Fast Fashion: Theory and Evidence from Portuguese Textile and Clothing Firms*

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Abstract

We study firms' adoption of just-in-time trade as a response to increased import competition. We use data on all Portuguese textile and clothing exporters' monthly transactions and exploit the exogenous increase in competition following the removal of Multi-Fibre Arrangement (MFA) quotas on Chinese exports. We find that exporting firms specialize in "fast-fashion" in response to increased competition from China—exporting higher quality products to closer markets at higher frequency. We rationalize our findings with a heterogeneous-firm model in which firms choose what products to export and where to sell them, and in each market, the frequency of shipments as well as the quality of products. In response to low-wage competition, the medium-productivity firms increase exports of high-quality products to nearby markets, while the least productive firms drop out from distant and low-income markets.

Key Words: Export frequency, Fast fashion, Just-in-time trade, low-wage country competition, heterogeneous firms, quality upgrading

JEL Classification Numbers: F1, F2.

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"The logic of selling cheaper man-hours is gone, it is via innovation, ability to deliver the needed quantities on time, hearing the client and integrating the production chain that one becomes competitive. There is quality and craftsmanship there that you don't find in Chinese or Turkish flannel." Luis Rodrigues, head of sales at Lameirinho.

1 Introduction

Two important trends have characterized the market for international trade in goods over the last decades: increased competition from low-wage countries and the rising prominence of just-in-time production in global trade.[1] While a body of work has shown that low-wage competition triggered substantial economic restructuring across the world, relatively little is known about the rise in just-in-time trade.[2] Fast changes in consumer tastes and demand for high quality products have contributed to an increased importance of timely delivery of goods and the adoption of faster inventory practices by firms. A well-known example of this is the so-called "fast-fashion", whereby new (clothing) products are developed and are in-store within weeks. Fashion apparel is a very competitive industry with volatile consumer tastes and short product life. With intensified low-wage competition in the industry, time and proximity to the sources of demand became sources of competitive advantage for firms in advanced economies.

This paper studies how import competition from China in third markets induces firms in high-wage economies to specialize in fast trade and quality production. We develop a continuous-time industry-equilibrium model of heterogeneous firms to study exporters' choices of destination markets, the frequency of exporting and the quality of exported products in each market. Changes in export patterns across firms imply that advanced economies become more specialized in fast fashion—exporting higher quality products to closer markets at higher frequency. We investigate the model's predictions using data on all Portuguese textile and clothing (T&C) producers' monthly export transactions. For identification, we exploit the exogenous increase in competition at the detailed product level following the removal of Multi-Fibre Arrangement (MFA) quotas on Chinese T&C exports in 2005.

The setting we analyze is exceptional to study the effects of low-wage competition on the patterns of specialization and trade in developed countries. T&C have been key industries for

[1] Just-in-time inventory (JIT) management was initially introduced in Japan by Toyota in the 1960s to reduce the response times from suppliers to customers, and the flow times within the production process. Recently, JIT has been adopted by manufacturing firms in many countries (see e.g. Sakakibara et al., 1997; White et al., 1999; Alles et al., 2000; Caro and Gallien, 2010).

[2] Studies about the economic effects of competition from low-wage countries, in particular China, include Autor et al., 2013; Acemoglu et al., 2014; Hummels et al., 2014; Bloom et al., 2016.

many countries. For the Chinese and Portuguese economies, the countries of focus in this paper, T&C accounted for 12 and 15 percent of manufacturing exports, respectively, in 2004, before the MFA liberalization. Like in many developed nations, the Portuguese industry had been protected from competition from China until 2005, when China's T&C exports surged by over 100 percent following the removal of MFA quotas (e.g., Khandelwal et al., 2012).[3] Despite the shock, the Portuguese T&C sector remained surprisingly resilient—there is no evidence of a decline in the employment, wages, value added, output, or sales of the Portuguese T&C firms that were exposed to the MFA shock. We relate this puzzle to firms' active quality upgrading of exported products, accompanied by just-in-time exports to proximate destinations.

To guide the empirical analysis of the extent to which firms increase export frequency and upgrade quality in response to low-wage competition, we develop a simple continuous-time industry-equilibrium model of heterogeneous firms. The model emphasizes a trade-off between shipping less frequently to save on fixed costs but experiencing depreciating quantity demanded (due to delayed delivery), and shipping more frequently to slowdown the pace of demand depreciation but experiencing higher fixed costs. Our model focuses on time sensitivity of consumer demand as the factor affecting the frequency of trade (Evans and Harrigan, 2005; Hummels and Schaur, 2013). Consumer electronics and fashionable clothing are examples of goods with time-sensitive demand. We also discuss how firms' decisions on location, frequency, and product quality of exports are interconnected.

Gaining access to large markets increases the returns to investment in quality upgrading. Given higher fixed costs for selling higher quality products, the more productive firms sell in the higher quality segments in each foreign market. In equilibrium, firms also choose to export higher quality products to a given destination at a higher frequency. Based on this firm productivity sorting pattern, and the observation that import competition shocks from low-wage countries are larger in the lower quality segments, following the shocks, profit losses of low-quality sellers are larger than those of high-quality sellers in each market. As such, the least productive firms will exit the market. The medium-productivity exporters that continue to export will upgrade product quality, while the most productive firms have limited incentive to further upgrade quality, due to weaker impact of the trade shocks in the high quality segments.

Consumers' taste for fashion is decreasing in the time gap between production and consumption. Therefore, high-quality firms experience larger loss in profits from delayed delivery, and will optimally choose higher frequency of exports and smaller volume per export transaction. Moreover, since iceberg trade cost is increasing in distance, high-frequency trade also implies an increase

[3]Exports of quota-bound products by T&C manufacturers in Portugal accounted for 55 percent of T&C exports in 2004, before MFA quotas were removed.

in exports to closer destinations at both intensive and extensive margins. In sum, firms escape competition by exporting faster and to closer markets.

We empirically examine the model's predictions using the unique episode of the sharp and permanent removal of MFA quotas on Chinese textile and clothing exports at the detailed product-country level for identification. This strategy exploits variation in competition across products and markets. We study the impact of this shock on essentially all T&C exporters in Portugal. We use four-way transaction-level data on prices and quantities of exports as well as frequency of export transactions and distance to the destinations.

As predicted by our model, we find that for continuing T&C exporters, the unit values of exported products subject to MFA quotas increased following the quota removal, relative to quota-free products. Firms in the middle of the initial productivity distribution are the ones that upgrade quality the most in response to increased competition from China. These patterns are identified within firm-product-countries, implying that quality upgrading is not driven entirely by product churning. We also uncover novel facts that with increased competition, firms become more specialized in what we call 'fast-fashion' exports to closer destinations, as evidenced by an increase in the frequency of export transactions and by a decrease in the average distance of exports. We also find that firms are more likely to drop low-priced products and distant and low-income markets.

Our findings suggest that the ability to deliver on time, easier logistics and the possibility of ordering smaller quantities of higher-quality products, as opposed to the mass production of standardized, lower-quality, products in which developing countries specialize, has been a source of competitive advantage of Portuguese T&C firms.

While our results are based on micro-level data, our paper has broader macroeconomic implications. Our findings that competition from developing countries induces firms in developed economies to specialize in Just-in-time exports to nearby destinations has potential implications for the regionalization of trade. Products that require timely delivery are increasingly produced closer to the final demand. JIT trade can also contribute to increased volatility of trade. Our finding that medium productivity firms respond more to increased competition suggests that medium-sized firms are more flexible in customization and in responding to competition, as evidenced in Holmes and Stevens (2014).

Our paper contributes to several strands of literature. First, it relates to studies on the economic effects of trade integration with developing countries, in particular China. Autor et al. (2013) and Acemoglu et al. (2014) show that increasing Chinese imports significantly suppress job creation, reduce wages and labor market participation in the US. Utar (2014) provides consistent evidence for Denmark.[4] In particular, our analysis complements studies on the effects of low-wage competition on firms' quality and technology upgrading (Barrows and Harrigan, 2009; Goldberg et al, 2010; Amiti and Khandelwal, 2013; Iacovone et al., 2013; Martin and Mejean, 2014; Fieler et al., 2018).[5] Verhoogen (2008) is an earlier paper which finds evidence of quality upgrading, by the more productive exporting firms, induced by a Mexican peso devaluation after the peso crisis. Bastos et al. (2018) document a tight link between firms' export and import unit values and destination countries' income levels, using the same data sets we use for Portugal. Bloom et al. (2016) and Autor et al. (2019) study the effects of import competition from China on firms' innovation and technical change.[6]

Second, our paper complements a still scarce literature on the importance of time and distance in international trade. Evans and Harrigan (2005) find that apparel goods for which timely delivery is important are increasingly imported from nearby countries, using data from a U.S. department store chain. Hummels and Schaur (2010) show that air transport helps firms smooth demand volatility in international markets. Hummels and Schaur (2013) study consumers' willingness to pay an air transport premium to save time. Kropf and Saure (2014) estimate a model that features per shipment fixed costs of exports, frequency of exports, and inventory costs. Our paper is also related to the literature on the lumpiness of trade transactions. Alessandria et al (2010) show that delivery lags and transaction-level economics of scale are important in international trade.

Our paper is distinct from previous studies, however, in several respects. We use exceptionally detailed data on the universe of T&C exports, at the firm-product-country-month level, to study the micro details on how firms react to import competition shocks by specializing in fast-fashion—exporting higher quality goods to nearby destinations at higher frequencies. Our findings about Portuguese exporters' surprising success in tackling China's shocks may provide insights to other developed nations. Our analysis, guided by a theoretical model, sheds light on which firms upgrade product quality and increase the frequency of trade and highlights the role played by medium-sized firms.

Finally, our paper relates to an extensive literature about the pattern and determinants of firms' heterogeneous quality of exports (e.g., Hallak, 2006; Hallak and Schott, 2011; Baldwin and Harrigan, 2011; Fieler, 2011; Johnson, 2012; Kugler and Verhoogen, 2012; Manova and Zhang,

[4] The large shock in China was also shown to cause sharp changes in employment and industrial structural changes in middle-income countries, such as Mexico (Utar and Torres Ruiz, 2013).

[5] We focus on within-firm quality upgrading rather than between firms. Focusing on the supply side (China) instead, Khandelwal, Schott, Wei (2013) uncover substantial productivity gain in the Chinese textile and clothing sector after the MFA liberalization, due to the severe misallocation of quota licenses across Chinese exporters before the MFA quotas were fully removed in 2005.

[6] Bernard et al. (2006) find negative effects of exposure to international trade on firms survival rates and growth in the U.S.

2012; Hallak and Sivadasan, 2013; Martin and Mejean, 2014, Lashkaripour, 2020; among others). Besides adding to the bulk of existing findings, our paper highlights that firms' quality choices of export goods are related to the speed and geography of their exports.

The paper proceeds as follows. Section 2 describes the data. Section 3 presents stylized facts. Section 4 presents the theoretical model. Section 5 discusses the context for our empirical analysis, as well as our empirical strategy. Section 6 presents and discusses the empirical results. The final section concludes.

2 Data

The main data set used in this paper is the Portuguese international trade customs data, from the Foreign Trade Statistics collected by the Office for National Statistics (INE). The data covers virtually the universe of monthly export and import transactions at the firm-product-country level. For each transaction, the data contains information, among others, on free-on-board (FOB) prices and physical quantities of each exported product and imported input (both at the CN 8-digit level, which we aggregate to the HS 6-digit level), from/ to each origin (destination) country (over 200 countries). Data for transactions with countries outside the European Union (EU) are collected by the Customs System ("Extrastat"), and covers the universe of international trade transactions. Due to the removal of physical customs barriers within the EU from 1993, data for transactions with other EU member states have been collected through the "Intrastat" system, under which all firms are required to report information on all of their monthly trade transactions if the total volume of the firms' annual exports or imports to/from the EU (declared on the VAT form) in the current year, the previous year, or two years before are above a legally binding threshold, applied to exports at the firm-level, while they do not preclude any firm below it from reporting.[7] The thresholds are set by each country and need to ensure that at least 97 percent of the country's exports and 93 per cent of imports within the EU are covered in the survey. For Portugal, the threshold was set at 85,000 euros for exports and 60,000 euros for imports.[8] Our sample period is 2000-2008, covering the years before and after the removal of MFA quotas on Chinese T&C imports in 2005. We concord the HS6 classification over time to the HS-1996 classification, to avoid spurious product dynamics. Table 1 reports summary statistics for the main variables used in the analysis.

[7] The Intrastat system is closely linked to the VAT system for intra-EU trade to ensure the completeness and quality of the statistical data. Eurostat regulation also ensures harmonization of methods and definitions for collection of international trade data for both the Intrastat and the Extrastat for compilation of data under both systems.

[8] It is unlikely that the threshold will affect the results since it is applied to exports at the firm-level and the value is only 85,000 euros. Moreover, since the threshold ensures that at least 97% of the country's exports to the EU are included, firms with exports below the threshold would account for a very small share of exports. Also, firms are not precluded from reporting.

We complement the trade data with information on firms' sales from the Enterprise Integrated Accounts System (SCIE), which contains information on sales, employment, industry, output, different types of inputs, and location, among others. Since 2004, detailed balance-sheet information on the universe of all manufacturing firms is available; and prior to 2004, its predecessor, the Annual Survey of Enterprises (IAE), covers the same data for a representative sample of around 40,000 firms. Data are also collected annually by INE. We also use matched employer-employee data from "Quadros de Pessoal", covering the universe of private sector firms and their employees, to obtain measures of skill intensity.

3 Stylized Facts

Before presenting our model and regression analysis on the effects of the removal of quotas on Chinese T&C products, we establish some stylized facts using our data on Portuguese firms' export transactions. Such facts will be used to guide and discipline our model. Some facts are consistent with existing findings in the literature. For instance, as reported in the appendix, Figure A1 shows that (1) export prices and destination income levels are positively correlated (as documented by Schott, 2004; Eaton and Fieler, 2019, among others).[9] In Table A1 in the appendix, we find that larger firms export more products in each destination, and to more destinations for each product, consistent with a body of existing evidence (see e.g., Bernard et al., 2011; Arkolakis et al., 2019).

The first new fact that we uncover, which received little attention in the literature, is a positive relationship between average firms' frequency of exports (within a year) and the economic size as well as the per-capita income of the destination markets. Figures 1 and 2 illustrate these relationships.

[Figure 1 about here]

[Figure 2 about here]

Fact 1: Frequency of export transactions and destination income levels are positively correlated.

The second fact we find in the data is a negative correlation between firms' average export frequency (within a year) and the distance to the destinations (see Figure 3). To the extent that

[9] To obtain weighted average price and frequency for the stylized fact graphs presented in this section, we first estimate the average price (and frequency) at the firm-country-year level, by regressing the ln unit value (and ln frequency) at the firm-product-country-year level on firm-country-year and product-year fixed effects. The firm-country-year estimated fixed effect reflects the average at the firm-country-year purged of effects due to composition of products. We then obtain the weighted average for a country-year, across firms, using export quantity as weights. We use data for 2004, the year before the MFA quotas were abolished, for the graphs presented.

trade costs are increasing distance, it is possible that per-shipment trade costs, both variable and fixed, are non-negligible.

[Figure 3 about here]

Fact 2: Frequency of export transactions and distance to destinations are negatively correlated.

Let us now present regression results relating the destinations' income levels and distance from the origin to firms' export patterns. We estimate the following equation:

$$Y_{isct} = \beta_1 \ln gdp_{ct} + \beta_2 \ln pcgdp_{ct} + \beta_3 \ln dist_c + FE_{ist} + \zeta_{isct}, \tag{1}$$

where gdp_{ct}, $pcgdp_{ct}$, and $dist_c$ measure the destination country's GDP, per-capita GDP, and physical distance to Portugal, respectively. We control for firm-product-year fixed effects, thus exploiting variation across countries within a firm-product-year. Standard errors are clustered by firm.[10]

[Table 2 about here]

Within each firm-product(HS6)-year, we find that Portuguese T&C firms export more frequently and more in each shipment to larger and closer markets on average.[11] They also tend to export more frequently but less in each shipment to high-income countries. This set of results is our first piece of evidence about firms' engaging in fast-fashion exports—shipping more frequently smaller batches of goods to richer markets.

In column (3) we show that the unit value of a firm-product-country triple in a year is positively correlated with per-capita income of the destination country, as well as the distance from it. The first fact has been confirmed by a number of studies about quality sorting based on income levels of the countries (e.g., Hallak and Sivadasan, 2013). The second fact confirms the famous "Washington Apple" hypothesis (Alchian and Allen, 1964; Hummels and Skiba, 2004).

The regression results in Table 2 are summarized in the following two stylized facts.

Fact 3: Firms export more frequently to the larger, richer, or closer markets on average. Their average shipment size is bigger in the larger, poorer, or closer markets. Their average export price is higher in the richer or more distant markets.

[10] Results are robust to alternative clustering of the standard errors, such as by country.
[11] Blum et al. (2019) document similar patterns using Chilean firm data, but for imports.

In addition to documenting the relationships between firms' export frequency, unit values and destination countries' characteristics, in Table 3, we report regression results about the relationship between firms' export unit values and export frequency. Column (1) shows that after controlling for firm-country and product fixed effects, export frequency at the firm-product-country-year is positively correlated with the products' price. In column (2), we find that larger firms export higher-priced products (Kugler and Verhoogen, 2012).

[Table 3 about here]

Fact 4: In a given destination, larger firms tend to export higher-priced products, which tend to be exported at a higher frequency.

Among these four stylized facts, in the rest of the paper, we will focus a firm's export frequency and its relationship with destination markets and firm product choices, which are the missing pieces in the literature. We will first develop a theoretical model to guide our empirical analysis.

4 Model

We develop a simple continuous-time industry-equilibrium model of heterogeneous firms. The goal is to examine exporters' choices of destination markets, the frequency of exporting and the quality of exported products in each market. The model incorporates the insights from Kropf and Saure (2014) and Blum et al. (2019), who emphasize a trade-off between shipping more frequently but incurring more fixed costs of trade, and shipping less frequently to save fixed costs but experiencing faster depreciation in the quantity demanded due to delayed delivery. Like Blum et al. (2019), we also consider heterogeneous product quality across firms. Different from these studies which consider inventory costs as the reason for declining profits, our model focuses on another aspect that should naturally affect the frequency of trade—the time sensitivity of consumer demand (Hummels and Schaur, 2012).

We will first characterize firms' equilibrium patterns of exports, keeping the four stylized facts above in mind. We will then conduct numerous comparative static exercises, which will be confronted with a empirical analysis below using the MFA liberalization shocks.

4.1 Set-up

Consider a world consisting of $M + 1$ countries, indexed by $m \in \{0, 1, 2...M\}$, with country 0 indicating Home (Portugal). Each country is endowed with a unit mass of labor, the only factor of production, and consumes a number of goods, of which T&C is one of them. We focus on solving for the industry equilibrium and examining firms' decisions to export to M countries, and abstract from analyzing firms' domestic sales decisions.

Each firm can choose to produce any product in the T&C sector (e.g., jackets, jeans, shirts, etc.) and sell them in any or none of the M foreign markets. In each market (defined as a country-product pair), the firm chooses a single quality segment to produce and sell horizontally differentiated products in the market.[12] Market structure is monopolistically competitive, implying that each firm faces its own demand. Each firm in a market is assumed to be small and takes aggregate variables as given. Trade is costly and entails both variable and fixed costs. The demand side of the model is similar to a multi-product version of Melitz (2003), as in Bernard, Redding, and Schott (2011).

4.1.1 Demand Side

The utility of a representative consumer in country j is given by a Cobb-Douglas function over K discrete T&C products, indexed by $k \in \{1, 2, .., K\}$: $U_j = \sum_{k=1}^{K} \zeta_k \ln C_{jk}$, where ζ_k is the spending share on product k in each country, and $\sum_{k=1}^{K} \zeta_k = 1$.

For each T&C product, aggregate consumer demand is structured as a 2-tier CES system. In the upper nest there is differentiation between different quality segments of the same good, indexed by $s \, \epsilon \, \{1, 2, ..., S\}$, with $S \, \epsilon \, [1, \infty)$.[13] A higher s indicates higher quality perceived by consumers. For simplicity, we assume that the maximum number of segments, S, is the same for all products.[14] Examples of a variety belonging to the high quality segment of a T&C good include a designer leather jacket or a hand knit dress. These items are usually produced in small batches with a unique design that is difficult to be mass-produced or replicated by machines. On the other hand, a low quality segment product can be a polyester jacket and a cotton T-shirt with heat-pressed printing.[15] Such products can be easily replicated, mass-produced by machines or low-skilled workers.

