Essays in International Economics

Renzo Cesar Castellares Anazco
Lima, Peru

Master of Arts in Economics, University of Virginia, 2012
Master of Arts in Economics, University of San Andres, 2010
Bachelor of Arts in Economics, Pontifical Catholic University of Peru, 2005

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Department of Economics

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Abstract

During the recent years the degree of trade integration has been increasing significantly across the world. In that sense, countries have been developing strategic partnerships, subscribing Free Trade Agreements to increase the amount of trade between partners. At the same time, this higher level of integration generates concerns about the effects of global financial crisis and recessions. In these three essays I explore some implications of trade integration on firm's production decisions considering differences across firms and products.

In chapter 1, I use the exponential growth in Chinese exports from 2001 to 2006 to evaluate the effects of a competition shock from a low-wage competitor on exporters from a developing country. In particular, this research considers heterogeneous quality upgrading strategies of Peruvian apparel firms in response to an influx of low-cost Chinese apparel goods. Using firm-level data from Peruvian customs and a survey of Peruvian manufactures, I find that more productive firms upgrade their product quality to differentiate them from low-cost and low-quality Chinese apparel goods. Conversely, less productive Peruvian firms, which are not able to increase their quality, react by reducing their prices. Finally, I also find evidence that the average quality of Peruvian apparel products increase during 2001 to 2007.

In chapter 2, I evaluate the effect of access to low-cost inputs from China on a firm's export outcomes. In a heterogeneous firms model, the use of low-cost inputs reduce the firm's marginal cost, increasing firm exporting at both the extensive and intensive margin. The reduction in cost allows a firm to become a new exporter, and current exporters become more competitive and increase their level of exports. The model considers firms producing two different quality varieties of a given good: a high-quality variety (HQV), which is intensive in high-quality inputs sourced from OECD countries; and a low-quality variety (LQV), which is intensive in low-quality inputs sourced from non-OECD countries. I find initial evidence of the two main predictions of the model using firm-level data from Peruvian Customs: 1) Inputs imported from China, which are of lower quality than inputs imported from OECD countries, are used proportionally more in the production of the low-quality variety after a tariff reduction of inputs imported from China. 2) A group of firms becomes more competitive and starts exporting the low-quality variety, whereas the current exporters increase the proportion of sales of the low-quality variety in their total

sales.

The final chapter exploits the fact that when products are more complex, they become more sensitive to imperfect contracting. Therefore, industries exhibit different degrees of contractual vulnerability. We build a simple theory in which: (i) exporters are paid after delivery of the goods, and (ii) a complementarity exists between (procyclical) contract enforcement at the importing-country level and contract vulnerability at the industry level. In this environment, an adverse aggregate shock (e.g., a recession or financial crisis) in an importing country generates a disproportional decline in imports in more contractually vulnerable industries. Using disaggregated bilateral trade data for many countries from 1989 to 2000, and exploiting the variation in contractual dependence across manufacturing industries, we find robust empirical support for the model's predictions. The estimated effects of this new mechanism in the literature on crises and trade are statistically and economically significant. Our analysis employs different industry measures of contractual vulnerability, including a novel indicator that reflects payment defaults among firms.

Acknowledgements

I am so thankful to my advisors James Harrigan, John McLaren and Ariell Reshef for their guidance. I would like to thank my classmates for all of their useful comments and their support. I consider that a significant part of this dissertation corresponds to them. I would like to thank my co-author Jorge Salas for his knowledge and fundamental contribution in one chapter of this dissertation.

…This dissertation is dedicated to the memory of my father, Jesus Castellares. He has been my main motivation along this process. I also want to dedicate this dissertation to my mother, Rosa Anazco who has been my strongest support during my life.

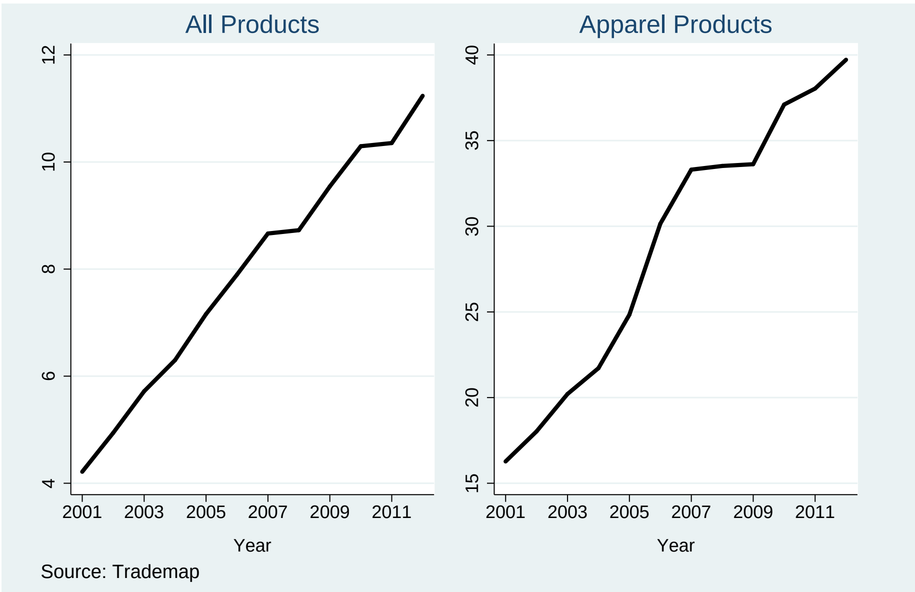
Contents

Chapter 1: Competition and Quality Upgrading in Export Markets: The Case of Peruvian Apparel Exports.

1.1 Introduction

China's exports grew more than 20 percent per year from 2001 to 2012. Their low cost in low-skilled-intensive products has been one of the main drivers of this exponential growth Amiti and Freund (2010), which has permitted China to capture more than 13 percent of total global exports by the end of 2012 (Figure 1). The evolution of China's apparel exports is an example of how China's global market share has increased from 10 percent to 40 percent in the last 12 years (Figure 1).

Figure 1: **China's Global Market Share (percentage)**



*Notes:*Apparel products include those classified under the Harmonized System (HS) in codes 60 (knitted or crocheted fabrics); 61 (articles of apparel & clothing accessories-knitted or crocheted); 62 (articles of apparel & clothing accessories-not knitted or crocheted) and 63 (made-up textile articles nesoi, needlecraft sets, worn clothing, rags)

Besides China's entry into the World Trade Organization (WTO), the end of the last stage of the Multifiber Agreement (MFA) and the corresponding elimination of the quota system accelerated the growth of China's apparel exports.[1] At the same time, this growth has produced a crowding out effect in the apparel production of other countries, mainly in high-middle income and Latin-American countries. The higher level of competition from Chinese apparel exports has also caused a lower price in the same products of some other apparel exporters. This research evaluates the heterogeneous quality upgrading strategies of Peruvian apparel firms in reaction to the lower prices of Chinese apparel. Firms competing against Chinese low-price apparel may prefer to differentiate their products vertically (quality) from their competitors and gain some monopoly power rather than start a price war (Gabszewicz and Thisse (1979); Shaked and Sutton (1982))

A recurring concern among other countries is whether China's export growth has displaced exports from other countries. Hanson and Robertson (2010) find that for the main developing countries in manufacturing exports, China's expansion has represented only a modest negative shock. However, this shock varies and is larger in low-skilled intensive sectors.[2] Greenaway et al. (2008) find that the displacement effect of Chinese exports on other Asian countries' exports varies, and is greater in high-income exporters such as Japan and South Korea. In the case of Latin American countries, Freund and Ozden (2006) find that Mexican exporters of industrial goods to the U.S. market have been negatively impacted by Chinese exports during the mid-1980s and the early 2000s. Chinese export growth in industrial products has led to 2 percentage point slower growth in Mexican exports to the US. Recently, Utar and Ruiz (2013) find a negative effect of Chinese imports in the US market on the total sales, value added and employment of Mexican maquiladoras, using plant-level data from 1990 to 2006.

The study of heterogeneous quality upgrading decisions in the Peruvian apparel industry is relevant for this economy since the apparel and textile industry has represented, on average, 20 percent of Peruvian manufacturing exports from 1993 to 2012. In addition, the apparel and textile sector represents around 10 percent of total employment in Peru, when considering both direct and indirect jobs.[3]

[1]At the time that the MFA was created, China was not a member of the WTO, so it was not part of the initial phases of the MFA. However, after China became a member of the WTO, it also became eligible for participation in the MFA quota elimination process.

[2]The authors find that if China's export supply capacity had been constant over the 1995-2005 period, the demand for exports would have been 0.8% to 1.6% higher in the 10 countries studied (Hungary, Malaysia, Mexico, Pakistan, the Philippines, Poland, Romania, Sri Lanka, Thailand, and Turkey).

[3]Paredes, Ricardo and Miluska Caceres (2004). "El Comercio Internacional sobre Textiles y Vestido

In this framework there are firms in two countries, Home (Peru) and Foreign (China), exporting horizontally and vertically differentiated goods to the rest of the world. A Peruvian firm's ability of vertically differentiate its products depends on the firm's productivity. Most productive firms can upgrade their quality and avoid a price war with low-priced Chinese products and sell these high-quality goods at even higher prices. Conversely, less productive Peruvian firms, which are not able to increase their quality and differentiate their products, are forced to reduce their prices and their profits. The least productive firms have to leave the market since they have negative profits. Recent work on firms quality upgrading includes Antoniades (2014), which incorporates an endogenous firm's quality decision in a Melitz and Ottaviano (2008) framework. In this model, more productive firms produce higher quality goods at higher prices. Additionally, these firms decide to increase their quality and their prices after a trade liberalization, whereas the less productive firms reduce their prices and the quality of their products. The firm's decision to increase (decrease) product quality depends on how costly it is for the firm to increase quality and how large the scope for quality differentiation is in a specific sector in the other country.[4]

There is empirical evidence for product quality upgrading at the firm-level (Verhoogen (2008); Amiti and Khandelwal (2013); Iacovone and Javorcik (2012). Additional evidence includes Fernandes and Paunov (2009), who use data of Chilean manufacturing plants to find a positive and robust effect of import competition on product quality. In this and other works, a higher unit value is used as a measure of higher quality. Bugamelli et al. (2010) find that import competition from China affects Italian firms' pricing strategies, causing a reduction in prices and markups in less technologically advanced sectors. They also find a higher negative effect in prices for less productive firms within sectors. Martin and Méjean (2011) find that French firms increased the average quality of their products by 11% during 1995 through 2005 in response to low-wage country exports to third markets. However, their work, an extension of the Harrigan and Barrows (2009) framework but at the firm level, assumes that firms are not able to change their product quality and that

y sus Perspectivas Futuras: El Caso del Peru" Montevideo, 2 de Junio del 2004.

