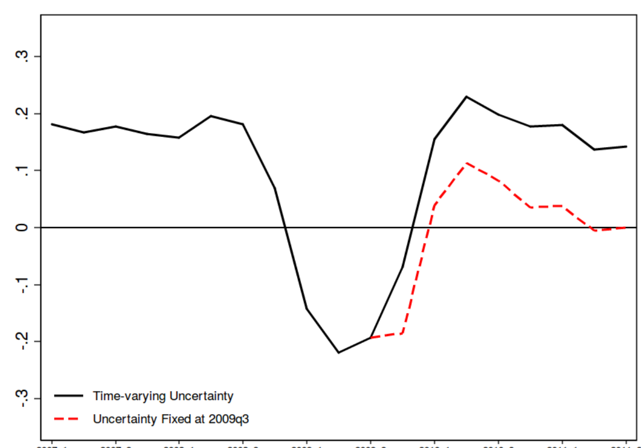


Figure 4.20: Time-varying Impact of Uncertainty - Exports to PTA partners



Appendix A: Global Sourcing under Uncertainty: Theory

A.1 Incomplete Contracts

Taking the initial preferences and the setup (see section 2), I obtain that the quantity demanded of the differentiated product is:

$$x(i) = \mu Y \frac{p(i)^{-\frac{1}{1-\alpha}}}{P^{-\frac{\alpha}{1-\alpha}}} = \mu Y \left[\frac{p(i)}{P^{\alpha}}\right]^{-\frac{1}{1-\alpha}} \tag{A.1.1}$$

$$p(i) = P^{\alpha} \left[\frac{\mu Y}{x(i)}\right]^{1-\alpha} \tag{A.1.2}$$

Hence the potential revenue is

$$R(i) = P^{\alpha}(\mu Y)^{1-\alpha}\theta^{\alpha} \left[\frac{h(i)}{\eta}\right]^{\alpha\eta} \left[\frac{m(i)}{1-\eta}\right]^{\alpha(1-\eta)} \tag{A.1.3}$$

Since output if not contractable, then parties (entrepreneur and manufacturer) choose noncooperatively their factor demands:

$$H: \max_{h(i)} \zeta_k R(i) - w^N h(i)$$

$$M: \max_{m(i)} (1-\zeta_k) R(i) - w^S m(i)$$

Hence the optimal demands are

$$\begin{aligned} w^N =& \zeta_k \frac{\partial R(i)}{\partial h(i)} = \frac{\zeta_k \alpha \eta R(i)}{h(i)} \\ w^S =& (1-\zeta_k) \frac{\partial R(i)}{\partial h(i)} = \frac{(1-\zeta_k)\alpha(1-\eta) R(i)}{m(i)} \end{aligned}$$

Then total profits are

$$R(i) = (\mu Y) \left(P\theta\alpha \left[\frac{\zeta_k}{w^N} \right]^{\eta} \left[\frac{(1-\zeta_k)}{w^S} \right]^{1-\eta} \right)^{\frac{\alpha}{1-\alpha}} \tag{A.1.4}$$

$$\pi_k(\mathcal{A}, \eta, \theta) = \mathcal{A} \theta^{\frac{\alpha}{1-\alpha}} \psi_k(\eta) \tag{A.1.5}$$

where

$$\mathcal{A} = (\mu Y) P^{\frac{\alpha}{1-\alpha}} \tag{A.1.6}$$

$$\psi_k(\eta) = \frac{(1 - \alpha [\zeta_k \eta + (1-\zeta_k)(1-\eta)])}{\left(\frac{1}{\alpha} \left[\frac{w^N}{\zeta_k} \right]^{\eta} \left[\frac{w^S}{(1-\zeta_k)} \right]^{1-\eta} \right)^{\frac{\alpha}{1-\alpha}}} \tag{A.1.7}$$

A.2 Demand Threshold

In order to solve for the demand thresholds that describe the decision rule of a firm, I needexpressions for either each of the value functions V_w, V_o, V_v or alternative find expressions for the difference of the value functions. I follow the second approach and construct the differences between the relevant pair of value functions for each decision. The three relevant difference between value function are: $(V_o - V_w)$, $(V_v - V_w)$ and $(V_v - V_o)$.

A.2.1 Value of Outsourcing - Value of waiting

Combining the expressions for $V_o(\mathcal{A})$ and $V_w(\mathcal{A})$, (2.2.5) and (2.2.7) respectively,

$$\begin{aligned}
V_o(\mathcal{A}) - V_w(\mathcal{A}) =& \frac{\pi_o(\mathcal{A}) - f_p}{1-\beta+\beta\gamma} + \frac{\beta\gamma[G(\mathcal{A}_v^e) - G(\mathcal{A}_o^x)]}{1-\beta+\beta\gamma}\mathbb{E}V_o(\mathcal{A}_o^x < \mathcal{A} < \mathcal{A}_v^e) \\
&- \frac{\beta\gamma[G(\mathcal{A}_v^e) - G(\mathcal{A}_o^e)]}{1-\beta+\beta\gamma}[\mathbb{E}V_o(\mathcal{A}_o^e < \mathcal{A} < \mathcal{A}_v^e) - f_e] \\
&+ \frac{\beta\gamma G(\mathcal{A}_o^x)}{1-\beta+\beta\gamma}[\mathbb{E}V_w(\mathcal{A} < \mathcal{A}_o^x) - f_x] \\
&- \frac{\beta\gamma G(\mathcal{A}_o^e)}{1-\beta+\beta\gamma}\mathbb{E}V_w(\mathcal{A} < \mathcal{A}_o^e) + \frac{\beta\gamma[1 - G(\mathcal{A}_v^e)]}{1-\beta+\beta\gamma}f_e
\end{aligned}$$

Note that $\mathbb{E}V_w(\mathcal{A} < \mathcal{A}_o^x) = \mathbb{E}V_w(\mathcal{A} < \mathcal{A}_o^e) = V_w(\mathcal{A})$ since the value of waiting for non-exporter is independent of the current realization. Focusing on the value of exporting via outsourcing, the next step is to express $\mathbb{E}V_o(\mathcal{A}_o^x < \mathcal{A} < \mathcal{A}_v^e)$ and

$\mathbb{E}V_o(\mathcal{A}_o^e < \mathcal{A} < \mathcal{A}_v^e)$ as a function of $V_o(\mathcal{A})$ using (2.2.5). After some manipulations:

$$\begin{aligned} V_o(\mathcal{A}) - V_w(\mathcal{A}) =& \frac{\pi_o(\mathcal{A}) - f_p}{1-\beta+\beta\gamma} + \frac{\beta\gamma}{1-\beta+\beta\gamma} \frac{\int_{\mathcal{A}_o^x}^{\mathcal{A}_o^e} [\pi_o(\mathcal{A}) - f_p] dG}{1-\beta+\beta\gamma\lambda_o^{ex}} \\ &+ \frac{\beta\gamma[1-G(\mathcal{A}_o^e)]f_e - \beta\gamma G(\mathcal{A}_o^x) f_x}{1-\beta+\beta\gamma\lambda_o^{ex}} \end{aligned} \tag{A.2.1}$$

where $\lambda_k^{rs} \equiv [1 - G(\mathcal{A}_k^r) + G(\mathcal{A}_k^s)]$, $k \in \{o, v\}$ and $r, s \in \{e, x\}$. λ_o^{ex} captures the probability that a shock outside of the inaction band for an exporter with outsourcing arrives.

This expression A.2.1 is intuitive. The difference between the value of exporting via outsourcing and the value of waiting is equal to discounted current profits, plus the discounted profits from the inaction band plus the difference between the sunk costs to start and stop exporting adjusted by their probability.

A.2.2 Value of Integration - Value of Outsourcing

Combining the expressions for $V_v(\mathcal{A})$ and $V_o(\mathcal{A})$, (2.2.5) and (2.2.6) respectively and after some algebra,

$$\begin{aligned} V_v(\mathcal{A}) - V_o(\mathcal{A}) =& \frac{\pi_v(\mathcal{A}) - \pi_o(\mathcal{A})}{1-\beta+\beta\gamma} + \frac{\beta\gamma[1-G(\mathcal{A}_v^e)]f_v}{1-\beta+\beta\gamma\lambda_v^{ex}} \\ &+ \frac{\beta\gamma}{1-\beta+\beta\gamma} \left[\frac{\int_{\mathcal{A}_o^x}^{\mathcal{A}_v^e} [\pi_v(\mathcal{A}) - \pi_o(\mathcal{A})] dG}{1-\beta+\beta\gamma\lambda_v^{ex}} + \frac{\int_{\mathcal{A}_v^x}^{\mathcal{A}_o^x} [\pi_v(\mathcal{A}) - \pi_o(\mathcal{A}_o^x)] dG}{1-\beta+\beta\gamma\lambda_v^{ex}} \right] \end{aligned} \tag{A.2.2}$$

The intuition is similar to A.2.1. The difference between the organizational forms to export is equal to the discounted difference of today profits plus the discounted difference in profits across the inaction band of both organizational forms and the discounted difference in the sunk costs.

A.2.3 Value of Integration - Value of Waiting

Combining the expressions for $V_v(\mathcal{A})$ and $V_w(\mathcal{A})$, (2.2.7) and (2.2.6) respectively, and following the same approach as the previous expressions for the differences between value functions, I obtain

$$
\begin{aligned}
V_v(\mathcal{A}) - V_w(\mathcal{A}) =& \frac{\pi_v(\mathcal{A}) - f_p}{1-\beta+\beta\gamma} + \frac{\beta\gamma[1-G(\mathcal{A}_v^e)][f_v+f_e] - \beta\gamma G(\mathcal{A}_v^x) f_x}{1-\beta+\beta\gamma\lambda_v^{ex}} \\
&+ \frac{\beta\gamma}{1-\beta+\beta\gamma}\left[\frac{\int_{\mathcal{A}_v^x}^{\mathcal{A}_v^e}[\pi_v(\mathcal{A}) - f_p]dG}{1-\beta+\beta\gamma\lambda_v^{ex}} - \frac{\int_{\mathcal{A}_o^e}^{\mathcal{A}_v^e}[\pi_o(\mathcal{A}) - \pi_o(A_e^o)]dG}{1-\beta+\beta\gamma\lambda_v^{ex}}\right]
\end{aligned}
\tag{A.2.3}
$$

Notice that this difference correspond to the cases where $\mathcal{A} < \mathcal{A}_o^e$ which is the case for $\mathcal{A}_v^x$.

A.2.4 Entry with Outsourcing

After computing the difference between the value functions $V_o(\mathcal{A})$ and $V_w(\mathcal{A})$, the expression for entry cutoff is quite direct since $f_e = V_o(\mathcal{A}_o^e) - V_w(\mathcal{A}_o^e)$. Formally:

$$f_e = \frac{\pi_o(\mathcal{A}_o^e) - f_p}{1 - \beta\tilde{\lambda}_o^x} + \frac{\beta\gamma}{1-\beta+\beta\gamma}\frac{\int_{\mathcal{A}_o^x}^{\mathcal{A}_o^e}[\pi_o(\mathcal{A}) - \pi_o(\mathcal{A}_o^e)]dG}{1-\beta\tilde{\lambda}_o^x} - \frac{\beta\gamma G(\mathcal{A}_o^x) f_x}{1-\beta\tilde{\lambda}_o^x} \tag{A.2.4}$$

where $\tilde{\lambda}_o^x = 1 - \gamma G(\mathcal{A}_o^x)$. Note that $\gamma \in (0,1)$ and $G(\mathcal{A}_o^x) < 1$ then $\tilde{\lambda}_o^x < 1$.

From the expression above is easy to show that $\mathcal{A}_o^e > \mathcal{A}_o^{eD}$. Noting that $f_e = \frac{\pi_o(\mathcal{A}_o^{eD})}{1-\beta}$ (see A.2.8 for the derivation of the expression on the deterministic framework) and rearranging the entry condition, I obtain:

$$\pi_o(\mathcal{A}_o^e) - \pi_o(\mathcal{A}_o^{eD}) = \beta\gamma G(\mathcal{A}_o^x)[f_e + f_x] + \frac{\beta\gamma}{1-\beta+\beta\gamma}\int_{\mathcal{A}_o^x}^{\mathcal{A}_o^e}[\pi_o(\mathcal{A}_o^e) - \pi(\mathcal{A})]\, dG(\mathcal{A})$$

Then $\pi_o(\mathcal{A}_o^e) - \pi_o(\mathcal{A}_o^{eD}) > 0 \Rightarrow \mathcal{A}_o^e > \mathcal{A}_o^{eD}$.

A.2.5 Integration Decision

Combining (2.2.2) and (A.2.2) and after some algebra:

$$\begin{aligned} f_v = &\frac{\pi_v(\mathcal{A}_v^e) - \pi_o(\mathcal{A}_v^e)}{1-\beta\tilde{\lambda}_v^x} - \frac{\beta\gamma[G(\mathcal{A}_v^e) - G(\mathcal{A}_x^v)]}{1-\beta+\beta\gamma}\left[\frac{\pi_v(\mathcal{A}_v^e) - \pi_o(\mathcal{A}_v^e)}{1-\beta\tilde{\lambda}_v^x}\right] \\ &+ \frac{\beta\gamma[G(\mathcal{A}_v^e) - G(\mathcal{A}_x^v)]}{1-\beta+\beta\gamma}\left[\frac{\mathbb{E}\pi_v(\mathcal{A}_x^v < \mathcal{A} < \mathcal{A}_v^e) - f_p}{1-\beta\tilde{\lambda}_v^x}\right] \\ &- \frac{\beta\gamma[G(\mathcal{A}_v^e) - G(\mathcal{A}_o^x)]}{1-\beta+\beta\gamma}\left[\frac{\mathbb{E}\pi_o(\mathcal{A}_o^x < \mathcal{A} < \mathcal{A}_v^e) - f_p}{1-\beta\tilde{\lambda}_v^x}\right] \\ &+ \frac{\beta\gamma[G(\mathcal{A}_o^x) - G(\mathcal{A}_x^v)][f_e + f_x]}{1-\beta\tilde{\lambda}_v^x} - \frac{\beta\gamma[G(\mathcal{A}_x^v) - G(\mathcal{A}_o^x)]}{1-\beta+\beta\gamma}\left[\frac{\pi_o(\mathcal{A}_e^o) - f_p}{1-\beta\tilde{\lambda}_v^x}\right] \end{aligned} \tag{A.2.5}$$

where $\tilde{\lambda}_v^x = 1 - \gamma G(\mathcal{A}_v^x)$.