Consumers in market m consume varieties from possibly all segments according to the following

[12] The assumption that each firm will only choose one quality segment per market (a country-product pair) is crucial for our results about firms' escaping competition later.

[13] An extensive literature provides evidence of the importance of product quality differences, which includes Hallak and Schott (2011), Hottman, Redding, and Weinstein (2015), Khandelwal (2010), Manova and Zhang (2012) and Schott (2004).

[14] None of our theoretical results depends on this assumption.

[15] Fajgelbaum, Grossman, and Helpman (2011), Holmes and Stevens (2014), and Lim, Trefler, and Yu (2019) also consider multiple discrete segments within sectors.

CES utility function

$$C_{mk} = \left[\sum_{s=1}^{S} \Theta_{mk}^{s} \left(C_{mk}^{s}\right)^{\frac{\kappa_k - 1}{\kappa_k}}\right]^{\frac{\kappa_k}{\kappa_k - 1}}, \tag{2}$$

where Θ_{mk}^{s} is a demand shifter that captures the overall appeal of s-segment products. Previous research (e.g., Hallak, 2006; Auer et al., 2018) and our own Fact 1 have shown that high-income individuals appear to have stronger preferences for high-quality/ high-priced products. It is therefore reasonable to assume that the representative consumer from a rich country will have higher Θ_{mk}^{s} for higher quality segments. More formally, $\frac{d\Theta_{mk}^{s'}}{dy_m} > \frac{d\Theta_{mk}^{s}}{dy_m}$ for $s' > s$, where y_m is per-capita income. The parameter $\kappa_k > 1$ stands for the product-specific elasticity of substitution between varieties from different segments. We normalize $\sum_{s=1}^{S} \Theta_{mk}^{s} = 1$.

Within a quality segment s, there is a continuum of varieties (indexed by ω), which are imperfectly substitutable according to the following CES aggregator:

$$C_{mk}^{s} = \left(\int_{\omega \in \Omega_{mk}^{s}} \left(\left(a_{mk\omega}^{s}\right)^{\lambda_{mk}} q_{mk\omega}^{s}\right)^{\frac{\sigma_k - 1}{\sigma_k}} d\omega\right)^{\frac{\sigma_k}{\sigma_k - 1}}, \tag{3}$$

where Ω_{mk}^{s} is the set of consumption varieties in segment s of product k in market m. σ_k is the elasticity of substitution between different varieties within the nest, which is assumed to be constant for the same product-segment pair in all countries. As in the existing literature, we assume that the elasticity of substitution between varieties is higher than the elasticity of substitution between products in the higher nest (i.e., $\sigma_k > \kappa_k$).

The variable $a_{mk\omega}^{s} > 0$ captures firm ω's product appeal in segment s of product k, while $\lambda_{mk} > 0$ captures country m's consumers' sensitivity to the variation in the product appeals across firms producing product k. A firm's product appeal is a multiple of two components:

$$a_{mk\omega}^{s} = \theta_{mk\omega}^{s} e^{-\beta_k t_{mk\omega}^{s}},$$

where $\theta_{mk\omega}^{s}$ stands for firm ω's market (mk)-specific product quality, and $e^{-\beta_k t_{mk\omega}^{s}}$ captures consumers' disutility from delayed delivery, as in Hummels and Schaur (2012). $t_{mk\omega}^{s}$ is the time lapsed since the goods left the factory gate of firm ω (to be elaborated below). When the time of production and consumption coincide, $t_{mk\omega}^{s} = 0$ and $a_{mk\omega}^{s} = \theta_{mk\omega}^{s}$. In general, $t_{mk\omega}^{s} > 0$ and $a_{mk\omega}^{s} < \theta_{mk\omega}^{s}$. Given $\theta_{mk\omega}^{s}$, the effective quality $a_{mk\omega}^{s}$will be smaller the longer the time lapsed since production. β_k captures consumers' sensitivity to delayed delivery of product k. We normalize $\theta_{mk}^{1} = 1$, which implies that $\theta_{mk}^{s} > 1$ $\forall s > 1$.

The price index dual to (3) of segment s of product k sold in market m, P_{mk}^{s}, is a CES aggregator over prices of individual varieties within the nest:

$$P^s_{mk} = \left[\int_{\omega \in \Omega^s_{mk}} \left(\frac{p^s_{mk\omega}}{\left(a^s_{mk\omega}\right)^{\lambda^s_{mk}}} \right)^{1-\sigma_k} d\omega \right]^{\frac{1}{1-\sigma_k}}, \tag{4}$$

while the price index of product k in country m dual to (2) is

$$P_{mk} = \left[\sum_{s=1}^{S} \left(\frac{P^s_{mk}}{\Theta^s_{mk}} \right)^{1-\kappa_k} \right]^{\frac{1}{1-\kappa_k}}, \tag{5}$$

Therefore, the expenditure share on each segment in the upper nest (i.e., $\frac{P^s_{mk} C^s_{mk}}{P_{mk} C_{mk}}$) can be expressed in terms of their corresponding price indices as $\left(\frac{P^s_{mk}/\Theta^s_{mk}}{P_{mk}} \right)^{1-\kappa_k}$. Similarly, the expenditure share for each variety in total expenditure on segment s in product k is $\left(\frac{p^s_{mk}/\theta^s_{mk\omega}}{P^S_{mk}} \right)^{1-\sigma_k}$.

Utility maximization implies that firm ω faces its iso-elastic demand in product k and country m:

$$r^s_{mk\omega} \equiv p^s_{mk\omega} q^s_{mk\omega} = \zeta_k Y_m \left(P^s_{mk}\right)^{\sigma_k - \kappa_k} \left(P_{mk}\right)^{\kappa_k - 1} \left(p^s_{mk\omega}\right)^{1-\sigma_k} \left(\Theta^s_{mk}\right)^{\kappa_k - 1} \left(a^s_{mk\omega}\right)^{\lambda_{mk}(\sigma_k - 1)} \tag{6}$$

where Y_m is market m's total nominal expenditure on T&C goods. We assume that each firm is small so that all price indices and Y_m are taken as given by the firm. Notice that the price of the good does not depend on the time of consumption, while demand does.

Now let us solve for the firm equilibrium in two steps. The first step involves the firm's choosing the optimal set of products and countries to export. A decision to export an additional product or to an additional country will be associated with extra fixed costs (below). For each country-product chosen, the firm will choose one optimal quality segment of goods and how frequent to sell the product there. All these choices are the solutions to the firm's maximization of the present discounted value (NPV) of a continuous stream of profits.

In the second step, conditional on choosing an optimal set of country-product-segment triples, each associated with an optimal frequency of exporting, the firm solves for the price and quantity sold in each triple. The firm is forward-looking and knows exactly the value of each export transaction, in the absence of information asymmetry.

4.1.2 Firms' Instantaneous Price and Profits

We will solve the model backward by first characterizing the solutions to the second step of a firm's problem. We focus on a particular firm and suppress the firm subscript ω from now on.

Conditional on choosing the optimal quality segment for a market (a mk pair), the firm's marginal cost of production is

$$c_{mk}^{s}\left(\theta_{mk}^{s},\varphi\right)=\tau_{mk}\frac{w\left(\theta_{mk}^{s}\right)^{\gamma_k}}{\varphi},$$

where φ is the firm's labor productivity, γ_k determines the increment in the marginal cost of quality production in product k, and w is the wage rate of labor at Home. τ_{mk} is the iceberg trade cost to export a variety from Home to market m in product k.

The standard mill price for each product-segment-market triple is

$$p_{mk}^{s}\left(\theta_{mk}^{s},\varphi\right)=\frac{\sigma_k\tau_{mk}w}{\sigma_k-1}\frac{\left(\theta_{mk}^{s}\right)^{\gamma_k}}{\varphi}. \tag{7}$$

Notice that we model time sensitivity of consumption as a purely subjective aspect of preferences so that prices are independent of the time gap between production and consumption. In other words, given the same price and objective quality of a variety (θ_{mk}^{s}), quantity demanded will be lower for varieties that were produced longer ago.

Conditional on the firm choosing the optimal set of country-product-segment triples and the optimal frequency of exports for each triple, the instantaneous operating profit from each triple, based on (6) and (7), is

$$\widetilde{\pi}_{mk}^{s}=\overline{\pi}_{mk}^{s}\left(\varphi\right)e^{-\beta_k t_{mk}^{s}\lambda_{mk}(\sigma_k-1)}, \tag{8}$$

where $\overline{\pi}_{mk}^{s}\left(\varphi\right)=\Phi_{mk}^{s}\varphi^{\sigma_k-1}\left(\theta_{k}^{s}\right)^{(\lambda_{mk}-\gamma_k)(\sigma_k-1)}$ and

$$\Phi_{mk}^{s}=\left(\sigma_k\right)^{-\sigma_k}\left(\sigma_k-1\right)^{\sigma_k-1}\zeta_k Y_m\left(P_{mk}^{s}\right)^{\sigma_k-\kappa_k}\left(P_{mk}\right)^{\kappa_k-1}\left(\Theta_{mk}^{s}\right)^{\kappa_k-1}\left(\tau_{mk}w\right)^{1-\sigma_k} \tag{9}$$

is a country-product-segment-specific variable, taken as given by the firm. Later on we assume that the MFA liberalization, which leads to a sudden rise in exports of T&C goods from China, affects Φ_{mk}^{s} differently for different combinations of m, k and s.

In general, conditional on selecting into a triple, there will be complementarity between market size of the destination (Y_m) and firm productivity in terms of profits, as $\frac{\partial^2\widetilde{\pi}_{mk}^{s}}{\partial Y_m\partial\varphi}>0$. Conditional on sufficiently high sensitivity of consumer demand to quality, compared to the increment in marginal cost of producing high-quality products (i.e., $\lambda_{mk}>\gamma_k$), there will also be complementarity between quality, productivity, and market size in terms of profits as $\frac{\partial\widetilde{\pi}_{mk}^{s'}}{\partial\varphi}>\frac{\partial\widetilde{\pi}_{mk}^{s}}{\partial\varphi}>0$, $\frac{\partial\widetilde{\pi}_{mk}^{s'}}{\partial Y_m}>\frac{\partial\widetilde{\pi}_{mk}^{s}}{\partial Y_m}>0$, and $\frac{\partial^2\widetilde{\pi}_{mk}^{s'}}{\partial\varphi\partial Y_m}>\frac{\partial^2\widetilde{\pi}_{mk}^{s}}{\partial\varphi\partial Y_m}>0$.[16] Fact 2 established above illustrates a positive correlation between the

[16] On the contrary, if $\lambda_{mk}<\gamma_k$, producing higher quality, all else equal, is associated with lower profits, especially for more productive firms or in larger markets.

average (log) unit value of firms' exports and destination countries' per capita GDP, suggesting firms' positive quality sorting across markets with different income levels.[17] We can confidently impose the following parametric assumption.

Assumption 1: $\lambda_{mk} > \gamma_k$.

As in many standard heterogeneous-firm model in trade, we can conduct simple comparative static exercises to show that given the wage rate, w_m, and economic size, Y_m, of destination m, the optimal sets of products, segments, countries, and export frequency for each country-product-segment triple chosen by a firm to maximize profit, a higher firm productivity is associated with (1) lower instantaneous prices; (2) higher profits; and (3) higher expenditure shares in the country-product-segment triple.

Within a country-product pair, our model also has implications about the likelihood that the firm will produce higher rather than lower quality segments.[18] Such decision will be related to the ratio that captures the relative profitability of selling high versus low quality products in a given market, which equals

$$\frac{\widetilde{\pi}_{mk}^{s'}}{\widetilde{\pi}_{mk}^{s}} = \frac{\Phi_{mk}^{s'}}{\Phi_{mk}^{s'}} \left(\frac{\theta_k^{s'}}{\theta_k^{s}} \right)^{(\lambda_{mk}-\gamma_k)(\sigma_k-1)} e^{\beta_k \lambda_{mk} \left(t_{mk}^{s} - t_{mk}^{s'} \right)(\sigma_k - 1)}. \tag{10}$$

Several remarks are in order. First, the relative profitability is increasing in $\Phi_{mk}^{s'}/\Phi_{mk}^{s} = \left(P_{mk}^{s'}/P_{mk}^{s}\right)^{\sigma_k-\kappa_k} \left(\Theta_{mk}^{s'}/\Theta_{mk}^{s}\right)^{\kappa_k-1}$ and $\theta_k^{s'}/\theta_k^{s}$ (given Assumption 1), respectively. This is especially true if the demand is more elastic (i.e., σ_k is higher).

Second, while the frequency of trade will be optimally chosen for different markets and segments, we can first discuss the complementarity between frequency and quality choices, an important feature that is behind various propositions below. In particular, the cross-partial $\log\left(\widetilde{\pi}_{mk}^{s'}/\widetilde{\pi}_{mk}^{s}\right)$ with respect to the time-lag difference $t_{mk}^{s} - t_{mk}^{s'}$ is

$$\frac{\partial^2 \log\left(\widetilde{\pi}_{mk}^{s'}/\widetilde{\pi}_{mk}^{s}\right)}{\partial\theta_k^{s'}\partial\left(t_{mk}^{s} - t_{mk}^{s'}\right)} \propto \left(\frac{\theta_k^{s'}}{\theta_k^{s}} \right)^{(\lambda_{mk}-\gamma_k)(\sigma_k-1)-1} e^{\beta_k \lambda_{mk} \left(t_{mk}^{s} - t_{mk}^{s'} \right)(\sigma_k - 1)} > 0.$$

Thus, producing varieties of higher quality, s', is more attractive if the optimal frequency chosen for those varieties ($1/t_{mk}^{s'}$) is higher than that ($1/t_{mk}^{s}$) for lower quality varieties (s) in the same market. This speed advantage is naturally greater if consumers are more time-sensitive (i.e., higher

[17] Manova and Zhang (2012) find consistent results using a sample of all Chinese exporting fims.

[18] Thus, the positive correlation between firm size (a proxy for productivity) and export prices, as established in Fact 5 above, is an outcome of product quality choices.

β_k) or more sensitive to differences in the product appeals across firms in product k (i.e., higher λ_{mk}). In general, any exogenous factor that discourages a firm from choosing a high frequency of exports will also deter the firm from choosing high quality, and vice versa.

Let us summarize the analysis of the profitability ratio in the following proposition.

Proposition 1. Given w_m, Y_m of each destination, the optimal sets of countries (m), products (k), segments (s), as well as export frequency for each country-product-segment triple chosen by the firm to maximize profit, the profitability of selling higher quality products (s') relative to selling lower quality products ($s < s'$) is higher if (1) $P^{s'}_{mk}/P^{s}_{mk}$ is larger and/ or (2) $\Theta^{s'}_{mk}/\Theta^{s}_{mk}$ is larger. The profitability ratio is also increasing in the quality difference between higher and lower quality products, more so if the higher quality products are delivered at a relatively faster rate to the same market (m, k).

Let us now characterize the solutions to the first step of the firm's problem. The firm in this step chooses the optimal set of (1) products, (2) countries, and (3) segments to export. Then for each chosen country-product-segment triple, the firm optimally chooses the frequency of exporting. Each decision will be associated with the corresponding fixed cost.

4.2 Firms' Choices of Export Frequency

Let us first analyze the problem of choosing the frequency of shipment, conditional on optimally chosen markets and quality segments. Each incident of exporting is associated with a country-product-specific fixed cost in terms of labor (wf_{mk}). Firms will never ship in every instantaneous period because otherwise, the sum of fixed costs will be infinite over continuous time. As such, each firm faces a trade-off between shipping less frequently to save fixed costs but experiencing depreciating quantity demanded due to delayed delivery, and paying more fixed costs to ship more frequently to slow down the pace of demand depreciation.

We denote the duration between two consecutive shipments of segment s to market mk by Δ^s_{mk}. Given an optimally chosen Δ^s_{mk}, the present discounted value over the instantaneous stream of profits between two consecutive shipments is

$$\Pi^s_{mk} = \int_0^{\Delta^s_{mk}} \left(e^{-rt'} \overline{\pi}^s_{mk}(\varphi) \, e^{-\beta_k t^s_{mk} \lambda_{mk}(\sigma_k - 1)} dt - wf_{mk} \right),$$

where r is the time discount rate.

We assume no uncertainty in decision making so once a firm chooses the set of optimal triples and the frequency of exports per triple, it has no incentive to change the decisions in the future. Given the absence of uncertainty and constant time discounting, the frequency of shipment ($1/\Delta^s_{mk}$) is determined by a firm's maximization of the NPV of all instantaneous profits over an infinite horizon. Specifically, the firm solves the following problem by choosing Δ^s_{mk}:

$$\begin{aligned} \pi^s_{mk}(\varphi) &= \max_{\Delta^s_{mk}} \left\{ \frac{1}{1-e^{-r\Delta^s_{mk}}} \left[\int_0^{\Delta^s_{mk}} \left(e^{-rt'} \overline{\pi}^s_{mk}(\varphi)\, e^{-\beta_k t^s_{mk} \lambda_{mk}(\sigma_k-1)} dt - w f_{mk} \right) \right] \right\} \\ &= \max_{\Delta^s_{mk}} \left\{ \frac{1}{1-e^{-r\Delta^s_{mk}}} \left[\left(\frac{1-e^{-(r+\phi_{mk})\Delta^s_{mk}}}{r+\phi_{mk}} \right) \overline{\pi}^s_{mk}(\varphi) - w f_{mk} \right] \right\} \end{aligned} \quad (11)$$

where $\overline{\pi}^s_{mk}(\varphi)$ is defined in (8) and $\phi_{mk} \equiv \lambda_{mk}\beta_k(\sigma_k - 1)$. wf_{mk} is the fixed cost per shipment. Conditional on choosing a country-product-segment triple to serve, the firm with productivity φ will initiate a shipment if $\pi^s_{mk}(\varphi) \geq 0$. Otherwise, the specific triple will not be chosen by the firm.

Taking derivative of (11) with respect to $e^{\Delta^S_{mk}}$ yields the following implicit equation that characterizes the optimal choice of the duration between two consecutive shipments Δ^{s*}_{mk}.

$$\frac{r + \phi_{mk} e^{(r+\phi_{mk})\Delta^{s*}_{mk}} - (r+\phi_{mk})\, e^{\phi_{mk}\Delta^{s*}_{mk}}}{r+\phi_{mk}} = \frac{r w f_{mk}}{\Phi^s_{mk} \varphi^{\sigma_k - 1} \left(\theta^s_k\right)^{(\lambda_{mk}-\gamma_k)(\sigma_k-1)}} \quad (12)$$

Notice that the left hand side of (12) monotonically increases in Δ^{s*}_{mk}, is negative when $\Delta^{s*}_{mk} = 0$, and becomes positive when $\Delta^{s*}_{mk} = \infty$. This guarantees that a unique Δ^{s*}_{mk} solves (12).

As a result, any parameter that results in a decline in the right hand side, such as a larger market size (that increases Φ^s_{mk}), lower iceberg trade costs (that decrease Φ^s_{mk}), or lower fixed shipment costs (f_{mk}) will lower Δ^{s*}_{mk}, and thus raise the frequency of exports to country m. These determinants of Δ^s_{mk} are summarized by the following testable hypothesis.

Proposition 2. The export frequency of a firm exporting goods in segment s of product k to country m (i.e., $1/\Delta^s_{mk}$) is positively correlated with the size of market m, but negatively correlated with the iceberg trade costs (τ_{mk}) and fixed costs of trade (f_{mk}).

To the extent that τ_{mk} is increasing in the distance between the exporting and importing countries, we can empirically verify the second part of Proposition 2 using data on firms' exports across destination countries. In fact, our Facts 3 and 4 above already offered evidence supporting Proposition 2.

If $\Phi^{s'}_{mk} > \Phi^s_{mk}$ for $s' > s$ within a market (mk), the right hand side of equation (12) is lower for the high-quality segment, all else being equal. Similar to the proof of Proposition 2, in particular the part about the positive relation between f_{mk} and Δ^{s*}_{mk} (i.e., a lower frequency of exports), we can also prove that the frequency of trade will be higher for the higher quality segment s' of a market, compared to the low-quality segment s. The assertion is likely to be true for richer markets than for poorer markets, as has been empirical verified in the existing literature (e.g., Hallak, 2006). The following proposition concludes this discussion.

Proposition 3. All else being equal, the frequency of a firm's exports of product k to country m is higher in the higher quality segments, especially to richer countries.

4.3 Firms' Export Entry Decisions

Let us analyze the first step of the firm's problem, in which it chooses the optimal sets of countries (Ω^*), products in each country (Ψ_m^*), and the unique quality segment in each market (a country-product pair) (s_{mk}^*) to maximize profit. In addition to the fixed cost for each incidence of exporting (wf_{mk}), there are fixed entry costs for each country m (wF_m^M), for each country-product pair mk (wF_{mk}^K), and for selling in a different quality segment in each country-product (wF_{mk}^s).