[4]See Khandelwal (2010). In that sense, a liberalization with a developed country, where the taste for quality is bigger than a developing country, give more chances of increasing the quality and more productive firms are able to recover the fixed cost of increasing the quality.

all quality changes are due to the composition of their high and low quality exports.[5] The present research, unlike these previous papers, considers a heterogeneous firm's quality upgrading reaction when the firm is exposed to tougher competition in a third market, and it is estimated empirically using Peruvian customs data and a survey of Peruvian manufactures.

The contribution of this research is to show that firms from developing countries can also compete against low-price products by vertical differentiation when the cost of this differentiation is not expensive or if the firm has the ability to develop quality.[6] In the case of apparel goods, the use of better inputs such as high quality cotton and better designs permits firms to differentiate their products vertically, avoiding lower prices, which can take firms out of export markets. The lesson from this study can be applied in other industries where there is space for quality differentiation and the adoption of better quality is not so expensive. The quality upgrading strategy could smooth labor transition between industries for sectors exposed to low-price product competition.

The quality upgrading decision involves improvements along the supply chain. In that sense, under the presence of market failures, coordination problems, or incomplete contracts, there is the possibility of developing an apparel cluster, which permits firms to integrate with other parts of their supply chain in order to get higher quality inputs. If it is the presence of high sunk cost or the high cost of hiring fashion designers that allows only large firms to improve their quality, public policy actions can be oriented to subsidize or coordinate these expenditures.

1.2 Motivation

1.2.1 Interviews with Peruvian Apparel Managers and Apparel Imports in the US Market

The main motivation for this research is the early work, "Potencial y Limitantes de las Exportaciones No Tradicionales" (BCRP, 2008) which studies the potential and the

[5]In that sense if the market share of the higher unit value exporters increases relative to the lower unit value exporters, then the average quality increases. This methodology can erroneously suggest an increase in quality even if in fact the firms have even reduced their quality but the market share of higher unit value exporters increases relative to the lower unit value exporters.

[6]This idea is also developed by Hallak and Sivadasan (2011).

limitations of Peruvian manufacturing exports. According to this document, Peruvian apparel firms had been exporting higher quality clothes in recent years.[7] Interviews with Peruvian apparel managers revealed that this behavior was in response to tougher competition from low-price but standard apparel goods exported from China and India.

The US is one of the most important destinations for apparel exporters, making it the best market for analyzing some recent trends in apparel products. Figure 2 (graph A) shows the market share evolution of the four main groups of apparel exporters to the US. These four groups include, with the exception of two African countries, the 34 most relevant apparel goods providers to the US between 1996 and 2012.[8] The graph shows that China's market share has increased rapidly since 2001 and even faster since 2005, when the last stage of the Multifiber Agreement (MFA) was executed. At the same time, the market share of apparel exports from high-and middle-income countries decreased approximately 15 percent between 1995 and 2007. In the same direction, the market share of low-income Latin American exporting countries, mainly Central American countries, decreased only after 2002.[9] Different from the high-and middle-income apparel exporters, Central American countries still had competitive wages and the strategic advantage of being located closer to the US market, which permitted them to respond more quickly to changes in the market demand conditions Evans and Harrigan (2005). Looking at graph B of Figure 2, almost all of the low-middle income Latin American exporters reduced their market share, Peru being an exception. Peru is a developing economy with an average GDP per capita of US$2300 from 1996 to 2006, close to other main Latin American apparel exporters to the US, including the Dominican Republic (US$2700), El Salvador (US$ 2300), and Guatemala (US$1900).[10]

Also, the tougher competition from low-middle income Asian countries and the gradual increase of quotas put pressure on apparel prices to fall. Harrigan and Barrows (2009) find that after the last stage of the MFA, the price of those products which were constrained by

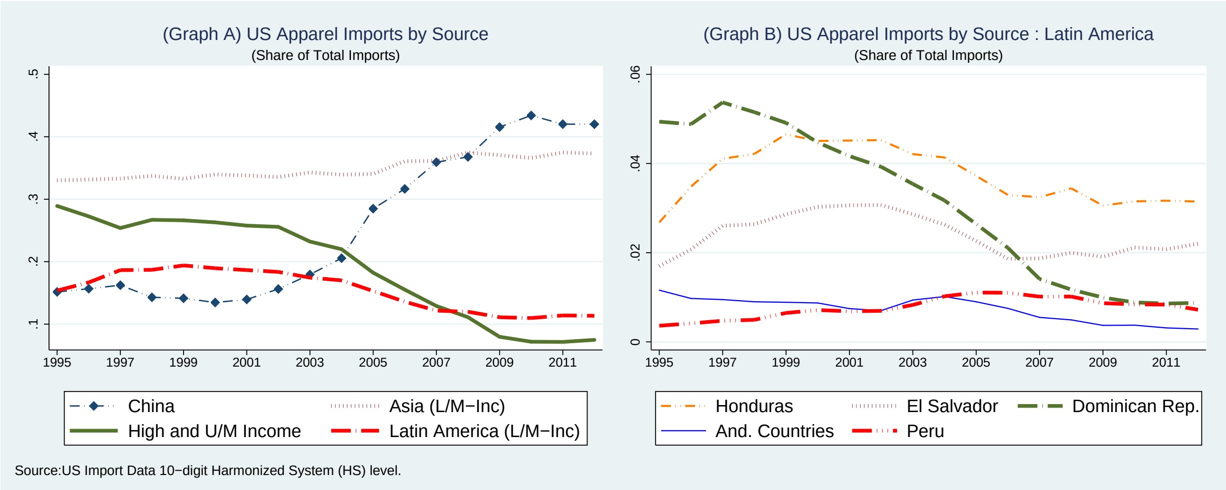
[7]Potencial y Limitantes de las Exportaciones No Tradicionales, page 36 paragraph 5. (Central Bank of Peru, 2008) http://www.bcrp.gob.pe/docs/Publicaciones/ Notas-Estudios/2008/Nota-Estudios-15-2008.pdf

[8]Kenya and Lesotho.

[9]One factor which explains the higher market share of Central American countries before 2003 was the US-Caribbean Basin Trade Partnership Act (CBTPA) signed in 2000. The agreement included an increase on textile tariff preferences for Central American and Caribbean countries.

[10]Source: World Development Indicators. GDP measured in current US dollars.

Figure 2: **US Apparel Imports by Source**



the quotas decreased considerably from 2004 to 2005.[11] Table 1 reports the estimates of the country fixed effects of a regression of the logarithm of the price of each HS10 apparel product exported for each country during 2001 and 2007 on product and country-time fixed effect. I choose this period after taking into account the year of China accession to the WTO and the Great Recession of 2008. The absolute change in the estimated country-time fixed effect is negative for China and for some of the low and middle income Asian countries during this period. Similar estimates are reported for the main Latin American exporting countries except Peru, Honduras and Guatemala. From these estimates, the difference in the price change of Peruvian apparel goods and those exported by the main Latin American exporting countries is also positive. The latter implies that the average price of a Peruvian product also increases relative to the average price of these countries.

1.2.2 Estimating the Average Quality Change in Apparel Products using US Apparel Imports

As a first step in calculating the average quality change in Peruvian apparel products in response to low-cost Chinese apparel products, I follow Amiti and Khandelwal (2013) framework. I calculate the unobserved quality per product using information from the Annual Survey of Manufactures (ASM) and the 10-digit HS code level of US imports and exports. I then I estimate the average apparel quality change per country from 2001 to

[11]For example, in the case of Chinese textiles subject to a binding quota in 2004 prices decreased 38 percent from 2004 to 2005.

Table 1: **Average Price of the Main Apparel Exporters to the US**

	Estimated Country-Time Fixed Effects			
	Country	**2001**	**2007**	**Change (2001-2007)**
	CHN	**-0.48**	**-0.89**	**-0.41**
	KEN	-0.76	-0.86	-0.10
	PHL	-0.38	-0.47	-0.09
	PAK	-1.02	-1.07	-0.05
	BGD	-0.83	-0.87	-0.04
	EGY	-0.40	-0.43	-0.03
L/L-M Income Asian countries	**IND**	-0.47	-0.45	0.02
	IDN	-0.54	-0.51	0.02
	KHM	-0.58	-0.53	0.04
	LKA	-0.50	-0.34	0.16
	THA	-0.47	-0.28	0.20
	JOR	-0.72	-0.47	0.25
	VNM	-1.27	-0.59	0.68
	HTI	-0.42	-0.94	-0.53
	SLV	-0.38	-0.43	-0.05
	NIC	-0.50	-0.53	-0.03
L/L-M Income Latin American countries	**DOM**	-0.47	-0.48	-0.02
	GTM	-0.54	-0.50	0.04
	HND	-0.55	-0.50	0.05
	PER	0.11	0.23	0.12
	COL	-0.02	0.20	0.22
	KOR	-0.48	-0.89	-0.41
	MYS	-0.23	-0.36	-0.13
	MAC	-0.25	-0.09	0.16
	MEX	-0.17	0.00	0.17
	ISR	0.18	0.40	0.22
	CRI	-0.24	0.02	0.26
H/U-M Income countries	**SGP**	-0.13	0.24	0.37
	ITA	0.79	1.19	0.40
	PRT	0.36	0.79	0.42
	GBR	0.69	1.12	0.43
	TUR	-0.41	0.06	0.47
	FRA	0.82	1.31	0.48
	BRA	-0.09	0.40	0.49

Notes: 1/ World Bank country classification by level of Income between 2001 and 2007 .