This condition allows U.S. to show that $\mathcal{A}_v^e > \mathcal{A}_v^{eD}$ as follows. Reexpressing the integration condition, recalling that $f_v = \frac{\pi_v(\mathcal{A}_v^{eD}) - \pi_o(\mathcal{A}_v^{eD})}{1-\beta}$ (see A.2.8 for the derivation of this expression) and using the functional form of the profit function

$$\begin{aligned}\mathcal{A}_v^e - \mathcal{A}_v^{eD} \propto & \frac{\beta\gamma[G(\mathcal{A}_v^e) - G(\mathcal{A}_x^v)]}{1-\beta+\beta\gamma}\left[\frac{\pi_v(\mathcal{A}_v^e) - \mathbb{E}\pi_v(\mathcal{A}_x^v < \mathcal{A} < \mathcal{A}_v^e)}{1-\beta\tilde{\lambda}_v^x}\right] \\ & - \frac{\beta\gamma[G(\mathcal{A}_v^e) - G(\mathcal{A}_o^x)]}{1-\beta+\beta\gamma}\left[\frac{\pi_o(\mathcal{A}_v^e) - \mathbb{E}\pi_o(\mathcal{A}_o^x < \mathcal{A} < \mathcal{A}_v^e)}{1-\beta\tilde{\lambda}_v^x}\right] \\ & + \frac{\beta\gamma[G(\mathcal{A}_o^x) - G(\mathcal{A}_x^v)]}{1-\beta+\beta\gamma}\left[\frac{\pi_o(\mathcal{A}_o^x) - f_p}{1-\beta\tilde{\lambda}_v^x}\right] + \beta\gamma G(A_x^v) f_v\end{aligned}$$

Hence $\mathcal{A}_v^e > \mathcal{A}_v^{eD}$ since the right hand side of the equation is positive. Note that showing that the first term is higher that the second term is sufficient to prove that $RHS > 0$.

$$\begin{aligned}\Gamma =& \beta\gamma[G(\mathcal{A}_v^e) - G(\mathcal{A}_x^v)]\left[\pi_v(\mathcal{A}_v^e) - \mathbb{E}\pi_v(\mathcal{A}_x^v < \mathcal{A} < \mathcal{A}_v^e)\right] \\ & - \beta\gamma[G(\mathcal{A}_v^e) - G(\mathcal{A}_o^x)]\left[\pi_o(\mathcal{A}_v^e) - \mathbb{E}\pi_o(\mathcal{A}_o^x < \mathcal{A} < \mathcal{A}_v^e)\right] \\ =& \beta\gamma[G(\mathcal{A}_v^e) - G(\mathcal{A}_o^x)]\left[\pi_v(\mathcal{A}_v^e - \bar{\mathcal{A}}) - \pi_o(\mathcal{A}_v^e - \bar{\mathcal{A}})\right] \\ & + \beta\gamma[G(\mathcal{A}_o^x) - G(\mathcal{A}_x^v)]\left[\pi_v(\mathcal{A}_v^e) - \mathbb{E}\pi_v(\mathcal{A}_x^v < \mathcal{A} < \mathcal{A}_o^x)\right]\end{aligned}$$

where I apply the second mean theorem for integration in the last step. By construction, $\mathcal{A}_v^e \geq \bar{\mathcal{A}}$ since $\bar{\mathcal{A}} \in [\mathcal{A}_o^x, \mathcal{A}_v^e]$. Then $\Gamma > 0$ and $\mathcal{A}_v^e > \mathcal{A}_v^{eD}$.

A.2.6 Exit from Outsourcing

Since the exit condition for an outsourcing exporter is $f_x = V_w(\mathcal{A}_o^x) - V_o(\mathcal{A}_o^x)$ and replacing the RHS using A.2.1, I obtain

$$
\begin{aligned}
f_x = & -\frac{\pi_o(\mathcal{A}_o^x) - f_p}{1 - \beta\tilde{\lambda}_o^x + \beta\gamma[1 - G(\mathcal{A}_o^e)]} \\
& - \frac{\beta\gamma[G(\mathcal{A}_o^e) - G(\mathcal{A}_o^x)]\left[\frac{\mathbb{E}\pi_o(\mathcal{A}_o^x < \mathcal{A} < \mathcal{A}_o^e) - \pi_o(\mathcal{A}_o^x)}{1-\beta+\beta\gamma}\right]}{1 - \beta + \beta\gamma[1 - G(\mathcal{A}_o^e)]} \\
& - \frac{\beta\gamma[G(\mathcal{A}_v^e) - G(\mathcal{A}_o^e)]f_e}{1 - \beta + \beta\gamma[1 - G(\mathcal{A}_o^e)]}
\end{aligned}
\tag{A.2.6}
$$

where $\tilde{\lambda}_o^x = 1 - \gamma(1 - G(\mathcal{A}_o^e))$. Reorganizing this conditionand replacing the exit condition in the deterministic framework (see A.2.8 for the expression), I get

$$
\begin{aligned}
\pi_o(\mathcal{A}_o^x) - \pi_o(\mathcal{A}_o^{xD}) = & -\frac{\beta\gamma[G(\mathcal{A}_e^o) - G(\mathcal{A}_o^x)]}{1 - \beta + \beta\gamma}\left[\mathbb{E}\pi_o(\mathcal{A}_o^x < \mathcal{A} < \mathcal{A}_e^o) - \pi_o(\mathcal{A}_o^x)\right] \\
& - \beta\gamma[G(\mathcal{A}_v^e) - G(\mathcal{A}_e^o)]f_e - \beta\gamma[1 - G(\mathcal{A}_e^o)]f_x \\
\pi_o(\mathcal{A}_o^x) - \pi_o(\mathcal{A}_o^{xD}) < & 0
\end{aligned}
$$

This is the case since $\mathcal{A}_o^e > \mathcal{A}_o^x$ and $\mathcal{A}_v^e > \mathcal{A}_o^e$. Hence $\frac{\partial \pi}{\partial \mathcal{A}} > 0$ implies $\mathcal{A}_o^x < \mathcal{A}_o^{xD}$.

A.2.7 Exit from Vertical Integration

A vertical integrated exporter make the decision to exit if $f_x = V_w(\mathcal{A}_v^x) - V_v(\mathcal{A}_v^x)$, applying (A.2.3) and doing some algebra

$$\begin{aligned} f_x = & -\frac{\pi_v(\mathcal{A}_v^x) - f_p}{1-\beta\tilde{\lambda}_v^x} - \frac{\beta\gamma}{1-\beta+\beta\gamma}\frac{\int_{\mathcal{A}_v^x}^{\mathcal{A}_v^e}\left[\pi_v(\mathcal{A}) - \pi_v(\mathcal{A}_v^x)\right] dG}{1-\beta\tilde{\lambda}_v^x} \\ & + \frac{\beta\gamma}{1-\beta+\beta\gamma}\frac{\int_{\mathcal{A}_o^e}^{\mathcal{A}_v^e}\left[\pi_o(\mathcal{A}) - \pi_o(\mathcal{A}_o^e)\right] dG}{1-\beta\tilde{\lambda}_v^x} - \frac{\beta\gamma[1-G(\mathcal{A}_v^e)][f_v + f_e]}{1-\beta\tilde{\lambda}_v^x} \end{aligned} \tag{A.2.7}$$

where $\tilde{\lambda}_v^x = 1 - \gamma(1 - G(\mathcal{A}_v^e))$.

Reorganizing this condition, I obtain

$$\begin{aligned} \pi_v(\mathcal{A}_v^x) - \pi_v(\mathcal{A}_v^{xD}) = & -\frac{\beta\gamma}{1-\beta+\beta\gamma}\int_{\mathcal{A}_o^e}^{\mathcal{A}_v^e}\left[\pi_v(\mathcal{A}) - \pi_o(\mathcal{A})\right] dG \\ & + \frac{\beta\gamma}{1-\beta+\beta\gamma}\int_{\mathcal{A}_o^e}^{\mathcal{A}_v^e}\left[\pi_v(\mathcal{A}_v^x) - \pi_o(\mathcal{A}_o^e)\right] dG \\ & - \frac{\beta\gamma}{1-\beta+\beta\gamma}\int_{\mathcal{A}_v^x}^{\mathcal{A}_o^e}\left[\pi_v(\mathcal{A}) - \pi_v(\mathcal{A}_v^x)\right] dG \\ & - \beta\gamma[1-G(\mathcal{A}_v^e)][f_v + f_e + f_x] \\ \pi_v(\mathcal{A}_v^x) - \pi_v(\mathcal{A}_v^{xD}) & < 0 \end{aligned}$$

since first term is negative because $\pi_v > \pi_o$ and the first term is higher, in absolute value, than the second term, and all remaining terms are negative. Since $\frac{\partial \pi}{\partial \mathcal{A}} > 0$ then $\mathcal{A}_v^x < \mathcal{A}_v^{xD}$.

A.2.8 Exit across Sourcing Decision

In order to compare the exit threshold across sourcing decisions, combining (A.2.6) and (A.2.7) to write an expression for $\pi_o(\mathcal{A}_x^o) - \pi_v(\mathcal{A}_v^x)$:

$$
\begin{aligned}
\pi_o(\mathcal{A}_o^x) - \pi_v(\mathcal{A}_v^x) =& \frac{\beta\gamma \int_{\mathcal{A}_v^x}^{\mathcal{A}_v^e} [\pi_v(\mathcal{A}) - \pi_v(\mathcal{A}_v^x)] dG}{1-\beta+\beta\gamma} - \frac{\beta\gamma \int_{\mathcal{A}_e^o}^{\mathcal{A}_v^e} [\pi_o(\mathcal{A}) - \pi_o(\mathcal{A}_o^e)] dG}{1-\beta+\beta\gamma} \\
&+ \beta\gamma[1 - G(\mathcal{A}_e^v)][f_v + f_e + f_x] \\
&- \frac{\beta\gamma \int_{\mathcal{A}_o^x}^{\mathcal{A}_o^e} [\pi_o(\mathcal{A}) - \pi_o(\mathcal{A}_o^x)] dG}{1-\beta+\beta\gamma} - \beta\gamma[1 - G(\mathcal{A}_e^o)][f_e + f_x] \\
\pi_o(\mathcal{A}_o^x) - \pi_v(\mathcal{A}_v^x) =& \frac{\beta\gamma \int_{\mathcal{A}_o^x}^{\mathcal{A}_v^e} [\Delta_{vo}\pi(\mathcal{A}) - \Delta_{vo}\pi(\mathcal{A}_o^x)] dG}{1-\beta+\beta\gamma} \\
&+ \frac{\beta\gamma \int_{\mathcal{A}_o^x}^{\mathcal{A}_v^e} [\pi_v(\mathcal{A}_o^x) - \pi_v(\mathcal{A}_v^x)] dG}{1-\beta+\beta\gamma} + \frac{\beta\gamma \int_{\mathcal{A}_v^x}^{\mathcal{A}_o^x} [\pi_v(\mathcal{A}) - \pi_v(\mathcal{A}_v^x)] dG}{1-\beta+\beta\gamma} \\
&+ \beta\gamma[1 - G(\mathcal{A}_e^v)] f_v \\
\pi_o(\mathcal{A}_o^x) - \pi_v(\mathcal{A}_v^x) >& 0
\end{aligned}
$$

Since $\pi_v > \pi_o$ for a given $\mathcal{A}$ and $\frac{\partial \pi}{\partial \mathcal{A}} > 0$ then $\mathcal{A}_o^x > \mathcal{A}_v^x$

Note that this result also implies that introducing foreign demand uncertainty expands the difference between the exit threshold across. This is the case since $\pi_v(\mathcal{A}_v^{xD}) = \pi_o(\mathcal{A}_o^{xD})$ and this implies that $[\pi_o(\mathcal{A}_x^o) - \pi_v(\mathcal{A}_v^x)] > [\pi_o(\mathcal{A}_x^{oD}) - \pi_v(\mathcal{A}_v^{xD})]$. Note that since uncertainty reduce both threshold then it has to be the case that the reduction on integration exit threshold is bigger than the reduction on the exit from outsourcing threshold.Deterministic Framework

A.3 The Deterministic Framework as Benchmark

In the deterministic framework firms compare the discounted value of the profits of their current state to the sunk cost and resulting profits from switching states. This implies that for a given demand level $\mathcal{A}_t$ the productivity cutoff for entry with outsourcing θ_o^{eD} is defined as

$$\frac{\pi_o(\mathcal{A}_t, \theta_o^{eD}) - f_p}{1-\beta} = f_e \Leftrightarrow \theta_o^{eD} = \left[\frac{[1-\beta]f_e + f_p}{\psi_o \mathcal{A}_t}\right]^{\rho} \tag{A.3.1}$$

where $\rho = (1-\alpha)/\alpha$. Hence firms with productivity θ_i just above θ_o^{eD} will pay the sunk cost and start exporting via outsourcing. However, since firms can integrate and get a higher flow of profits by paying an additional sunk cost, firms with high enough productivity will integrate rather than outsource. More specifically, firms with $\theta_i > \theta_v^{eD} > \theta_o^{eD}$ will start exporting with integration. Formally, θ_v^{eD} is defined as follows for a given demand level of $\mathcal{A}_t$:

$$\frac{\pi_v(\mathcal{A}_t, \theta_v^{eD}) - \pi_o(\mathcal{A}_t, \theta_v^{eD})}{1-\beta} = f_v \Leftrightarrow \theta_v^{eD} = \left[\frac{[1-\beta]f_v}{(\psi_v - \psi_o)\mathcal{A}_t}\right]^{\rho} \tag{A.3.2}$$

In the case of the exit decision, for a given demand level $\mathcal{A}_t$, firms that are currently exporting via outsourcing will exit if their productivity level is below the exit productivity cutoff, i.e. $\theta_i < \theta_o^{xD}$. The exit productivity cutoff satisfies the following expression:

$$-\frac{\pi_o(\mathcal{A}_t, \theta_o^{xD}) - f_p}{1-\beta} = f_x \Leftrightarrow \theta_o^{xD} = \left[-\frac{[1-\beta]f_x - f_p}{\psi_o \mathcal{A}_t}\right]^{1/\rho} \tag{A.3.3}$$

Note that since $\theta > 0$, it will be optimal for some firms to exit if and only if $(1-\beta)f_x - f_p < 0$.[1] Similarly, the exit productivity cutoff for integrated firms θ_v^{xD} is as follows:

$$-\frac{\pi_v(\mathcal{A}_t, \theta_v^{xD}) - f_p}{1-\beta} = f_x \Leftrightarrow \theta_v^{xD} = \left[-\frac{[1-\beta]f_x - f_p}{\psi_v \mathcal{A}_t}\right]^{\rho} \tag{A.3.4}$$

It is easy to prove that the rankings of the productivity cutoffs satisfy $\theta_v^{xD} < \theta_o^{xD} < \theta_o^{eD} < \theta_v^{eD}$.

A.4 Parametrizing Firms' Decisions

A.4.1 Productivity Cutoff Entry with Outsourcing

The entry condition is

$$[1-\beta]f_e = [\pi_o(\mathcal{A}_o^e) - f_p] + \frac{\beta\gamma \int_{A_x^o}^{A_e^o} [\pi_o(A) - \pi_o(A_e^o)]dG}{[1-\beta(1-\gamma)]} - \beta\gamma G(\mathcal{A}_o^x)[f_x + f_e]$$

[1]Note that in the case of $f_x = 0$, the exit cutoff will be $\theta_o^{xD} = [f_p/\psi_o \mathcal{A}_t]^{1/\rho}$, and firms will exit as soon as the profit flow cannot cover the fixed per period costs.

For the marginal firm that $\mathcal{A}_o^e = \mathcal{A}_t$,

$$
\begin{aligned}
[1-\beta]f_e =& \psi_o[\theta_e^o]^{\frac{\alpha}{1-\alpha}}\mathcal{A}_t - f_p + \frac{\beta\gamma\psi_o[\theta_e^o]^{\frac{\alpha}{1-\alpha}}\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t}[\mathcal{A}-\mathcal{A}_t]dG}{[1-\beta(1-\gamma)]} - \beta\gamma G(\mathcal{A}_o^x)[f_x+f_e] \\
[\theta_e^o]^{\frac{\alpha}{1-\alpha}} =& [\theta_e^{oD}]^{\frac{\alpha}{1-\alpha}} \times \frac{1+\frac{\beta\gamma G(\mathcal{A}_t\xi_o^e)[f_x+f_e]}{(1-\beta)f_e+f_p}}{1+\frac{\beta\gamma\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t}[\mathcal{A}-\mathcal{A}_t]/\mathcal{A}_t dG}{1-\beta(1-\gamma)}}
\end{aligned}
$$

Taking logs

$$
\begin{aligned}
\ln[\theta_e^o] =& \ln[\theta_e^{oD}] + \rho\ln\left[1+\frac{\beta\gamma G(\mathcal{A}_t\xi_o^e)[f_x+f_e]}{(1-\beta)f_e+f_p}\right] \\
&- \rho\ln\left[1+\frac{\beta\gamma\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t}\frac{[\mathcal{A}-\mathcal{A}_t]}{\mathcal{A}_t}dG}{1-\beta(1-\gamma)}\right]
\end{aligned}
\tag{A.4.1}
$$

where $\rho = (1-\alpha)/\alpha$.