Specifically, a firm's profit maximization problem at the point of entry is

$$\max_{\{m\in\Omega;k\in\Psi_m;s\in S_{mk}\}} \sum_{m\in\Omega}\sum_{k\in\Psi_m}\sum_{s\in S_{mk}} \pi_{mk}^s(\varphi)$$
$$-\sum_{m\in\Omega} wF_m^M - \sum_{k\in\Psi_m}\sum_{m\in\Omega} wF_{mk}^K - \sum_{s\in S_{mk}}\sum_{k\in\Psi_m}\sum_{m\in\Omega} wF_{mk}^s,$$

where $\pi_{mk}^s(\varphi)$ is the NPV, as defined in (11). Let us make two more parametric assumptions to discipline the theoretical predictions.

Assumption 2: $F_{mk}^S > F_{mk}^{S-1} > ... > F_{mk}^1 > 0 \ \forall s \in \{1, 2, ..., S\}$

This assumption states that the fixed costs for exporting higher quality products are higher. One can think of additional marketing and wholesale-retail activities that are more costly for high quality products.

Assumption 3:

There exists a segment $l \in [2, S]$ such that $\Phi_{mk}^l > \Phi_{mk}^1$.

Assumption 3 implies that the lowest quality segment cannot be the segment offering the highest NPV for any firm. This assumption should hold intuitively as Portuguese T&C firms, compared to emerging markets' firms, are unlikely to have a comparative advantage in selling the lowest quality products.

Let us define the productivity range over which a firm will sell only in the lowest quality segment, conditional on choosing to export product k to country m. After incurring the corresponding country-specific and country-product-specific fixed costs, a firm will choose the lowest quality segment as the only segment in the market if its productivity φ satisfies the following two inequalities:

$$\pi_{mk}^{1}(\varphi) - wF_{mk}^{1} \geq 0; \tag{13}$$

$$\pi_{mk}^{1}(\varphi) - wF_{mk}^{1} > \pi_{mk}^{1+}(\varphi) - wF_{mk}^{1+}, \tag{14}$$

where

$$\pi_{mk}^{1+}(\varphi) - wF_{mk}^{1+} = \min_{s'} \left\{ \pi_{mk}^{s'}(\varphi) - wF_{mk}^{s'} \right\} \quad \forall s' \in \{2, ..., S\}.$$

By solving (13) and (14) at equality, we can derive the productivity thresholds $\overline{\varphi}_{mk}^{1}$ and $\overline{\varphi}_{mk}^{1+}$ in closed form, such that a firm with productivity $\varphi \in [\overline{\varphi}_{mk}^{1}, \overline{\varphi}_{mk}^{1+})$ will export only in segment 1. Specifically (see the appendix for details):

$$\left(\overline{\varphi}_{mk}^{1}\right)^{\sigma_k - 1} = \frac{w\left(\delta_{mk}^{1} f_{mk} + F_{k}^{1}\right)}{\psi_{mk}^{1} \Phi_{mk}^{1}}; \tag{15}$$

$$\left(\overline{\varphi}_{mk}^{1+}\right)^{\sigma_k - 1} = \frac{w\left(\Delta\delta_{mk}^{1+} f_{mk} + \Delta F_{k}^{1+}\right)}{\psi_{mk}^{1+} \Phi_{mk}^{1+} \widetilde{\theta}_{k}^{1+} - \psi_{mk}^{1} \Phi_{mk}^{1}}, \tag{16}$$

where $\delta_{mk}^{s} = \frac{1}{1-e^{-r\Delta_{mk}^{s}}}$, $\psi_{mk}^{s} = \frac{1-e^{-(r+\phi_{mk})\Delta_{mk}^{s*}}}{\left(1-e^{-r\Delta_{mk}^{s*}}\right)(r+\phi_{mk})}$, $\Delta\delta_{mk}^{1+} = \delta_{mk}^{1+} - \delta_{mk}^{1}$, $\Delta F_{k}^{1+} = F_{k}^{1+} - F_{k}^{1}$, and $\widetilde{\theta}_{k}^{1+} = \left(\theta_{k}^{1+}\right)^{(\lambda_{mk}-\gamma_k)(\sigma_k-1)}$. Given Assumptions 2 and 3, we can also show that $\overline{\varphi}_{mk}^{1+} > \overline{\varphi}_{mk}^{1}$.

Conditional on the firm's overcoming the fixed costs to export product k of country m, $\Delta_{mk}^{s'} < \Delta_{mk}^{s}$ for any $s' > s$ according to Proposition 4. These results, however, do not imply that a firm will always sell in segment s' in market mk, as higher fixed costs may imply losses from selling in the higher quality segments, despite higher revenue. That said, with Assumption 3, we know that there exists segment $s \geq 1$, for which we can solve for threshold $\overline{\varphi}_{mk}^{s}$, so that firms' with productivity above $\overline{\varphi}_{mk}^{s}$ will export in quality segment s or in higher quality segments. Specifically, firms with productivity φ, that satisfies the following set of inequalities will export in segment $s > 1$ in market

mk:

$$\pi_{mk}^{s}(\varphi) - wF_k^s \geq \pi_{mk}^{s-}(\varphi) - wF_k^{s-}; \tag{17}$$

$$\pi_{mk}^{s+}(\varphi) - wF_k^{s+} < \pi_{mk}^{s}(\varphi) - wF_k^{s}, \tag{18}$$

where

$$\begin{aligned} s^- &\equiv \arg\min_{s'} \left\{ \pi_{mk}^{s'}(\varphi) - wF_{mk}^{s'} \right\} \quad \forall s' \in \{1, ..., s-1\}; \\ s^+ &\equiv \arg\min_{s'} \left\{ \pi_{mk}^{s'}(\varphi) - wF_{mk}^{s'} \right\} \quad \forall s' \in \{s+1, ..., S\}. \end{aligned}$$

We can solve for both (17) and (18) at equality and pin down the productivity range $[\overline{\varphi}_{mk}^{s}, \overline{\varphi}_{mk}^{s+})$, over which a firm will export in segment s only.[19] Solving them yields (see the appendix for details):

$$\left(\overline{\varphi}_{mk}^{s}\right)^{\sigma_k - 1} = \frac{w\left(\Delta\delta_{mk}^{s} f_{mk} + \Delta F_k^s\right)}{\psi_{mk}^{s} \Phi_{mk}^{s} \widetilde{\theta}_k^{s} - \psi_{mk}^{s-l} \Phi_{mk}^{s-} \widetilde{\theta}_k^{s-}} \tag{19}$$

$$\left(\overline{\varphi}_{mk}^{s+}\right)^{\sigma_k - 1} = \frac{w\left(\Delta\delta_{mk}^{s+} f_{mk} + \Delta F_k^{s+}\right)}{\psi_{mk}^{s+} \Phi_{mk}^{s+} \widetilde{\theta}_k^{s+} - \psi_{mk}^{s} \Phi_{mk}^{s} \widetilde{\theta}_k^{s}} \tag{20}$$

where $\Delta\delta_{mk}^{s} = \delta_{mk}^{s} - \delta_{mk}^{s-}$, $\Delta F_k^s = F_k^s - F_k^{s-}$, $\widetilde{\theta}_k^{s+} = \left(\theta_k^{s+}\right)^{(\lambda_{mk} - \gamma_k)(\sigma_k - 1)}$, and $\widetilde{\theta}_k^{s} \equiv \left(\theta_k^{s}\right)^{(\lambda_{mk} - \gamma_k)(\sigma_k - 1)}$.The lower bound of the productivity range ($\overline{\varphi}_{mk}^{s}$) is decreasing in the segment-specific market size (Φ_{mk}^{s}) and increasing in the market size of the active segment immediately below it (Φ_{mk}^{s-}), all else being equal. It is increasing in the gap in the fixed costs between selling in the segment and the segment immediately below ($F_k^s - F_k^{s-}$). The same analysis can be discussed for the next active quality segment ($s+$).

In general, firms that are sufficiently productive will overcome higher fixed costs to sell in higher quality segments. Whenever there are at least two active quality segments in a market, which is guaranteed by Assumptions 3 and 4, we will have the more productive firms choosing to overcome the higher fixed costs to export in the higher quality segments. Figure 4 graphically illustrates the pattern of productivity sorting in a simplified two-segment version of our model. Together with Proposition 3, we can also show that the frequency of exports is higher for these more efficient higher quality exporters in the same market. The predictions are supported by Fact 4 above. We summarize firm productivity sorting into different quality segments and frequency of trade in the following proposition.

[19] Figure 5 graphically illustrates the linear relationship between $\pi_{mk}^{s}(\varphi)$ and $\varphi^{\sigma_k - 1}$ for the two-segment case, and how $\pi_{mk}^{2}(\varphi)$ undercuts the profit line associated with $\pi_{mk}^{1}(\varphi)$ due to higher marginal revenue and also higher fixed costs.

[Figure 4 about here]

Proposition 4. Within a market (mk), more productive firms tend to export in the higher quality segment (high-priced products), which tend to be associated with a higher frequency of export transactions.

Regarding productivity sorting in terms of the scope of exporting, we can simply follow the proofs in Bernard et al. (2018) to show that given w_m, Y_m of each destination, and an optimal set of markets chosen by a firm, an increase in the firm's productivity implies higher variable profits from an expansion of products sold in each country, or from an expansion of countries served for each product. An immediate outcome is that more productive firms will export to more countries, and in each country served, export more products, and within each country-product pair, more likely to export in high–quality segments, instead of low-quality segments. All these predictions are already empirically verified by the regression results as reported in Table A1.

4.4 Impact of Trade Shocks from Low-wage Countries

Based on the firm equilibrium characterized in the previous section, we can now examine how a sudden increase in import competition from developing countries across markets (country-product pairs) and segments would result in lower demand and thus lower profits for exporting firms in developed countries (e.g., Portugal).

To illustrate the basic idea, let us consider the simplified version of the model with only two segments in each market: s and $s' > s$. Given the comparative advantage of low-wage countries in labor-intensive mass production, it is safe to assume that the negative impact would be larger in the low quality segments than in the high quality segments in each market (a fact we will verify in the empirical analysis below). Such an increase in import competition drives the price index down more in the lower quality segments in the affected market. Since $\frac{\partial \Phi^s_{mk}}{\partial\left(-P^s_{mk}\right)} < \frac{\partial \Phi^{s'}_{mk}}{\partial\left(-P^s_{mk}\right)} < 0$ for all s and $s\prime$, according to (9), $\widetilde{\pi}^s_{mk}(\varphi)$ will decline for all s even when there is no change in the prices of varieties in segment s. Hence, for $s' > s$, if the import shock hits harder in segment s than $s\prime$, P^s_{mk} drops more than $P^{s'}_{mk}$, and $\Phi^{s'}_{mk}/\Phi^s_{mk}$ will increase. According to (12), the ratio $t^s_{mk}/t^{s'}_{mk}$ will increase, given that all parameters and variables in (12) are identical for a given market mk. A combination of higher $P^{s'}_{mk}/P^s_{mk}$ and $t^s_{mk}/t^{s'}_{mk}$ implies higher $\widetilde{\pi}^{s'}_{mk}/\widetilde{\pi}^s_{mk}$ and thus higher $\pi^s_{mk}(\varphi)/\pi^{s'}_{mk}(\varphi)$. These changes in firm profitability across different segments in a market will affect the extensive margin of export participation in different quality segments. In particular, the least productive firms, which specialize in exporting the lowest quality goods, will drop out from exporting altogether, while the relatively more productive firms in a segment that is affected the most may choose to overcome the additional fixed costs to move up the quality ladder. Figure 5 illustrates the movements of the productivity thresholds for exiting and for quality upgrading in a simplified two-segment model.

[Figure 5 about here]

The discussion above is for a case with only two quality segments. The impact of import competition from low-income countries on heterogeneous firms depend on their initial sorting across markets and the distribution of the shocks on different segments in the market. For instance, in low-income markets, the import shock from other low-income countries may be more concentrated in the intermediate quality segments; while in high-income markets the shocks are more concentrated in the low-quality segments. While we will verify empirically these conjecturers below, for now, we can shed some light about how shocks in the lowest quality segments will affect product prices and firms' decisions in different segments within and across markets (country-product pairs).

Let us consider that the import shock only hits the lowest quality segment (i.e., segment 1) of a market and reduces P^1_{mk} but not the price index of other segments. Using the productivity threshold for firms' exiting from the lowest quality segment, as specified in equation (15), the impact of a decline in P^1_{mk} on the productivity threshold $\overline{\varphi}^1_{mk}$ can derived as (see the appendix for details):

$$\frac{\partial \left(\overline{\varphi}^1_{mk}\right)^{\sigma_k - 1}}{\partial \left(-P^1_{mk}\right)} > 0.$$

This negative partial implies that the least productive firms, which used to export goods in the lowest quality segment in market mk (those with productivity near the threshold $\overline{\varphi}^1_{mk}$), will exit.

On the other hand,

$$\frac{\partial \left(\overline{\varphi}^s_{mk}\right)^{\sigma_k - 1}}{\partial \left(-P^1_{mk}\right)} < 0.$$

For some $s > 1$ if ΔF^s_k is sufficiently large or $\psi^s_{mk}\Phi^s_{mk}\widetilde{\theta}^s_k - \psi^{s-}_{mk}\Phi^{s-}_{mk}\widetilde{\theta}^{s-}_k$ is sufficiently small. In other words, if two quality segments in a market are associated with a larger difference in sunk cost of entry or if the two markets have more similar quality-adjusted sizes, the productivity threshold will decline, implying that more productive firms in segment $s-$ near the productivity threshold ($\overline{\varphi}^s_{mk}$) will upgrade quality to segment s in response to a low-income country's import competition shock in segment 1.

In addition, to the extent that iceberg trade costs (τ_{mk}) in the same market are increasing in distance from the destination, the firm's propensity to exit in response to the shocks will be larger for the more distant destinations. This can be proved by $\frac{\partial^2 \overline{\varphi}^1_{mk}}{\partial (-P^s_{mk}) \partial \tau_{mk}} > 0$ (see the appendix for details). Similarly, under the intuitive assumption that $\frac{d\Theta^{s'}_{mk}}{dy_m} > \frac{d\Theta^{s}_{mk}}{dy_m}$ for $s' > s$, we can also show that $\frac{\partial^2 \overline{\varphi}^1_{mk}}{\partial\left(-P^s_{mk}\right)\partial y_m} > 0$. The following proposition summarizes the discussion of these second derivatives.

Proposition 5. (across markets). Given w_m, Y_m of each destination, competition from a low-wage country, which lowers the price indices of the low-quality segments in a market, will induce the least productive firms to drop out from the market. The mass of firms exiting is larger from the lower income or more distant markets.

We can prove heuristically about how import shocks affect other quality segments as well. Despite the independent market-segment-specific price index, the lower market-specific price index will imply lower profits for all firms selling in segments that are not directly hit by the low-income price shock. Given that the shocks from low-income countries are concentrated in the low quality segments, we can prove that in consecutive quality segments where the corresponding sunk costs of entry are substantially different or if the quality-adjusted market sizes are more similar, there will be firms moving up from the low to the high quality segments in response to the low-income import shock (see the appendix for the proof). Moreover, the most productive firms, which are specialized in exporting the highest quality products, will have the weakest incentives to upgrade quality since their segment's aggregate price index drops the least in response to the shock. Together with Proposition 3, we also know that firms upgrading quality will also raise the frequency of exports.

Proposition 6. (within each market). Given w_m, Y_m of each destination, competition from a low-wage country, which lowers the price indices of the low-quality segments in a market, will induce the more (but not the most) productive firms in some higher quality segments to upgrade quality and thus increase the frequency of exports, if the fixed costs for the two consecutive quality segments are substantially different and/or the quality-adjusted size of the two markets are more similar.

The exits of the least productive firms (Proposition 5) and the within-market quality upgrading (Proposition 6) have implications about how import competition from low-wage countries can shape the spatial patterns of continuing exporters. Given that the low-wage countries shocks tend to be more concentrated in lower quality segments, and those segments tend to command larger expenditure and import shares in lower income countries, it is expected that firms' exits are more concentrated in the lower income countries. The combinations of Propositions 5 and 6 yield the following firm outcomes, which we refer to as the "fast fashion" phenomenon.

Proposition 7. As relatively more productive firms' move up the quality ladder within markets, while relatively less productive firms drop low-quality products from distant and low-income markets, advanced economies' firms, in response to import competition from low-wage countries, will become more specialized in exporting (1) higher quality products; (2) to closer market; (3) at higher frequency.

5 Empirical Analysis and Context

5.1 The Portuguese Textiles and Clothing Industry

The textiles and clothing sectors constitute an important part of the Portuguese economy and its exports. These sectors have historically been the pillar of Portuguese engagement in the global economy, dating to its accession to the European Free Trade Association (EFTA) in 1960. The trade liberalization following the EFTA contributed to a significant growth of the Portuguese T&C sectors, as the relatively labor-intensive production of these goods suited the relatively labor abundance of Portugal in those decades. While the sectors underwent several structural changes and had become less important to the Portuguese economy over the last two decades, they still account for significant shares of employment and trade in Portugal as of today. The two sectors together accounted for over 12 percent of gross manufacturing value added, 23 percent of manufacturing employment and over 12 percent of total manufacturing exports in 2005, the year when the MFA quotas were completely removed.

The accession of Portugal to the European Economic Community (later European Union) in 1986 and the implementation of the European Single Market in 1993 resulted in further liberalization for T&C. The EU market was as a whole protected by import quotas imposed under the MFA. This benefited the Portuguese T&C producers and exporters, protecting them from foreign competition and allowing them to develop competitive advantage in the foreign market. The progressive phasing-out of the quantitative restrictions that took place under the ATC between 1995 and 2005 posed challenges to Portuguese producers and exporters, who now faced competition from Chinese large scale T&C producers. These had been mostly quota-constrained and highly unproductive due to quota misallocation in China before the MFA quotas were lifted in 2005 (Khandelwal et al., 2013). In this context, Portugal has been pointed out as one of the developed countries that was most affected by the liberalization. Surprisingly, following the MFA liberalization, Portuguese T&C exports and unit values increased (Figures A.3 and 7). Our empirical analysis aims to explain this puzzle systematically.

5.2 Empirical Strategy

Our empirical strategy exploits the removal of the MFA quotas on T&C exports from China to the European Union and the United States in 2005 as an exogenous shock from low-wage countries.[20] We employ a difference-in-difference approach to assess the effects of the shock on firm- and firm-product-level outcomes for Portuguese T&C manufacturers. Given Portugal's small size and reliance on T&C sectors, the trade shock associated with the end of the MFA quotas was arguably both exogenous and abrupt. By using the quota removal as a quasi-natural experiment, the empirical analysis does not need to rely on the construction of import competition measures, such as weighted average tariff rates, which are likely to be endogenous due to the changes in the composition of imported goods and domestic political factors.

We use the following difference-in-difference specification to gauge the effect of the quota removal on firm outcomes:

$$Y_{it} = \alpha + \beta Quota_i \times Post05_t + \mathbf{X}_{it}\Gamma + [FE_i + FE_t] + \epsilon_{it}, \tag{21}$$

where Y_{it} stands for different firm outcomes, such as (the log of) sales, employment, wages and value added. To study changes in production structure, the dependent variable, Y_{it}, is either the firm's skill intensity or the share of imports in material purchases or sales.

$Quota_i$ is a time-invariant firm-level measure of whether or by how much firm i is affected by the MFA quota removal. We use 2000 as the base year to select the treatment and control groups to avoid any potential endogenous changes in outcomes in response to the quota removal on Chinese imports in 2005 (e.g., endogenous entry or exit from a product market). $Post05_t$ is a dummy which equals 1 for all years since and including 2005. To gauge the effects based on the degree of a firm's exposure, we use as baseline a measure of $Quota_i$ which takes the value 1 if in 2000 the export revenue share by firm i in products subject to binding quotas was at least 50 percent, and zero otherwise. We confirm that results remain robust to using a $Quota_i$ variable taking the value 1 if in 2000 firm i exported products that were shielded from Chinese competition due to the MFA quotas, or a continuous measure of $Quota_i$, equal to the share of revenue from quota-bound products in the firm's exports.[21] To ensure that the removal of quotas on imports from China increased competitive pressure on Portugal's T&C firms, we consider a product to be "treated" if the quotas were binding (fill rate above 90 percent) in 2004, the year before their removal, as explained in more detail in section 3.1.