2007. According to their procedure, and keeping their notation, I estimate the following equation:

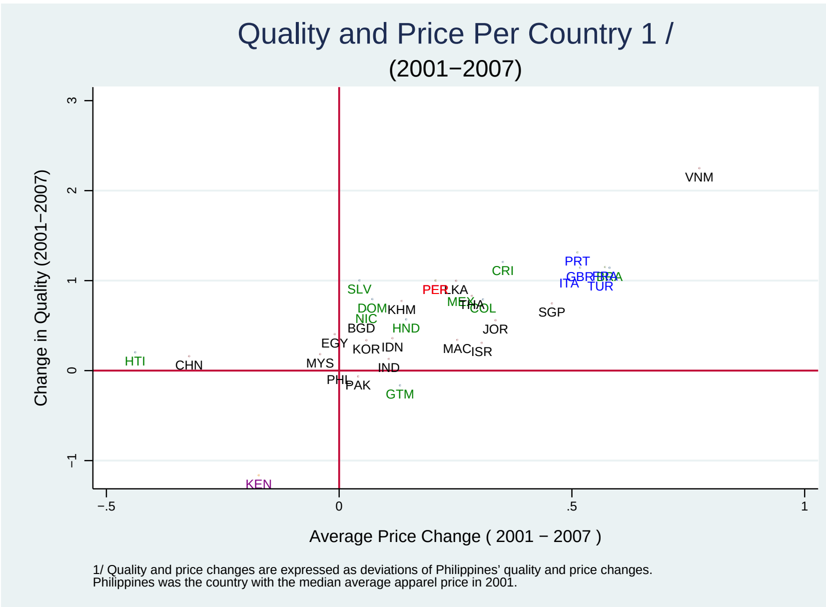
$$ln(s_{cht}) - ln(s_{0t}) = \lambda_{1,ch} + \lambda_{2,t} - \alpha p_{cht} + \sigma ln(vs_{cht}) + lnpop_{ct} + \lambda_{3,cht}, \qquad (1)$$

where s_{cht} represents the share of product h imported from county c in industry I (6-digit level of North American Industry Classification System (NAICS)) at time t in the US. s_{0t} is the "outside option" for the consumer; in this case, the market share of US producers of product in industry I. p_{cht} is the price of product h imported from country c, and vs_{cht} represents the share of country c in US total consumption of product h (10-digit HS code level). Finally, to control for the fact that larger countries generally export more varieties, which cannot be distinguished at the 10-digit product disaggregation level, I follow Amiti and Khandelwal and include the population in country c at time t , pop_{ct}, to capture this effect.

The regression from equation (1) also controls for country and product fixed effect λ_{1ch} and a time fixed effect $\lambda_{2,t}$. The resulting estimated residuals, $\hat{\lambda}_{3,cht}$, capture the qualities of the products. As well as Amiti and Khandelwal (2013) framework I use tariffs and trade costs as instruments for price, because there may exist a positive correlation between prices and quality.

The difference in the residuals, $\Delta\hat{\lambda}_{3,cht}$, measures the change in quality for a product h imported from country c between 2001 and 2007. I estimate the average quality change per country by regressing $\Delta\hat{\lambda}_{3,cht}$ on country fixed effects. Figure 3 shows the relationship between the change in the average price and the average quality during 2001 and 2007 for the top apparel exporters to the US.[12] Both axes are expressed as deviations with respect to the estimates for the Philippines, the country with the median average apparel price in 2001. The graphs show the expected positive relationship between changes in price and quality since higher market shares and higher prices are only consistent with positive changes in quality. All of the European countries show a positive change in quality. There are similar results in some of the Latin American countries, whereas most of the Asian countries, with the exception of Vietnam, present smaller changes in quality and prices.

Figure 3: **Quality and Price**



[12]To calculate the average price per country in apparel products, I regress the logarithm of the price of each HS10 apparel product exported to the US during 2001 and 2007 on product and country-time fixed effects.

1.3 Heterogeneous firms

The recent literature of heterogeneous firms suggests firms follow different quality upgrading/downgrading strategies after a trade liberalization Antoniades (2014). Even though the change in the average quality of Peruvian apparel exports was positive between 2001 and 2007, this change might imply heterogeneous quality upgrading decisions across firms. In the next subsection I describe a model that explains different quality upgrading strategies of firms in reaction to competition from low-price and low-quality goods.

1.3.1 Model

The model considers a representative consumer with quasilinear preferences for J different varieties of one good. The consumer has different quality preferences within varieties but similar preferences between varieties. Firms from two countries, Home and Foreign, produce only one variety of a good, which also differs in quality. These variety-quality pairs are exported to a third country; or, to generalize, the rest of the world.

Consumers

There is a representative consumer in the rest of the world with quasilinear J preferences who can buy different varieties (e.g. colors) of one good (e.g. t-shirts) and for each variety j, three different types of qualities: low ($y_{j,l}$), medium ($y_{j,m}$), and high quality ($y_{j,h}$). The utility that the consumer gets from different qualities of the variety j is the following:

$$W_j = \alpha_l y_{j,l} - \frac{1}{2}\beta_l y_{j,l}^2 + \alpha_m y_{j,m} - \frac{1}{2}\beta_m y_{j,m}^2 + \alpha_h y_{j,h} - \frac{1}{2}\beta h y_{j,h}^2 - \gamma y_{j,l} y_{j,m}$$

The parameters α_l , α_m and α_h are the qualities associated with each type of variety y_l, y_m, and y_h, respectively, with $\alpha_l < \alpha_m < \alpha_h$; $\beta_h < \beta_m < \beta_l$ and $\beta_m\beta_l - \gamma^2 > 0$. According to these preferences, the low, l, and medium, m, quality varieties are imperfect substitutes within varieties because of the presence of the parameter γ, whereas the demand for the high quality variety, h, is independent of the other two qualities of the same variety. Additionally, given the quasilinear preferences, the demand for any variety j is independent of any other variety $j^{'}$. Finally, the quasilinear utility function of the representative consumer can also be expressed as:

$$U = \sum_{j \epsilon J} W_j + z.$$

The demand of the representative consumer for each type of variety low, medium and high is given respectively by:[13]

$$y_l = \frac{\beta_m \alpha_l - \gamma \alpha_m}{\beta_m \beta_l - \gamma^2} - \frac{\beta_m}{\beta_m \beta_l - \gamma^2} p_l + \frac{\gamma}{\beta_m \beta_l - \gamma^2} p_m;$$

$$y_m = \frac{\beta_l \alpha_m - \gamma \alpha_l}{\beta_m \beta_l - \gamma^2} - \frac{\beta_l}{\beta_m \beta_l - \gamma^2} p_m + \frac{\gamma}{\beta_m \beta_l - \gamma^2} p_l;$$

and

$$y_h = \frac{\alpha_h}{\beta_h} - \frac{p_h}{\beta_h}.$$

The market demand for each quality variety is given by the corresponding representative consumer's demand times the size of the rest of the world, L. I normalize L to 1 for simplicity in order to keep the notation simple.

Firms

Each firm in country H (Home) and in country F (Foreign) produces one variety (color) of a good. Firms from both countries export all of their production to a third country, X or in general, the rest of the world (ROW). Also, firms must choose one of three different types of qualities for their variety: high, medium and low quality. There exists a large set of varieties J (colors) that can be produced, but each firm only produces one variety-quality pair which differs from another firm's variety.

Firms in country H are heterogeneous in productivity. After paying a fixed market entry fee, F_E^H, firms in country H draw a productivity parameter that determines their marginal cost, c. The distribution of c is $G(c)$ with support on $[0, c_{max}]$.

The production of each type of quality involves different levels of fixed costs, which also differ across countries. The investment cost associated with each type of quality in each country is increasing in the level of quality; therefore $F_h^c > F_m^c > F_l^c$, for $c = H, F$. I assume that firms in country F do not have the technology for producing medium and

[13]Given that consumers have quasilinear preferences, I assume that the representative consumer has a positive consumption of the numeraire good.

high-quality varieties. Equivalently, I can assume that the fixed costs F_m^F and F_h^F are high enough to that forces firms in country to produce only low-quality varieties. Conversely, I assume that firms in country H only produce medium-or high-quality varieties.[14]

Finally, I assume that all firms in country F are equally productive, with a marginal cost equal to c^F. Since I am only interested in the effect of lower prices of foreign goods on home country firms' profits, this assumption is not restrictive.

Home Country Firm Maximization Problem

Firms in the home country produce the medium-or high-quality varieties.

a. Producers of a high quality variety, y_h. From the consumer maximization problem, a producer of this type of quality-variety good is a monopolist because the demand for their type of variety depends only on its own price:

$$y_h = \frac{\alpha_h}{\beta_h} - \frac{1}{\beta_h} p_h$$

Profits from producing a high-quality variety for firm i with marginal cost c_i are:

$$\pi_h = (\frac{\alpha_h}{\beta_h} - \frac{p_h}{\beta_h})(p_h - c_i) - F_h^H$$

and the optimal price that maximizes monopolist's profits and its corresponding profits are respectively:

$$p_h = \frac{\alpha_h + c_i}{2},$$

and

$$\pi_h = \frac{1}{4\beta_h}(\alpha_h + c_i)^2 - F_h^H.$$

b. Producers of medium quality variety, y_m. From the consumer maximization problem, the corresponding demands for low-, y_l, and medium-, y_m, quality varieties are:

$$y_l = A - b_1 p_l + b_3 p_m$$

[14] This assumption can be replaced by a result of the model if the profits of producing the lowest quality variety in country H are dominated by the profits of producing varieties of the two other qualities for any level of productivity. I can also assume that $F_m^H \simeq F_l^H$ so firms in home country always prefers to produce medium quality goods rather than low quality goods.

and

$$y_m = D - b_2 p_m + b_3 p_l,$$

where $A = \frac{\beta_m \alpha_l - \gamma \alpha_m}{\beta_m \beta_l - \gamma^2}$; $D = \frac{\beta_l \alpha_m - \gamma \alpha_l}{\beta_m \beta_l - \gamma^2}$; $b_1 = \frac{\beta_m}{\beta_m \beta_l - \gamma^2}$; $b_2 = \frac{\beta_l}{\beta_m \beta_l - \gamma^2}$ and $b_3 = \frac{\gamma}{\beta_m \beta_l - \gamma^2}$.

The demand for a medium-quality variety, which is only produced in country H, also depends on the price of the low-quality variety which is only produced in country F. Firms of these two types of quality-varieties compete in a Bertrand competition, selling their products in a third country. The corresponding profits for each firm from producing a low-quality variety, y_l, or medium-quality variety, y_m, in countries F and H, respectively are:

$$\pi_l^F = (A - b_1 p_l + b_3 p_m)(p_l - c^F) - F_l^F$$

and

$$\pi_{m,i}^H = (D - b_2 p_m + b_3 p_l)(p_m - c_i) - F_m^H$$

Profits from producing the low-quality variety, produced exclusively in country F, are decreasing in the marginal cost of producing them, c^F.[15] Similarly, profits for firm i in country H from producing the medium-quality variety are decreasing in the marginal cost of producing them, c_i^H.