A.4.2 Productivity Cutoff Exit from Outsourcing

For the marginal firm that $\mathcal{A}_o^x = \mathcal{A}_t$ it is the case that

$$
\begin{aligned}
(1-\beta)f_x =& -[\psi_o\mathcal{A}_t[\theta_o^x]^{1/\rho} - f_p] - \beta\gamma[1-G(\mathcal{A}_t\xi_o^x)][f_e+f_x] \\
&- \frac{\beta\gamma[G(\mathcal{A}_t\xi_o^x)-G(\mathcal{A}_t)]}{1-\beta+\beta\gamma}[\mathbb{E}\pi_o(\mathcal{A}_t<\mathcal{A}<\mathcal{A}_t\xi_o^x)-\pi_o(\mathcal{A}_t)] \\
[\theta_o^x]^{1/\rho} =& [\theta_o^{xD}]^{1/\rho} \times \frac{1-\frac{\beta\gamma[1-G(\mathcal{A}_t\xi_o^x)][f_e+f_x]}{f_p-[1-\beta]f_x}}{1+\frac{\beta\gamma\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi_o^x}[\mathcal{A}-\mathcal{A}_t]/\mathcal{A}_t dG}{1-\beta(1-\gamma)}}
\end{aligned}
$$

Taking logs

$$
\ln\theta_o^x = \ln\theta_o^{xD} + \rho\ln[1-\kappa_1^o(x)] - \rho\ln[1+\kappa_2^o(x)] \tag{A.4.2}
$$

where

$$\kappa_1^o(x) = \frac{\beta\gamma[1 - G(\mathcal{A}_t\xi_o^x)][f_e + f_x]}{f_p - [1-\beta]f_x}$$
$$\kappa_2^o(x) = \frac{\beta\gamma\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi_o^x}[\mathcal{A} - \mathcal{A}_t]/\mathcal{A}_t dG}{[1-\beta(1-\gamma)]}$$

Note that $\kappa_1^o(x) > 0$ since $f_p - [1-\beta]f_x > 0$ and $G(\mathcal{A}_t\xi_o^x) \leq 1$; and $\kappa_2^o(x) > 0$ since $\mathcal{A} \geq \mathcal{A}_t$ for the integration interval.

A.4.3 Productivity Cutoff Integration

For the case that the firm $\mathcal{A}_v^e = \mathcal{A}_t$

$$\begin{aligned}[1-\beta]f_v =&(\psi_v - \psi_o)\theta^{\frac{\alpha}{1-\alpha}}\mathcal{A}_v^e + \beta\gamma\frac{(\psi_v - \psi_o)[\theta_e^v]^{\frac{\alpha}{1-\alpha}}\int_{\mathcal{A}_o^x}^{\mathcal{A}_v^e}[\mathcal{A} - \mathcal{A}_v^e]dG}{[1-\beta+\beta\gamma]} \\ &+ \beta\gamma\frac{\int_{\mathcal{A}_v^x}^{\mathcal{A}_o^x}[\pi_v(\mathcal{A}) - \pi_o(\mathcal{A}_o^x) - (\psi_v - \psi_o)\theta^{\frac{\alpha}{1-\alpha}}\mathcal{A}_v^e]dG}{[1-\beta+\beta\gamma]} \\ &- \beta\gamma G(\mathcal{A}_v^x)f_v\end{aligned}$$

Applying the inaction bands expressions and after some manipulations,

$$[\theta_e^v]^{1/\rho} = [\theta_e^{vD}]^{1/\rho} \times \frac{\left[1 + \frac{\beta\gamma G(\mathcal{A}_t\xi_o^x)}{[1-\beta]}\right]}{\left[1 + \frac{\beta\gamma\int_{\mathcal{A}_t\xi_o^x}^{\mathcal{A}_t}\frac{[\mathcal{A}-\mathcal{A}_t]}{\mathcal{A}_t}dG}{[1-\beta+\beta\gamma]} + \varphi\frac{\beta\gamma\int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t\xi_o^x}\frac{[\mathcal{A}-\mathcal{A}_t\xi_v^x]}{\mathcal{A}_t}dG}{[1-\beta+\beta\gamma]}\right]}$$

where $\varphi = \frac{\psi_v}{\psi_v - \psi_o}$. Taking logs

$$\ln\theta_e^v = \ln\theta_e^{vD} + \rho\ln[1+\kappa_1^v] - \rho\ln[1+\kappa_2^v + \varphi\kappa_3^v(e)] \tag{A.4.3}$$

where

$$\begin{aligned}
\kappa_1^v =& \frac{\beta\gamma G(\mathcal{A}_t\xi_v^x)}{1-\beta} \\
\kappa_2^v =& \frac{\beta\gamma\int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t}\frac{[\mathcal{A}-\mathcal{A}_t]}{\mathcal{A}_t}dG}{1-\beta+\beta\gamma} \\
\kappa_3^v(e) =& \frac{\beta\gamma\int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t\xi_o^x}\frac{[\mathcal{A}-\mathcal{A}_t\xi_o^x]}{\mathcal{A}_t}dG}{1-\beta+\beta\gamma}
\end{aligned}$$

A.4.4 Productivity Cutoff Exit from Integration

In the case of the firm such that $\mathcal{A}_t = \mathcal{A}_v^x$, recalling that $[\theta_x^{vD}]^{\frac{\alpha}{1-\alpha}} = \frac{f_p-[1-\beta]f_x}{\psi_v\mathcal{A}_t}$ and exploiting the inaction band expression, the exit condition for an integrated firm is

$$\begin{aligned}
[1-\beta]f_x =& -[\psi_v[\theta_x^v]^{\frac{1}{\rho}}\mathcal{A}_t - f_p] - \frac{\beta\gamma\psi_v[\theta_x^v]^{\frac{1}{\rho}}\mathcal{A}_t\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi_v^e}[\mathcal{A}-\mathcal{A}_t]/\mathcal{A}_t dG}{1-\beta+\beta\gamma} \\
&+ \frac{\beta\gamma\psi_o[\theta_x^v]^{\frac{1}{\rho}}\mathcal{A}_t\int_{\mathcal{A}_o^e}^{\mathcal{A}_t\xi_v^e}[\mathcal{A}-\mathcal{A}_t\xi_o^e]/\mathcal{A}_t dG}{1-\beta+\beta\gamma} - \beta\gamma[1-G(\mathcal{A}_t\xi_v^e)][f_v+f_e+f_x] \\
[\theta_x^v]^{\frac{1}{\rho}} =& [\theta_x^{vD}]^{\frac{1}{\rho}} \times \frac{1-\kappa_1^v(x)}{1+\kappa_2^v(x) - \frac{\psi_o}{\psi_v}\kappa_3^v(x)}
\end{aligned}$$

where

$$\kappa_1^v(x) = \frac{\beta\gamma[1 - G(\mathcal{A}_t\xi_v^e)][f_v + f_e + f_x]}{f_p - [1-\beta]f_x}$$
$$\kappa_2^v(x) = \frac{\beta\gamma \int_{\mathcal{A}_t}^{\mathcal{A}_t\xi_v^e} \frac{[\mathcal{A}-\mathcal{A}_t]}{\mathcal{A}_t} dG}{1 - \beta + \beta\gamma}$$
$$\kappa_3^v(x) = \frac{\beta\gamma \int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t\xi_v^e} \frac{[\mathcal{A}-\mathcal{A}_t\xi_o^e]}{\mathcal{A}_t} dG}{1 - \beta + \beta\gamma}$$

Then taking logs

$$\ln\theta_x^v = \ln\theta_x^{vD} + \rho\ln\left[1 - \kappa_1^v(x)\right] - \rho\ln\left[1 + \kappa_2^v(x) - \frac{\psi_o}{\psi_v}\kappa_3^v(x)\right] \tag{A.4.4}$$

A.4.5 Productivity Cutoffs Ranking

Proving that $\theta_o^x > \theta_v^x$ is trivially after showing that $\mathcal{A}_v^x < \mathcal{A}_o^x$ for any productivity level. For the marginal integrated that is going to exit such that $\mathcal{A}_v^x = \mathcal{A}_t$ with productivity θ_v^x, then it has to be the case that $\mathcal{A}_o^x > \mathcal{A}_t$. Similarly for the marginal firm exporting via outsourcing that is going to exit such that $\mathcal{A}_o^x = \mathcal{A}_t$ with productivity θ_o^x is true that $\mathcal{A}_v^x < \mathcal{A}_t$. Since $\frac{\partial\theta}{\partial\mathcal{A}} < 0$ then it is the case that $\theta_v^x < \theta_o^x$.

A.5 Comparative Statics

A.5.1 Entry - Outsourcing

A.5.1.1 Arrival Rate

$$
\begin{aligned}
\frac{\partial \ln \theta_e^o}{\partial \gamma} =& \frac{\rho\beta G(\mathcal{A}_t \xi_o^e)[f_x + f_e]}{(1-\beta)f_e + f_p + \beta\gamma G(\mathcal{A}_t \xi_o^e)[f_x + f_e]} \\
&+ \frac{\rho}{1-\beta+\beta\gamma} \frac{\beta(1-\beta)\int_{\mathcal{A}_t \xi_o^e}^{\mathcal{A}_t}[\mathcal{A}_t - \mathcal{A}]/\mathcal{A}_t dG}{[1-\beta(1-\gamma)] + \beta\gamma \int_{\mathcal{A}_t \xi_o^e}^{\mathcal{A}_t}[\mathcal{A} - \mathcal{A}_t]/\mathcal{A}_t dG} \\
\frac{\partial \ln \theta_e^o}{\partial \gamma} =& \frac{\mathcal{A}_t - \mathcal{A}_t \xi_o^e}{\mathcal{A}_t} \frac{\rho\beta G(\mathcal{A}_t \xi_o^e)}{(1-\beta+\beta\gamma) + \beta\gamma \int_{\mathcal{A}_t \xi_o^e}^{\mathcal{A}_t}[\mathcal{A} - \mathcal{A}_t]/\mathcal{A}_t dG} \\
&+ \frac{\rho}{1-\beta+\beta\gamma} \frac{\beta(1-\beta)\int_{\mathcal{A}_t \xi_o^e}^{\mathcal{A}_t}[\mathcal{A}_t - \mathcal{A}]/\mathcal{A}_t dG}{[1-\beta(1-\gamma)] + \beta\gamma \int_{\mathcal{A}_t \xi_o^e}^{\mathcal{A}_t}[\mathcal{A} - \mathcal{A}_t]/\mathcal{A}_t dG}
\end{aligned}
$$

Hence $\frac{\partial \ln \theta_e^o}{\partial \gamma} > 0$, when uncertainty increases the productivity required to start exporting is higher.

A.5.1.2 Current Realization

$$\begin{aligned}
\frac{\partial \ln \theta_e^o}{\partial \mathcal{A}_t} =& \frac{\partial \ln \theta_e^{oD}}{\partial \mathcal{A}_t} + \frac{\rho\beta\gamma g(\mathcal{A}_t\xi_o^e)\left\{\xi_o^e + \mathcal{A}_t \frac{\partial \xi_o^e}{\partial \mathcal{A}_t}\right\}[f_x + f_e]}{(1-\beta)f_e + f_p + \beta\gamma G(\mathcal{A}_t\xi_o^e)[f_x + f_e]} \\
&+ \frac{\rho\beta\gamma g(\mathcal{A}_t\xi_o^e)\left\{\xi_o^e + \mathcal{A}_t \frac{\partial \xi_o^e}{\partial \mathcal{A}_t}\right\}[\mathcal{A}_t\xi_o^e - \mathcal{A}_t]/\mathcal{A}_t}{[1-\beta+\beta\gamma] + \beta\gamma\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t}[\mathcal{A} - \mathcal{A}_t]/\mathcal{A}_t dG} \\
&+ \frac{\rho\beta\gamma\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t}[\mathcal{A}/\mathcal{A}_t^2]dG}{[1-\beta+\beta\gamma] + \beta\gamma\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t}[\mathcal{A} - \mathcal{A}_t]/\mathcal{A}_t dG} \\
\frac{\partial \ln \theta_e^o}{\partial \mathcal{A}_t} - \frac{\partial \ln \theta_e^{oD}}{\partial \mathcal{A}_t} =& \frac{\rho\beta\gamma\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t}[\mathcal{A}/\mathcal{A}_t^2]dG}{[1-\beta+\beta\gamma] + \beta\gamma\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t}[\mathcal{A} - \mathcal{A}_t]/\mathcal{A}_t dG} \\
=& \frac{\rho\beta\gamma\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t}[\mathcal{A}/\mathcal{A}_t^2]dG}{[(1-\beta)f_e + f_p + \beta\gamma G(\mathcal{A}_t\xi_o^e)[f_x + f_e]]}\frac{[f_e + f_x]}{(1-\xi_o^e)}
\end{aligned}$$

Hence $\frac{\partial \ln \theta_e^o}{\partial \mathcal{A}_t} - \frac{\partial \ln \theta_e^{oD}}{\partial \mathcal{A}_t} > 0$ and uncertainty reduces the response to changes in current realization. From here it easy to spot that the cross-partial between uncertainty and current realization is not null:

$$\begin{aligned}
\frac{\partial^2 \ln \theta_e^o}{\partial \mathcal{A}_t \partial \gamma} =& \frac{[1-\beta]\left[\rho\beta\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t}[\mathcal{A}/\mathcal{A}_t^2]dG\right]}{\left[1-\beta+\beta\gamma+\beta\gamma\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t}[\mathcal{A} - \mathcal{A}_t]/\mathcal{A}_t dG\right]^2} \\
&- \frac{\left[\rho\beta\gamma\xi_o^e g(\mathcal{A}_t\xi_o^e)\frac{\partial \xi_o^e}{\partial \gamma}\right]\left[1-\beta+\beta\gamma-\beta\gamma\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t}[\mathcal{A}_t^2 - \mathcal{A}(\mathcal{A}_t - 1)]/\mathcal{A}_t^2 dG\right]}{\left[1-\beta+\beta\gamma+\beta\gamma\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t}[\mathcal{A} - \mathcal{A}_t]/\mathcal{A}_t dG\right]^2}
\end{aligned}$$

Note that this expression can be signed if it is evaluated around $\gamma = 0$,

$$\frac{\partial^2 \ln \theta_e^o}{\partial \mathcal{A}_t \partial \gamma}|_{\gamma=0} = \frac{\beta\rho}{1-\beta}\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t} \frac{\mathcal{A}_t}{\mathcal{A}_t^2} dG > 0$$

This result is consistent with $\frac{\partial \ln \theta_e^o}{\partial \mathcal{A}_t} - \frac{\partial \ln \theta_e^{oD}}{\partial \mathcal{A}_t} > 0$ noting that $\frac{\partial \ln \theta_e^{oD}}{\partial \mathcal{A}_t} < 0$

A.5.2 Entry - Integration

A.5.2.1 Arrival rate

Totally differentiating with respect to γ

$$\begin{aligned} d\ln\theta_e^v =& \frac{\rho}{1+\kappa_1^v}\left[\frac{\partial \kappa_1}{\partial \gamma} + \frac{\partial \kappa_1}{\partial \xi_v^x}\frac{\partial \xi_v^x}{\partial \gamma}\right] d\gamma \\ & - \frac{\rho}{1+\kappa_2^v+\varphi\kappa_3^v}\left[\frac{\partial \kappa_2}{\partial \gamma} + \frac{\partial \kappa_3}{\partial \gamma} + \left(\frac{\partial \kappa_2}{\partial \xi_v^x} - \frac{\partial \kappa_3}{\partial \xi_v^x}\right)\frac{\partial \xi_v^x}{\partial \gamma} + \frac{\partial \kappa_3}{\partial \xi_o^x}\frac{\partial \xi_o^x}{\partial \gamma}\right] d\gamma \\ =& \frac{\rho\kappa_1^v/\gamma}{1+\kappa_1^v} - \frac{\rho}{1+\kappa_2^v+\varphi\kappa_3^v}\left[\frac{(1-\beta)[\kappa_2^v+\varphi\kappa_3^v]/\gamma}{[1-\beta+\beta\gamma]} + \frac{\varphi\beta\gamma\int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t\xi_o^x}\frac{\partial \xi_o^x}{\partial \gamma}dG}{1-\beta+\beta\gamma}\right] \\ & + \rho\beta\gamma g(\mathcal{A}_t\xi_v^x)\mathcal{A}_t\frac{\partial \xi_v^x}{\partial \gamma}\Xi \end{aligned}$$

where $\Xi = \left[\frac{1}{\left[1+\kappa_1^v\right](1-\beta)} + \frac{[\mathcal{A}_t\xi_v^x - \mathcal{A}_t]/\mathcal{A}_t}{\left[1+\kappa_2^v\right](1-\beta+\beta\gamma)} + \frac{\varphi_o[\mathcal{A}_t\xi_v^x - \mathcal{A}_t\xi_o^x]/\mathcal{A}_t}{\left[1+\kappa_2^v\right](1-\beta+\beta\gamma)}\right]$. After some algebra, it is the case that $\Xi = 0$, then plugging into the condition

$$\frac{d\ln\theta_e^v}{d\gamma} = \frac{\rho\kappa_1^v/\gamma}{1+\kappa_1^v} - \frac{\rho}{1+\kappa_2^v+\varphi\kappa_3^v}\left[\frac{(1-\beta)[\kappa_2^v+\varphi\kappa_3^v]/\gamma}{[1-\beta+\beta\gamma]} + \frac{\varphi\beta\gamma\int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t\xi_o^x}\frac{\partial \xi_o^x}{\partial \gamma}dG}{1-\beta+\beta\gamma}\right]$$

Then evaluating around the deterministic framework, i.e. $\gamma = 0$, $\frac{d\ln\theta_e^v}{d\gamma} > 0$ since $\kappa_2^v(e) + \varphi\kappa_3^v(e) < 0$ and $(1+\kappa_2^v(e)+\varphi\kappa_3^v(e)) > 0$. Hence uncertainty delays the decision to integrate.