[20] This strategy was also employed by Bloom et al. (2015), Khandelwal et al. (2013), Utar (2012), Martin and Mejean (2014).

[21] The results also remain robust to using alternative years before 2005 to define the $Quota_i$ measures.

By interacting the $Quota_i$ "treatment" variable with the post-liberalization dummy, we capture the affected firms' responses to the increased competition from China, relative to T&C firms that were not exposed to the shock. $\mathbf{X}_{it}$ is a vector of time-varying firm characteristics, including lagged firm sales. Firm fixed effects (FE_i) control for factors that vary across firms, in particular, any systematic differences between firms exposed to the shock and those unaffected. All aggregate trends in the T&C sector are absorbed by the year fixed effects, FE_t. ϵ_{it} is the mean-zero disturbance term. Standard errors are clustered at the firm level.

Since the MFA quotas were applied at the product-country level, a cleaner identification for the analysis at the firm-product-country-level exploits differential effects for quota-bound products, or product-country pairs, relative to quota-free products within a firm. For export prices, and frequency of export transactions, we estimate the following specification at the firm-product-country level:

$$Y_{isct} = \alpha + \beta Quota_{sc} \times Post05_t + \mathbf{X}_{it}\Gamma + [FE_{isc} + FE_t] + \zeta_{isct}, \tag{22}$$

where the subscript s stands for product and c for country, and $Quota_{sc}$ takes the value 1 if country c (any EU member country or the US) imposes a quota on Chinese imports of product s that was binding in 2004 and permanently removed in 2005, and zero otherwise.[22] We include firm-product-country fixed effects (FE_{isc}) to control for unobservable factors that affect prices of products exported by a firm to a destination country (e.g., brand name), and to account for any potential pre-existing trends by firm-product-country. In alternative specifications we include product-country fixed effects, exploiting variation across firms within a market (product-country) before and after the shock. The remaining variables are the same as above. Standard errors are clustered at the firm-product-country level.

We also investigate whether there are heterogenous responses to the shock for firms with different productivity. To that end, we estimate a specification with interactions with the firm's productivity:

$$\begin{aligned} Y_{isct} &= \alpha + \beta_1(Quota_{sc} \times Post05_t) + \beta_2(Quota_{sc} \times Post05_t \times TFP_i) + \beta_3(Post05_t \times TFP_i) \\ &\quad + \mathbf{X}_{it}\Gamma + [FE_{isc} + FE_t] + \zeta_{isct}, \end{aligned} \tag{23}$$

where TFP_i is the firms' total factor productivity (TFP) measured in 2000, prior to the MFA liberalization, and also preceding China joining the WTO, to avoid any potential endogenous changes in response to the shock. For our preferred estimation of TFP, we use the Levinsohn and Petrin

[22] Products with quotas with fill rates below 90% and "quota-free" product-country pairs are included in the control group.

(2003) approach, which uses intermediate inputs as a proxy to control for the correlation between input levels and unobserved firm-specific productivity.[23] The other variables are the same as above. The remaining lower-order terms of the triple interaction $Quota_{sc} \times TFP_i$ and TFP_i are absorbed by the fixed effects or included explicitly.

We also investigate how the effects differ across firms by quartiles of initial total factor productivity. This provides non-parametric evidence and ensures that the results are not driven by a linear specification. We estimate the following equation:

$$\begin{aligned} Y_{isct} &= \alpha + \sum_{r=1}^{4} \beta^r (Quota_{sc} \times Post05_t \times Q_i^r) + \sum_{r=1}^{4} \delta^r (Q_i^r \times FE_t) + \mathbf{X}_{it}\Gamma \\ &\quad + [FE_{isc} + FE_t] + \zeta_{isct}, \end{aligned} \tag{24}$$

where Q_i^r are quartile dummy variables, taking the value 1 if firm i belongs to quartile r of the TFP distribution in 2000. In addition to the variables and controls described above, we also control for quartile×year fixed effects to absorb any trends of the quartile (e.g., reversal to the mean). The lower order terms of the triple interactions are either included explicitly or are absorbed by the sets of fixed effects.

5.3 Background of the MFA Liberalization

This section briefly describes the background of the Multifiber Arrangement (MFA) and the Agreement on Textiles and Clothing (ATC). The MFA was introduced by developed countries in 1974, originally as a temporary measure, to curb textiles and clothing (T&C) imports from low-wage countries, particularly from Asia at that time. The arrangement, however, ended up limiting T&C exports from the developing world to the US, EU, Canada, and Turkey until the end of 2004. As a result of the MFA, T&C products and the bargaining over their quotas remained at the margin of multilateral trade negotiations until the conclusion of the Uruguay Round of the WTO meetings in 1994. A result of the Uruguay Round was the agreement by participants to replace the MFA by a new system, the Agreement on Textiles and Clothing (ATC), which put in place a gradual elimination of the quotas over four stages: January of 1995, 1998, 2002, and 2005, respectively. The US, EU and Canada were required to eliminate quotas representing at least 16, 17 and 18 percent of their 1990 import volumes; and by 2005, the remaining quotas, representing 49 percent

[23] Levinsohn and Petrin's estimator has the advantage that, unlike the Olley and Pakes (1996) estimator, it does not suffer from the potential truncation bias induced by the requirement that firms have nonzero levels of investment. We also verify that our resuts remain robust to using alternative proxies for firm performance, such as sales, export value or value added per worker.

of import volume, were to be eliminated. We drop Canada from the analysis as we do not have access to the list of products covered by their quotas.[24] The agreement also established a special safeguard mechanism for protection against surges and a monitoring body to supervise the phasing out of the MFA quotas.

The type of goods allocated to each phase varied across importing countries, and given the choice of which quotas to remove in each phase, less sensitive products - with non-binding quotas - were likely to be liberalized first. Products that were more susceptible to competition were usually liberalized in the final phase to delay competition from low-wage countries. As discussed in Khandelwal et al. (2013), this feature of the liberalization suggests that in the last (2005) phase, competition shocks from low-wage countries are the largest as quotas were the most binding. We therefore focus our analysis on the 2005 phase. Moreover, as the goods to be liberalized under each phase were chosen in 1995, the choice was unaffected by demand or supply conditions in 2005. In addition, being outside of the WTO before 2002, China did not benefit from the first phases of quota abolishment until it joined the WTO. As such, the removal of the quotas under the first three stages all occurred in 2002. The elimination of the 2005 stage quotas, which our analysis focuses on, occurred in January 2005 as negotiated. China's export surge in the T&C products across the globe after quotas were removed provides a quasi-natural experiment for identification in our analysis.

Data on MFA quotas imposed by the US on T&C imports from China is from Brambilla et al. (2010). The MFA group categories are concorded to the HS 10-digit categories using concordances from the US Office of Textiles and Apparel (OTEXA). Since we use data at the HS 6-digit level, an HS 6-digit product is "treated" if at least one corresponding HS 10-digit category had a binding quota on Chinese imports in 2004, then removed in 2005. We follow Evans and Harrigan (2005) and Brambilla et al. (2010) and consider quotas to be binding if the fill rate for the product (exports as a percentage of adjusted base quota) in 2004 was above 90 percent.

Data on quotas imposed by the EU on T&C imports from China is from the Système Intégré de Gestion de Licenses (SIGL), classified according to EU aggregate categories, which we convert to the HS 6-digit level using concordances in Annex I of the "Council Regulation (EEC) No 3030/93 on common rules for imports of certain textile products from third countries".[25] In our analysis, we consider binding quotas at the product-country level, imposed by the EU, US or both.[26] Of the 793 different HS6 T&C products exported by Portuguese firms, 316 were subject to binding

[24] In 2004 T&C exports to Canada represented less than 0.7 percent of Portugal's T&C exports.

[25] SIGL is the integrated system for the management of licences for imports of textiles, clothing, footwear, steel and wood to the EU.

[26] Exports to the EU in 2004 accounted for 85.4% of Portugal's T&C exports and the share of exports to the US was 7%.

quotas imposed on China in 2004, abolished in 2005. These products accounted for 55 percent of total Portugal's T&C exports in 2004 (see Table A2).

6 Empirical Results

6.1 Effect of the MFA Shock on Firm Size and Specialization Patterns

Previous studies have documented that increased competition from China has led to declines in employment and wages in the U.S. (Autor et al. 2013; Acemoglu et al., 2014) and Denmark (Utar, 2014), among other countries. It has also been shown that the trade shock in China following the expiration of the MFA quotas on T&C products led to decreases in sales and value added of firms in developed countries (Utar, 2014). In this section, we start by investigating the effect of the MFA liberalization on Portugal's T&C manufacturers' (log of) sales, value added, output, employment and wages. We estimate Eq. (21) for those firm-level outcomes. Table 4 presents the estimation results. All the regressions include lagged (log) firm sales (except sales regressions), firm fixed effects, and year fixed effects as controls.

The coefficient of main interest is that on the $Quota_i \times Post05_t$ interaction, which captures the differential effect of the shock for firms that were more vulnerable to competition from China following the removal of MFA quotas, relative to firms not exposed to the shock. The treatment variable, $Quota_i$, takes the value 1 if the firm's export revenue share of MFA quota-bound products in 2000 is at least 50 percent, and zero otherwise.[27] The results show that the MFA shock has had no statistically significant effect on sales, value added, output, employment or wages for Portugal's T&C firms' exposed to Chinese competition. These finding contrast with evidence reported for other countries, which have been negatively affected by the increased competition from China.

[Table 4 about here]

Despite the fact that exports of quota-bound products accounted for over 50 percent of the country's T&C exports and sales, the large China shock did not decrease sales of affected Portugal's T&C manufacturers following the sharp increase in China's exports of those products around the world, of 307 percent over the period, with a jump of 119 percent in 2005, when quotas were removed.[28] In the rest of the paper we aim to explain this puzzle, and in particular to show that by upgrading the quality of products exported, particularly those previously subject to quotas,

[27] Results remain robust to alternative definitions of the treatment variable.

[28] Compared to the 119 percent increase in quota-bound exports from China in 2005, quota free exports grew by 29 percent (Khandelwal et al. 2013).

and increasing export frequency to nearby markets, Portugal's T&C firms avoided the significant negative effects of the increased competition from China experienced in other countries.

In columns (6) through (10) of Table 4, we start by presenting evidence of these patterns at the firm level. Column (6) shows that the average (log) unit values of exports increased for MFA-affected firms, by about 6%. This finding supports firms' escaping competition by upgrading quality, as predicted by Proposition 6. In columns (7) and (8), we show that the increase in export price is accompanied by an increase in the (log) price of imported inputs and an increase in skill-intensity within firms, which are normally associated with quality upgrading of goods. Columns (9) and (10) show that average frequency or exports increases and distance to the destinations decreases for firms exposed to the China shock. These changes in export patterns suggest that firms become more specialized in fast-fashion, exporting higher quality products to closer markets at higher frequency, consistent with the prediction in Proposition 7.

In the next sections we investigate the effects of the shock on export patterns at a more granular level. Before presenting the regression results, we start by reporting some aggregate patterns of trade-induced quality upgrading and fast-fashion. Figure 6 shows that the average price of MFA-bound exports from Portugal has grown substantially since 2005, while the corresponding average prices of non-MFA products experienced a downward trend until 2004 and stayed at roughly the same level since then. Figure 7 shows that the average distance of exports of MFA quota-bound exports declined over the sample period, particularly since the removal of quotas, while that of quota-free exports increased since 2005. Figure 8 shows that the average export frequency increased since 2006.[29] Figure A2 in the appendix shows that the number of T&C producers and exporters declined between 2005 and 2007, consistent with import competition driving firms to exit.

[Figures 6 through 8 about here]

6.2 Effect of the MFA Shock on Market Dropping

This section investigates the effect of the MFA shock on market dropping at the firm level. We start by investigating the effect of the shock on destination market dropping according to destination characteristics, in particular distance and per capita GDP. We estimate a linear probability model of the form:

$$Drop_{ict} = \alpha + \beta_1 (Quota_i \times Post05_t \times \ln Z_{ct}) + \beta_2 (Quota_i \times Post05_t) + \mathbf{X}_{it}\Gamma + [FE_i + FE_c + FE_t] + \epsilon_{it}, \tag{25}$$

[29] Averages in Figures 7-9 are computed as weighted averages, using export quantity as weights.

where the dependent variable, $Drop_{ict}$ is a dummy equal to one if trade flow ic is not active in t+1, that is, if firm i exports to country c for the last time in t. $Quota_i$ is the treatment variable for firms affected by the MFA shock, as explained in previous sections. Z_{ct} is either the destination country's GDP per capita or distance from Portugal (in the later case the subscript t is dropped). All remaining lower-order terms of the triple interaction are included explicitly or absorbed by the sets of fixed effects. We include country and firm fixed effects, thus estimating the effect of the shock on the probability of dropping destinations within a firm, accounting for destination characteristics. We also include year dummies to absorb global trends.

[Table 5 about here]

As reported in Table 5, MFA-affected firms are more likely to drop distant markets and lower-income countries, supporting Proposition 5. In Panel B of Table 5, we investigate the role of firm productivity heterogeneity in the pattern of destination dropping. To that end, we include interactions with firm TFP, measured prior to the MFA shock. We find that in response to the shock, affected firms are more likely to drop distant destinations and more so among the least productive firms (column 1); the estimated coefficient on the term $Quota_i \times Post05_t \times \ln dist_{ct}$ is positive, while its interaction with the firms' TFP is negative, showing that more productive firms are less likely to drop countries than less productive ones. Similarly, firms are more likely to drop low-income countries on average, but less productive firms are more likely to do so than more productive ones (column 2).[30] In sum, lower-productivity firms are more likely to drop distant and low-income countries, which are associated with low-priced export products, in response to increased Chinese competition. All results reported in Table 5 are consistent with the predictions in Proposition 5.

Appendix Table A.2 reports results for the probability of dropping export products (HS6 categories), at the firm-product-year, on an interaction between the $Quota_i \times Post05_t$ term and the product's price.[31] We control for firm, product and year fixed effects. In column (1), we obtain a negative coefficient on the $Quota_i \times Post05_t \times lprice$ interaction, suggesting that firms are less likely to drop higher-price products, but the coefficient is statistically insignificant. In panel B, the interactions with TFP are also statistically insignificant. These results suggest that the shock did not contribute to significant product dropping.

This section shows that, in accordance with the theoretical predictions, in response to the MFA shocks, affected firms drop distant and low-price destinations, particularly the less productive firms.

[30] The number of observations is lower for the heterogeneous results due to missing data for TFP and because we measure TFP in 2003, prior to the MFA, and hence include only firms that already exist in that year.

[31] Product prices are the estimated firm-product fixed effects from a regression of ln unit values at the firm-product-country-year on firm-product and country-year fixed effects, over the pre-MFA period.

6.3 Import Competition from China in the Textile and Clothing Industry

This section documents the rise in Chinese competition in the global T&C industry, and how it is related to destination countries' characteristics, in particular their income levels. We use data on bilateral values and quantities of exports at the HS 6-digit product level for each exporting and importing country pair, in each year, from the BACI database provided by CEPII.[32]

To assess the extent of the increase in competition from China in export markets, for HS6 categories subject to quotas, we estimate the following regression:

$$\Delta IMP_{sc}^{CH} = \alpha + \beta_1 (Quota_{sc} \times \ln pcgdp_c) + \beta_2 Quota_{sc} + \beta_3 \ln pcgdp_c + \beta_4 \ln dist_c + FE_c + FE_s + \epsilon_{sc}, \quad (26)$$

The unit of observation is the country-product(HS6) level. The dependent variable, ΔIMP_{sc}^{CH}, is the change in import share from China between 2003 and 2007, by product-country (sc).[33] $pcgdp_c$ is real GDP per capita of the importer in the beginning of the period (2003) and $dist_c$ is the distance between China and the importer. $Quota_{sc}$ takes the value one if country c imposed quotas on Chinese imports of good s, which were removed in 2005, and zero otherwise. We also include country and product dummies.

Table 6 reports the regression results. In column (1), the sample includes all HS6-country pairs, while in column (2) the sample is restricted to countries that imposed quotas on China (EU countries and US), identification is thus based on comparing import shares for quota-bound and quota-free imports, for the countries that ever imposed quotas. Standard errors are clustered by country.

[Table 6 about here]

The results show that the estimate of coefficient β_1 is positive and statistically significant. That is, the import share from China in product categories that were restricted by quotas rose more in higher-income countries. The estimates in column (2) imply that for the average country GDP per capita, import shares from China grew by an additional 3.2 percentage points on average for MFA products after quotas were removed, while for countries one standard deviation above the mean

[32] The database is constructed by harmonizing United Nations Statistical Division COMTRADE database, reconciling the declarations of the exporter and the importer (Gaulier and Zignago, 2010). We exclude Canada from the analysis as it is also excluded from the regressions that study Portugal's T&C exports using Portuguese customs data, as we do not have information on quotas imposed by Canada. Canada accounts for just 2% of China's T&C exports in 2004, and for 0.7% of Portugal's exports.

[33] The results remain robust to using different years to obtain the difference and to using the difference in average shares over the pre- and post-mfa periods.

GDP per capita, the differential increase is of 5.5 percentage points, this represents an increase of 64% and 110%, respectively, relative to the average change in import shares from China across country-product pairs.

Next, we estimate the differential impact of the MFA shock on the change in China's export prices of products restricted by quotas, and how it is affected by destination per capita GDP. For this analysis, we use data for T&C exports from Portugal and China across all destinations and HS6 products. We estimate a specification for the (log) change in the export price between $t-1$ and t, at the origin-destination-product (HS6)-year level. As is common in the literature, the proxy for price is the unit value, computed as the ratio between the value and the quantity, measured in weight in the BACI data, of a trade flow. To estimate the differential effect of the shock on Chinas' export price, we include interactions with a dummy variable for exports from China. To assess how the effects change with destination income, we include interactions with per capita GDP. We cluster standard errors by product-destination.

[Table 7 about here]

The results are presented in Table 7. We control for product and destination fixed effects in column (1) and for product×destination in column (2); these capture heterogeneous trends by product-country since the equation is estimated in differences. The coefficients of main interest are on the term $China \times Quota \times Post05$, which captures the differential effect of the quota removal on the price of Chinese exports of quota-bound products, and $China \times Quota \times Post05 \times lnpcgdp$, which captures how the effect varies with GDP per capita of the destination. The estimated coefficients are negative for both terms, showing that the price of MFA exports from China is significantly reduced on average after the shock, and more so for exports to higher-income countries.

Figures A.4 and A.5 in the appendix show the average price of Chinese and Portuguese exports to each country in 2003 and 2007. They present graphical evidence that the price of Portugal's exports increased after the shock, widening the gap, particularly for countries with higher income, such as the UK, Germany, Sweden and Denmark.

The results in this section show that MFA import shares from China increased more in richer countries, and that the prices of Chinese exports of MFA categories are lower in richer destinations after the shock. These findings are therefore suggestive of an incentive for quality upgrading by Portuguese exporters in high-income countries, where the Chinese shocks are mostly concentrated in the lower quality segments. In the following sections we show evidence of quality upgrading by Portuguese exporters in those markets.

6.4 Effect of the MFA Shock on Quality Upgrading

In this section, we examine the hypothesis that competition from China induced Portuguese T&C firms to upgrade the quality of their exported products, within country-product markets. We conduct the analysis on the price effects at the firm-product-country level for a clean identification of the differential effects on quota-bound products, relative to quota-free ones. We estimate specification (22), where the $Quota_{sc}$ treatment variable is defined at the product-country level, at which quotas were applied; it takes the value 1 if product s was subject to binding-quotas imposed by country c on China, which were abolished in 2005.

We focus on quality upgrading of exports as a result of individual firms improving the quality of their existing HS6 products. This "within-firm-product" channel has been relatively less exploited in previous studies, which have focused on the role of reallocations across firms within a sector (Martin and Mejean, 2014) or within product-country pairs across firms (Khandelwal et al., 2013).

In Table 8, we examine the effects of the shock on quality upgrading of products exported, for all and continuing products.[34] The dependent variable is the log real price, measured by the unit value computed as the ratio of export value to quantity exported for each firm-product-country-year. We control for firm lagged sales, and for year and firm-product-country fixed effects. The difference-in-differences coefficient on the $Quota_{sc} \times Post05_t$ term identifies the extent to which the quality of quota-bound products was upgraded following the MFA quota removal, relative to quota-free products. The within country-product identification relies on the country-product pair being exported by the firm before and after the shock. The results show that on average, firms increase the price of their quota-bound exported products to the same country, which suggests quality upgrading in response to the shock. The effect is statistically significant at the 1% level. The magnitude of the estimates is economically significant, implying a relative increase of around 15% in the price of quota-bound products.