The corresponding firm's reaction functions for producing a low-quality variety in country F and medium quality in country H are:

$$p_l = \frac{A}{2b_1} + \frac{b_3 p_m}{2b_1} + \frac{c^F}{2} \quad and \quad p_m = \frac{D}{2b_2} + \frac{b_3 p_l}{2b_2} + \frac{c_i}{2}.$$

The correspondent profits for producing each type of quality are:

$$\pi_l^F = b_1 \left(\frac{2Ab_2 + Db_3 + b_2 b_3 c_i - (2b_1 b_2 - b_3^2) c^F}{4b_1 b_2 - b_3^2} \right)^2 - F_l^F$$

$$\pi_{m,i}^H = b_2 \left(\frac{2Db_1 + Ab_3 + b_1 b_3 c^F - (2b_1 b_2 - b_3^2) c_i}{4b_1 b_2 - b_3^2} \right)^2 - F_m^H$$

[15] I intentionally omit the subscript for the foreign firms because all of them share the same marginal cost.

Which firms produce medium and high quality varieties in country H?

Given the values of the parameters $\alpha_l, \alpha_m, \alpha_h, \beta_l, \beta_m, \beta_h$ and γ, the threshold that determines which firms produce the high-or the medium-quality varieties is defined by the marginal cost c_i, which makes a home country firm i indifferent between producing any of these two types of varieties:

$$\pi(i)_h^H = \pi(i)_m^H$$

Then, the marginal cost cut-off for producing the high-quality variety, c_h^*, is defined by:

$$\frac{1}{4\beta_h}(\alpha_h + c_i)^2 - F_h^H = b_2\left(\frac{2Db_1 + Ab_3 + b_1b_3c^F - (2b_1b_2 - b_3^2)c_i}{4b_1b_2 - b_3^2}\right)^2 - F_m^H,$$

whereas the marginal cost cut-off for producers of the medium quality, c_m^*, is defined by the marginal cost that makes zero profits:

$$\pi(i)_m^H = b_2\left(\frac{2Db_1 + Ab_3 + b_1b_3c^F - (2b_1b_2 - b_3^2)c_i}{4b_1b_2 - b_3^2}\right)^2 - F_m^H = 0.$$

Given the parameters, more productive firms produce high quality varieties, because their lower per-unit cost permits them to recover the higher fixed cost of producing high-quality varieties. Figure 4 (graph A) depicts the cut-offs for each type of quality.

1.3.2 Effect of a Reduction in the Low-Quality Variety Price

Suppose that firms in country F have to pay a per-unit tariff, τ^F, to sell their goods in the rest of the world. Then, a tariff reduction to foreign firms allows them to sell their products at lower prices. The optimal price for the low-quality producers in country F is:

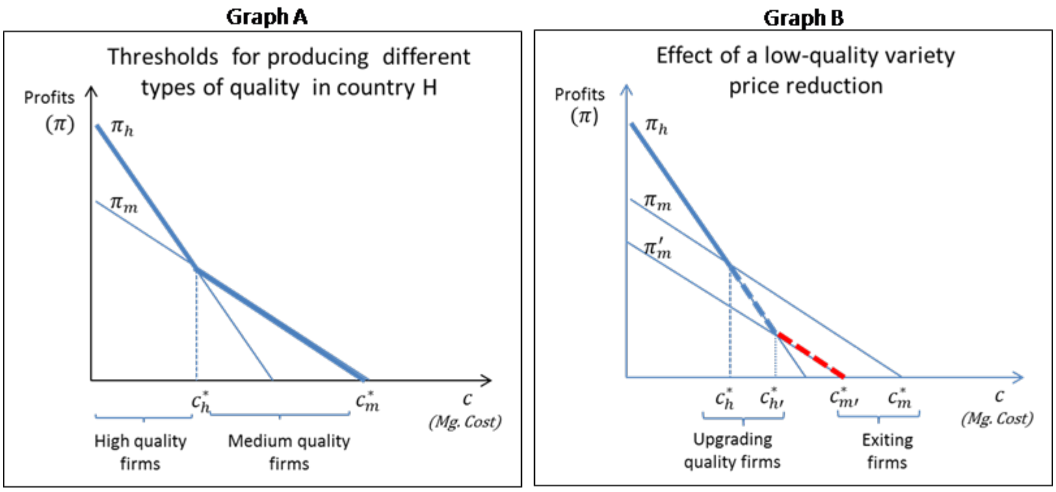
$$p_l = \left(\frac{A}{2b_1} + \frac{b_3D}{4b_1b_2} + \frac{b_3c_m^H}{4b_1} + \frac{c^F + \tau^F}{2}\right)\left(\frac{4b_1b_2}{4b_1b_2 - b_3^2}\right),$$

and the derivative with respect to the tariff, τ^F, is:

$$\frac{\partial p_l}{\partial \tau^F} = \frac{2b_1b_2}{4b_1b_2 - b_3^2} > 0$$

since by assumption $\beta_m \beta_l - \gamma^2$.

Figure 4: **Productivity Thresholds**



The effect of a lower tariff for foreign firms, τ^F, on firms producing in country H is depicted in Figure 4 (graph B). The lower tariff and the corresponding lower price of low-quality varieties, p_l, reduces the profits from producing medium-quality varieties in country H (see appendix 1). The least productive firms make negative profits and they stop producing. The new cut-off for producing a medium-quality variety in country H changes from c_m^* to $c_{m'}^*$. The more productive firms among those producing medium-quality varieties (firms whose marginal cost are between c_h^* and $c_{h'}^*$ switch to the production of high-quality varieties to avoid lower profits due to the price competition. Finally, the group of firms with marginal costs between $c_{h'}^*$ and c_m^* keep producing the medium-quality varieties at lower prices and make lower profits. This reallocation in firms' quality production increases the average quality of the varieties produced in country H.

1.4 Data and Empirical Strategy

I use information on Peruvian apparel exports provided by the Superintendencia Nacional de Administracion Tributaria (SUNAT). This dataset is classified at the 6-digit HS for all trading partners. Each observation in the raw data contains information on the exporting firm, the importing country and the total weight and f.o.b. value for each exported item. I use information for Chinese exports by destination and product at HS6-digit level from Trademap.[16] Table 2 presents some summary statistics of Peruvian apparel exports between 2000 and 2008. There is a significant increase in the number of exporting firms and the total exported value during this period, as well as in the average number of exported products per firm. The average number of destinations and firms per product increased considerably during this period as well.

[16] http://www.trademap.org/SelectionMenu.aspx

Table 2: **Peruvian Exports, summary statistics at 6-digit product level 1/**

Year	**# of Firms**	**# of Products**	**Average # of products p/firm**	**Average # of firms p/product**	**Average # of destinations p/firm**	**Average # of destinations p/product**	**Total Exported Value (Millions of US$)**	**Total Exported Weight) (Millions of KG.)**
2000	415	234	7.9	14.1	3.1	6.9	504.9	22.9
2001	536	222	9.1	22.0	2.7	8.4	506.0	23.8
2002	626	253	9.3	23.0	2.6	7.7	537.1	26.7
2003	725	257	9.1	25.8	2.5	8.7	657.5	28.7
2004	827	261	10.2	32.2	2.6	10.0	891.4	39.0
2005	1024	268	11.0	41.9	2.5	10.9	1069.8	43.0
2006	1148	271	11.4	48.1	2.5	11.9	1220.7	47.4
2007	1220	274	10.7	47.8	2.6	11.7	1440.1	51.7
2008	1458	279	10.0	52.4	2.5	12.5	1736.8	60.1

Notes: 1/ This calculus do not consider any registered export in the data (firm-product-destination-year) below US$ 5000.

1.4.1 Empirical Strategy

In this subsection I describe the empirical strategy for testing one of the main implications derived from the model: bigger and more productive firms stayed in the market, but with higher quality products and higher prices. This implication is evaluated by estimating the following regression:

$$\Delta P_{pf(q)ct} = \beta_1 \Delta Comp_{pct} + \sum_{q=2}^{5} \beta_q d_q \Delta Comp_{pct} + \Delta\alpha_{ct} + \Delta e_{pf(q)ct}, \tag{2}$$

where $\Delta P_{pf(q)ct}$ represents the change in unit values (quality) of product p exported by firm f, which belongs to quantile q, to country c during 2001 and 2007.[17] $\Delta Comp_{pct}$ captures the competition of Chinese products and is measured as the change in the Chinese share of total imports of product p to country c during 2001 and 2006. Figure 5 depicts the change in China's market share in apparel imports from the rest of the world and in the US. δ_q is a dummy variable that equals 1 if the firm belongs to the quantile q . Finally, $\Delta\alpha_{ct}$ accounts for any difference in aggregate shocks between period $t-1$ and t, i.e. during 2001 and 2007 in country c. A large value of β_q as q increases suggests that more productive firms increased the quality of their products and were therefore able to charge a higher price. To evaluate heterogeneous quality upgrading decisions I test $\beta_5 - \beta_2 > 0$, $\beta_4 - \beta_2 > 0$, and $\beta_3 - \beta_2 > 0$.