A.5.2.2 Current Realization

$$\begin{aligned}\frac{d\ln\theta_e^v}{d\mathcal{A}_t} =& \frac{d\ln\theta_e^{vD}}{d\mathcal{A}_t} + \frac{\rho}{1+\kappa_1^v(e)}\left[\frac{\partial\kappa_1^v(e)}{\partial\mathcal{A}_t}\right] \\ &- \frac{\rho}{1+\kappa_2^v(e)+\kappa_3^v(e)}\left[\frac{\partial\kappa_2^v(e)}{\partial\mathcal{A}_t} + \varphi_o\frac{\partial\kappa_3^v(e)}{\partial\mathcal{A}_t}\right] + \\ &- \frac{\rho}{1+\kappa_2^v(e)+\kappa_3^v(e)}\varphi_o\frac{\partial\kappa_3^v(e)}{\partial\xi_o^x}\frac{\partial\xi_o^x}{\partial\mathcal{A}_t} \\ \frac{d\ln\theta_e^v}{d\mathcal{A}_t} - \frac{d\ln\theta_e^{vD}}{d\mathcal{A}_t} =& \frac{\rho}{1+\kappa_2^v(e)+\kappa_3^v(e)} \\ &\times\left[\frac{\beta\gamma\int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t}\frac{\mathcal{A}}{\mathcal{A}_t^2}dG}{1-\beta+\beta\gamma} + \frac{\varphi_o\beta\gamma\int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t\xi_o^x}\frac{\mathcal{A}}{\mathcal{A}_t^2}dG}{1-\beta+\beta\gamma} - \frac{\varphi_o\beta\gamma\int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t\xi_o^x}\frac{\partial\xi_o^x}{\partial\mathcal{A}_t}dG}{1-\beta+\beta\gamma}\right]\end{aligned}$$

Solving for $\frac{\partial\xi_o^x}{\partial\mathcal{A}_t}$,

$$\begin{aligned}\xi_o^x =& \left[\frac{(\psi_v-\psi_o)}{\psi_o}\frac{[1-\beta+\beta\gamma]}{[1-\beta]}\frac{[\theta_e^{vD}]^{\frac{\alpha}{1-\alpha}}}{[\theta_e^v]^{\frac{\alpha}{1-\alpha}}} - \frac{(\psi_v-\psi_o)}{\psi_o} + \frac{\psi_v}{\psi_o}\frac{\mathcal{A}_v^x}{\mathcal{A}_t}\right] \\ \frac{\partial\xi_o^x}{\partial\mathcal{A}_t} =& \frac{(\psi_v-\psi_o)}{\psi_o}\frac{[1-\beta+\beta\gamma]}{[1-\beta]}\frac{[\theta_e^{vD}]^{\frac{\alpha}{1-\alpha}}}{[\theta_e^v]^{\frac{\alpha}{1-\alpha}}}\frac{1}{\rho}\left[\frac{d\ln\theta_e^{vD}}{d\mathcal{A}_t} - \frac{d\ln\theta_e^v}{d\mathcal{A}_t}\right] \\ &- \frac{\psi_v}{\psi_o}\frac{\mathcal{A}_t\xi_v^x}{\mathcal{A}_t^2}\end{aligned}$$

Plugging back and after some manipulations

$$\left[\frac{d\ln\theta_e^v}{d\mathcal{A}_t} - \frac{d\ln\theta_e^{vD}}{d\mathcal{A}_t}\right] = \frac{\rho\beta\gamma}{\omega_v^e(\mathcal{A}_t)}\frac{\left[\int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t}\frac{\mathcal{A}}{\mathcal{A}_t^2}dG + \varphi_o\int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t\xi_o^x}\frac{\mathcal{A}}{\mathcal{A}_t^2}dG + \varphi_v\int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t\xi_o^x}\frac{\mathcal{A}_t\xi_v^x}{\mathcal{A}_t^2}dG\right]}{[1+\kappa_2^v(e)+\kappa_3^v(e)][1-\beta+\beta\gamma]} > 0$$

A.5.3 Exit - Outsourcing

A.5.3.1 Arrival Rate

Computing the total differential with respect to γ

$$
\begin{aligned}
d\ln\theta_o^x =&\rho\frac{1}{1-\kappa_1^o(x)}\left[\frac{\partial\kappa_1^o(x)}{\partial\gamma}+\frac{\partial\kappa_1^o(x)}{\partial\xi_o^x}\frac{\partial\xi_o^x}{\partial\gamma}\right]d\gamma \\
&-\rho\frac{1}{1+\kappa_2^o(x)}\left[\frac{\partial\kappa_2^o(x)}{\partial\gamma}+\frac{\partial\kappa_2^o(x)}{\partial\xi_o^x}\frac{\partial\xi_o^x}{\partial\gamma}\right]d\gamma \\
\frac{d\ln\theta_o^x}{d\gamma} =&-\frac{\rho}{1-\kappa_1^o(x)}\left[\kappa_1^o(x)/\gamma\right]-\frac{\rho}{1+\kappa_2^o(x)}\left[\frac{(1-\beta)\kappa_2^o(x)/\gamma}{[1-\beta+\beta\gamma]}\right] \\
&-\Xi_o^x\beta\gamma g(\mathcal{A}_t\xi_o^x)\mathcal{A}_t\frac{\partial\xi_o^x}{\partial\gamma}
\end{aligned}
$$

where $\Xi_o^x=\left[\frac{\rho}{1-\kappa_1^o(x)}\frac{[f_e+f_x]}{f_p-[1-\beta]f_x}-\frac{\rho}{1+\kappa_2^o(x)}\frac{[\mathcal{A}_t\xi_o^x-\mathcal{A}_t]/\mathcal{A}_t}{[1-\beta+\beta\gamma]}\right]$

$$
\begin{aligned}
\Xi_o^x =&\left[\frac{\rho}{1-\kappa_1^o(x)}\frac{[f_e+f_x]}{f_p-[1-\beta]f_x}-\frac{\rho}{1+\kappa_2^o(x)}\frac{[\mathcal{A}_t\xi_o^x-\mathcal{A}_t]/\mathcal{A}_t}{[1-\beta+\beta\gamma]}\right] \\
=&\left[\frac{\rho}{1-\kappa_2^o(x)}\frac{[\mathcal{A}_t\xi_o^x-\mathcal{A}_t]/\mathcal{A}_t}{(1-\beta+\beta\gamma)}-\frac{\rho}{1+\kappa_2^o(x)}\frac{[\mathcal{A}_t\xi_o^x-\mathcal{A}_t]/\mathcal{A}_t}{[1-\beta+\beta\gamma]}\right] \\
\Xi_o^x =&0
\end{aligned}
$$

Plugging back into the total differential

$$
\frac{d\ln\theta_o^x}{d\gamma}=-\rho\frac{\kappa_1^o(x)/\gamma}{1-\kappa_1^o(x)}-\frac{\rho(1-\beta)}{[1-\beta+\beta\gamma]}\frac{\kappa_2^o(x)/\gamma}{1+\kappa_2^o(x)}<0
$$

A.5.3.2 Current Realization

$$
\begin{aligned}
d\ln\theta_o^x =& \frac{d\ln\theta_o^{xD}}{d\mathcal{A}_t} d\mathcal{A}_t + \frac{\rho}{1-\kappa_1^o(x)}\left[\frac{\partial\kappa_1^o(x)}{\partial\mathcal{A}_t} + \frac{\partial\kappa_1^o(x)}{\partial\xi_o^x}\frac{\partial\xi_o^x}{\partial\mathcal{A}_t}\right] d\mathcal{A}_t \\
&- \frac{\rho}{1+\kappa_2^o(x)}\left[\frac{\partial\kappa_2^o(x)}{\partial\mathcal{A}_t} + \frac{\partial\kappa_2^o(x)}{\partial\xi_o^x}\frac{\partial\xi_o^x}{\partial\mathcal{A}_t}\right] d\mathcal{A}_t \\
\frac{d\ln\theta_o^x}{d\mathcal{A}_t} =& \frac{d\ln\theta_o^{xD}}{d\mathcal{A}_t} + \frac{\rho}{1+\kappa_2^o(x)}\left[\frac{\beta\gamma\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi_o^x}\mathcal{A}/\mathcal{A}_t^2 dG}{1-\beta+\beta\gamma}\right] \\
\frac{d\ln\theta_o^x}{d\mathcal{A}_t} - \frac{d\ln\theta_o^{xD}}{d\mathcal{A}_t} =& \frac{\rho}{1+\kappa_2^o(x)}\left[\frac{\beta\gamma\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi_o^x}\mathcal{A}/\mathcal{A}_t^2 dG}{1-\beta+\beta\gamma}\right] > 0
\end{aligned}
$$

A.5.4 Exit - Vertical Integration

A.5.4.1 Arrival Rate

$$
\begin{aligned}
d\ln\theta_x^v =& -\frac{\rho}{1-\kappa_1^v(x)}\left[\frac{\kappa_1^v(x)}{\gamma} - \beta\gamma\frac{[f_v+f_e+f_x]}{f_p-[1-\beta]f_x}g(\mathcal{A}_t\xi_v^e)\mathcal{A}_t\frac{\partial\xi_v^e}{\partial\gamma}\right]d\gamma \\
& -\frac{\rho\left[\frac{(1-\beta)}{1-\beta+\beta\gamma}\frac{\kappa_2^v(x)}{\gamma} - \frac{\psi_o}{\psi_v}\frac{(1-\beta)}{1-\beta+\beta\gamma}\frac{\kappa_3^v(x)}{\gamma}\right]}{1+\kappa_2^v(x)-\frac{\psi_o}{\psi_v}\kappa_3^v(x)}d\gamma \\
& -\frac{\rho\left[\frac{[\mathcal{A}_t\xi_v^e-\mathcal{A}_t]}{\mathcal{A}_t} - \frac{\psi_o}{\psi_v}\frac{[\mathcal{A}_t\xi_v^e-\mathcal{A}_t\xi_o^e]}{\mathcal{A}_t}\right]}{1+\kappa_2^v(x)-\frac{\psi_o}{\psi_v}\kappa_3^v(x)}\frac{\beta\gamma}{1-\beta+\beta\gamma}g(\mathcal{A}_t\xi_v^e)\mathcal{A}_t\frac{\partial\xi_v^e}{\partial\gamma}d\gamma \\
& -\frac{\rho}{1+\kappa_2^v(x)-\frac{\psi_o}{\psi_v}\kappa_3^v(x)}\frac{\beta\gamma\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t\xi_v^e}\frac{\partial\xi_o^e}{\partial\gamma}dG}{1-\beta+\beta\gamma}d\gamma \\
\frac{d\ln\theta_x^v}{d\gamma} =& -\frac{\rho\kappa_1^v(x)/\gamma}{1-\kappa_1^v(x)} - \frac{(1-\beta)}{1-\beta+\beta\gamma}\frac{\rho\left[\frac{\kappa_2^v(x)}{\gamma}-\frac{\psi_o}{\psi_v}\frac{\kappa_3^v(x)}{\gamma}\right]}{1+\kappa_2^v(x)-\frac{\psi_o}{\psi_v}\kappa_3^v(x)} \\
& -\frac{\rho}{1+\kappa_2^v(x)-\frac{\psi_o}{\psi_v}\kappa_3^v(x)}\frac{\beta\gamma\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t\xi_v^e}\frac{\partial\xi_o^e}{\partial\gamma}dG}{1-\beta+\beta\gamma}
\end{aligned}
$$

Then evaluating at $\gamma = 0$, $\frac{d\ln\theta_x^v}{d\gamma} < 0$ since $\kappa_2^v(x) > \kappa_3^v(x)$ because $\psi_v > \psi_o$ and $\xi_o^e > 1$ which implies that $\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi_v^e}\frac{[\mathcal{A}-\mathcal{A}_t]}{\mathcal{A}_t}dG > \int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t\xi_v^e}\frac{[\mathcal{A}-\mathcal{A}_t\xi_o^e]}{\mathcal{A}_t}dG$. Hence as a first order effect uncertainty delays the decision to stop exporting under integration.