[Table 8 about here]

To investigate whether there is heterogeneity across exporters in product quality upgrading, Panel B of Table 8, presents results from estimating Eq. (24). The coefficients of interest are now the triple interactions with the quartile dummies for the firms' initial total factor productivity distribution. We obtain positive and statistically significant estimates on the quartile interactions, and we find that they are largest for firms in the third quartile. This shows that medium productivity firms upgrade the quality of quota-bound products the most in response to the shock.

[34] The results for continuing products exclude products that are dropped from exports in each year.

In Table 8, we identify the average effect of the MFA quota removal on export prices over the entire post-MFA period. Next, we estimate effects in each year, before and after the expiration of MFA quotas, thus assessing whether the effects vary over time. We estimate a specification which includes interactions between the MFA treatment variable, for product-countries subject to quotas, and a set of year dummy variables, for each lag and lead year, relative to the year when quotas were abolished. Figure 9 presents the estimated coefficients for each lag and lead year and the 95% confidence interval, from a specification similar to column (1) in Table 8. As the figure shows, the estimated coefficients become positive and statistically significant only in the years after the quotas were removed. This supports our identification, and confirms that there is no evidence of anticipatory effects on export prices.

[Figure 9 about here]

In sum, the results in this section support the hypothesis that the trade liberalization shock in China, which affected the low-quality product segment the most, induced firms in Portugal to upgrade the quality of products previously subject to quotas. We show that medium productivity firms are the ones that upgrade quality the most, consistent with our model's predictions. Our findings are consistent with results in Amiti and Khandelwal (2013) who show that import competition induces firms to invest in quality upgrading of products close to the quality frontier in order to survive competition.

6.5 Fast Fashion: Effect of the MFA shock on the Frequency and Distance of Export Transactions

T&C fashion apparel is a very competitive industry with volatile consumer tastes and short product life. With intensified competition, distance and time increasingly become sources of competitive advantage. Anecdotal evidence suggests that in addition to craftsmanship and innovation, the ability to deliver quantities on time, and work closely with clients in an integrated production process has been an advantage of Portugal's T&C firms. Easier logistics and the possibility of frequent delivery of higher-quality products, as opposed to the mass production of standard, lower-quality, products from the Asian industry has been a source of advantage. If "fast-fashion" has been a strategy of Portugal's T&C firms to respond to foreign competition following the MFA liberalization shock, we should see an increase in the average frequency of firms' exports and a decrease in the average distance of exporting, as predicted by Proposition 7 above.

Table 9 aims to empirically verify that proposition 7. We estimate Eq. (22), using the log number of monthly shipments by firm-product-country-year as dependent variable. The MFA treatment variable is defined at the product-country level ($Quota_{sc}$). To investigate how the effect of the shock on export frequency differs across destinations with varying distance from Portugal, in column (1) we use a sample with all European countries, while in column (2) we use a sample of countries with distance to Portugal below the median across destinations, and in column (3) we include all destinations. Firm-product-country and year fixed effects are always included as controls.

[Table 9 about here]

We find that the frequency of export transactions of quota-bound products increased after the MFA quotas were removed. The coefficient on the interaction term of main interest, $Quota_{sc} \times Post05_t$, is positive and statistically significant for the samples of European countries and countries below the median distance (columns 1 and 2). This shows that the frequency of exports increased after the China shock, within the same firm-product-country, particularly to nearby destinations, as our model predicts.

In Panel B of Table 9, we investigate whether the effects differ according to firm productivity. We include interactions with quartile dummies of the firms' total factor productivity distribution prior to the shock, $Quota_{sc} \times Post05_t \times Q_i^r$. The results show that medium-productivity exporters, in the third quartile, increase the frequency of export transactions of MFA products, particularly to closer destinations. These firms are also found to have upgraded quality the most. The estimate in column (1), implies a 7 percent increase in the frequency of export transactions following the quota-removal, within a product-country. These results support our model predictions; more productive firms, exporting products with quality above those where the China shocks are concentrated, upgrade quality and increase the frequency of exports after the shock.

Similar to the previous section, we also estimate the effects of the MFA shock on export frequency in each year, before and after the removal of quotas. Figure 10 reports the coefficients and confidence intervals for each lead and lag, for a specification with all destinations. The effect of the shock on export frequency becomes positive and statistically significant only after the quotas were abolished, while it is statistically insignificant in the years prior to 2005, confirming that there are no anticipatory effects.

[Figure 10 about here]

Next, we investigate the effects of the shock on the average distance of exports. We test the theoretical prediction that in response to the MFA shock, firms' average distance from destination markets will decrease. In Table 10, we regress the weighted average log distance from Portugal to the destination countries, at the firm-product-year level, using export quantity as weights, on the shock interaction term, $Quota_i \times Post05_t$. For this analysis, since the dependent variables are by firm-product, the $Quota_i$ variable is defined at the firm-level, for firms exposed to Chinese competition, as described in section 5.2. We control for lagged sales and include firm-product and year fixed effects. In Panel A, we report average effects across firms, while Panel B reports heterogenous results by quartiles of firm productivity. We find that T&C firms that were more exposed to the MFA shock in foreign markets decreased the distance of exports within a HS6 product. The results are robust for different measures of distance, reported across the columns of Table 10. We use simple distance (column 1), distance between capitals (column 2) and population-weighted distance (column 3).

We also find that the effects of the liberalization on export distance are larger for medium-productivity firms. The estimated coefficients are negative and statistically significant for firms in the third quartile of the TFP distribution, which are also the firms that upgraded quality the most and increased the frequency of trade after the shock. The estimates imply that firms in the third quartile of productivity reduced average export distance by 12%.

[Table 10 about here]

In sum, results in this section suggest that proximity to the sources of demand and the ability to deliver more frequently have been advantages of Portugal's T&C firms. By exporting higher-quality products, for which timely delivery is important, and by increasing the frequency of exports to nearby destinations, they were able to escape Chinese competition and avoid the associated negative effects.

7 Conclusion

This paper studies how import competition from China in third markets induces firms in high-wage economies to specialize in fast trade and quality production. We develop a simple continuous-time industry-equilibrium model of heterogeneous firms to study exporters' choices of destination markets, the frequency of exporting and the quality of exported products in each market. With increased competition from low-wage countries, advanced economies become more specialized in fast fashion—exporting higher quality products to closer markets at higher frequency. We use data on all Portuguese textile and clothing producers' monthly export transactions and exploit the exogenous increase in competition following the removal of Multi-Fibre Arrangement (MFA) quotas on Chinese T&C exports for identification.

Our results show that firms upgrade the quality of quota-bound products after the shock, particularly medium-productivity firms. Quality upgrading is accompanied by increased frequency of exports of quota-bound products, but reduced distance of export transactions. Faced with increased competition, Portuguese firms increasingly specialize in exporting higher quality products at higher frequency to nearby destinations. The easier logistics and ability to deliver quantities on time became sources of competitive advantage relative to China. Our results have potential implications for global specialization and regionalization of trade, where products that require timely delivery are produced closer to the final demand.

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9 Appendix

9.1 Proofs

9.1.1 Productivity Thresholds

To solve for $\overline{\varphi}^1_{mk}$, the productivity for entry into the lowest quality segment, which satisfies $\pi^1_{mk}(\varphi) - wF^1_k = 0$, notice that the equality implies

$$\psi^1_{mk}\Phi^1_{mk}\varphi^{\sigma_k - 1} = w\left(\delta^1_{mk}f_{mk} + F^1_k\right)$$

where $\psi^1_{mk} \equiv \left(\frac{1-e^{-(r+\phi_{mk})\Delta^1_{mk}}}{r+\phi_{mk}}\right)$ and $\delta^s_{mk} \equiv \frac{1}{1-e^{-r\Delta^s_{mk}}}$. Solving it out yields

$$\left(\overline{\varphi}^1_{mk}\right)^{\sigma_k - 1} = \frac{w\left(\delta^1_{mk}f_{mk} + F^1_k\right)}{\psi^1_{mk}\Phi^1_{mk}}. \tag{A1}$$

Consider three consecutive segments centered around an active segment s (i.e., $s^- < s$, s, and $s^+ > s$). To guarantee that all three segments are active, let us define s^- and s^+ as

$$\begin{aligned} s^- &\equiv \arg\min_{s'}\left\{\pi^{s'}_{mk}(\varphi) - wF^{s'}_{mk}\right\} \quad \forall s' \in \{1, ..., s-1\}; \\ s^+ &\equiv \arg\min_{s'}\left\{\pi^{s'}_{mk}(\varphi) - wF^{s'}_{mk}\right\} \quad \forall s' \in \{s+1, ..., S\}. \end{aligned}$$

We can then solve for the productivity thresholds $\overline{\varphi}^s_{mk}$ and $\overline{\varphi}^{s+}_{mk}$, between which a firm with productivity $\varphi \in [\overline{\varphi}^s_{mk}, \overline{\varphi}^{s+}_{mk})$ will export in segment s only. In particular, the lower bound of the productivity range $\overline{\varphi}^s_{mk}$ can be solved in closed form by rearranging

$$\begin{aligned} & \pi^s_{mk}(\varphi) - wF^s_k = \pi^{s-}_{mk}(\varphi) - wF^{s-}_k \\ & \psi^s_{mk}\Phi^s_{mk}\varphi^{\sigma_k-1}\left(\theta^s_k\right)^{(\lambda_{mk}-\gamma_k)(\sigma_k-1)} - \psi^{s-}_{mk}\Phi^{s-}_{mk}\varphi^{\sigma_k-1}\left(\theta^{s-}_k\right)^{(\lambda_{mk}-\gamma_k)(\sigma_k-1)} \\ = \; & w\left(\left(\delta^s_{mk} - \delta^{s-}_{mk}\right)f_{mk} + F^s_k - F^{s-}_k\right), \end{aligned}$$

which yields

$$\left(\overline{\varphi}^s_{mk}\right)^{\sigma_k - 1} = \frac{w\left(\Delta\delta^s_{mk}f_{mk} + \Delta F^s_k\right)}{\psi^s_{mk}\Phi^s_{mk}\widetilde{\theta}^s_k - \psi^{s-l}_{mk}\Phi^{s-}_{mk}\widetilde{\theta}^{s-}_k}, \tag{A2}$$

where $\psi^s_{mk} = \left(\frac{1-e^{-(r+\phi_{mk})\Delta^s_{mk}}}{r+\phi_{mk}}\right)$, $\Delta\delta^s_{mk} = \delta^s_{mk} - \delta^{s-}_{mk}$, $\Delta F^s_k = F^s_k - F^{s-}_k$, $\widetilde{\theta}^s_k = \left(\theta^s_k\right)^{(\lambda_{mk}-\gamma_k)(\sigma_k-1)}$ and $\widetilde{\theta}^{s-}_k = \left(\theta^{s-}_k\right)^{(\lambda_{mk}-\gamma_k)(\sigma_k-1)}$.

Similarly, we can express $\overline{\varphi}_{mk}^{s+}$ in closed form by solving $\pi_{mk}^{s+}(\varphi) - wF_k^{s+} = \pi_{mk}^{s}(\varphi) - wF_k^{s}$ as

$$\left(\overline{\varphi}_{mk}^{s+}\right)^{\sigma_k - 1} = \frac{w\left(\Delta\delta_{mk}^{s+} f_{mk} + \Delta F_{kk}^{s+}\right)}{\psi_{mk}^{s+}\Phi_{mk}^{s+}\widetilde{\theta}_k^{s+} - \psi_{mk}^{s}\Phi_{mk}^{s}\widetilde{\theta}_k^{s}}, \tag{A3}$$

where $\widetilde{\theta}_k^{s+} \equiv \left(\theta_k^{s+}\right)^{(\lambda_{mk}-\gamma_k)(\sigma_k - 1)}$.

Given that in equilibrium, $\Delta_{mk}^{s^+} > \Delta_{mk}^{s} > \Delta_{mk}^{s-}$, $\Delta\delta_{mk}^{s} > 0\ \forall s > 1$, and $\Delta\psi_{mk}^{s} > 0\ \forall s > 1$, as well as by assumption $\theta_k^{s+} > \theta_k^{s} > \theta_k^{s-}$ and $F_k^{s+} > F_k^{s} > F_k^{s-}$, we can show that $\overline{\varphi}_{mk}^{s+} > \overline{\varphi}_{mk}^{s}$.

$\overline{\varphi}_{mk}^{s^+}$ is increasing in F_k^{s+}/F_k^{s} and decreasing in $\theta_k^{s+}/\theta_k^{s}$ and $\Phi_{mk}^{s+}/\Phi_{mk}^{s}$, respectively.

9.1.2 Proof of $\frac{\partial\left(\overline{\varphi}_{mk}^{s}\right)^{\sigma_k-1}}{\partial\left(-P_{mk}^{1}\right)} > 0$

First and foremost,

$$\frac{\partial\left(\overline{\varphi}_{mk}^{1}\right)^{\sigma_k-1}}{\partial\left(-P_{mk}^{1}\right)} = \frac{\partial}{\partial\left(-P_{mk}^{1}\right)}\frac{w\left(\delta_{mk}^{1} f_{mk} + F_k^{1}\right)}{\psi_{mk}^{1}\Phi_{mk}^{1}} = \frac{\partial\left(\psi_{mk}^{1}\Phi_{mk}^{1}\right)}{\partial P_{mk}^{1}}\frac{w\left(\delta_{mk}^{1} f_{mk} + F_k^{1}\right)}{\left(\psi_{mk}^{1}\Phi_{mk}^{1}\right)^2}.$$

Given that $\frac{\partial\left(\psi_{mk}^{1}\Phi_{mk}^{1}\right)}{\partial P_{mk}^{1}} < 0$, we can assure that $\frac{\partial\left(\overline{\varphi}_{mk}^{1}\right)^{\sigma_k-1}}{\partial\left(-P_{mk}^{1}\right)} > 0$.

Using equation (A2), we can also show that

$$\frac{\partial\left(\overline{\varphi}_{mk}^{s}\right)^{\sigma_k-1}}{\partial\left(-P_{mk}^{1}\right)} \propto \frac{\partial\Delta\delta_{mk}^{s}}{\partial\left(-P_{mk}^{1}\right)} f_{mk} + \frac{\Delta\delta_{mk}^{s} f_{mk} + \Delta F_k^{s}}{\psi_{mk}^{s}\Phi_{mk}^{s}\widetilde{\theta}_k^{s} - \psi_{mk}^{s-}\Phi_{mk}^{s-}\widetilde{\theta}_k^{s-}} \times \left[\begin{array}{c} \left(\Phi_{mk}^{s-}\widetilde{\theta}_k^{s-}\frac{\partial\psi_{mk}^{s-}}{\partial\left(-P_{mk}^{1}\right)} - \Phi_{mk}^{s}\widetilde{\theta}_k^{s}\frac{\partial\psi_{mk}^{s}}{\partial\left(-P_{mk}^{1}\right)}\right) \\ + \left(\psi_{mk}^{s-}\widetilde{\theta}_k^{s-}\frac{\partial\Phi_{mk}^{s-}}{\partial\left(-P_{mk}^{1}\right)} - \psi_{mk}^{s}\widetilde{\theta}_k^{s}\frac{\partial\Phi_{mk}^{s}}{\partial\left(-P_{mk}^{1}\right)}\right) \end{array}\right] \tag{A4}$$

Recall that $\delta_{mk}^{s} \equiv \frac{1}{1-e^{-r\Delta_{mk}^{s}}}$,

$$\psi_{mk}^{s} = \frac{1 - e^{-(r+\phi_{mk})\Delta_{mk}^{s}}}{\left(1 - e^{-r\Delta_{mk}^{s}}\right)(r + \phi_{mk})},$$

and $\Phi_{mk}^{s} = (\sigma_k)^{-\sigma_k}(\sigma_k - 1)^{\sigma_k - 1}\beta_k Y_m\left(P_{mk}^{s}\right)^{\sigma_k - \kappa_k}(P_{mk})^{\kappa_k - 1}\left(\Theta_{mk}^{s}\right)^{\kappa_k - 1}(\tau_{mk}w)^{1-\sigma_k}$. First notice that $\psi_{mk}^{s}\widetilde{\theta}_k^{s} > \psi_{mk}^{s-}\widetilde{\theta}_k^{s-}$ because $\psi_{mk}^{s} > \psi_{mk}^{s-}$ as an outcome of Proposition 3 and $\widetilde{\theta}_k^{s} > \widetilde{\theta}_k^{s-}$ by assumption. Also, due to Proposition 3 $\delta_{mk}^{s} > \delta_{mk}^{s-}$. Moreover, because of inequality (17) in the main text, $\psi_{mk}^{s}\Phi_{mk}^{s}\widetilde{\theta}_k^{s} > \psi_{mk}^{s-1}\Phi_{mk}^{s-1}\widetilde{\theta}_k^{s-1}$

Let us now sign $\frac{\partial\left(\overline{\varphi}_{mk}^{s}\right)^{\sigma_k-1}}{\partial\left(-P_{mk}^{1}\right)}$ according to the expression of (A4). First, given that $\frac{\partial\Delta_{mk}^{s-}}{\partial\left(-P_{mk}^{1}\right)} > \frac{\partial\Delta_{mk}^{s}}{\partial\left(-P_{mk}^{1}\right)} > 0$, the first term in (A4), $\frac{\partial\Delta\delta_{mk}^{s}}{\partial\left(-P_{mk}^{1}\right)} f_{mk} > 0$, is positive.

Turning to the second term of (A4), notice that

$$\frac{\partial \ln \psi_{mk}^{s-}}{\partial\left(-P_{mk}^{1}\right)} \propto \left[\left(r+\phi_{mk}\right)e^{-\left(r+\phi_{mk}\right)\Delta_{mk}^{s}} - \frac{\left(1-e^{-\left(r+\phi_{mk}\right)\Delta_{mk}^{s}}\right)re^{-r\Delta_{mk}^{s}}}{\left(1-e^{-r\Delta_{mk}^{s}}\right)}\right]\frac{\partial \Delta_{mk}^{s}}{\partial\left(-P_{mk}^{1}\right)} \quad \text{(A5)}$$

$$\propto \frac{\partial \Delta_{mk}^{s}}{\partial\left(-P_{mk}^{1}\right)}\underbrace{\left(r+\phi_{mk}+\frac{re^{-r\Delta_{mk}^{s}}}{1-e^{-r\Delta_{mk}^{s}}}-\frac{re^{\phi_{mk}\Delta_{mk}^{s}}}{1-e^{-r\Delta_{mk}^{s}}}\right)e^{-\phi_{mk}\Delta_{mk}^{s}}}_{R\left(\Delta_{mk}^{s}\right)}$$

Since $\frac{\partial \Delta_{mk}^{s}}{\partial\left(-P_{mk}^{1}\right)} > 0$ according to Proposition 2 and that the term inside the brackets, $R\left(\Delta_{mk}^{s}\right)$, is positive, $\frac{\partial \ln \psi_{mk}^{s-}}{\partial\left(-P_{mk}^{1}\right)} > 0$.

Next let us check how the derivative varies across quality segments. Notice that

$$\begin{aligned}\frac{\partial R\left(\Delta_{mk}^{s}\right)}{\partial \Delta_{mk}^{s}} &= -\frac{\left(r+\phi_{mk}\right)e^{\left(r+\phi_{mk}\right)\Delta_{mk}^{s-}}}{\left(e^{\left(r+\phi_{mk}\right)\Delta_{mk}^{s-}}-1\right)^{2}}\left[\phi_{mk}-r\frac{e^{\phi_{mk}\Delta_{mk}^{s-}}-1}{1-e^{-r\Delta_{mk}^{s-}}}\right] \\ &\quad -\frac{r}{\left(e^{\left(r+\phi_{mk}\right)\Delta_{mk}^{s-}}-1\right)\left(1-e^{-r\Delta_{mk}^{s-}}\right)}\left[\phi_{mk}e^{\phi_{mk}\Delta_{mk}^{s-}}+\frac{r\left(e^{\phi_{mk}\Delta_{mk}^{s-}}-1\right)\left(e^{-r\Delta_{mk}^{s-}}\right)}{1-e^{-r\Delta_{mk}^{s-}}}\right] \\ &< 0,\end{aligned}$$

and according to (12), $\frac{\partial \Delta_{mk}^{s}}{\partial\left(-P_{mk}^{1}\right)}$ is more positive for lower s. Thus, we can show that $\frac{\partial \ln \psi_{mk}^{s}}{\partial\left(-P_{mk}^{1}\right)} > \frac{\partial \ln \psi_{mk}^{s-}}{\partial\left(-P_{mk}^{1}\right)} > 0$. Taking stock, we can conclude that the first term inside the square brackets $\left(\psi_{mk}^{s-}\Phi_{mk}^{s-}\widetilde{\theta}_{k}^{s-}\frac{\partial \ln \psi_{mk}^{s-}}{\partial\left(-P_{mk}^{1}\right)} - \psi_{mk}^{s}\Phi_{mk}^{s}\widetilde{\theta}_{k}^{s}\frac{\partial \ln \psi_{mk}^{s}}{\partial\left(-P_{mk}^{1}\right)}\right)$ is negative.