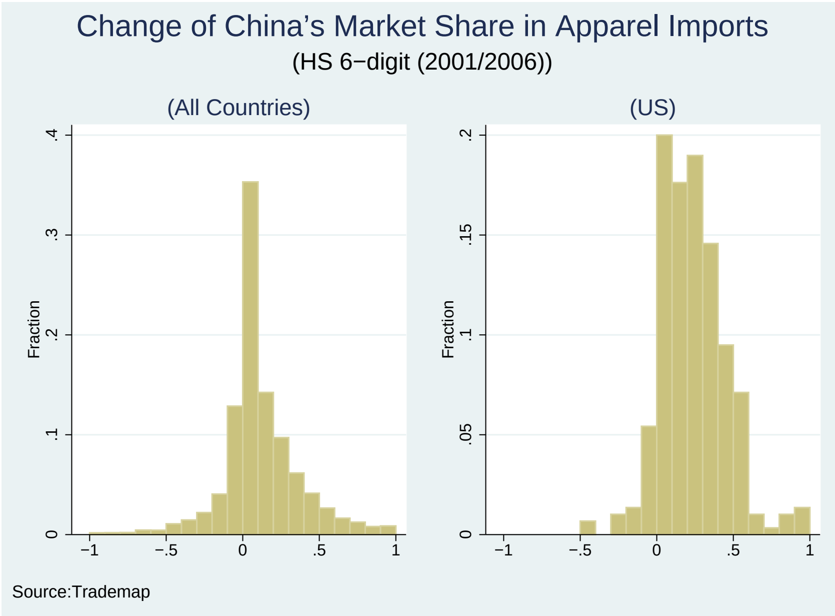
I use unit values as a proxy for quality even though higher unit values could be capturing higher market power instead of higher quality. Despite this potential pitfall, the use of unit values of domestic or exported products as a proxy for quality is a common convention in the literature.[18] I trim unit values in order to avoid the effect of outliers in the final estimates. In particular, I regress the unit value (price) of product exported to country on product and country fixed effects and use the resulting residuals. I drop observations that have residuals outside of the $1^{st}-99^{th}$ confidence interval of the empirical distribution of the error term. Finally, to evaluate how different firms behaved differently, firms are classified by their level of productivity.

I use firm sales as a proxy for productivity, as has been previously used in the lit-

[17] As I mention earlier, I choose this period after taking into account the year of China accession to the WTO and the Great Recession of 2008.

[18] Fernandes and Paunov (2010); Iacovone and Javorcik (2012); and Kugler and Verhoogen (2012).

Figure 5



erature.[19] Particularly, I classify firms in five different quantiles, with the first quantile being the smallest and the fifth being the largest. The quantiles are calculated based and weighted on firm sales; therefore, not all the quantiles have the same number of firms. I calculate the maximum annual level of exports of each firm between 2000 and 2010 and then classify the firm in one of the five quantiles. I eliminate from the sample any reported export value which is less than US$ 5000.

1.5 Results

1.5.1 Quality Upgrading

Table 3 reports the estimates for equation (2). The first 6 columns use information about apparel exports to the top 32 destinations, which covers 99 percent of total Peruvian apparel exports, whereas the last 3 columns of the same table consider only products exported to the US, the main destination of Peruvian apparel exports.[20]

[19] Aitken et al. (1997); Roberts and Tybout (1997);Bernard and Jensen (2004); Hanson and Xiang (2008); Helpman et al. (2008); Helpman et al. (2008); Eaton et al. (2011); Chaney (2008), and Crozet and Koenig (2010).

[20] The destination countries are: Argentina, Australia, Belgium, Bolivia, Brazil, Chile, Colombia, Ecuador, El Salvador, Finland, France, Germany, Guatemala, Honduras, Hong Kong, Ireland, Italy, Japan, Luxembourg, Mexico, Norway, New Zealand, Netherlands, Panama, United Kingdom, Singapore, South Korea, Spain, Sweden, Switzerland, United States, Venezuela.

As is expected, columns 1 to 4 show a negative effect of $\Delta Comp_{pct}$ (or the competition shock) on the price of Peruvian apparel products. However, the estimates of the interaction of $\Delta Comp_{pct}$ and d_q (or the firm size q) show different quality upgrading strategies by firm size. According to the estimates in columns 1-3 of Table 3, firms in the third and fourth quantiles show a net positive effect of the competition shock on product prices.

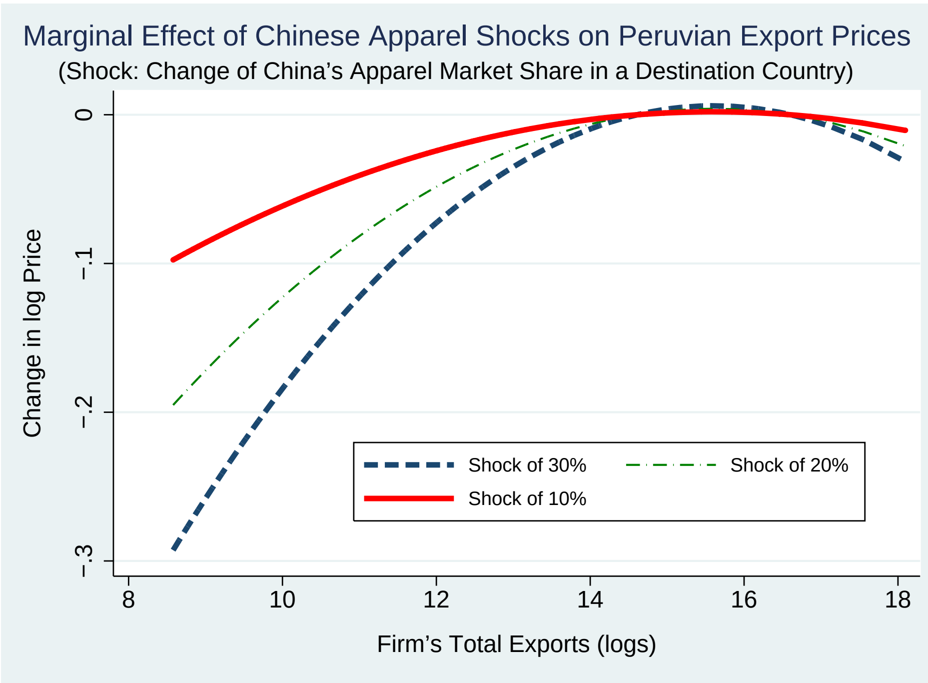
Table 3: **Competition and Quality Upgrading**
Dependent Variable: Change in log Price (2001-2007)

	Full Sample							**US**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Competition Shock	-0.548***	-0.572***	-0.404**	-0.320**	-3.961**	-4.892***	-0.615***	-4.788**	1.136
	(0.128)	(0.127)	(0.172)	(0.134)	(1.648)	(1.695)	(0.139)	(1.874)	(2.023)
(F.size 2)*(Competition Shock)	0.365**	0.345**	0.306**	0.117			0.369**		
	(0.155)	(0.150)	(0.150)	(0.218)			(0.162)		
(F.size 3)*(Competition Shock)	0.594***	0.608***	0.530***	0.177			0.523***		
	(0.157)	(0.161)	(0.158)	(0.204)			(0.149)		
(F.size 4)*(Competition Shock)	0.663***	0.698***	0.664***	0.312			0.854**		
	(0.225)	(0.231)	(0.243)	(0.237)			(0.336)		
(F.size 5)*(Competition Shock)	0.411***	0.393***	0.314**	0.241			0.415**		
	(0.148)	(0.145)	(0.157)	(0.170)			(0.160)		
(Firm size)*(Competition Shock)					0.500**	0.629**		0.586**	-0.235
					(0.241)	(0.248)		(0.276)	(0.297)
(Firm size square)*(Competition Shock)					-0.0158*	-0.0202**		-0.0180*	0.0100
					(0.00866)	(0.00885)		(0.0101)	(0.0108)
Firm size					0.0474***	0.0281		0.0592***	0.421***
					(0.00819)	(0.0240)		(0.0126)	(0.0722)
Firm size square					-0.00172***	-0.00113		-0.00239***	-0.0147***
					(0.000491)	(0.000910)		(0.000774)	(0.00239)
Observations	1,321	1,321	1,321	1,321	1,321	1,321	546	546	546
R-squared	0.391	0.408	0.427	0.412	0.404	0.407	0.469	0.460	0.475
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	-	-	-
HS2 FE	No	Yes	No	Yes	No	Yes	Yes	No	Yes
HS4 FE	No	No	Yes	No	No	No	No	No	No
Firm Size FE	No	No	No	Yes	-	-	No	-	-

Notes: Country-product clustered standard errors in parenthesis. in parentheses with ***,**,* respectively denoting significance at the 1%, 5% and 10% levels.

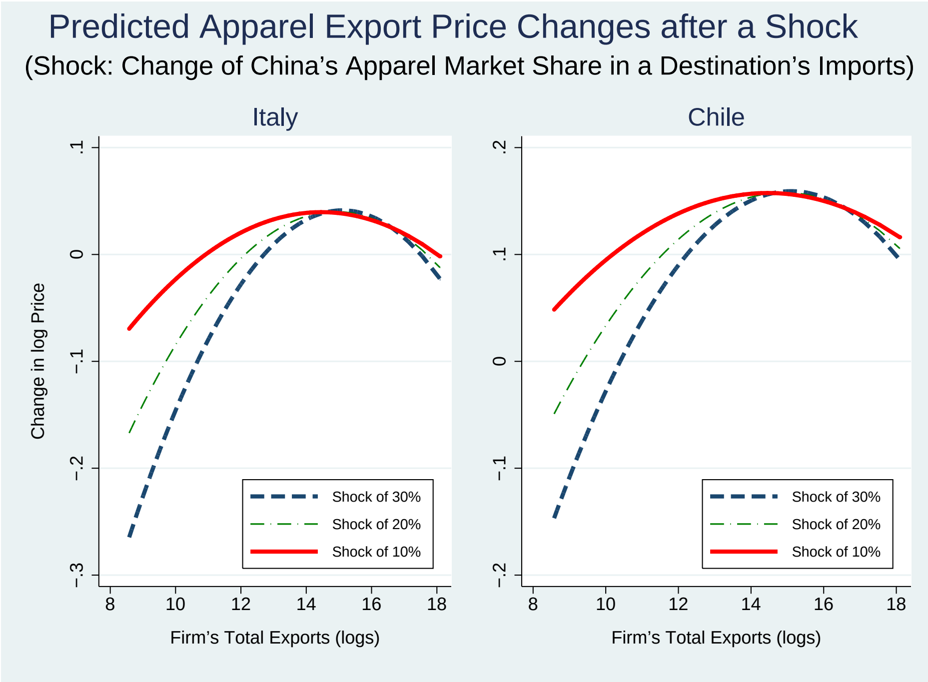
This effect is consistent with the production of higher quality products. Table 3 also shows the results of a formal test of heterogeneous responses to the competition of Chinese apparel products by firm size. The null hypothesis of equal price reaction from both large and small firms is rejected, supporting the idea that more productive firms increased their qualities more than less productive firms in response to the Chinese competition in foreign markets. The fact that firms from the third and fourth quantiles report the largest changes in prices is consistent with figure 4 (graph B), since firms with a median productivity are those that decided to increase their quality and therefore their prices.