A.5.4.2 Current Realization

$$
\begin{aligned}
d\ln\theta_x^v =& \frac{d\ln\theta_x^{vD}}{d\mathcal{A}_t}d\mathcal{A}_t - \frac{\rho}{1-\kappa_1^v(x)}\left[\frac{\partial\kappa_1^v(x)}{\partial\mathcal{A}_t}\right]d\mathcal{A}_t \\
&- \frac{\rho\left[\frac{\partial\kappa_2^v(x)}{\partial\mathcal{A}_t} - \frac{\psi_o}{\psi_v}\frac{\partial\kappa_3^v(x)}{\partial\mathcal{A}_t} - \frac{\psi_o}{\psi_v}\frac{\partial\kappa_3^v(x)}{\partial\xi_o^e}\frac{\partial\xi_o^e}{\partial\mathcal{A}_t}\right]}{1+\kappa_2^v(x) - \frac{\psi_o}{\psi_v}\kappa_3^v(x)}d\mathcal{A}_t \\
\frac{d\ln\theta_x^v}{d\mathcal{A}_t} - \frac{d\ln\theta_x^{vD}}{d\mathcal{A}_t} =& \frac{\rho\beta\gamma\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi_v^e}[\mathcal{A}_t/\mathcal{A}_t^2]dG + \frac{\psi_o}{\psi_v}\rho\beta\gamma\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t\xi_v^e}[\mathcal{A}_t/\mathcal{A}_t^2]dG}{[1+\kappa_2^v(x) - \frac{\psi_o}{\psi_v}\kappa_3^v(x)](1-\beta+\beta\gamma)} \\
&- \frac{\frac{\psi_o}{\psi_v}\rho\beta\gamma\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t\xi_v^e}\frac{d\xi_o^e}{d\mathcal{A}_t}dG}{[1+\kappa_2^v(x) - \frac{\psi_o}{\psi_v}\kappa_3^v(x)](1-\beta+\beta\gamma)}
\end{aligned}
$$

Solving for $\frac{d\xi_o^e}{d\mathcal{A}_t}$

$$
\begin{aligned}
\xi_o^e =& \left[\frac{\psi_v}{\psi_o}\frac{[1-\beta+\beta\gamma][f_v+f_e+f_x]}{f_p-[1-\beta]f_x}\frac{[\theta_x^{vD}]^{\frac{1}{\rho}}}{[\theta_v^x]^{\frac{1}{\rho}}} - \frac{(\psi_v-\psi_o)}{\psi_o}\frac{\mathcal{A}_v^e}{\mathcal{A}_t} + \frac{\psi_v}{\psi_o}\right] \\
\frac{\partial\xi_o^e}{\partial\mathcal{A}_t} =& \frac{\psi_v}{\psi_o}\frac{1}{\rho}\frac{[1-\beta+\beta\gamma][f_v+f_e+f_x]}{f_p-[1-\beta]f_x}\frac{[\theta_x^{vD}]^{\frac{1}{\rho}}}{[\theta_v^x]^{\frac{1}{\rho}}}\left[\frac{d\ln\theta_x^{vD}}{d\mathcal{A}_t} - \frac{d\ln\theta_x^v}{d\mathcal{A}_t}\right] - \frac{(\psi_v-\psi_o)}{\psi_o}\frac{\mathcal{A}_t\xi_v^e}{\mathcal{A}_t^2}
\end{aligned}
$$

Then plugging back into the condition and after some algebra

$$
\begin{aligned}
\frac{d\ln\theta_x^v}{d\mathcal{A}_t} - \frac{d\ln\theta_x^{vD}}{d\mathcal{A}_t} =& \frac{\rho\beta\gamma}{\left[1+\kappa_2^v(x) - \frac{\psi_o}{\psi_v}\kappa_3^v(x)\right]\omega_v^x} \\
&\times\left[\frac{\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi_v^e}\frac{1}{\mathcal{A}_t}dG}{1-\beta+\beta\gamma} + \frac{\psi_o}{\psi_v}\frac{\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t\xi_v^e}\frac{1}{\mathcal{A}_t}dG}{1-\beta+\beta\gamma} + \frac{(\psi_v-\psi_o)}{\psi_v}\frac{\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t\xi_v^e}\frac{1}{\mathcal{A}_t}dG}{1-\beta+\beta\gamma}\right]
\end{aligned}
$$

where $\frac{d\ln\theta_x^v}{d\mathcal{A}_t} - \frac{d\ln\theta_x^{vD}}{d\mathcal{A}_t} > 0$ since all terms are positive and ω_v^x is a positive weight.

A.5.5 Heterogeneity on The Impact of Demand Changes

A.5.5.1 Entry and Integration

$$
\begin{aligned}
\frac{d\ln\theta_e^v}{d\mathcal{A}_t} - \frac{d\ln\theta_e^o}{d\mathcal{A}_t} =& \frac{\rho\beta\gamma\left[\frac{\int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t}\frac{\mathcal{A}}{\mathcal{A}_t^2}dG}{1-\beta+\beta\gamma} + \frac{\varphi_o\int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t\xi_o^x}\frac{\mathcal{A}}{\mathcal{A}_t^2}dG}{1-\beta+\beta\gamma} + \frac{\varphi_v\int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t\xi_o^x}\frac{\mathcal{A}_t\xi_v^x}{\mathcal{A}_t^2}dG}{1-\beta+\beta\gamma}\right]}{1+\kappa_2^v(e)+\kappa_3^v(e)} \\
&+ \frac{\beta\gamma}{[1-\beta]}\frac{1}{[1+\kappa_1^v(e)]}\int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t\xi_o^x}\left[\frac{d\ln\theta_e^v}{d\mathcal{A}_t} - \frac{d\ln\theta_e^{vD}}{d\mathcal{A}_t}\right]dG \\
=& \frac{\rho}{1+\kappa_2^v(e)+\kappa_3^v(e)}\frac{\beta\gamma\int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t}[\mathcal{A}/\mathcal{A}_t^2]dG}{1-\beta+\beta\gamma} - \frac{\rho}{1+\kappa_2^o(e)}\frac{\beta\gamma\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t}[\mathcal{A}/\mathcal{A}_t^2]dG}{1-\beta+\beta\gamma} \\
&+ \frac{\rho}{1+\kappa_2^v(e)+\kappa_3^v(e)}\left[\frac{\varphi_o\beta\gamma\int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t\xi_o^x}\frac{\mathcal{A}}{\mathcal{A}_t^2}dG}{1-\beta+\beta\gamma} + \frac{\varphi_v\int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t\xi_o^x}\frac{\mathcal{A}_t\xi_v^x}{\mathcal{A}_t^2}dG}{1-\beta+\beta\gamma}\right] \\
&+ \frac{\beta\gamma}{[1-\beta]}\frac{1}{[1+\kappa_1^v(e)]}\int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t\xi_o^x}\left[\frac{d\ln\theta_e^v}{d\mathcal{A}_t} - \frac{d\ln\theta_e^{vD}}{d\mathcal{A}_t}\right]dG
\end{aligned}
$$

$$
\frac{d\ln\theta_v^e}{d\ln\mathcal{A}_t} - \frac{d\ln\theta_o^e}{d\ln\mathcal{A}_t} > 0
$$

This is the case since $\kappa_2^v(e) < 0$, $\kappa_3^v(e) < 0\,\kappa_1^o(e) < 0$ and $1 > abs(\kappa_2^v(e)) > abs(\kappa_2^o(e))$, hence $\frac{\rho}{1+\kappa_2^v(e)+\kappa_3^v(e)} > \frac{\rho}{1+\kappa_2^o(e)}$; and $\int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t}[\mathcal{A}/\mathcal{A}_t^2]dG > \int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t}[\mathcal{A}/\mathcal{A}_t^2]dG$. Since $\frac{d\ln\theta^v}{d\ln\mathcal{A}_t} < 0$ then the elasticity with respect to current demand level is higher for outsourcing than integration.

A.5.5.2 Exit across Organizational Forms

$$\begin{aligned}\frac{d\ln\theta_v^x}{d\ln\mathcal{A}_t}-\frac{d\ln\theta_o^x}{d\ln\mathcal{A}_t}=&\frac{\rho}{1+\kappa_2^v(x)-\frac{\psi_o}{\psi_v}\kappa_3^v(x)}\left[\frac{\beta\gamma\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi_v^e}\mathcal{A}dG}{1-\beta+\beta\gamma}+\frac{\psi_o}{\psi_v}\frac{\beta\gamma\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t\xi_v^e}\mathcal{A}dG}{1-\beta+\beta\gamma}\right]\\&-\frac{\rho}{1+\kappa_2^o(x)}\left[\frac{\beta\gamma\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi_o^x}\mathcal{A}dG}{1-\beta+\beta\gamma}\right]\\=&\frac{\rho\left[\kappa_2^v(x)+\frac{\beta\gamma\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi_v^e}\mathcal{A}_tdG}{1-\beta+\beta\gamma}\right]}{1+\kappa_2^v(x)-\frac{\psi_o}{\psi_v}\kappa_3^v(x)}-\frac{\rho\left[\kappa_2^o(x)+\frac{\beta\gamma\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi_o^x}\mathcal{A}_tdG}{1-\beta+\beta\gamma}\right]}{1+\kappa_2^o(x)}\\>&0\end{aligned}$$

since $\kappa_2^v(x)>\kappa_2^o(x)$ and $\kappa_3^v(x)<1$.

A.5.6 Foreign Demand Uncertainty Distribution

A.5.6.1 Exit with Outsourcing

The exit condition from outsourcing is the following for each firm

$$(1-\beta)f_x=-\left[\pi_o(\mathcal{A}_o^x)-f_p\right]-\beta\gamma[1-G(\mathcal{A}_o^e)][f_e+f_x]-\beta\gamma\int_{\mathcal{A}_o^x}^{\mathcal{A}_o^e}\frac{\pi_o(\mathcal{A})-\pi_o(\mathcal{A}_o^x)}{1-\beta+\beta\gamma}dG$$

Integrating by parts

$$
\begin{aligned}
(1-\beta)f_x =& -[\pi_o(\mathcal{A}_o^x)-f_p]-\beta\gamma[1-G(\mathcal{A}_o^e)][f_e+f_x] \\
& + \beta\gamma\frac{G(\mathcal{A}_o^e)[\pi_o(\mathcal{A}_o^x)-\pi_o(\mathcal{A}_o^e)]}{1-\beta+\beta\gamma} + \beta\gamma[\theta_i]^{\frac{1}{\rho}}\psi_o\frac{\int_{\mathcal{A}_o^x}^{\mathcal{A}_o^e} G(z)dz}{1-\beta+\beta\gamma} \\
=& -[\pi_o(\mathcal{A}_o^x)-f_p]-\beta\gamma[1-G(\mathcal{A}_o^e)][f_e+f_x]+\beta\gamma G(\mathcal{A}_o^e)[f_e+f_x] \\
& + \beta\gamma[\theta_i]^{\frac{1}{\rho}}\psi_o\frac{\int_{\mathcal{A}_o^x}^{\mathcal{A}_o^e} G(z)dz}{1-\beta+\beta\gamma} \\
(1-\beta)f_x =& -[\pi_o(\mathcal{A}_o^x)-f_p]-\beta\gamma[f_e+f_x]+\beta\gamma[\theta_i]^{\frac{1}{\rho}}\psi_o\frac{\int_{\mathcal{A}_o^x}^{\mathcal{A}_o^e} G(z)dz}{1-\beta+\beta\gamma}
\end{aligned}
$$

This expression is particularly useful because the distribution function of the stochastic process only shows up in the last term.

For the marginal firm that is exiting from outsourcing with productivity θ_o^x and $\mathcal{A}_o^x = \mathcal{A}_t$ then

$$
\begin{aligned}
(1-\beta)f_x &= -([\theta_o^x]^{\frac{1}{\rho}}\psi_o\mathcal{A}_t - f_p) - \beta\gamma[f_e+f_x] + \beta\gamma[\theta_o^x]^{\frac{1}{\rho}}\psi_o\frac{\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi} G(z)dz}{1-\beta+\beta\gamma} \\
[\theta_o^x]^{\frac{1}{\rho}} &= [\theta_o^{xD}]^{\frac{1}{\rho}}(1-\frac{\beta\gamma[f_e+f_x]}{f_p-(1-\beta)f_x})/\left[\frac{1-\beta+\beta\gamma-\beta\gamma\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi} G(z)dz/\mathcal{A}_t}{1-\beta+\beta\gamma}\right] \\
[\theta_o^x]^{\frac{1}{\rho}} &= [\theta_o^{xD}]^{\frac{1}{\rho}}(1-\frac{\beta\gamma[f_e+f_x]}{f_p-(1-\beta)f_x})\frac{1-\beta+\beta\gamma}{1-\beta+\beta\gamma\omega(\mathcal{A}_t)}
\end{aligned}
$$

Then consider $G(z)$ and $H(z)$ and the objective is to compare the exit productivity threshold between the two demand distribution: θ_o^x and $\theta_o^{x\prime}$. In order to compare the cutoff I compute the ratio

$$\left[\frac{\theta_o^x}{\theta_o^{x\prime}}\right]^{\frac{1}{\rho}} = \frac{\left[1-\beta+\beta\gamma-\beta\gamma\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi} H(z)dz/\mathcal{A}_t\right]}{\left[1-\beta+\beta\gamma-\beta\gamma\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi} G(z)dz/\mathcal{A}_t\right]}$$

$$\left[\frac{\theta_o^x}{\theta_o^{x\prime}}\right]^{\frac{1}{\rho}} = \frac{[1-\beta+\beta\gamma\omega'(\mathcal{A}_t)]}{[1-\beta+\beta\gamma\omega(\mathcal{A}_t)]}$$

Hence by comparing $\omega(\mathcal{A}_t)$ and $\omega'(\mathcal{A}_t)$ the productivity cutoff can be ranked. Note thatif $\theta_o^x < \theta_o^{x\prime}$ then it should be the case that $[1-\beta+\beta\gamma\omega(\mathcal{A}_t)] > [1-\beta+\beta\gamma\omega'(\mathcal{A}_t)]$ since $\rho > 0$.

$$\omega(\mathcal{A}_t) = 1 - \frac{\beta\gamma\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi} G(z)dz}{\mathcal{A}_t}$$

$$\omega'(\mathcal{A}_t) = 1 - \frac{\beta\gamma\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi} H(z)dz}{\mathcal{A}_t}$$

$$\Delta\omega(\mathcal{A}_t) = \frac{\beta\gamma\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi}[H(z)-G(z)]dz}{\mathcal{A}_t}$$

$$\Delta\omega(\mathcal{A}_t) = \frac{\beta\gamma}{\mathcal{A}_t}\left\{\int_0^{\mathcal{A}_t\xi}[H(z)-G(z)]dz - \int_0^{\mathcal{A}_t}[H(z)-G(z)]dz\right\}$$

If $G(z)$ FOSD $H(z)$if $G(z) \leq H(z)$ for all z with strict inequality for at least one z, then $\Delta\omega(\mathcal{A}_t) \geq 0$ with strict inequality when it is the case that $G(z) < H(z)$ and $\theta_o^x < \theta_o^{x\prime}$.

Now suppose that the distribution of demand $H(\mathcal{A})$ is a mean-preserving spread of $G(\mathcal{A})$ such that $G(\mathcal{A})$ and $H(\mathcal{A})$ cross only once at $\tilde{\mathcal{A}}$. Then for a current realization $\mathcal{A}_t < \tilde{\mathcal{A}}/\xi$ it is the case that $\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi}[H(z)-G(z)]dz > 0$ and $\Delta\omega(\mathcal{A}_t) > 0$ which in turns implies that $\theta_o^x < \theta_o^{x\prime}$. In the case that the current realization $\mathcal{A}_t > \tilde{\mathcal{A}}$, $\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi}[H(z)-G(z)]dz < 0$ and $\Delta\omega(\mathcal{A}_t) < 0$ which in turns implies that $\theta_o^x > \theta_o^{x\prime}$.

A.5.6.2 Entry with Outsourcing

Reexpressing the entry condition, I obtain:

$$
\begin{aligned}
[1-\beta]f_e =& [\pi_o(\mathcal{A}_o^e) - f_p] - \beta\gamma G(\mathcal{A}_o^x)[f_x + f_e] \\
& - \frac{[G(\mathcal{A}_o^e) - G(\mathcal{A}_o^x)]\pi_o(\mathcal{A}_e^o)}{1-\beta+\beta\gamma} + \frac{\beta\gamma \int_{A_x^o}^{A_e^o} \pi_o(A) dG}{[1-\beta(1-\gamma)]} \\
1-\beta]f_e =& [\pi_o(\mathcal{A}_o^e) - f_p] - \frac{\beta\gamma[\theta_i]^{\frac{1}{\rho}}\psi_o \int_{A_x^o}^{A_e^o} G(z) dG}{1-\beta+\beta\gamma}
\end{aligned}
$$

Parametrizing for $\mathcal{A}_t = \mathcal{A}_o^e$

$$
\begin{aligned}
[1-\beta]f_e =& - f_p + [\theta_o^e]^{\frac{1}{\rho}} \left[\psi_o \mathcal{A}_t - \frac{\beta\gamma\psi_o \int_{\mathcal{A}_t \xi_o^e}^{\mathcal{A}_t} G(z) dG}{1-\beta+\beta\gamma} \right] \\
\psi_o \mathcal{A}_t [\theta_o^{eD}]^{\frac{1}{\rho}} =& [\theta_o^e]^{\frac{1}{\rho}} \left[\psi_o \mathcal{A}_t - \frac{\beta\gamma\psi_o \int_{\mathcal{A}_t \xi_o^e}^{\mathcal{A}_t} G(z) dG}{1-\beta+\beta\gamma} \right] \\
[\theta_o^e]^{\frac{1}{\rho}} =& [\theta_o^{eD}]^{\frac{1}{\rho}} / [1 - \frac{\beta\gamma \int_{\mathcal{A}_t \xi_o^e}^{\mathcal{A}_t} G(z) dG / \mathcal{A}_t}{1-\beta+\beta\gamma}] \\
[\theta_o^e]^{\frac{1}{\rho}} =& [\theta_o^{eD}]^{\frac{1}{\rho}} \frac{1-\beta+\beta\gamma}{1-\beta+\beta\gamma\omega(\mathcal{A}_t)}
\end{aligned}
$$

Then

$$
\left[\frac{\theta_o^e}{\theta_o^{e\prime}} \right]^{\frac{1}{\rho}} = \frac{[1-\beta+\beta\gamma\omega'(\mathcal{A}_t)]}{[1-\beta+\beta\gamma\omega(\mathcal{A}_t)]}
$$

since $\omega'(\mathcal{A}_t) < \omega(\mathcal{A}_t)$ if $G(z)$ FOSD $H(z)$ then $\theta_o^e < \theta_o^{e'}$.