Finally, since we can express $\left(\psi_{mk}^{s-}\widetilde{\theta}_{k}^{s-}\frac{\partial \Phi_{mk}^{s-}}{\partial\left(-P_{mk}^{1}\right)} - \psi_{mk}^{s}\widetilde{\theta}_{k}^{s}\frac{\partial \Phi_{mk}^{s}}{\partial\left(-P_{mk}^{1}\right)}\right)$ as $\left(\psi_{mk}^{s-}\widetilde{\theta}_{k}^{s-}\Phi_{mk}^{s-} - \psi_{mk}^{s}\widetilde{\theta}_{k}^{s}\Phi_{mk}^{s}\right)\frac{\kappa_k-1}{P_{mk}}\frac{\partial P_{mk}}{\partial\left(-P_{mk}^{1}\right)}$, given that $\psi_{mk}^{s}\Phi_{mk}^{s}\widetilde{\theta}_{k}^{s} > \psi_{mk}^{s-1}\Phi_{mk}^{s-1}\widetilde{\theta}_{k}^{s-1} > 0$ and $\frac{\partial P_{mk}}{\partial\left(-P_{mk}^{1}\right)} < 0$. we can show that $\psi_{mk}^{s-}\widetilde{\theta}_{k}^{s-}\frac{\partial \Phi_{mk}^{s-}}{\partial\left(-P_{mk}^{1}\right)} - \psi_{mk}^{s}\widetilde{\theta}_{k}^{s}\frac{\partial \Phi_{mk}^{s}}{\partial\left(-P_{mk}^{1}\right)} < 0$. So the sum of all terms inside the square brackets is negative.

Thus, if the second term is sufficiently negative, $\frac{\partial\left(\overline{\varphi}_{mk}^{s}\right)^{\sigma_k-1}}{\partial\left(-P_{mk}^{1}\right)} < 0$. This will happen if the the fixed cost of entering the two segments are very different (i.e., ΔF_{k}^{s} is large) or if $\psi_{mk}^{s}\Phi_{mk}^{s}\widetilde{\theta}_{k}^{s} - \psi_{mk}^{s-}\Phi_{mk}^{s-}\widetilde{\theta}_{k}^{s-}$ is close to zero, which would happen if the two segments have similar market size (i.e., Φ_{mk}^{s} and Φ_{mk}^{s-} are close, all else equal) or the quality difference is not that big (i.e., $\widetilde{\theta}_{k}^{s}$ is close to $\widetilde{\theta}_{k}^{s-}$, all else equal). These results are summarized in Proposition 6 in the main text.

9.1.3 Proof $\frac{\partial\left(\overline{\varphi}_{mk}^{1}\right)^{\sigma_k-1}}{\partial\left(-P_{mk}^{1}\right)\partial\tau_{mk}} > 0$

Recall that $\frac{\partial\left(\overline{\varphi}_{mk}^{1}\right)^{\sigma_k-1}}{\partial\left(-P_{mk}^{s}\right)} = \frac{\partial\left(\psi_{mk}^{1}\Phi_{mk}^{1}\right)}{\partial P_{mk}^{s}}$ and from (A4), we know $\frac{\partial\psi_{mk}^{1}}{\partial P_{mk}^{s}} > 0$. Thus, $\forall s \geq 1$.

$$\frac{\partial\left(\overline{\varphi}_{mk}^{1}\right)^{\sigma_k-1}}{\partial\left(-P_{mk}^{s}\right)} = \Phi_{mk}^{1}\left[\underbrace{\frac{\partial\psi_{mk}^{1}}{\partial P_{mk}^{s}}}_{>0} + (\kappa_k - 1)\left(P_{mk}\right)^{-1}\underbrace{\frac{\partial P_{mk}}{\partial P_{mk}^{s}}}_{>0}\right] > 0$$

The derivative of this partial with respect to τ_{mk} yields

$$\frac{\partial^2\left(\overline{\varphi}_{mk}^{1}\right)^{\sigma_k-1}}{\partial\left(-P_{mk}^{s}\right)\partial\tau_{mk}} = \frac{\partial}{\partial\tau_{mk}}\left(\frac{\partial\psi_{mk}^{1}}{\partial P_{mk}^{s}}\right) + (\kappa_k - 1)\left(P_{mk}\right)^{-1}\frac{\partial}{\partial\tau_{mk}}\left(\frac{\partial P_{mk}}{\partial P_{mk}^{s}}\right) \tag{A6}$$

First, notice that the second term is zero, as based on (5), $\frac{\partial P_{mk}}{\partial P_{mk}^{s}}$ is independent of τ_{mk}.

The first term of (A6) is $\frac{\partial}{\partial\tau_{mk}}\left(\frac{\partial\psi_{mk}^{1}}{\partial P_{mk}^{s}}\right) = \frac{\partial}{\partial\tau_{mk}}\left(\frac{\partial\Delta_{mk}^{1}}{\partial P_{mk}^{s}}R\left(\Delta_{mk}^{s}\right)\right) = \frac{\partial\left(\frac{\partial\Delta_{mk}^{1}}{\partial P_{mk}^{s}}\right)}{\partial\tau_{mk}}R\left(\Delta_{mk}^{1}\right) + \frac{\partial R\left(\Delta_{mk}^{1}\right)}{\partial\tau_{mk}}\frac{\partial\Delta_{mk}^{1}}{\partial P_{mk}^{s}}$.

We know from (12) that $\frac{\partial\left(\frac{\partial\Delta_{mk}^{1}}{\partial P_{mk}^{1}}\right)}{\partial\tau_{mk}} > 0$ and $\frac{\partial\Delta_{mk}^{1}}{\partial P_{mk}^{s}} < 0$, while

$$\begin{aligned}
\frac{\partial R\left(\Delta_{mk}^{1}\right)}{\partial\tau_{mk}} &= -\left(re^{-r\Delta_{mk}^{1}}\left(1 + \frac{e^{-r\Delta_{mk}^{1}}}{1 - e^{-r\Delta_{mk}^{1}}}\right) + e^{\phi_{mk}\Delta_{mk}^{1}}\left(\phi_{mk} - \frac{re^{-r\Delta_{mk}^{1}}}{1 - e^{-r\Delta_{mk}^{1}}}\right)\right)\frac{re^{-\phi_{mk}\Delta_{mk}^{1}}}{1 - e^{-r\Delta_{mk}^{1}}}\frac{\partial\Delta_{mk}^{1}}{\partial\tau_{mk}} \\
&\quad -\phi_{mk}\left(r + \phi_{mk} + \frac{re^{-r\Delta_{mk}^{1}}}{1 - e^{-r\Delta_{mk}^{1}}} - \frac{re^{\phi_{mk}\Delta_{mk}^{1}}}{1 - e^{-r\Delta_{mk}^{1}}}\right)e^{-\phi_{mk}\Delta_{mk}^{1}}\frac{\partial\Delta_{mk}^{1}}{\partial\tau_{mk}} \\
&< 0.
\end{aligned}$$

$$\frac{\partial}{\partial\tau_{mk}}\left(\frac{\partial\psi_{mk}^{1}}{\partial P_{mk}^{s}}\right) = \underbrace{\frac{\partial\left(\frac{\partial\Delta_{mk}^{1}}{\partial P_{mk}^{1}}\right)}{\partial\tau_{mk}}}_{>0}R\left(\Delta_{mk}^{1}\right) + \underbrace{\frac{\partial R\left(\Delta_{mk}^{1}\right)}{\partial\tau_{mk}}}_{<0}\underbrace{\frac{\partial\Delta_{mk}^{1}}{\partial P_{mk}^{s}}}_{<0} > 0.$$

In sum, the expression in (A6) $\frac{\partial^2\left(\overline{\varphi}_{mk}^{1}\right)^{\sigma_k-1}}{\partial\left(-P_{mk}^{s}\right)\partial\tau_{mk}}$ is positive.

Similarly, given that $\frac{d\Theta_{mk}^{s'}}{dy_m} > \frac{d\Theta_{mk}^{s}}{dy_m}$ for $s' > s$, we can show that $\frac{\partial\Delta_{mk}^{1}}{\partial y_m} < 0$ and

$$\begin{aligned}
\frac{\partial R\left(\Delta_{mk}^{s}\right)}{\partial y_m} &= -\left(re^{-r\Delta_{mk}^{s}}\left(1 + \frac{e^{-r\Delta_{mk}^{s}}}{1 - e^{-r\Delta_{mk}^{s}}}\right) + e^{\phi_{mk}\Delta_{mk}^{s}}\left(\phi_{mk} - \frac{re^{-r\Delta_{mk}^{s}}}{1 - e^{-r\Delta_{mk}^{s}}}\right)\right)\frac{re^{-\phi_{mk}\Delta_{mk}^{s}}}{1 - e^{-r\Delta_{mk}^{s}}}\frac{\partial\Delta_{mk}^{s}}{\partial y_m} \\
&\quad -\phi_{mk}\left(r + \phi_{mk} + \frac{re^{-r\Delta_{mk}^{s}}}{1 - e^{-r\Delta_{mk}^{s}}} - \frac{re^{\phi_{mk}\Delta_{mk}^{s}}}{1 - e^{-r\Delta_{mk}^{s}}}\right)e^{-\phi_{mk}\Delta_{mk}^{s}}\frac{\partial\Delta_{mk}^{s}}{\partial y_m} \\
&> 0.
\end{aligned}$$

$$\frac{\partial}{\partial y_m}\left(\frac{\partial \psi_{mk}^1}{\partial P_{mk}^s}\right) = \underbrace{\frac{\partial\left(\frac{\partial \Delta_{mk}^1}{\partial P_{mk}^1}\right)}{\partial y_m}}_{<0} R\left(\Delta_{mk}^1\right) + \underbrace{\frac{\partial R\left(\Delta_{mk}^1\right)}{\partial y_m}}_{>0} \underbrace{\frac{\partial \Delta_{mk}^1}{\partial P_{mk}^s}}_{<0} < 0.$$

In sum, $\frac{\partial^2 \left(\overline{\varphi}_{mk}^1\right)^{\sigma_k - 1}}{\partial\left(-P_{mk}^s\right)\partial y_m} = \frac{\partial}{\partial y_m}\left(\frac{\partial \psi_{mk}^1}{\partial P_{mk}^s}\right)$ is negative.

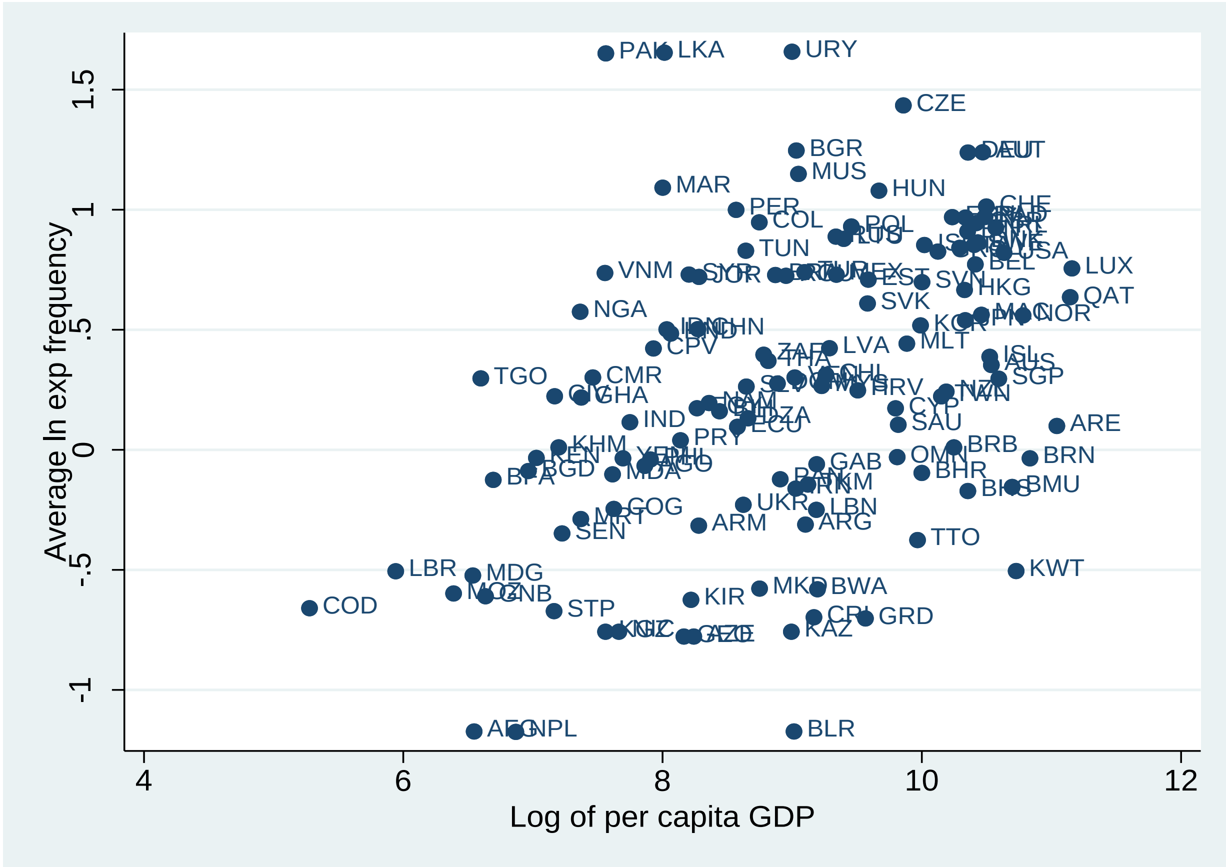

Figure 1: Export frequency and destination per capita income

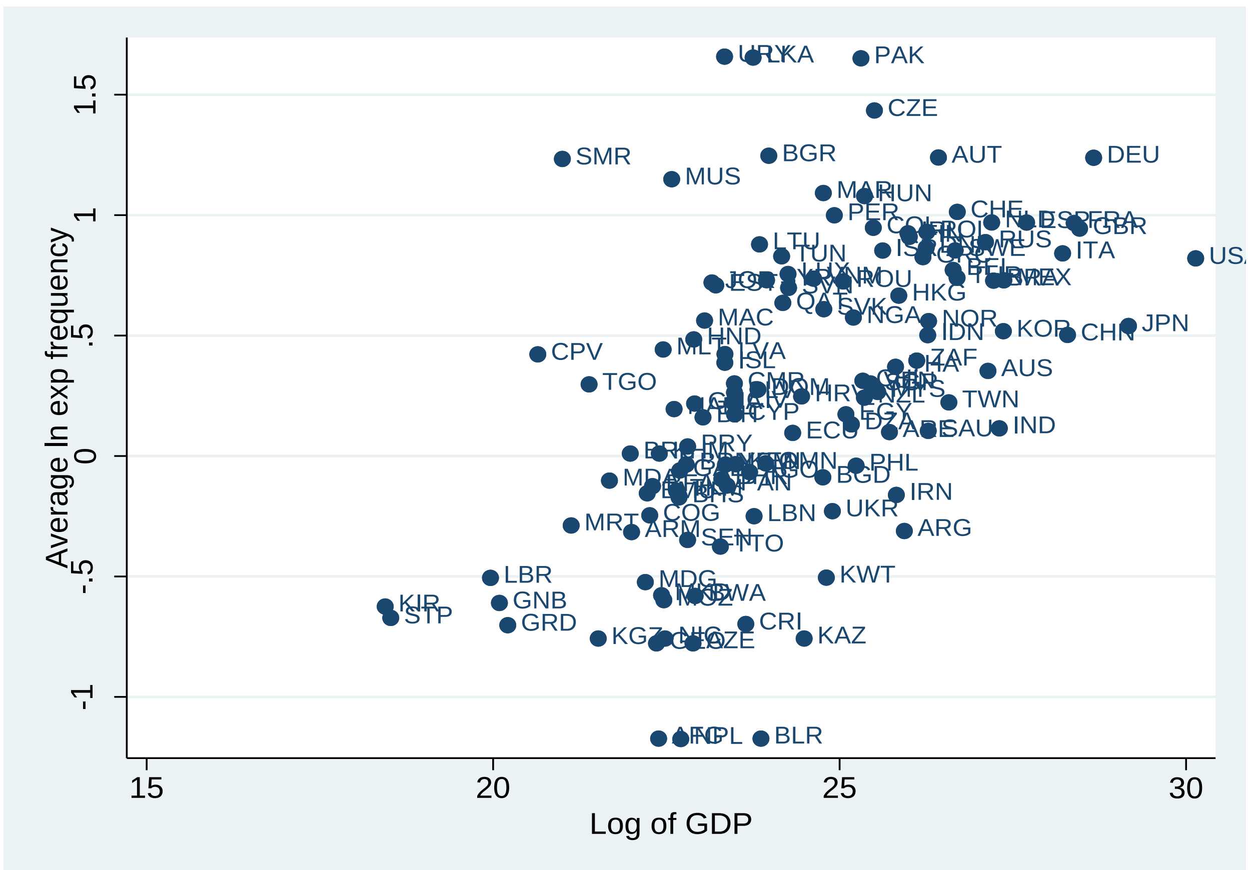

Figure 2: Export frequency and destination GDP

Figure 3: Export frequency and distance to destination

Figure 4: NPV of profits and productivity for a two-quality segment case of a market