Figure 6



Another way to measure the heterogeneous response at the firm level is using a continuous measure of firm size instead of classifying firms in quantiles. The results of this specification are presented in columns 5,6,8 and 9 of Table 3 and are similar to the previous findings; bigger firms are able to increase the prices (qualities) of their products. The coefficient of the interaction term firm size and competition shock is positive and statistically significant in columns 5, 6, and 8. Using the estimates of column 6 of Table 3, Figure 6 shows the heterogeneous impact of the competition shock depending of the firm size (firm's total exports). After some threshold, the effect of the competition on firm's export prices stops being negative. Figure 7 shows the same marginal effect on prices of products exported to Chile and Italy.

Figure 7



1.5.2 Input Prices: Intermediate Inputs

There is empirical evidence of quality upgrading strategies in response to import competition; however, many of these papers use only the change in unit values to infer changes in quality. However, changes in product quality should also be consistent with changes in the quality of inputs used by firms (Verhoogen (2008);Kugler and Verhoogen (2012)). Then, it should also be the case that more productive firms switched to the use of higher quality inputs during 2001 and 2007. This higher demand for high quality inputs in turn, would lead to an increase in these input prices. To formally estimate a heterogeneous change in input prices by firm size, I use information on apparel inputs collected by the Instituto Nacional de Estadistica e Informatica (INEI) in the annual survey Encuesta Economica Anual (EEA) from 2001 to 2008. One chapter of the survey collects information on input prices from exporting and non-exporting apparel firms. These firms report the name of the input they bought during the previous year, the number of units and the price per unit of each input. Some common inputs in the survey are cotton (Tanguis, Pima, others), buttons, elastics, labels and threads. Unfortunately, not all firms answered the survey during the whole period of analysis, reducing the number of observations in the sample. Like the previous subsection, I classify firms in five quantiles based on their total sales. Even though I am not able to join this data set with the customs data to evaluate the direct impact of the Chinese competition shock, according to Table 4, the average export by quantile in the two sources is quite similar.

Table 4: **Descriptive Statistics by Firm Size**

	Custom Data				**EEA Survey**					
Quantile	**Avg. Firm Exports US$**		**Stock of Capital US$**		**Avg. Firm Exports US$**		**Avg. Number of Workers Full Sample**		**Exporters**	
	2001	**2007**	**2001**	**2007**	**2001**	**2007**	**2001**	**2007**	**2001**	**2007**
1	47,768	48,618	66,400	73,574	145,028	166,663	6.8	8.0	3.2	13.7
2	228,694	268,897	67,919	63,670	214,615	187,279	18.8	12.1	18.3	13.6
3	449,938	1,039,879	81,522	77,548	345,330	1,003,901	34.7	36.1	30.6	39.5
4	1,703,756	4,689,059	129,467	132,228	1,589,092	4,111,254	123.7	174.5	133.3	187.8
5	15,626,960	34,703,150	1,386,464	2,109,372	15,339,800	26,446,130	408.8	333.4	427.4	338.5

The following equation estimates the average effect of firm size, $\alpha_{f(s)}$, on the change in the price of input i, measured in units u, used by firm of size s, $\Delta Price_{iuf(s)}$, between 2001 and 2007, after controlling for input and unit of measure fixed effects.

$$\Delta Price_{iuf(s)} = \alpha_{f(s)} + \alpha_i + \alpha_u + e_{iuf(s)} \tag{3}$$

Table 5 reports the estimates of equation (3). It shows an increasing average effect by firm size, $\alpha_{f(s)}$, implying that more productive firms (larger firms) pay more for their inputs. This result is consistent with the quality upgrading decision taken by more productive firms. Also, according to the test reported in the same table, the estimated fixed effects $\alpha_{f(s)}$ are statistically different between bigger (quantiles 3, 4, and 5) and smaller firms (quantiles 1 and 2). Similarly to the previous subsection, I also estimate the same regression with $FirmSize$ as a continuous variable, and the results reported in columns 3 and 4 of Table 5 are consistent with the previous findings.

1.5.3 Other Inputs

Wages: One of the main inputs in the apparel industry is labor. I use information on wages reported by workers in the Encuesta Permanente de Empleo (EPE), which is also collected by the INEI, to calculate the change in the average wage per firm size. Workers report in this survey the exact number of employees in their work if the firm has fewer

Table 5: **Inputs: Quality and Productivity**
Dependent Variable Change in the log price of input (i) (2001-2007)

	(1)	(2)	(3)	(4)
	Exp.	**Full**	**Exp.**	**Full**
F. size 1	0.104	-0.886***		
	(0.392)	(0.240)		
F. size 2	0.237	-0.888***		
	(0.420)	(0.224)		
F. size 3	0.181	-0.874***		
	(0.437)	(0.215)		
F. size 4	0.336	-0.807***		
	(0.398)	(0.223)		
F. size 5	0.392	-0.756***		
	(0.407)	(0.223)		
Firm Size (logs)			0.0346*	0.0223*
			(0.0190)	(0.0119)
Observations	248	479	248	479
R-squared	0.557	0.440	0.547	0.436
Product FE	Yes	Yes	Yes	Yes
Units FE	Yes	Yes	Yes	Yes

Tests		
Null Hypothesis H0:	**Exp.**	**Full Sample**
	Prob	Prob
F. size 3 ¡= F. size 1	0.33	0.43
F. size 4 ¡= F. size 1	0.09	0.16
F. size 5 ¡= F. size 1	0.04	0.05
F. size 3 ¡= F. size 2	0.65	0.42
F. size 4 ¡= F. size 2	0.22	0.14
F. size 5 ¡= F. size 2	0.09	0.03

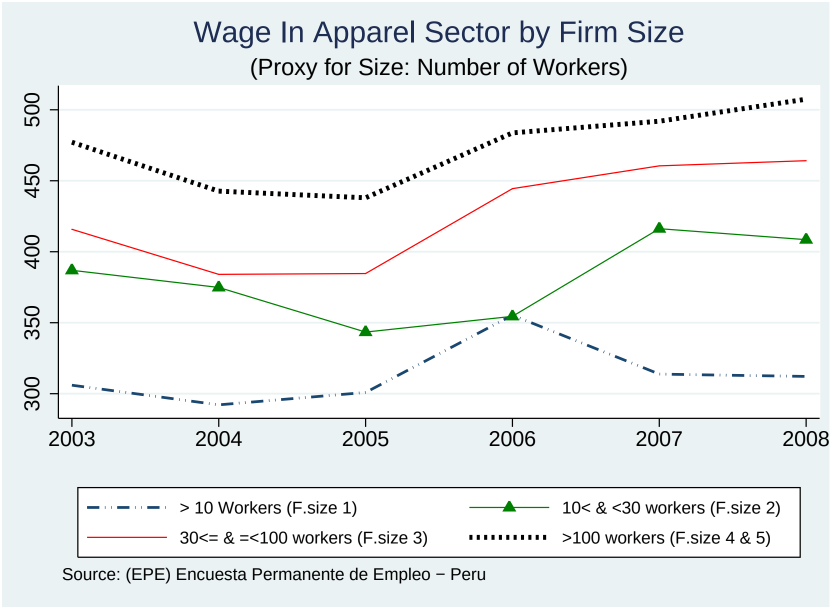
Notes: Full regressions include exporters and domestic firms. Robust standard errors in parentheses in parentheses with ***,** ,* respectively denoting significance at the 1%, 5% and 10% levels.

than 100 workers. I classify workers in four groups based on the total number of coworkers they have and to be consistent with the average number of workers by quantile from the EEA survey, which is reported in Table 4. The smallest group includes firms with 10 or fewer workers; a second group comprises employees working with more than 10 but fewer than 30 coworkers. The third group is individuals working in firms with more than 30 but fewer than or equal to 100 employees, and finally the fourth group includes workers in firms with more than 100 employees. Unfortunately, the survey does not report the exact number of workers when a firm has more than 100 employees. There is also no information about workers' occupations before 2002, so the initial year for estimating the average wage by firm size is 2002. I estimate the following equation using individual level data of occupations in the apparel sector to calculate the average wage by firm size:

$$wage_{iotf(s)} = \alpha_{f(s)t} + demog_{it} + \alpha_o + e_{iotf(s)},$$

where $wage_{iotf(s)}$ is the real wage of employee i working in occupation o in firm f of size s. The regression controls for individual demographic characteristics, $demog_{it}$, and occupation fixed effects, α_o. Then, the estimated size-time fixed effect, $\alpha_{f(s)t}$, captures the average wage per firm size. Figure 8 shows different trends for the average wage by firm size; more productive and larger firms, those in the third and fourth groups, increased their wages after 2004. A different trend is observed for small firms. Those with fewer than 10 workers registered a consistent reduction in their wages along the sample period.

Figure 8



Imports of Capital Goods: Another potential source for product quality upgrading is the acquisition of more sophisticated machines. I use information on Peruvian imports of capital goods acquired by apparel exporters, which is also provided by the Superintendencia Nacional de Administracion Tributaria (SUNAT).[21] I calculate the stock of capital in period as the stock of capital in the previous period plus investment expenditures. Since I only have information about imported capital goods, I can only use this information to calculate the stock of capital, and I ignore information on domestic capital goods. I consider an initial stock of capital of $100000 when the firm was established, and I assume a depreciation rate of 10 percent per year. Then, the stock of capital at time is calculated using the following law of motion for capital:

$$K_t = (1 - \delta)K_{t-1} + I_t$$

To estimate different responses by firm size at the firm level, I first calculate a weighted average Chinese competition shock per each firm, ΔW_Comp_f.

$$\Delta W\_Comp_f = \sum_{c=1}^{c} \sum_{p=1}^{p} \left(\frac{X_{pcf}}{X_f} \right) \Delta Comp_{p,c},$$

[21]Imports classified in the 4-digit HS codes 8444 to 8453.

where $\Delta Comp_{pc}$, as before, is the change in the market share of the Chinese apparel product p in country c, and the firm weights are the initial shares of product p in country c of firm f on firm $f's$ total exports, $\frac{X_{pcf}}{X_f}$. I estimate the following equation to evaluate heterogeneous responses for different firm size.

$$\Delta \log K_{f(q),2001-2007} = \sum_{q=1}^{5} \beta_q d_q \Delta WComp_{f(q)} + \log K_{f(q),2001} + e_f(q), \tag{4}$$

where d_q is a dummy variable which takes the value of 1 if the firm is of size q. Column 1 of Table 6 reports the estimates of equation (4), which shows an increasing marginal effect β_q as a response to the weighted average Chinese competition shock. More productive firms, those which belong to size five, increased their stock of capital in response to the Chinese apparel shock, differently from the less productive firms (quantiles 1 and 2). Additionally, I also estimate equation (4) with the size of the firm as a continuous variable, and the results of this regression, which are reported in column 2 of Table 6, are consistent with the previous findings. The coefficient of the interaction term of the $FirmSize$ and the weighted competition shock is positive and significantly different from zero.