Now suppose that the distribution of demand $H(\mathcal{A})$ is a mean-preserving spread of $G(\mathcal{A})$ such that $G(\mathcal{A})$ and $H(\mathcal{A})$ cross only once at $\tilde{\mathcal{A}}$. Then for a current realization $\mathcal{A}_t < \tilde{\mathcal{A}}$ it is the case that $\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t}[H(z) - G(z)]dz > 0$ and $\Delta\omega(\mathcal{A}_t) > 0$ which in turns implies that $\theta_o^e < \theta_o^{e\prime}$. In the case that the current realization $\mathcal{A}_t > \tilde{\mathcal{A}}/\xi_o^e$, $\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t}[H(z) - G(z)]dz < 0$ and $\Delta\omega(\mathcal{A}_t) < 0$ which in turns implies that $\theta_o^e > \theta_o^{e\prime}$.

A.5.6.3 Integration

Rearranging the integration condition, integrating by parts and after the algebra

$$[1-\beta]f_v = (\psi_v - \psi_o)\theta^{\frac{\alpha}{1-\alpha}}\mathcal{A}_e^v - \frac{\beta\gamma(\psi_v - \psi_o)\theta^{\frac{\alpha}{1-\alpha}}\int_{\mathcal{A}_x^o}^{\mathcal{A}_e^v} G(z)dz}{1-\beta+\beta\gamma} - \frac{\beta\gamma\psi_v\theta^{\frac{\alpha}{1-\alpha}}\int_{\mathcal{A}_v^x}^{\mathcal{A}_x^o} G(z)dz}{1-\beta+\beta\gamma}$$

Parametrizing this expression for the marginal integrated firm $\mathcal{A}_e^v = \mathcal{A}_t$, I obtain

$$[\theta_e^v]^{\frac{\alpha}{1-\alpha}} = [\theta_e^{vD}]^{\frac{\alpha}{1-\alpha}}\frac{1-\beta+\beta\gamma}{1-\beta+\beta\gamma\omega^v(\mathcal{A}_t)}$$

where $\omega^v(\mathcal{A}_t) = 1 - \int_{\mathcal{A}_t\xi_o^x}^{\mathcal{A}_t} G(z)dz/\mathcal{A}_t - \varphi_v\int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t\xi_o^x} G(z)dz/\mathcal{A}_t$.

Consider two distribution $G(z)$ and $H(z)$ with respective θ_v^e and $\theta_v^{e\prime}$ integration productivity cutoffs. Computing the ratio for two distribution

$$\left[\frac{\theta_v^e}{\theta_e^{v\prime}}\right]^{\frac{1}{\rho}} = \frac{1-\beta+\beta\gamma\omega^{v\prime}(\mathcal{A}_t)}{1-\beta+\beta\gamma\omega^{v}(\mathcal{A}_t)}$$

Hence $\theta_v^{e\prime} > \theta_v^e$ if $\omega^{v\prime}(\mathcal{A}_t) < \omega^v(\mathcal{A}_t)$ or $\Delta\omega^v > 0$. Then

$$\Delta\omega^v = \int_{\mathcal{A}_t\xi_o^x}^{\mathcal{A}_t} [H(z) - G(z)]dz + \varphi_v\beta\gamma \int_{\mathcal{A}_t\xi_v^x}^{\mathcal{A}_t\xi_o^x} [H(z) - G(z)dz$$

and $\Delta\omega^v > 0$ if $G(z)$ FOSD $H(z)$ since $H(z) \geq G(z)$ for all z with strict inequality for at least one z. Hence $\theta_v^e < \theta_v^e$ if $G(z)$ FOSD $H(z)$.

Now suppose that the distribution of demand $H(\mathcal{A})$ is a mean-preserving spread of $G(\mathcal{A})$ such that $G(\mathcal{A})$ and $H(\mathcal{A})$ cross only once at $\tilde{\mathcal{A}}$. Then for a current realization $\mathcal{A}_t < \tilde{\mathcal{A}}$ it is the case that $\Delta\omega^v > 0$ which in turns implies that $\theta_v^e < \theta_v^{e\prime}$. In the case that the current realization $\mathcal{A}_t > \tilde{\mathcal{A}}/\xi_v^x$, $\Delta\omega^v > 0 < 0$ which in turns implies that $\theta_v^e > \theta_v^{e\prime}$.

A.5.6.4 Exit with Vertical Integration

$$\begin{aligned}[1-\beta]f_x = &- [\psi_v[\theta]^{\frac{1}{\rho}}\mathcal{A}_v^x - f_p] - \beta\gamma[f_v + f_e + f_x] \\ &+ \frac{\beta\gamma\psi_v[\theta]^{\frac{1}{\rho}}\int_{\mathcal{A}_v^x}^{\mathcal{A}_v^e} G(z)dz}{1-\beta+\beta\gamma} - \frac{\beta\gamma\psi_o[\theta]^{\frac{1}{\rho}}\int_{\mathcal{A}_o^e}^{\mathcal{A}_v^e} G(z)dz}{1-\beta+\beta\gamma}\end{aligned}$$

Parametrizing for the marginal exit integrated exporter and after some algebra

$$[\theta_x^v]^{\frac{1}{\rho}} = [\theta_x^{vD}]^{\frac{1}{\rho}} \left[1 - \frac{\beta\gamma[f_v + f_e + f_x]}{f_p - [1-\beta]f_x}\right] \left[\frac{1-\beta+\beta\gamma}{1-\beta+\beta\gamma\omega_v^x(\mathcal{A}_t)}\right]$$

where $\omega_v^x(\mathcal{A}_t) = 1 - \int_{\mathcal{A}_t}^{\mathcal{A}_t\xi_v^e} \frac{G(z)}{\mathcal{A}_t}dz + \varphi_o \int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t\xi_v^e} \frac{G(z)}{\mathcal{A}_t}dz$.

Consider two distribution $G(z)$ and $H(z)$ with respective θ_v^x and $\theta_v^{x\prime}$ exit from integration productivity cutoffs. Computing the ratio for two distribution

$$\left[\frac{\theta_x^v}{\theta_x^{v\prime}}\right]^{\frac{1}{\rho}} = \frac{1-\beta+\beta\gamma\omega_v^{x\prime}(\mathcal{A}_t)}{1-\beta+\beta\gamma\omega_v^x(\mathcal{A}_t)}$$

and $\theta_v^{x\prime} > \theta_v^x$ if $\Delta\omega_v^x$¿0. Computing $\Delta\omega_v^x$ I get

$$\Delta\omega_v^x = \beta\gamma(1-\varphi_o)\int_{\mathcal{A}_t\xi_o^e}^{\mathcal{A}_t\xi_v^e}[H(z)-G(z)]dz + \beta\gamma\int_{\mathcal{A}_t}^{\mathcal{A}_t\xi_o^e}[H(z)-G(z)]dz$$

If $G(z)$ FOSD $H(z)$ then $H(z) \geq G(z)$ for all z with strict inequality for at least one z, then $\Delta\omega_v^x > 0$ and $\theta_v^x < \theta_v^{x\prime}$. Now suppose that the distribution of demand $H(\mathcal{A})$ is a mean-preserving spread of $G(\mathcal{A})$ such that $G(\mathcal{A})$ and $H(\mathcal{A})$ cross only once at $\tilde{\mathcal{A}}$. Then for a current realization $\mathcal{A}_t < \tilde{\mathcal{A}}/\xi_v^e$ it is the case that $\Delta\omega_v^x > 0$ which in turns implies that $\theta_v^x < \theta_v^{x\prime}$. In the case that the current realization $\mathcal{A}_t > \tilde{\mathcal{A}}$, $\Delta\omega(\mathcal{A}_t) < 0$ which in turns implies that $\theta_v^x > \theta_v^{x\prime}$.

Appendix B: Trade Collapse: The Role of Economic and Policy Uncertainty in the Great Recession

B.1 Descriptive Section

B.1.1 Mid-point Decomposition

The aggregate mid-point growth rate of exports is defined as follows:

$$G(q) = \frac{X(q) - X(q-4)}{\frac{1}{2}[X(q) + X(q-4)]}$$

$$G(q) = \sum_i \sum_c \sum_k \underbrace{\frac{[x_{ick}(q) + x_{ick}(q-4)]}{[X(q) + X(q-4)]}}_{s_{ick}(q)} \times \underbrace{\frac{[x_{ick}(q) - x_{ick}(q-4)]}{\frac{1}{2}[x_{ick}(q) + x_{ick}(q-4)]}}_{g_{ick}(q)}$$

$$G(q) = \sum_i \sum_c \sum_k s_{ick}(q) \times g_{ick}(q)$$

where x denotes exports and i, c, k, q index firm, country, product and quarter respectively; $g_{ick}(q)$ is the midpoint growth rate of firm i exports of product k to country c in quarter q; and $s_{ick}(q)$ is the weight corresponding to $g_{ick}(q)$ in total exports.

Changes in exports at the firm-product-country level can be classified into: (i) extensive positive ("Entry") where $x_{ick}(q) > 0$ and $x_{ick}(q-4) = 0$; (ii) extensive negative ("Exit") where $x_{ick}(q) = 0$ and $x_{ick}(q-4) > 0$; (iii) intensive positive ("Growers") where $x_{ick}(q) > x_{ick}(q-4) > 0$; and (iv) intensive negative ("Shrinkers") where $x_{ick}(q-4) > x_{ick}(q) > 0$. Thus, the aggregate midpoint growth rate can be expressed as

$$\begin{aligned} G(q) = &\sum_{i}^{NE_{ck}} \sum_{c} \sum_{k} [s_{ick}(q) \times g_{ick}(q)] + \sum_{i}^{NX_{ck}} \sum_{c} \sum_{k} [s_{ick}(q) \times g_{ick}(q)] \\ &+ \sum_{i}^{CN1_{ck}} \sum_{c} \sum_{k} [s_{ick}(q) \times g_{ick}(q)] + \sum_{i}^{CN2_{ck}} \sum_{c} \sum_{k} [s_{ick}(q) \times g_{ick}(q)] \end{aligned}$$

where $NE_{ck}, NX_{ck}, CN1_{ck}$ and $CN2_{ck}$ denote respectively the sets of entering, exiting, growing and shrinking firms exporting product k to country c.

B.1.2 Counterfactuals

An alternative way to weight the contribution of the extensive and intensive margin during the GTC is to perform some counterfactuals exercises. These counterfactuals exercises allow us to consider what the GTC growth rate would have been in the case that some of the margins do not adjust during the collapse. More specifically, we compute how the mid-point growth rate would have been if entry, exit and intensive margin growth rate behave as the previous 12 month.

To motivate this counterfactual exercise, recall that the quarterly mid-point growth rate can be expressed as follows,

$$
\begin{aligned}
G(q) = &\sum_{i}^{NE_{ck}} \sum_{c} \sum_{k} [s_{ick}(q) \times g_{ick}(q)] + \sum_{i}^{NX_{ck}} \sum_{c} \sum_{k} [s_{ick}(q) \times g_{ick}(q)] \\
&+ \sum_{i}^{CN} \sum_{c} \sum_{k} [s_{ick}(q) \times g_{ick}(q)] \\
= &ne_q + nx_q + cn_q
\end{aligned}
$$

where ne_q, nx_q and cn_q denotes the growth rate of entry, exit and continuation in period q. Hence if we are interested in computing how much less or more growth would have been if, say, the continuation growth rate remains at the pre-crisis level we can compute the counterfactual growth rate $\tilde{G}$ as follows

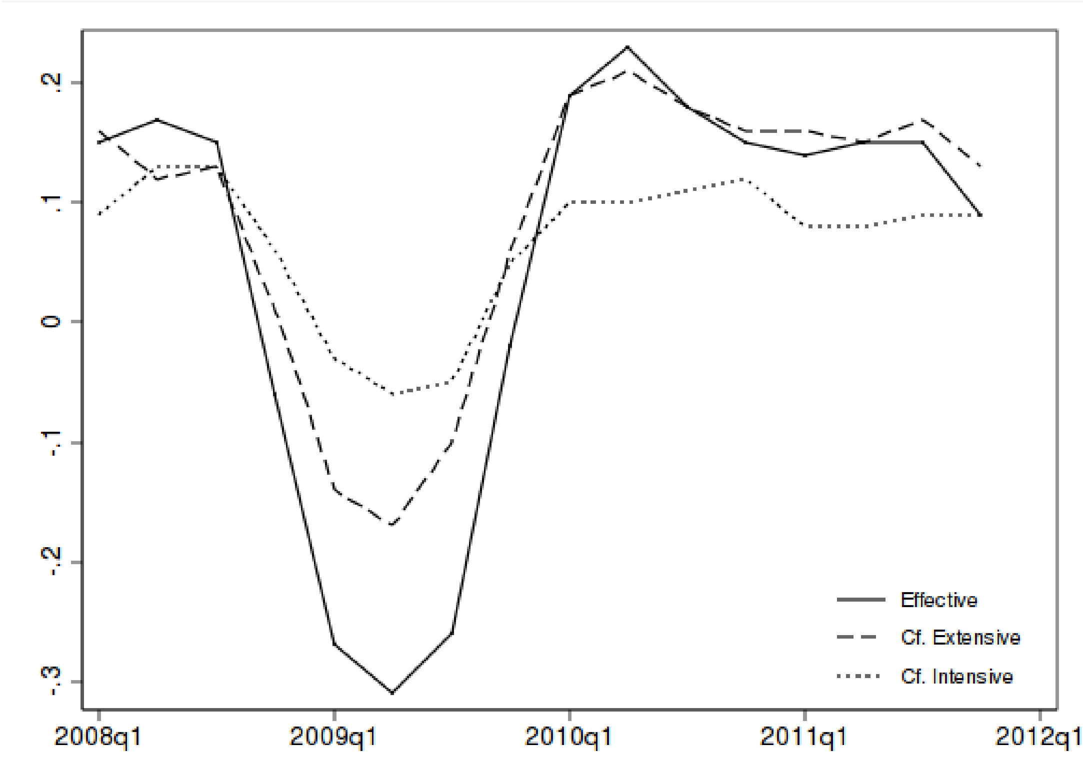
$$
\begin{aligned}
\tilde{G}(q; cn) = &\frac{X_n(q) - X_n(q-4)}{\frac{1}{2}[X_n(q) + X_n(q-4)]} - \left. \frac{X_n(q) - X_n(q-4)}{\frac{1}{2}[X_n(q) + X_n(q-4)]} \right|_{counter, cn_{q-4}} \\
&= ne_q + nx_q + cn_q - ne_q - nx_q - cn_{q-4} \\
&= cn_q - cn_{q-4}
\end{aligned}
$$

Thus we can easily compute how would have been the difference between the actual growth rate and the counterfactual growth rate if the entry, exit or continuation growth rate remains constant at pre-crisis level by computing the difference between the actual growth rate of each margin between the periods under consideration. In the following figure we present three different counterfactuals exercises where the exit, extensive and intensive margins have been kept at their 2007 values respectively.