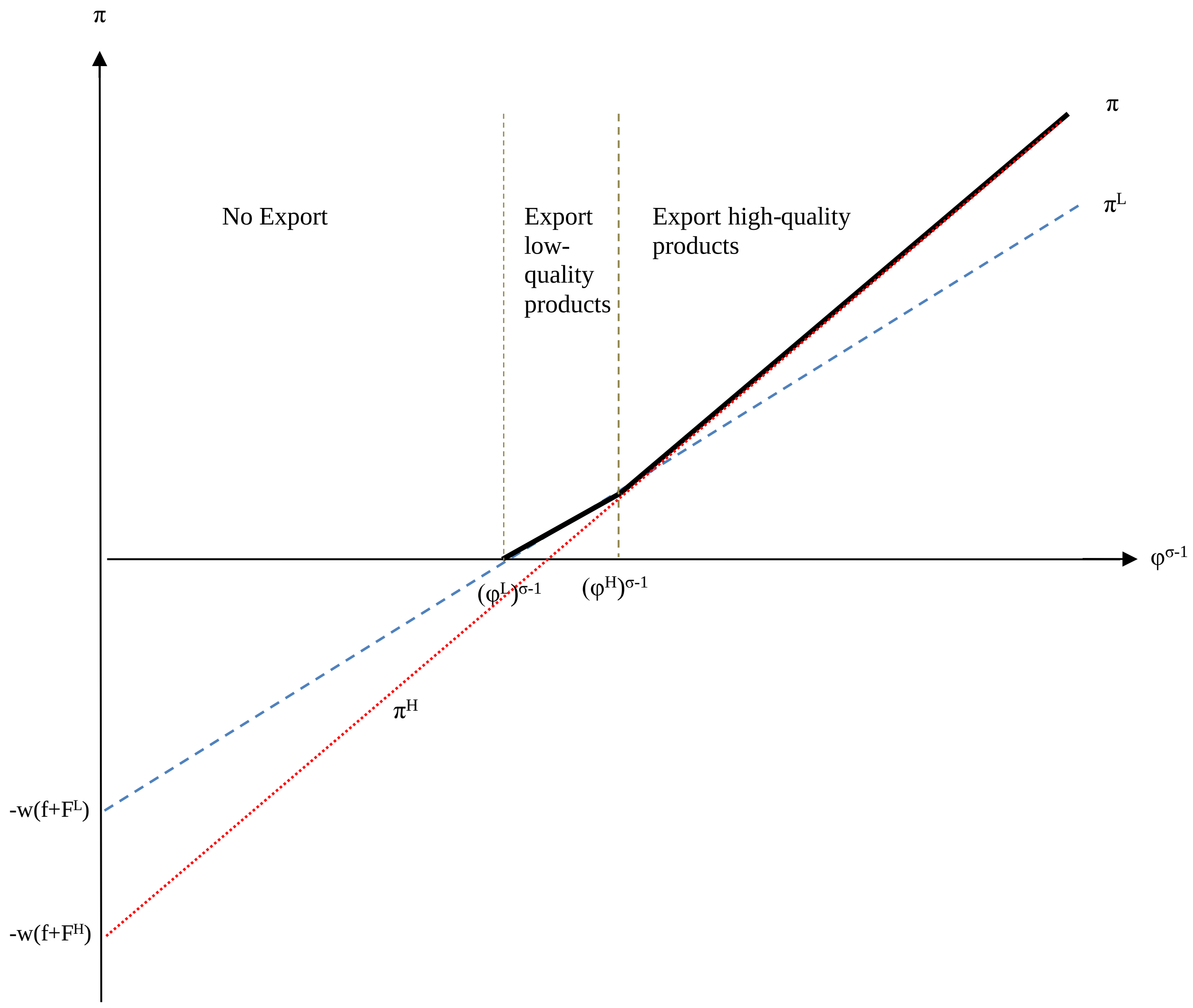

Figure 5: After large MFA shocks in the two-quality segments in the market

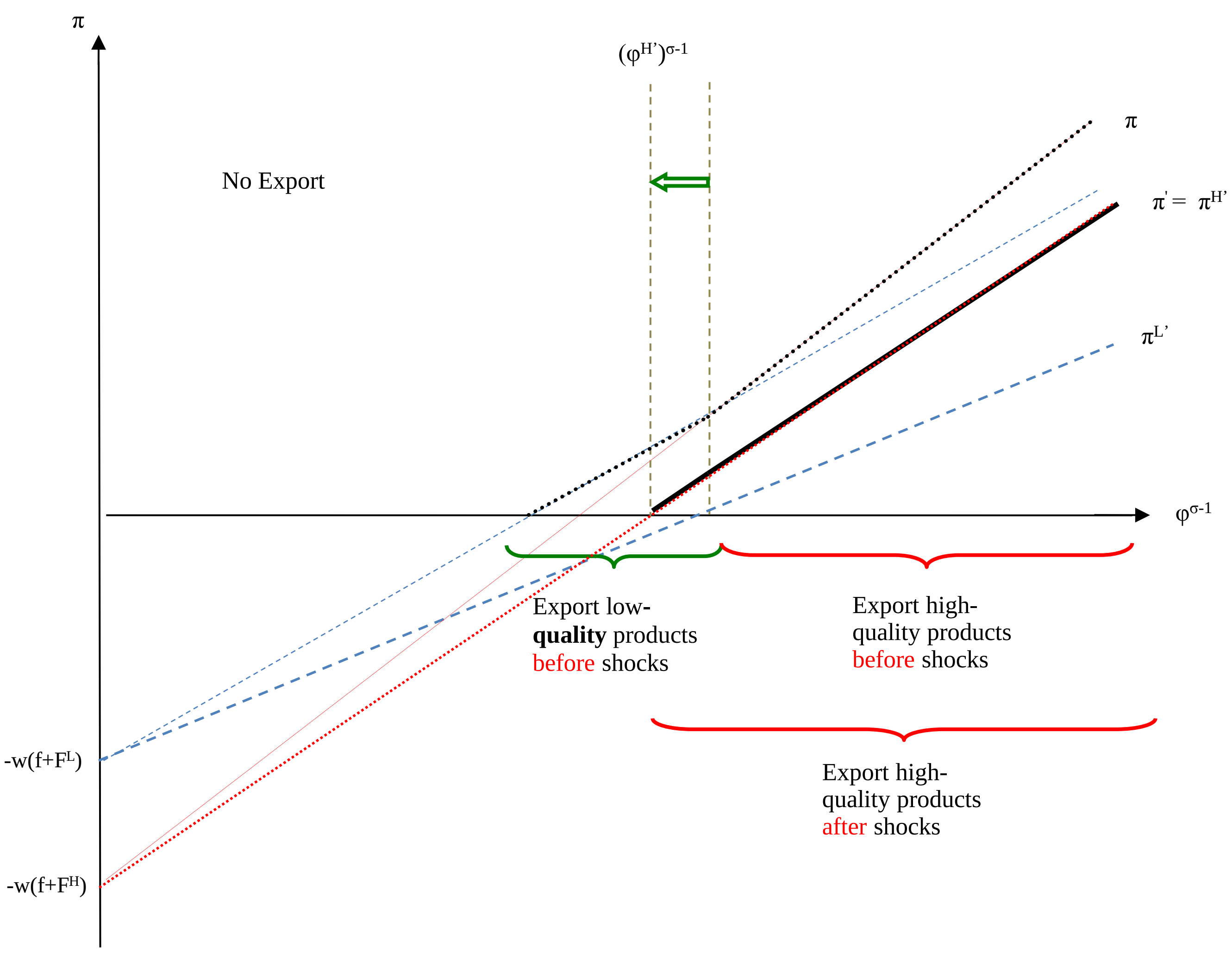

Figure 6: log average price of MFA and non-MFA exports

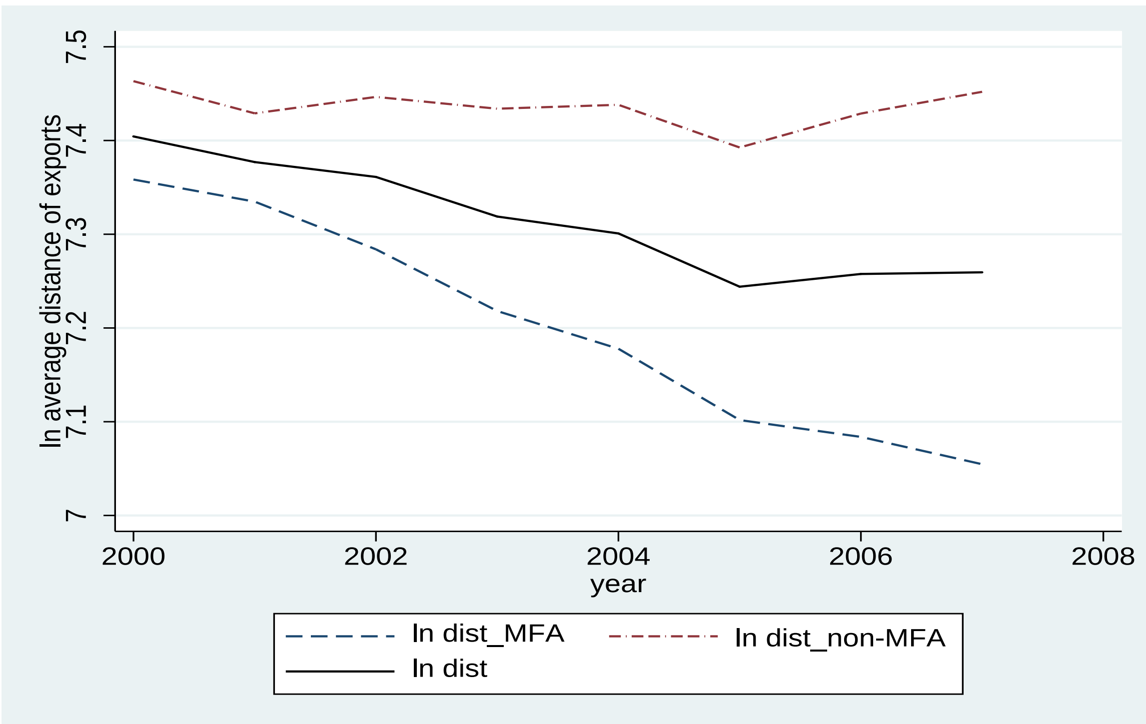

Figure 7: log average distance of MFA and non-MFA exports

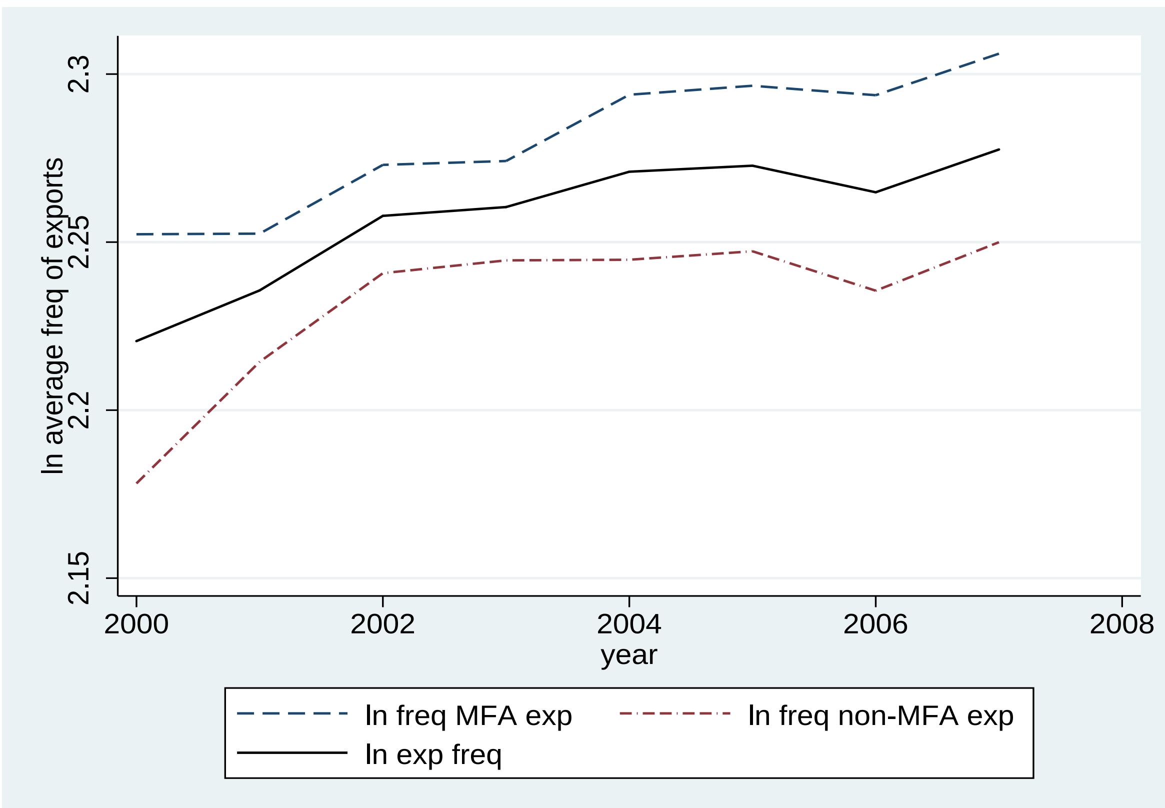

Figure 8: log average frequency of MFA and non-MFA exports

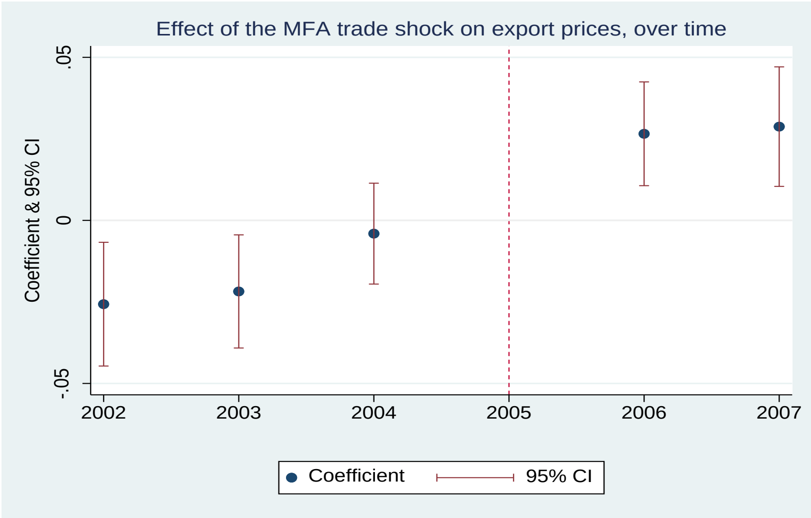

Figure 9: Effect of MFA shocks on Portugal's export price, over time

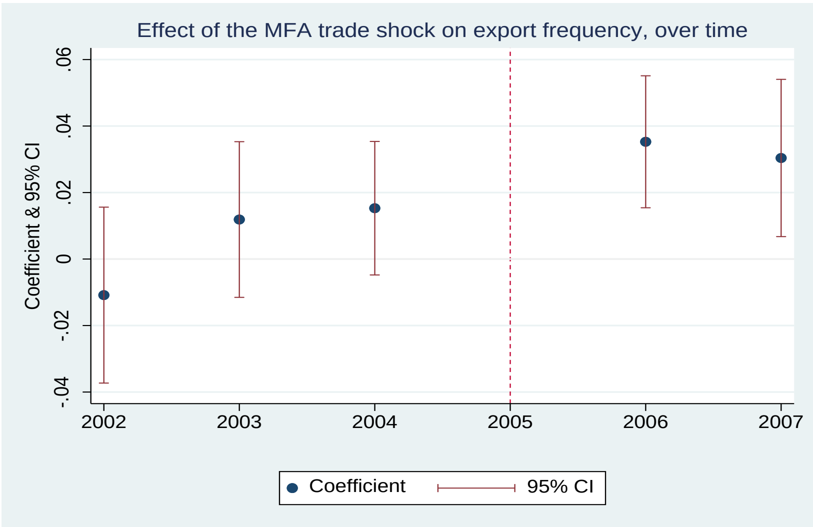

Figure 10: Effect of MFA shocks on Portugal's export frequency, over time

Table 1: Summary Statistics

Variable	mean	p50	p75	std dev
Variety Measures (firm-level)				
Number of exported products (HS6)	10	5	13	13
Number of new exported products (HS6)	3	1	3	5
Number of dropped exported products (HS6)	2	1	2	3
Number of export destinations	6	3	8	7
Export prices and frequency (firm-product-country-level)				
Average ln real unit value of exports	2.92	2.90	3.69	1.12
Average ln frequency of exports (nb. shipments)	0.83	0.69	1.61	0.86
Weighted average (quant) distance of export (firm-product-level)				
Weighted average distance	7.46	7.45	7.89	0.86
Weighted average distance to capital	7.48	7.45	7.91	0.87
Weighted average population-weighted distance	7.52	7.44	7.87	0.82
Product-country level Shocks				
MFA product-country dummy	0.45	0	1.00	0.50
Firm-level Shocks				
Quota Dummy - MFA exports > 50%	0.39	0	1.00	0.49
Firm-level				
ln TFP	6.78	6.19	7.46	16.43
ln Sales (in '000 Euro)	14.24	14.22	15.22	1.41
ln Exports (in '000 Euro)	12.79	13.21	14.54	2.47

Summary statistics for textiles and clothing firms, over 2000-2008. Monetary variables reported in euros.

Table 2: Export frequency, quantity and value of shipments and destination characteristics, firm-product-country regressions

	(1)	(3)	(3)
Dep. variable:	ln (exp frequency)	ln (avg shipment value)	ln (unit value)
ln (gdp)	0.107***	0.186***	-0.00239
	(19.65)	(21.21)	(-0.77)
ln (gdp per capita)	0.115***	-0.0908***	0.0419***
	(12.64)	(-3.12)	(2.85)
ln (distance)	-0.277***	-0.252***	0.150***
	(-31.07)	(-11.44)	(12.37)
Fixed effects			
Num of Obs	300015	300015	300015
R-squared	.149	.0408	.035

Observations are by firm-product-country-year. The sample is for 2000-2008; results remain the same if the sample is restricted to 2000-2004, pre-MFA quota removal. Standard errors are clustered by firm. A constant term is always included. t-statistics in parenthesis. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 3: Firms' unit values and export frequency

	(1)	(2)
Dep. variable:	ln (frequency)$_{isct}$	ln (unit value)$_{isct}$
ln (unit value)$_{isct}$	0.0222***	
	(2.64)	
ln (firm sales)$_{it}$		0.0514***
		(10.52)
Fixed effects	firm-country + product	country-product
Num of Obs	27854	26298
R-squared	.493	.675

Observations are by firm-product-country-year. The sample is for 2002, pre-MFA. Standard errors are clustered by country-product. A constant term is included. t-statistics in parenthesis. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 4: Impact of T&C trade shock on firm-level variables

	(1)	(2)	(3)	(4)	(5)
Dep. variable:	ln(sales)	ln(val. added)	ln(output)	ln(employm)	ln(wages)
Quota x Post05	-0.0370	0.0246	-0.0124	0.0316	0.00486
	(-1.40)	(1.06)	(-0.74)	(1.35)	(0.56)
Firm FE	yes	yes	yes	yes	yes
year FE	yes	yes	yes	yes	yes
ln(sales)t-1	no	yes	yes	yes	yes
Num of Obs	9533	6708	6787	9361	7912
R-sq	.0893	.195	.346	.115	.0601

	(6)	(7)	(8)	(9)	(10)
Dep. variable:	ln(export price)	ln(import price)	skill intensity	ln(frequency)	ln(distance)
Quota x Post05	0.0594***	0.0889**	0.0441**	0.130***	-0.0481**
	(2.67)	(2.00)	(2.44)	(4.11)	(-2.01)
Firm FE	yes	yes	yes	yes	yes
year FE	yes	yes	yes	yes	yes
ln(sales)t-1	yes	yes	yes	yes	yes
Num of Obs	9652	6883	7823	9052	9052
R-sq	.0232	.0129	.0216	.036	.0119

The unit of observation is at the firm level. All dependent variables are logged. Quota is the treatment variable for firms affected by the shock, which is equal to one if the firm's sales of quota-bound products in the year 2000 (before China joins the WTO) are at least 50% (results remain robust to alternative definitions of the treatment variable). In unit values, distance and frequency are export quantity-weighted averages at the firm-year level. Skill intensity is the share of workers with high-school or university degree. Post05 takes the value of 1 in 2005 and then onwards. All columns, except column (1) include ln(lagged firm sales), firm fixed effects and year fixed effects as controls. In all regressions the sample period is 2000-2008. Standard errors are clustered by firm. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 5: Impact of MFA shock on the probability of dropping destinations and destination characteristics

Panel A: Average effects

	(1)	(2)
Dependent variable:	Pr(drop country)$_{ict}$	
Quota x Post05 x ln distance	0.0166**	
	(2.37)	
Quota x Post05 x ln gdpcap		-0.00782
		(-1.03)
Quota x Post05	-0.150***	0.0601
	(-2.81)	(0.77)
Fixed effects	country + firm + year	
Num of Obs	59300	59228
R-squared	.0915	.0913

Panel B: Heterogeneous effects

	(1)	(2)
Country Characteristic (Z):	distance	per cap GDP
Quota x Post05 x ln distance	0.0675**	
	(2.45)	
Quota x Post05 x ln distance x TFP	-0.00663**	
	(-2.24)	
Quota x Post05 x ln gdpcap		-0.0682**
		(-2.00)
Quota x Post05 x ln gdpcap x TFP		0.00783**
		(2.14)
Quota x Post05	-0.515**	0.710**
	(-2.42)	(2.03)
Fixed effects	country + firm + year	
Num of Obs	31346	31285
R-squared	.0969	.0961

The unit of observation is at the firm-country-year level. The Quota shock variable is at the firm level. The dependent variable is a dummy variable that takes the value one if the firm-country trade flow is dropped in year t, that is, if the firm exports to the country for the last time in t. the Drop-country dependent variable is not defined for 2008, the last year of the sample. TFP is the firms's total factor productivity in 2003, prior to the MFA liberalization. All lower-order terms of the main interactions are included but not reported. All columns include ln(lagged firm sales) as controls, and sets of fixed effects. The sample period is 2000-2008. Standard errors are clustered by firm-country. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 6: Import competition from China and per capita GDP of destination

	(1)	(2)
Dep. variable:	$\Delta IMPS_{sc}^{CH}$	
Sample	All countries	Quota-imposing countries
Quota x ln pcgdp	0.0633***	0.0589***
	(4.58)	(4.43)
ln pcgdp	-0.111***	-0.0939***
	(-39.10)	(-16.23)
Quota	-0.628***	-0.563***
	(-4.45)	(-4.00)
ldist	0.223***	0.217***
	(47.10)	(72.52)
Num of Obs	69990	17257
R-squared	.0719	.208

The unit of observation is at the country-HS6 level. Data is from BACI dataset, from CEPII. The dependent variable is the change in import shares from China, by hs6-country, between 2003 and 2007. Ln real gdp per capita is for 2003. Quota takes the value one if the HS6 was subject to quotas imposed by the importer and zero otherwise. Product and country dummies are always included. In colum (1) we use a sample with all HS6-country pairs, in colum (2) the sample is restricted to countries which imposed quotas on China (EU countries and US), thus comparing quota-free and quota-bound HS6. Standard errors are clustered by country. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 7: Impact of the MFA shock on China's exports prices and destination GDP per capita