Table 6: **Investment:Quality and Productivity**
Dependent Variable: Change in log of the Stock of Capital (2001-2007)

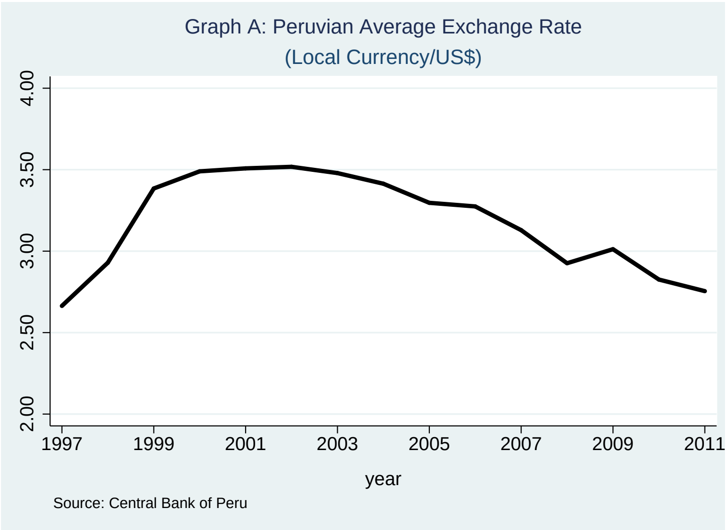
	(1)	(2)
(F.size 1)*(Weighted Comp. Shock)	-0.495**	
	(0.245)	
(F.size 2)*(Weighted Comp. Shock)	-0.421*	
	(0.236)	
(F.size 3)*(Weighted Comp. Shock)	0.697	
	(0.666)	
(F.size 4)*(Weighted Comp. Shock)	0.395	
	(0.554)	
(F.size 5)*(Weighted Comp. Shock)	6.510***	
	(1.868)	
Weighted Comp. Shock		-6.257***
		(2.137)
(Firm Size)*(Weighted Comp. Shock)		0.508**
		(0.197)
Firm Size (logs)		0.0294**
		(0.0123)
Stock of Capital in 2001 (logs)	0.00159	-0.0274**
	(0.00382)	(0.0115)
Observations	202	202
R-squared	0.197	0.136
Null Hypothesis H0:	Prob	
(F.size 3)*(Weighted Comp. Shock)¡=(F.size 1)*(Weighted Comp. Shock)	0.030	-
(F.size 4)*(Weighted Comp. Shock)¡=(F.size 1)*(Weighted Comp. Shock)	0.049	-
(F.size 5)*(Weighted Comp. Shock)¡=(F.size 1)*(Weighted Comp. Shock)	0.000	-
(F.size 3)*(Weighted Comp. Shock)¡=(F.size 2)*(Weighted Comp. Shock)	0.039	-
(F.size 4)*(Weighted Comp. Shock)¡=(F.size 2)*(Weighted Comp. Shock)	0.065	-
(F.size 5)*(Weighted Comp. Shock)¡=(F.size 2)*(Weighted Comp. Shock)	0.000	-

Notes: Robust standard errors in parentheses in parentheses with ***,** ,* respectively denoting significance at the 1%, 5% and 10% levels.

Alternative Hypothesis: Exchange Rate Appreciation and Pass-Through?

Higher changes in product prices of some group of firms is also consistent with the hypothesis of a Peruvian exchange rate appreciation and the ability of more productive (larger) firms to increase their prices to compensate for the negative effects of a lower exchange rate (pass-through) on revenues. Figure 9 shows a 10 percent appreciation of the Peruvian currency, Nuevo Sol, relative to the US dollar from 2001 to 2007. However, assuming that the exchange rate pass-through explains the heterogeneous price change during this period, I should not necessarily observe heterogeneous changes in the input prices by firm size as was depicted in the previous subsection.[22]

Figure 9



1.5.4 Exit Rate

According to the theoretical model, less productive firms leave the market after the competition shock from the Chinese apparel products, since these firms would produce negative profits. To evaluate this prediction I calculate the share of exiting firms by product p and country c, $ExitShare_{pc}$, which reports the percentage of firms which were exporting product p to country c at the initial period of the sample but not at the end of it.[23] I also calculate the relative average productivity at product-country level, defined as:

[22]An exchange rate appreciation could also explain a lower price of inputs for small firms relative to large firms if the former firms are more intensive in imported inputs.

[23]I use the proportion of exiting firms rather than a binary variable which reports if the firm is still exporting product p to country c because larger firms export more products to more destinations. Even controlling for firm size, product and destination country, less important products for larger firms exported

$$RelProductivity_{pc} = \frac{\sum_f w_f Size_{fpc}}{\sum_f w_f Size_f},$$

where w_f is the weight of firm f, and then the numerator represents the weighted average size of firms exporting product p to country c whereas the denominator is the average size of all apparel firms. Therefore if the relative productivity is greater than one, firms exporting the product-country pair (p, c) are on average more productive than the average apparel exporters and are less reluctant to exit after the competition shock. In that sense, the share of exiting firms is not only higher when the competition shock, $\Delta Comp_{pc}$, is higher, but also when there is a lower relative productivity exporting product p to country c. I estimate the following equation using a two-limit Tobit model, since the $ExitShare_{pc}$ is bounded between 0 and 1.

$$\begin{aligned} ExitShare_{pc} = \beta_1 \Delta Comp_{pc} + \beta_2 RelProductivity_{pc} * \Delta Comp_{pc} \\ + \beta_3 RelProductivity_{pc} + \alpha_p + \alpha_c + \epsilon_{pc} \end{aligned} \tag{5}$$

Table 7: **Exit and Productivity**
Dependent Variable: Proportion of Exiting firms

	(1)	(2)
Competition Shock	0.637***	1.656***
	(0.0832)	(0.0786)
(Relative Firms' Size)*(Competition Shock)	-0.389***	-1.325***
	(0.0688)	(0.0650)
Relative Firms' Size	-0.772***	-0.445***
	(0.0161)	(0.0147)
Sigma	0.697***	0.622***
	(0.00460)	(0.00432)
Observations	659	659
Country FE	Yes	Yes
HS2 FE	Yes	No
HS4 FE	No	Yes

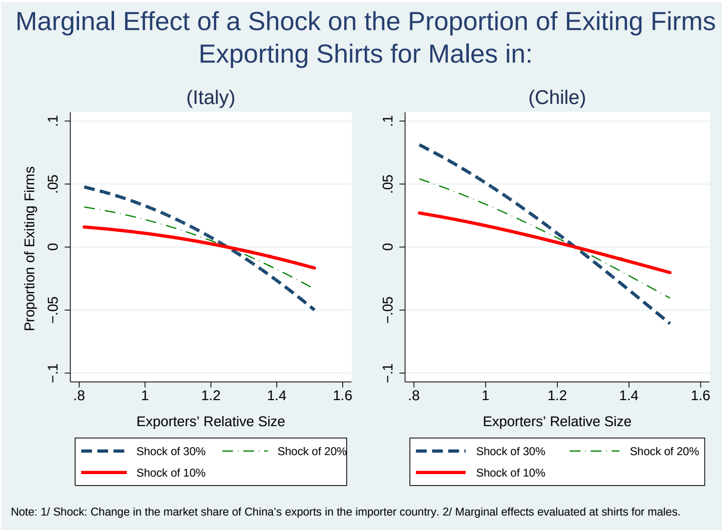
Notes: Robust standard errors in parentheses in parentheses with ***,** ,* respectively denoting significance at the 1%, 5% and 10% levels. Comp. Shock: Competition Shock.

The results reported in Table 7, in columns 4 and 5, confirm that the effect of the competition shock on the proportion of firms exiting the export markets is lower when the relative productivity of those firms is higher. In fact, the estimated coefficient β_2 in both regressions is negative (-0.389 and -1.325). Using the estimates of columns 5, Figure 10 shows, a predicted decreasing effect of the competition shock on the proportion of

to less attractive destinations might be taken out of the market and small firms which produce the same product to the same destination may keep exporting its main product. The use of the share of exiting firms avoids this problem.

exiting firms in two countries, Italy and Chile, as long as the relative productivity of the exporters to those destinations is higher.

Figure 10



1.6 Conclusions

In this research I find evidence of heterogeneous quality upgrading strategies of Peruvian apparel firms in reaction to lower prices of Chinese apparel. More productive firms upgraded the qualities of their products, avoiding a price war with low-priced Chinese products. Differently from previous works, I also find evidence for changes in input prices consistent with the quality upgrading strategy. More productive firms pay higher wages and buy more expensive intermediate inputs to produce higher quality goods in response to the low-cost Chinese apparel products. Finally, following Amiti and Khandelwal (2013) framework, I find evidence that the average quality of Peruvian apparel products increased between 2001 and 2007.