Figure (B.1) shows that the collapse during 2009 would have been significantly lower if any of the margins would have not adjust during the GTC collapse. For example, if the exit would have remained constant at its 2007 level, the collapse would have been on average 10 percentage points lower. Furthermore, if on top of the exit margin also the entry would have kept its 2007 level, the collapse would have been on average 13 percentage points lower. Thus, if the extensive margin would have remained at its 2007 levels, the collapse would have been 43% of the effective contraction at the trough of the recession.[1] Now turning to the intensive margin, the collapse would have been, on average, 17 percentages points lower if the intensive margin during 2009 would have behave as in 2007. At the trough of the collapse, the fall would have been 70% lower if the intensive margin remains at its 2007 level. Summing up, these counterfactual exercises show that the intensive margin generates the higher gains if its behavior would have remained at pre-crisis level. However, the contribution of the net extensive margin in these counterfactuals exercises is significant and shows that the GTC would have been considerable smaller if the extensive margin would have remained at its pre-crisis level. For example, in the second quarter of 2009, the extensive margin represents 37% of the counterfactuals gains while the intensive margin adds the other 63%.

[1]More specifically, the collapse at the second quarter of 2009 reached a remarkable contraction of 29.8% while the counterfactual contraction, under the assumption that the extensive margin behaved as in the second quarter of 2007, is 12.5%.

Figure B.1: Counterfactuals Growth Rates



B.2 A Theory of Export Dynamics under Multiple Sources of Uncertainty

B.2.1 Derivation of Cutoff Initial Regime

To derive the cutoff, we first combine (4.3.6) and (4.3.7)

$$\Pi_w(c,r) = \frac{\beta\gamma(1-H(\bar{a}))}{1-\beta+\beta\gamma(1-H(\bar{a}))}\left[\frac{\mathbb{E}\pi\left(a' \geq \bar{a}, c, r\right)}{1-\beta+\beta\gamma} + \frac{\beta\gamma}{1-\beta}\frac{\mathbb{E}\pi(a,c)}{1-\beta+\beta\gamma}\right]$$

then plug in 4.3.4 with (4.3.5) and rearranging, we find the expression

$$K = \frac{\pi(a_t, c_t^U)}{1-\beta(1-\gamma)} + \frac{\beta\gamma}{1-\beta}\frac{\mathbb{E}\pi(a', c_t^U)}{1-\beta(1-\gamma)} + \frac{\beta\gamma\left(1-H(a_t)\right)}{1-\beta}\frac{\pi(a_t, c_t^U) - \mathbb{E}\pi\left(a' \geq a_t, c_t^U, r\right)}{1-\beta(1-\gamma)}$$

Then replacing the profit function and writing the expression for c_t^U

$$
\begin{aligned}
c_t^U =& U_t \times c_t^D \\
U_t =& \frac{1-\beta+\beta\gamma\omega(a_t)}{1-\beta+\beta\gamma} \leq 1 \\
\omega(a_t) =& \frac{a_t - H(a_t)\left[a_t - \mathbb{E}(a' \leq a_t)\right]}{a_t} \leq 1
\end{aligned}
$$

From here it is direct to prove that $\omega(a_t) \leq 1$ and $U_t \leq 1$. Note that the $\big(a_t - H(a_t)\left[a_t - \mathbb{E}(a' \leq a_t)\right]\big) < a_t$ since $H(a_t) \leq 1$ because $H(.)$ is CDF function and $\mathbb{E}(a' \leq a_t) \leq a_t$ by definition then $\omega(a_t) \leq 1$. Thus, $U_t(a_t) \leq 1$ since $\beta \in (0,1)$ and $\gamma \in (0,1)$.

B.2.2 Proof of Remark 1

From (4.3.10) we see that H affects entry only through ω and the latter only affects entry if $\gamma > 0$. Consider M which is a AMPS of H then there is more entry under H if $\omega > \omega_M$. First rewrite ω as

$$
\begin{aligned}
\omega(a_t) &= 1 - H(a_t) + \frac{H(a_t)}{a_t} \int_0^{a_t} ah\left(a|a \leq a_t\right) da \\
&= 1 - H(a_t) + \frac{1}{a_t} \int_0^{a_t} adH\left(a\right) \\
&= 1 - H(a_t) + \frac{1}{a_t} \left(\left[aH\left(a\right)\right]_0^{a_t} - \int_0^{a_t} H\left(a\right) da \right) \\
&= 1 - \frac{1}{a_t} \int_0^{a_t} H\left(a\right) da
\end{aligned}
$$

where first line uses definition of ω and of conditional mean and second uses $h\left(a|a \leq a_t\right) = h\left(a\right)/H\left(a_t\right)$ and $dH\left(a\right) = h\left(a\right) da$. Third uses integration by parts and fourth simplifies. We can do the same for ω_M and subtract from ω to obtain

$$\omega - \omega_M = \frac{1}{a_t}\left(\int_0^{a_t} M\left(a\right)da - \int_0^{a_t} H\left(a\right)da\right) > 0 \text{ for all } a_t < a^{\max}$$

where the inequality holds if M is an AMPS of H.

B.2.3 Derivation of Cutoff with different arrival rates

The solution of the cutoff in the generalized demand regime follows the approach of focusing on the difference between the value of waiting and the value of exporting. More specifically, the entry condition for any firm with productivity c is

$$\begin{aligned} \Pi_e\left[a_t(Y_t,\tau_t)\right] - \Pi_w\left[a_t(Y_t,\tau_t)\right] =& K \\ W\left[a_t(Y_t,\tau_t)\right] =& K \end{aligned} \tag{B.2.1}$$

where $W\left[a_t(Y_t,\tau_t)\right]$ denotes $\Pi_e\left[a_t(Y_t,\tau_t)\right] - \Pi_w\left[a_t(Y_t,\tau_t)\right]$.

Using (4.3.14) and rewriting (4.3.13) to exploit symmetry between the value functions we obtain the initial expression

$$\begin{aligned} W\left[a_t(Y_t,\tau_t)\right] =& \frac{\pi(a_t(Y_t,\tau_t))}{1-\beta+\beta\gamma} + \frac{K}{1-\beta+\beta\gamma}\left[\beta\gamma(1-\gamma_\tau)H(a>\bar{a}|\tau_t) + \beta\gamma\gamma_\tau(1-H(\bar{a}))\right] \\ &+ \frac{\beta\gamma(1-\gamma_\tau)H(\bar{a}|\tau_t)}{1-\beta+\beta\gamma}\underbrace{\left\{\mathbb{E}_y\Pi_e\left[a'(Y',\tau_t)|a<\bar{a}\right] - \mathbb{E}_y\Pi_w\left[a'(Y',\tau_t)|a<\bar{a}\right]\right\}}_{A_1} \\ &+ \frac{\beta\gamma\gamma_\tau H(\bar{a})}{1-\beta+\beta\gamma}\underbrace{\left\{\mathbb{E}_a\Pi_e\left[a'(Y',\tau')|a<\bar{a}\right] - \mathbb{E}_a\Pi_w\left[a'(Y',\tau')|a<\bar{a}\right]\right\}}_{A_2} \end{aligned}$$

Working first with A_1, note that since Π_w only depends on τ then $\mathbb{E}_y \Pi_w \left[a'(Y', \tau_t)|a < \bar{a}\right] = \Pi_w \left[a(Y_t, \tau_t)\right]$. Then what we need to find an expression connecting $\Pi_e \left[a(Y_t, \tau_t)\right]$ and $\mathbb{E}\Pi_e \left[a'(Y', \tau_t)|a < \bar{a}\right]$. Using (4.3.13) and taking differences between the value of exporting, we find

$$\mathbb{E}_y \Pi_e \left[a'(Y', \tau_t)|a < \bar{a}\right] = \frac{\mathbb{E}_y \pi[(Y', \tau_t)|a < \bar{a}] - \pi(a_t(Y_t, \tau_t))}{(1 - \beta(1 - \gamma))} + \Pi_e \left[a_t(Y_t, \tau_t)\right] \quad \text{(B.2.2)}$$

Plugging this expression back and after some algebra, we obtain

$$\begin{aligned} W\left[a_t(Y_t, \tau_t)\right] = & \frac{\pi(a_t(Y_t, \tau_t))}{1 - \beta + \beta\gamma[1 - (1 - \gamma_\tau)H(\bar{a}|\tau_t)]} \qquad \text{(B.2.3)} \\ & + \frac{K\left[\beta\gamma(1 - \gamma_\tau)H(a > \bar{a}|\tau_t) + \beta\gamma\gamma_\tau(1 - H(\bar{a}))\right]}{1 - \beta + \beta\gamma[1 - (1 - \gamma_\tau)H(\bar{a}|\tau_t)]} \\ & + \frac{\beta\gamma(1 - \gamma_\tau)H(\bar{a}|\tau_t)}{(1 - \beta(1 - \gamma))} \left\{ \frac{\mathbb{E}_y \pi[(Y', \tau_t)|a < \bar{a}] - \pi(a_t(Y_t, \tau_t))}{1 - \beta + \beta\gamma[1 - (1 - \gamma_\tau)H(\bar{a}|\tau_t)]} \right\} \\ & + \frac{\beta\gamma\gamma_\tau H(\bar{a}) \left\{ \mathbb{E}_a \Pi_e \left[a'(Y', \tau')|a < \bar{a}\right] - \mathbb{E}_a \Pi_w \left[a'(Y', \tau')|a < \bar{a}\right] \right\}}{1 - \beta + \beta\gamma[1 - (1 - \gamma_\tau)H(\bar{a}|\tau_t)]} \end{aligned}$$

Note that first two lines of the last equation captures the differences in the profits today, the entry cost saved if a shock above entry threshold arrives, plus the additional profits if shocks are below the entry cutoff when only a income shock arrives. The last line captures the differences between the value functions when both shocks arrives such that they are below the entry threshold. Taking expectations of (B.2.3) with respect to a conditional on $a < \bar{a}$, we obtain

$$\mathbb{E}_a W\left[a'(Y', \tau')|a < \bar{a}\right] = \frac{\mathbb{E}_a[\pi(a(Y, \tau))|a < \bar{a}]}{1 - \beta + \beta\gamma[1 - H(\bar{a})]} + \frac{K\beta\gamma(1 - H(\bar{a}))}{1 - \beta + \beta\gamma[1 - H(\bar{a})]} \quad \text{(B.2.4)}$$

Plugging (B.2.4) into (B.2.3) and then into (B.2.1), we obtain

$$\begin{aligned} K =& \frac{\pi(a_t(Y_t,\tau_t)) + K\left[\beta\gamma(1-\gamma_\tau)H(a>\bar{a}|\tau_t) + \beta\gamma\gamma_\tau(1-H(\bar{a}))\right]}{1-\beta+\beta\gamma[1-(1-\gamma_\tau)H(\bar{a}|\tau_t)]} \\ &+ \frac{\beta\gamma(1-\gamma_\tau)H(\bar{a}|\tau_t)}{(1-\beta(1-\gamma))}\left\{\frac{\mathbb{E}_y\pi[(Y',\tau_t)|a<\bar{a}] - \pi(a_t(Y_t,\tau_t))}{1-\beta+\beta\gamma[1-(1-\gamma_\tau)H(\bar{a}|\tau_t)]}\right\} \\ &+ \frac{\beta\gamma\gamma_\tau H(\bar{a})\left\{\frac{\mathbb{E}_a[\pi(a(Y,\tau))|a<\bar{a}]}{1-\beta+\beta\gamma[1-H(\bar{a})]} + \frac{K\beta\gamma(1-H(\bar{a}))}{1-\beta+\beta\gamma[1-H(\bar{a})]}\right\}}{1-\beta+\beta\gamma[1-(1-\gamma_\tau)H(\bar{a}|\tau_t)]} \end{aligned} \tag{B.2.5}$$

Evaluating at $\gamma_t = 1$ we obtain (4.3.8). Solving for K

$$\begin{aligned} K =& \frac{\pi(a_t(Y_t,\tau_t))}{[1-\beta]} + \frac{\beta\gamma\gamma_\tau H(\bar{a})\left\{\mathbb{E}_a[\pi(a(Y,\tau))|a<\bar{a}] - \pi(a_t(Y_t,\tau_t))\right\}}{[1-\beta]\left[1-\beta+\beta\gamma(1-H(\bar{a}))+\beta\gamma\gamma_\tau H(\bar{a})\right]} \\ &+ \frac{\beta\gamma(1-\gamma_\tau)H(\bar{a}|\tau_t)\left[1-\beta+\beta\gamma(1-H(\bar{a}))\right]}{[1-\beta]\left[1-\beta+\beta\gamma(1-H(\bar{a}))+\beta\gamma\gamma_\tau H(\bar{a})\right]} \\ &\times \left\{\frac{\mathbb{E}_y\pi[(Y',\tau_t)|a<\bar{a}] - \pi(a_t(Y_t,\tau_t))}{(1-\beta(1-\gamma))}\right\} \end{aligned} \tag{B.2.6}$$

then we find the expression for c_t^U for any given a_t

$$c_t^U = U_t \times c_t^D \tag{B.2.7}$$

$$U_t = \left[1 - \frac{\beta\gamma\left(\gamma_\tau\omega(a_t) + (1-\gamma_\tau)\phi(a_t,\gamma)\omega(a_t|\tau_t)\right)}{1-\beta+\beta\gamma(1-(1-\gamma_t)H(a_t))}\right]^{\frac{1}{\sigma-1}} \tag{B.2.8}$$

where $\omega(a_t) = -H(a_t)\mathbb{E}_a[\frac{a(y,\tau)-a_t}{a_t}|a < a_t]$ and $\omega(a_t|\tau_t) = -H(a_t|\tau_t)\mathbb{E}_y[\frac{a(y,\tau_t)-a_t}{a_t}|a < a_t]$. From here it is easy to see that $c^U < c^D$ since $U_t < 1$ because $\omega(a_t) \in (0,1)$,

$\omega(a_t|\tau_t) \in (0,1)$ and $\phi(a_t,\gamma) \in (0,1)$. Formally,

$$
\begin{aligned}
U_t &= \left[1 - \frac{\beta\gamma\gamma_\tau\omega(a_t) + \beta\gamma(1-\gamma_\tau)\phi(a_t,\gamma)\omega(a_t|\tau_t)}{1-\beta+\beta\gamma(1-(1-\gamma_t)H(a_t))}\right]^{\frac{1}{\sigma-1}} \\
U_t^{\sigma-1} &= \left[\frac{1-\beta+\beta\gamma[1-(1-\gamma_t)H(a_t)-\gamma_\tau\omega(a_t)-(1-\gamma_\tau)\phi(a_t,\gamma)\omega(a_t|\tau_t)]}{1-\beta+\beta\gamma(1-(1-\gamma_t)H(a_t))}\right] \\
1-U_t^{\sigma-1} &= \left[\frac{\beta\gamma\gamma_\tau\omega(a_t) + \beta\gamma(1-\gamma_\tau)\phi(a_t,\gamma)\omega(a_t|\tau_t)}{1-\beta+\beta\gamma(1-(1-\gamma_t)H(a_t))}\right] > 0
\end{aligned}
$$

and this directly implies $U_t < 1$ as long as $a_t > a_{min}$ and $\gamma > 0$.