	(1)	(2)
Dep variable:	Δln(export Price)$_{sodt}$	
China	-0.361***	-0.325***
	(-4.26)	(-3.23)
China x Quota x Post05	-1.787***	-1.651***
	(-3.53)	(-2.97)
China x Quota x Post05 x ln pcgdp	-0.111***	-0.130***
	(-2.76)	(-3.02)
ln pcgdp	0.0856***	0.0566**
	(3.45)	(2.13)
Quota x Post05	0.0818	-0.133
	(0.23)	(-0.32)
Quota x Post05 x ln pcgdp	0.0483	0.0725*
	(1.51)	(1.77)
Quota x Post05 x ln dist	-0.0818***	-0.0880***
	(-4.35)	(-4.22)
China x Quota x Post05 x ln dist	0.339***	0.347***
	(6.10)	(5.88)
Product fixed effects	yes	
Destination fixed effects	yes	
Product-destination fixed effects		yes
Year fixed effects	yes	yes
Num of Obs	396657	396657
R-squared	.00601	.00398

Observations are by origin-destination-HS6-year. The data are from the BACI dataset, from CEPII. We include as origins Portugal and China, and estimate the differential effect on Chinas' export price after MFA quotas were lifted. The Quota shock variable is at the hs6-destination level; it takes the value one if the HS6 was subject to quotas applied by the destination. The dependent variable is the log difference in export prices between t and t-1. Standard errors are clustered by product-destination. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 8: Impact of T&C trade shock on export prices; firm-product-country level

Panel A: Average effects		
	(1)	(2)
Dep. variable:	$\ln(\text{export Price})_{isct}$	
Sample:	All	Cont
Quota x Post05	0.146***	0.156***
	(23.52)	(24.37)
Firm-product-country fixed effects	yes	yes
Year fixed effects	yes	yes
ln(sales)t-1	yes	yes
Num of Obs	276862	226995
R-sq	.0371	.042

Panel B: Heterogeneous effects		
	(1)	(2)
Quota x Post05 x		
1st TFP quartile	0.0889***	0.0841***
	(3.06)	(2.74)
2nd TFP quartile	0.110***	0.107***
	(6.64)	(6.28)
3rd TFP quartile	0.150***	0.161***
	(10.71)	(11.37)
4th TFP quartile	0.141***	0.145***
	(10.69)	(10.72)
Firm-prod-country fixed effects	yes	yes
Year fixed effects	yes	yes
ln(sales)t-1	yes	yes
Num of Obs	140056	120860
R-sq	.00552	.00605

The unit of observation is at the firm-product-country-level. The Quota shock variable is at the product-country level. The dependent is (log) export prices. All columns include ln(lagged firm sales) as controls, and sets of fixed effects. In Panel B, all columns include quartile-year fixed effects as controls, other sets of fixed effects included. TFP quartiles are based on the firms's total factor productivity in 2000, prior to the MFA liberalization. Odd columns include all products, while even columns exclude products that were dropped each year. In all regressions the sample period is 2000-2008. Standard errors are clustered firm-product-country. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 9: Impact of T&C trade shock on the frequency of export transactions; firm-product-country level

Panel A: Average effects			
	(1)	(2)	(3)
Dep. Variable:		ln(# shipments)$_{isct}$	
Sample:	Europe	Below-med dist	All dest
Quota x Post05	0.0178*	0.0185**	0.00487
	(1.86)	(2.02)	(0.55)
Firm-product-country fixed effects	yes	yes	yes
Year fixed effects	yes	yes	yes
ln(sales)t-1	yes	yes	yes
Num of Obs	226197	253503	277483
R-sq	.00563	.00533	.00506

Panel B: Heterogeneous effects			
	(1)	(2)	(3)
	Europe	Below-med dist	All dest
Quota x Post05 x			
1st TFP quartile	0.00101	-0.00340	-0.0210
	(0.02)	(-0.09)	(-0.57)
2nd TFP quartile	-0.0284	-0.0204	-0.0202
	(-1.00)	(-0.74)	(-0.75)
3rd TFP quartile	0.0681***	0.0648***	0.0568***
	(3.06)	(3.04)	(2.78)
4th TFP quartile	0.0148	0.0116	-0.0107
	(0.78)	(0.64)	(-0.61)
Firm-prod-country fixed effects	yes	yes	yes
Year fixed effects	yes	yes	yes
ln(sales)t-1	yes	yes	yes
Num of Obs	112787	126031	140370
R-sq	.00634	.00613	.00576

The dependent variable is the ln number of shipments by firm-hs6-country-year. In column (1) we include European countries, in column (2) countries with below-median of distance to Portugal, in column (3) all destination countries are included. The Quota shock variable is at the product-country level. All columns include sets of fixed effects as specified. A constant term is also included. In Panel B, all columns include quartile-year fixed effects as controls, other sets of fixed effects included. TFP quartiles are based on the firms's total factor productivity in 2000, prior to the MFA liberalization. In all regressions the sample period is 2000-2008. Standard errors are clustered by firm-product-country. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 10: Impact of T&C trade shock on the distance of exports; firm-product level

Panel A: Average effects			
	(1)	(2)	(3)
Dep. variable:	ln (dist)	ln (distcap)	ln (distw)
Quota x Post05	-0.0542***	-0.0570***	-0.0486***
	(-4.42)	(-4.62)	(-4.22)
Firm-product fixed effects	yes	yes	yes
Year fixed effects	yes	yes	yes
ln(sales)t-1	yes	yes	yes
Num of Obs	105653	105653	105653
R-sq	.00234	.00255	.0018

Panel B: Heterogeneous effects			
	(1)	(2)	(3)
Quota x Post05 x			
1st TFP quartile	0.0414	0.0393	0.0265
	(0.73)	(0.68)	(0.50)
2nd TFP quartile	0.00291	0.00342	0.0168
	(0.10)	(0.11)	(0.61)
3rd TFP quartile	-0.117***	-0.115***	-0.111***
	(-3.54)	(-3.46)	(-3.55)
4th TFP quartile	-0.0351	-0.0399	-0.0492
	(-1.09)	(-1.23)	(-1.59)
Firm-product fixed effects	yes	yes	yes
Year fixed effects	yes	yes	yes
ln(sales)t-1	yes	yes	yes
Num of Obs	51192	51192	51192
R-sq	.00436	.00448	.0045

The dependent variable is export quantity-weighted average log distance of exports by firm-product-year. In column (1) we use simple distance, in col (2) distance between capitals, in col (3) population-weighted distance. Quota is the treatment variable for firms affected by the shock, which is equal to one if the firm's exports in quota-bound products in 2000 (before China joins the WTO) are at least 50%. Post05 takes the value of 1 in 2005 and then onwards. All columns include sets of fixed effects as specified and ln(lagged firm sales) as controls as well as a constant term. In Panel B, all columns include quartile-year fixed effects as controls, other sets of fixed effects included. TFP quartiles are based on the firms's total factor productivity in 2000, prior to the MFA liberalization. Standard errors are clustered by firm-product. In all regressions the sample period is 2000-2008. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table A1: More productive firms export more products and to more countries

	(1)	(2)	(3)	(4)
Dep. variable:	ln (nb exp products)$_{ict}$		ln (nb exp countries)$_{ist}$	
ln (firm sales)$_{ft-1}$	0.164***	0.0551***	0.156***	0.0590***
	(10.20)	(5.19)	(15.49)	(8.03)
Fixed effects	country + year	firm + country-year	product + year	firm + product-year
Num of Obs	74956	74232	112878	111704
R-squared	.0671	.463	.09	.382

Observations are by firm-country-year in columns (1)-(2) and by firm-product-year in columns (3)-(4). A product is a HS6 digit category. The sample is for 2000-2008; results remain the same if the sample is restricted to 2000-2004, pre-MFA quota removal. Standard errors are clustered by firm. A constant term is always included. t-statistics in parenthesis. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table A2: Number and export share of T&C HS6 with binding quotas in 2004

	2000	2002	2004	2006
share of PT exp to the EU	83.1%	83.3%	85.4%	86.4%
share of PT exp to the US	8.9%	8.2%	7.1%	6.4%
share of quota-bound exp in total PT exp	54.7%	53.1%	54.6%	53.8%
share of quota-bound exp to the EU in total PT exp	47.5%	47.0%	49.5%	49.4%
share of quota-bound exp to the US in total PT exp	7.3%	6.2%	5.1%	4.4%
share of quota-bound exp to the EU in total exp to EU	57.1%	56.4%	57.9%	57.2%
share of quota-bound exp to the US in total exp to US	81.6%	75.4%	72.0%	68.9%
Nb. T&C hs6 exported (with binding quotas)	708 (258)	715 (265)	714 (267)	724 (251)
Nb. T&C hs6 exported to EU (with binding quotas)	678 (187)	668 (183)	680 (185)	671 (181)
Nb. T&C hs6 exported to US (with binding quotas)	326 (159)	361(180)	358 (176)	352 (167)

The table reports export shares and number of products exported, for products subject to binding-quotas in 2004, the year before the MFA quotas were lifted, and when the treatment group for analysis is selected. For the number of products, the figures in brackets refer to the nb of prods exported in each year that were among the HS6 with binding quotas in 2004. The numbers may vary as some quota-bound products may be dropped from exports. For 2004, T&C firms exported 714 different T&C HS6 products, of which 267 were subject to binding quotas on China by the EU or the US, and these accounted for 55% of total Portuguese T&C export value that year.

Table A3: Impact of MFA shock on the probability of dropping products and product price

	(1)	(2)
Dependent variable:	Pr(drop product)$_{ist}$	
Quota x Post05 x ln price	-0.00261	0.00415
	(-0.43)	(0.66)
Quota x Post05	-0.0178***	-0.0221***
	(-2.81)	(-3.41)
Fixed effects	product + firm + year	product-firm + year
Num of Obs	69021	67537
R-squared	.173	.382

Panel B: Heterogeneous effects

	(1)	(2)
Quota x Post05 x ln price	0.0275	0.0185
	(0.94)	(0.63)
Quota x Post05 x ln price x TFP	-0.00186	0.000170
	(-0.53)	(0.05)
Quota x Post05	-0.0559*	-0.0417
	(-1.85)	(-1.38)
Fixed effects	product + firm + year	product-firm + year
Num of Obs	33310	33088
R-squared	.157	.367

The unit of observation is at the firm-hs6-year level. The Quota shock variable is at the firm level. The dependent variable is a dummy variable that takes the value one if the firm-product trade flow is dropped in year t, that is, if the firm exports the product for the last time in t. the Drop-product dependent variable is not defined for 2008, the last year of the sample. Price is the firm-hs6 estimated fixed effects for the pre-mfa period, from a regression with firm-product and country-year fixed effects. All lower-order terms of the main interactions are included, but not reported. All columns include ln(lagged firm sales) as controls, and sets of fixed effects. The sample period is 2000-2008. Standard errors are clustered by firm-product. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

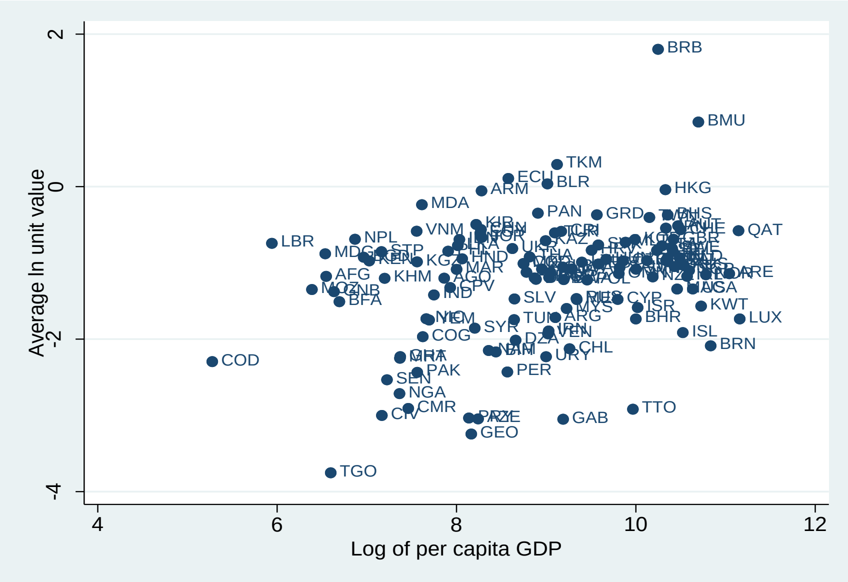

Figure A1: Export price and destination per capita income

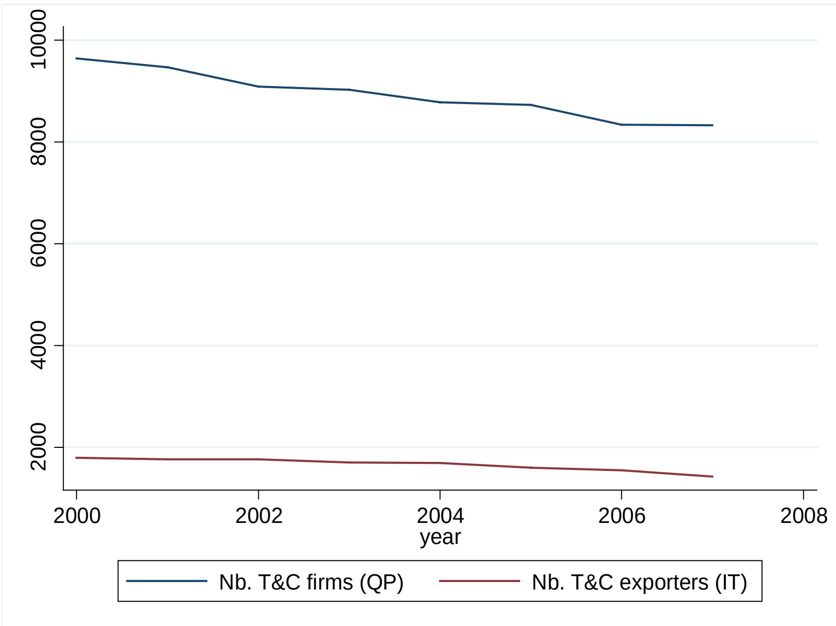

Figure A2: Total Number of T&C firms and exporters

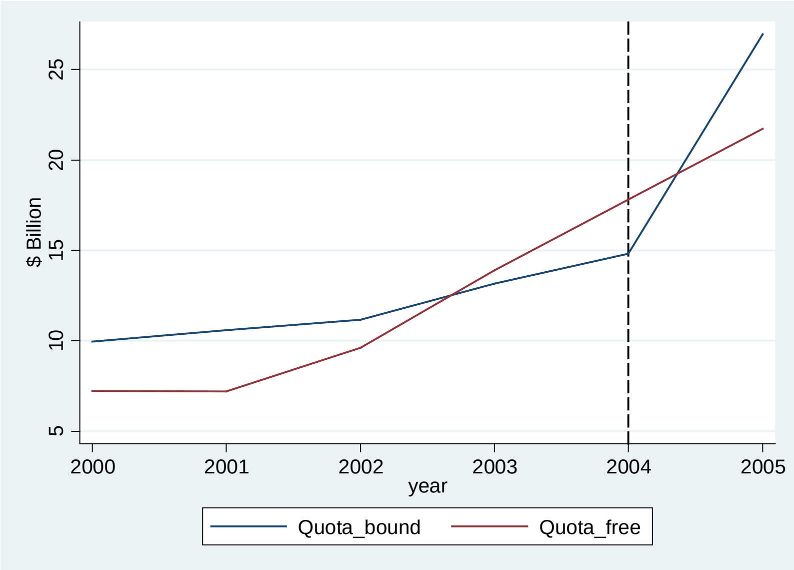

Figure A3: China aggregate T&C exports to the EU and US, quota-bound and quo

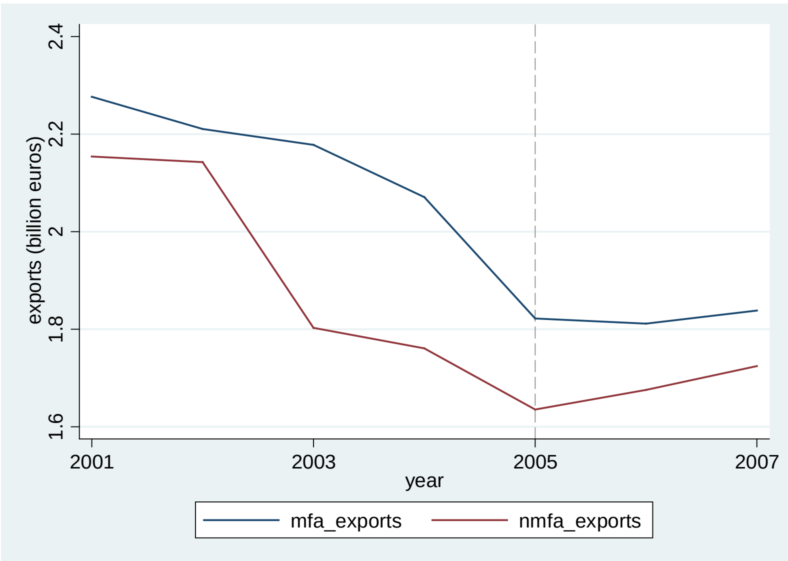

Figure A4: Quota-bound and quota-free exports

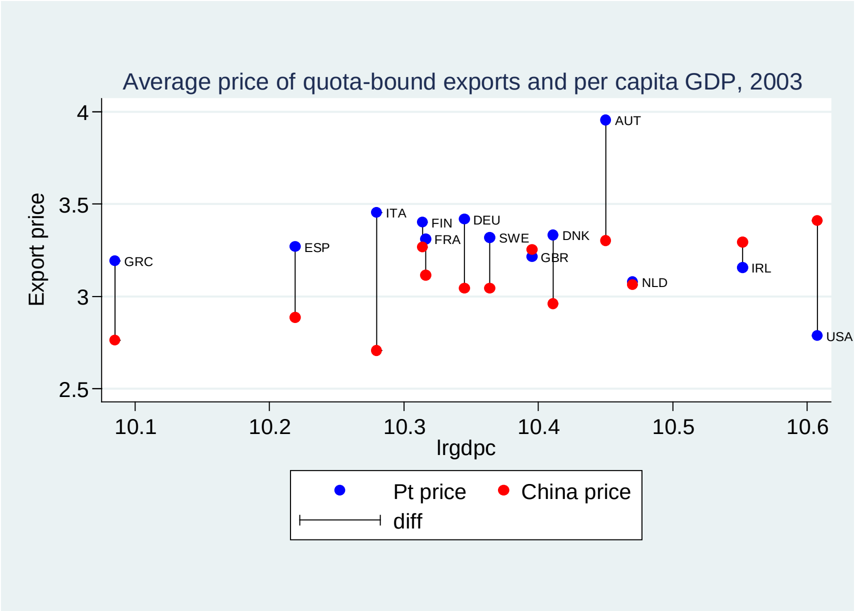

Figure A.4: Average price of quota-bound exports and destination per capita GDP, 2003

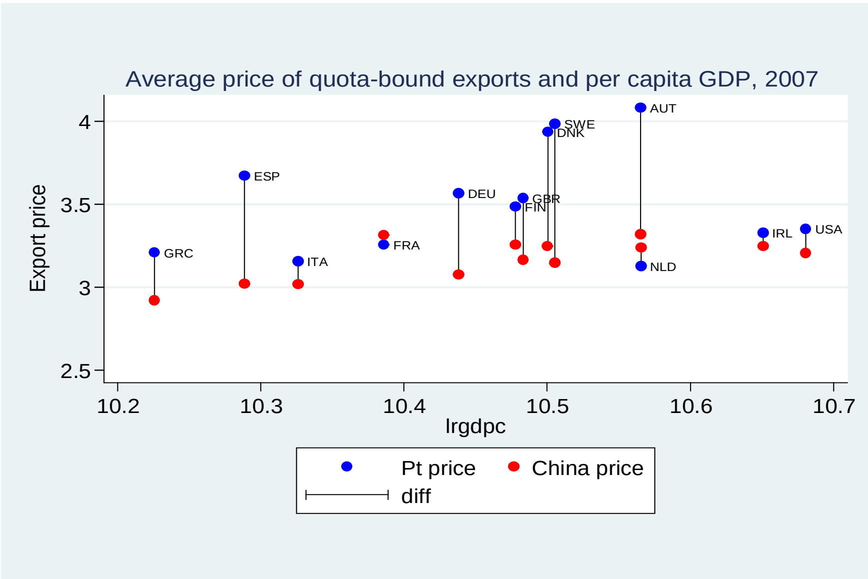

Figure A.5: Average price of quota-bound exports and destination per capita GDP, 2007