B.2.4 Comparative Statics

Taking logs on (B.2.7)

$$
\begin{aligned}
\ln c_v^U =& \ln c_v^D - \frac{1}{\sigma-1}\ln\left(1-\beta+\beta\gamma[1-(1-\gamma_\tau)H(a_t)]\right) \\
&+ \frac{1}{\sigma-1}\ln(1-\beta+\beta\gamma[1-(1-\gamma_\tau)H(a_t)-\gamma_\tau\omega(a_t)-(1-\gamma_\tau)\phi(a_t,\gamma)\omega(a_t|\tau_t)])
\end{aligned}
\tag{B.2.9}
$$

1. **Entry monotonically decreasing in γ**

$$
\frac{\partial \ln c_v^U}{\partial\gamma} = -\frac{\beta(1-\beta)}{\sigma-1}\frac{\gamma_\tau\omega(a_t)+(1-\gamma_\tau)\omega(a_t|\tau_t)[1-\beta]\nu(\gamma,a_t)}{\left(1+U_t^{\sigma-1}\right)(1-\beta+\beta\gamma[1-(1-\gamma_\tau)H(a_t)])} < 0
$$

This is negative because $\omega(a_t) \geq 0$, $\omega(a_t|\tau_t) \geq 0$ and $v(\gamma,a_t) \geq 0$ where $v(\gamma,a_t)$ summarizes a number of parameters and it is equal to $v(\gamma,a_t) = (1-\beta\gamma H(a_t))/(1-\beta+\beta\gamma)^2 + (1-\gamma_\tau)(\beta\gamma H(a_t))^2/(1-\beta+\beta\gamma)^2$. Note that an increase in γ also generates an increase in the arrival rate of policy shock, since a economic is a necessary condition for the policy shock. In order to control for this, we evaluate $\frac{\partial \ln c_v^U}{\partial \gamma}$ at $\gamma_\tau = 0$ to eliminate the effect of an increase of the economic shock on the policy shock arrival.

$$\left.\frac{\partial \ln c_v^U}{\partial \gamma}\right|_{\gamma_\tau = 0} = -\frac{\beta(1-\beta)}{\sigma - 1} \frac{\gamma_\tau \omega(a_t) + (1-\gamma_\tau)\omega(a_t|\tau_t)[1-\beta]\nu(\gamma, a_t)}{\left(1 + U_t^{\sigma-1}\right)\left(1 - \beta + \beta\gamma[1-(1-\gamma_\tau)H(a_t)]\right)} < 0$$

2. **Entry undefined in γ_τ**

$$\frac{\partial \ln c_v^U}{\partial \gamma_\tau} = -\frac{\beta\gamma}{\sigma - 1} \frac{\omega(a_t) - \omega(a_t|\tau_t)}{1 + U_t^{\sigma-1}} \frac{1 - \beta + \beta\gamma(1 - H(a_t))}{1 - \beta + \beta\gamma[1-(1-\gamma_\tau)H(a_t)]}$$

Then c_t^U is either increasing or decreasing on γ_τ depending whether $\omega(a_\tau) - \omega(a_\tau|\tau_t) > 0$ and this depends on τ_t.

3. **$\omega(a_t)$ and $\omega(a_t|\tau_t)$ increasing in y_t and decreasing in τ_t**

$$\frac{\partial \omega(a_t)}{\partial y_t} = \frac{\partial \omega(a_t)}{\partial a_t}\frac{\partial a_t}{\partial y_t} > 0$$
$$\frac{\partial \omega(a_t)}{\partial \tau_t} = \frac{\partial \omega(a_t)}{\partial a_t}\frac{\partial a_t}{\partial \tau_t} < 0$$

since $\frac{\partial \omega(a_t)}{\partial a_t} = \frac{\int_0^{a_t} ah(a)dt}{a_t} > 0$, $\frac{\partial a_t}{\partial y_t} = \frac{\varepsilon}{\varsigma_t} > 0$ and $\frac{\partial a_t}{\partial \tau_t} = -\sigma\frac{y_t\varepsilon}{\varsigma_t\tau_t} < 0$. The same holds true for $\frac{\partial \omega(a_t|\tau_t)}{\partial y_t} > 0$.

4. **Less responsive to a_t**

$$\begin{aligned}
\frac{\partial \ln c_t^U}{\partial a_t} =& \frac{\partial \ln c_t^D}{\partial a_t} + \frac{\partial \ln U_t}{\partial a_t} \\
\frac{\partial \ln U_t}{\partial a_t} =& -\frac{1}{\sigma-1} \frac{\beta\gamma(1-\gamma_t)h(a_t)\left[1-U_t^{\sigma-1}+\frac{\beta\gamma\omega(a_t|\tau_t)}{1-\beta+\beta\gamma}\right]}{U_t^{\sigma-1}[1-\beta+\beta\gamma(1-(1-\gamma_t)H(a_t))]} \\
& -\frac{1}{\sigma-1} \frac{\beta\gamma\gamma_t\mathbb{E}_a(a<a_t)/a_t+\beta\gamma(1-\gamma_t)\phi(a_t,\gamma)\mathbb{E}_a(a<a_t|\tau_t)/a_t}{U_t^{\sigma-1}[1-\beta+\beta\gamma(1-(1-\gamma_t)H(a_t))]} < 0
\end{aligned}$$

Then it is the case that $\frac{\partial \ln c_t^U}{\partial a_t} - \frac{\partial \ln c_t^D}{\partial a_t} < 0$ and this implies that $\frac{\partial \ln c_t^D}{\partial a_t} = \frac{1}{\sigma-1} > \frac{\partial \ln c_t^U}{\partial a_t}$.

B.2.5 MPS in the 2 arrival process

Consider M which is a AMPS of F and that G remains the same. Then there is more entry under F if $U > U_M$. In order to show this, we first rewrite $\omega(a_t)$

$$\begin{aligned}
\omega(a_t) =& H(a_t) - \frac{\varepsilon}{a_t}\int_{\varsigma=0}^{\varsigma^{\max}} \frac{1}{\varsigma}\left[\int_0^{y=a_t\varsigma/\varepsilon} yf(y)\,dy\right] g(\varsigma)\,d\varsigma \\
=& H(a_t) - \int_{\varsigma=0}^{\varsigma^{\max}} F(\frac{a_t\varsigma}{\varepsilon}) g(\varsigma)\,d\varsigma - \frac{\varepsilon}{a_t}\int_{\varsigma=0}^{\varsigma^{\max}} \frac{1}{\varsigma}\left[\int_0^{y=a_t\varsigma/\varepsilon} F(y)\,dy\right] g(\varsigma)\,d\varsigma \\
=& \int_{\varsigma=0}^{\varsigma^{\max}} F(\frac{a_t\varsigma}{\varepsilon}) g(\varsigma)\,d\varsigma - \int_{\varsigma=0}^{\varsigma^{\max}} F(\frac{a_t\varsigma}{\varepsilon}) g(\varsigma)\,d\varsigma \\
& + \frac{\varepsilon}{a_t}\int_{\varsigma=0}^{\varsigma^{\max}} \frac{1}{\varsigma}\left[\int_0^{y=a_t\varsigma/\varepsilon} F(y)\,dy\right] g(\varsigma)\,d\varsigma \\
\omega(a_t) =& \frac{\varepsilon}{a_t}\int_{\varsigma=0}^{\varsigma^{\max}} \frac{1}{\varsigma}\left[\int_0^{y=a_t\varsigma/\varepsilon} F(y)\,dy\right] g(\varsigma)\,d\varsigma
\end{aligned}$$

where the first line applies the definition of conditional expectation and exploits the assumption of independence between F and G, the second line integrates by parts and the third line cancels the terms. Then taking the difference with $\omega_M(a_t)$

$$\omega(a_t) - \omega_M(a_t) = \frac{\varepsilon}{a_t} \int_{\varsigma=0}^{\varsigma^{\max}} \frac{1}{\varsigma} \left[\int_0^{y=a_t\varsigma/\varepsilon} \left(F\left(y\right) - M(y)\right) dy \right] g\left(\varsigma\right) d\varsigma$$

and recalling that the $F(z)$ SSOD $M(z)$ if

$$[\int_0^x M(z)dz - \int_0^x F(z)dz] > 0 \, \forall x$$

then $\omega(a_t) - \omega_M(a_t) < 0$ for all a_t. $\omega(a_t|\tau_t) - \omega_M(a_t|\tau_t) < 0$ follows directly from the more general result. Hence the numerator of the negative term in U_t is bigger with a AMPS of F. Since the denominator of the negative term in U_t is decreasing in $H(a_t)$, then as long as $H'(a_t) \leq H(a_t)$, a AMPS of F reduce entry.

B.2.6 Equivalence of higher discount and depreciation

In the text we claim that if a firm's export capital fully depreciates in any given period with exogenous probability d and re-entry requires payment of the original sunk cost then the firm's entry decision is independent of whether it will ever be able to re-enter that market or not after re-paying the cost if we use an effective discount rate $\beta = (1-\delta)(1-d) < 1$. We show this explicitly in this appendix by incorporating the value of re-entry and solving for the cutoff to show it yields the same we obtain in the text. The expected value of starting to export at time t

conditional on observing a_t is

$$\Pi_e(a_t) = \pi(a_t) + \delta(1-\gamma)\varpi(a_t) + \delta\gamma V$$

where V is the expected continuation value if there is a shock and ϖ is the expected profits that incorporate the probability that export capital depreciates. These terms are defined as follows:

$$\begin{aligned} V =& (1-d)\,\mathbb{E}\Pi_e(a') + d\left((1-H(\bar{a}))\left(\mathbb{E}\Pi_e\left(a' \mid a' \geq \bar{a}\right) - K\right) + H(\bar{a})\Pi_w(c)\right) \\ \varpi(a_t < \bar{a}) =& \Pi_e(a_t) + d\Pi_w(a_t < \bar{a}) \\ \varpi(a_t \geq \bar{a}) =& (1-d)\,\Pi_e(a_t) + d\left(\Pi_e(a_t) - K\right) \end{aligned}$$

and the unconditional expected value of ϖ can be defined as

$$\varpi^e = (1-d)\,\mathbb{E}\Pi_e(a') + d\left((1-H(\bar{a}))\left(\mathbb{E}\Pi_e\left(a' \mid a' \geq \bar{a}\right) - K\right) + H(\bar{a})\Pi_w(c)\right)$$

note that $\varpi^e = V$.

In this setting the value of exporting Π_e needs to be adjusted to the probability of depreciation. Focusing in the expected value of exporting $\mathbb{E}\Pi_e$

$$\begin{aligned} \mathbb{E}\Pi_e(a') &= \mathbb{E}\pi(a') + \delta\left(1-\gamma\right)\varpi^e + \delta\gamma V \\ &= \mathbb{E}\pi(a') + \delta V \end{aligned}$$

Now we need expressions for $\mathbb{E}\Pi_e\left(a' \mid a' \geq \bar{a}\right)$ and Π_w. Starting with the $\mathbb{E}\Pi_e\left(a' \mid a' \geq \bar{a}\right)$:

$$
\begin{aligned}
\mathbb{E}\Pi_e\left(a' \mid a' \geq \bar{a}\right) &= \mathbb{E}\pi\left(a' \mid a' \geq \bar{a}\right) + \delta(1-\gamma)\mathbb{E}\Pi_e\left(a' \mid a' \geq \bar{a}\right) - \delta(1-\gamma)dK + \delta\gamma V \\
\mathbb{E}\Pi_e\left(a' \mid a' \geq \bar{a}\right) &= \frac{\mathbb{E}\pi\left(a' \mid a' \geq \bar{a}\right) + \delta\gamma V - \delta(1-\gamma)dK}{1-\delta(1-\gamma)}
\end{aligned}
$$

Now focusing on Π_w

$$
\begin{aligned}
\Pi_w &= 0 + \delta[(1-\gamma)\Pi_w + \gamma H(\bar{a}))\Pi_w + \gamma(1-H(\bar{a}))(\mathbb{E}\Pi_e\left(a' \mid a' \geq \bar{a}\right) - K) \\
\Pi_w &= \frac{\delta\gamma H}{1-\delta\left(1-\gamma(1-H)\right)}\left(\frac{\mathbb{E}\pi\left(a' \mid a' \geq \bar{a}\right)}{1-\delta(1-\gamma)} + \frac{\delta\gamma V - \delta(1-\gamma)dK}{1-\delta(1-\gamma)} - K\right)
\end{aligned}
$$

Solving for V

$$
\begin{aligned}
V &\equiv \left(\left(1-d\right)\mathbb{E}\Pi_e(a') + d\left(\left(1-H\right)\left(\mathbb{E}\Pi_e\left(a' \mid a' \geq \bar{a}\right) - K\right) + H\Pi_w\right)\right) \\
V &= \left(1-d\right)\left(\mathbb{E}\pi(a') + \delta V\right) + d\Pi_w\left(\frac{\left(1-\delta(1-\gamma(1-H))\right)}{\delta\gamma} + H\right) \\
V\left(1-\delta\left(1-d\right)\right) &= \left(1-d\right)\mathbb{E}\pi(a') + d\frac{\left(1-H\right)\left(\mathbb{E}\pi\left(a' \mid a' \geq \bar{a}\right)\right)}{1-\delta\left(1-\gamma(1-H)\right)} \\
&\quad + d\frac{\left(\delta\gamma V - \left(1-\delta(1-\gamma)\left(1-d\right)\right)K\right)}{1-\delta\left(1-\gamma(1-H)\right)} \\
V &= \frac{\left[1-\delta\left(1-\gamma(1-H)\right)\right]\left(1-d\right)\mathbb{E}\pi(a')}{\left(1-\delta\right)\left(1-\delta\left(1-d\right)\left(1-\gamma(1-H)\right)\right)} \\
&\quad + \frac{d(1-H)\left(\mathbb{E}\pi\left(a' \mid a' \geq \bar{a}\right) - \left(1-\delta\left(1-d\right)\left(1-\gamma\right)\right)K\right)}{\left(1-\delta\right)\left(1-\delta\left(1-d\right)\left(1-\gamma(1-H)\right)\right)}
\end{aligned}
$$

Replacing Π_w, Π_e and V in the entry condition and after some algebra we obtain

$$K = \frac{\pi(\bar{a})}{1-\tilde{\beta}(1-\gamma)} + \frac{\tilde{\beta}\gamma}{1-\tilde{\beta}} \frac{\mathbb{E}\pi(a')}{\left(1-\tilde{\beta}(1-\gamma)\right)} + \frac{\tilde{\beta}\gamma}{1-\tilde{\beta}} \frac{H\left[\pi(\bar{a}) - \mathbb{E}\pi\left(a' \mid a' \geq \bar{a}\right)\right]}{\left(1-\tilde{\beta}(1-\gamma)\right)}$$

This is the same expression we obtained by assuming an effective discount rate of $\tilde{\beta}$ and ignoring the continuation payoff when the firm has to restart.

B.3 Empirical Section

B.3.1 Uncertainty Measure

In order to construct our measure of uncertainty, we model the Gross Domestic Product stochastic process for foreign destinations. More specifically, we assume that $\ln gdp_c(t)$ for country c follows an AR(1) process in differences with a Gaussian distributed error term:

$$\Delta \ln gdp_c(t+1) = a_c + \rho_c \Delta \ln gdp_c(t) + \epsilon_c(t+1)$$

We estimate destination-specific parameters for each destination using quarterly frequency data. We compute the uncertainty measure as the share of GDP that a country will lose in the next period if a bad shock arrives.

$$unc_c(t) = 1 - \frac{\exp(\ln gdp_c(t) + \hat{\rho}_c \Delta \ln gdp_c(t) + \hat{\epsilon}_{c,0.05})}{gdp_c(t)}$$

and more specifically we compute this measure at the fourth quarter of 2001. Implicitly, this measure is approximating the expected profit loss using a two state process, involving GDP at the fourth quarter of 2001 and a bad shock at the 0.05 percentile of the distribution. This approach simplifies the construction of the measure and highlights the role of severe shocks, such as the GTC, in firms' decisions.

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