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1.7 Appendix

1.7.1 Demand Functions: First Order Conditions

$$\alpha_l - \beta_l y_l - \gamma y_m = \lambda p_l$$

$$\alpha_m - \beta_m y_m - \gamma y_l = \lambda p_m$$

$$\alpha_h - \beta_h y_h = \lambda p_h$$

$$\lambda = 1$$

1.7.2 Effect of a foreign tariff reduction on the low and medium quality producers

The new profit function for a firm in a country F after including a per-unit tariff τ^F is given by:

$$\pi_l^F = (A - b_1 p_l + b_3 p_m)(p_l - c^F - \tau^F) - F_l^F$$

Then the corresponding reaction functions for producing low and medium qualities are respectively:

$$p_l = \frac{A}{2b_1} + \frac{b_3 p_m}{2b_1} + \frac{c^F + \tau^F}{2} \quad and \quad p_m = \frac{D}{2b_2} + \frac{b_3 p_l}{2b_2} + \frac{c_m^H}{2}$$

and the optimal prices for low- and medium-quality varieties are:

$$p_l = \left(\frac{A}{2b_1} + \frac{b_3 D}{4b_1 b_2} + \frac{b_3 c_m^H}{4b_1} + \frac{c^F + \tau^F}{2}\right)\left(\frac{4b_1 b_2}{4b_1 b_2 - b_3^2}\right) \quad and$$

$$p_m = \left(\frac{D}{2b_2} + \frac{b_3 A}{4b_1 b_2} + \frac{b_3 c^F + b_3 \tau^F}{4b_2} + \frac{c_m^H}{2}\right)\left(\frac{4b_1 b_2}{4b_1 b_2 - b_3^2}\right),$$

The effect of a lower tariff for firms producing goods at country F on low and medium-quality variety prices is:

$$\frac{\partial p_l}{\partial \tau^F} = \frac{2b_1 b_2}{4b_1 b_2 - b_3^2} > 0 \quad and \quad \frac{\partial p_m}{\partial \tau^F} = \frac{b_1 b_3}{4b_1 b_2 - b_3^2} > 0$$

since by assumption $\beta_m \beta_l - \gamma^2$.

The effect of a lower tariff for firms producing goods at country F on medium-quality producer's profits is negative. Clearly, profits of producing medium-quality varieties at home country are increasing in foreign firm's marginal cost c^F and the tariff τ^F, since both increases p_l. Profits of producing the medium-quality are given by:

$$\pi^H_{m,i} = b_2\left(\frac{2Db_1 + Ab_3 + b_1 b_3 c^F - (2b_1 b_2 - b_3^2)c_i}{4b_1 b_2 - b_3^2}\right)^2 - F^H_m$$

Then the effect of an increase in the marginal cost c^F or the tariff τ^F paid by foreign firm in country X is the same:

$$\frac{\partial \pi^H_{m,i}}{\partial \tau^F} = \frac{\partial \pi^H_{m,i}}{\partial c^F} = \frac{2b_1 b_3}{4b_1 b_2 - b_3^2}\left(b_2\left(\frac{2Db_1 + Ab_3 + b_1 b_3 c^F - (2b_1 b_2 - b_3^2)c_i}{4b_1 b_2 - b_3^2}\right)\right)$$

and replacing the values for b_1, b_2 and b_3:

$$\frac{\partial \pi^H_{m,i}}{\partial \tau^F} = \frac{\partial \pi^H_{m,i}}{\partial c^F} = \frac{2\beta_m \gamma}{4\beta_l \beta_m - \gamma^2} K > 0$$

Since by assumption $\beta_l \beta_m - \gamma^2 > 0$ and $K = b_2\left(\frac{2Db_1 + Ab_3 + b_1 b_3 c^F - (2b_1 b_2 - b_3^2)c_i}{4b_1 b_2 - b_3^2}\right) > 0$, because profits should be greater than zero to produce a positive number of units.

Chapter 2: Input Sourcing and Product Quality Differentiation

2.1 Introduction

Peru and China signed a Free Trade Agreement (FTA) in April of 2009, after a year and a half of negotiations, and it came into effect on March 1, 2010. The agreement gave Peruvian firms access to more than 3,500 zero-tariff goods including intermediate inputs and capital goods. Peruvian firms also received access to more than 1,400 intermediate inputs from China and the guarantee that firms would have those tariffs permanently. Even if the reduction of tariffs for Chinese products relative to the tariff for the same products from other countries without a FTA was not large, the certainty of an agreement and the enforcement of the rules that a FTA involves motivates firms to decide to start importing inputs from China instead of from other countries. This access to cheap and diverse inputs from China allows Peruvian firms to reduce their costs and gives them the opportunity to produce and export new products.

I develop a simple model with heterogeneous firms. The firms are able to produce two different types of varieties, low- and high-quality varieties. A firm uses two imported intermediate inputs for producing these varieties, a composite low-quality input (a mixture of non-OECD and Chinese intermediate input) and a high-quality input, sourced from OECD countries. The model predicts that a reduction in tariffs for imported intermediate inputs from China leads a firm to substitute its imports from non-OECD rather than its imported inputs from OECD countries. This effect is even larger for those firms producing and exporting low-quality varieties. Additionally, the model predicts that firms using intermediate inputs from China have a higher chance of exporting to non-OECD countries. These predictions are tested empirically using Peruvian firm-level data, and taking the FTA with China as exogenous variation for identifying causal effects.

There are several papers in the literature that find a positive effect of imported intermediate inputs after a liberalization on firm's productivity: Amiti and Konings (2007), Lileeva and Trefler (2007), and Yu (2010). Also, Bas (2012), using Argentine firm-level data, finds that firms that had a reduction in tariffs of imported inputs increased their exports more than firms that did not have a reduction. Other literature evaluates the role of imported intermediate inputs and the effect on exports. Among these works, Kasahara and Lapham (2013) and Feng et al. (2012) find that access to intermediate inputs increases both the extensive (more products and destinations) and the intensive margin of current exporters.[24]

My work is closely related to Fan et al. (2014) which presents theory and evidence that a tariff reduction on intermediate inputs induced Chinese producers to upgrade the quality of their exports during the period of 2002-2006, using China accession to the WTO as an exogenous shock. Feng et al. (2012) use a similar database and find that firms that increase their imported intermediate input expand the volume of their exports but also increase their export scope. In addition, they find that imported inputs from OECD rather than non-OECD countries generated larger firm export improvements.[25]

This study is similar in spirit to these recent papers but differs in two important respects. To my knowledge, this is the first study for a small open economy. This is important in order to avoid general equilibrium effects and also takes advantage of the fact that there were no other important reforms involved in that period.[26] Secondly, and more importantly, this research also focuses on the substitution of imported Chinese intermediate inputs for non-OECD and OECD intermediate inputs at the firm-level, considering different degrees of substitution depending on the firm's export destinations, non-OECD or OECD countries.

2.2 Data: Stylized Facts

Peru and China signed a Free Trade Agreement (FTA) in April of 2009, and it was confirmed by both country governments in December of 2009. However, the FTA came into effect in March of 2010. As Table 8 shows, this FTA lowered tariffs for more than 1,400 intermediate inputs. Even though there were not many products with absolute changes greater than 7 percentage points during 2010 and in the following years, the

[24]Other works relating imported intermediate inputs and productivity are Ge et al. (2011), and Halpern et al. (2009).

[25]Export scope is defined as the number of products, destinations, and product-destinations pairs.

[26]China's accession to the WTO also implied a reduction in tariffs for thousands of Chinese products to the rest of the world.

certainty of an agreement and the enforcement of the rules that an FTA involves, likely motivated firms to decide to start importing inputs from China instead of from other countries.

Table 8: **Tariff Reduction for Chinese Intermediate Inputs (# of products)**

	Years			
Change	10'/09'	11'/10'	12'/11'	13'/12'
No Change	2108	2396	2396	2396
$(0; -3)$	1094	1094	1094	1094
$[-3; -7)$	21	21	21	21
$[-7; -10)$	267	0	0	0
$[-10\ or\ less]$	21	0	0	0
Total	**3511**	**3511**	**3511**	**3511**

In addition to the tariff data I also use import-export firm-product level data collected by Peruvian Customs for every transaction of Peruvian firms from 2009 to 2013. The data contains information on unit values, f.o.b. values and quantities as well as the destination (origin) country of every export (import).

Figure 11: **Price Index of Intermediate Inputs by Source**

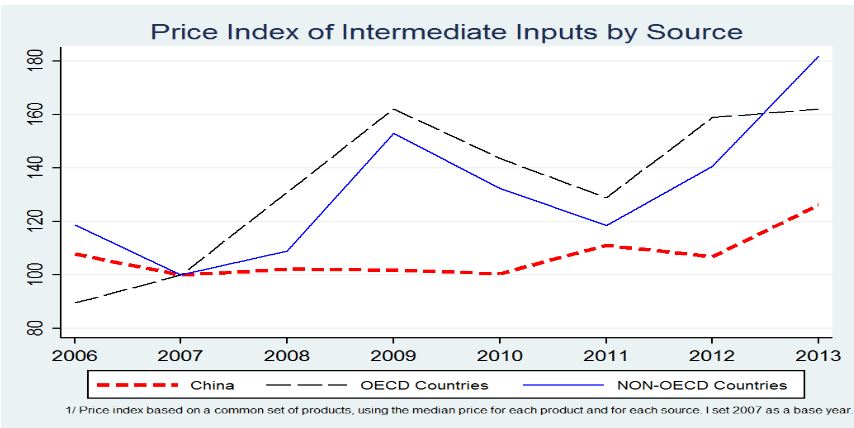
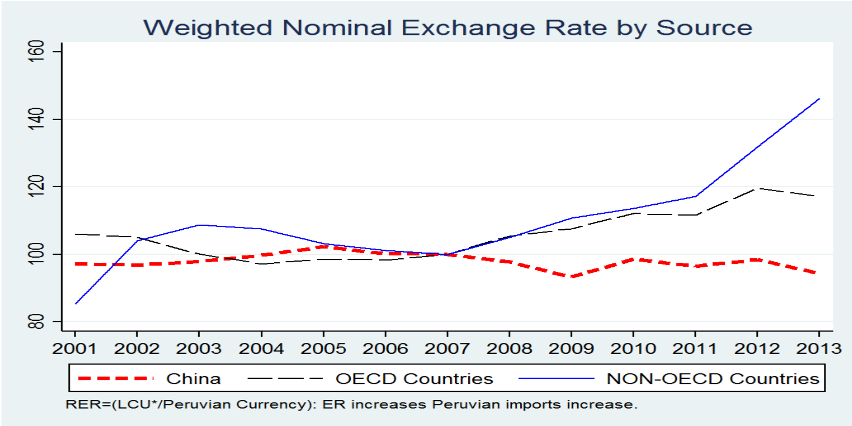


Figure 11 shows that a price index of OECD and non-OECD intermediate inputs rose faster than prices of intermediate inputs sourced from China. Lower exchange rates can explain higher prices for OECD and non-OECD intermediate inputs. However, Figure 12 shows an increasing weighted exchange rate for OECD and non-OECD countries. Differently from these two groups, China's exchange rate decreased after 2007, which raised the price of Chinese intermediate inputs. Lower prices increases the demand for

Chinese intermediate inputs vis a vis other sources, as depicted in Figure 13.[27]

Figure 12: **Weighted Exchange Rate by Source**



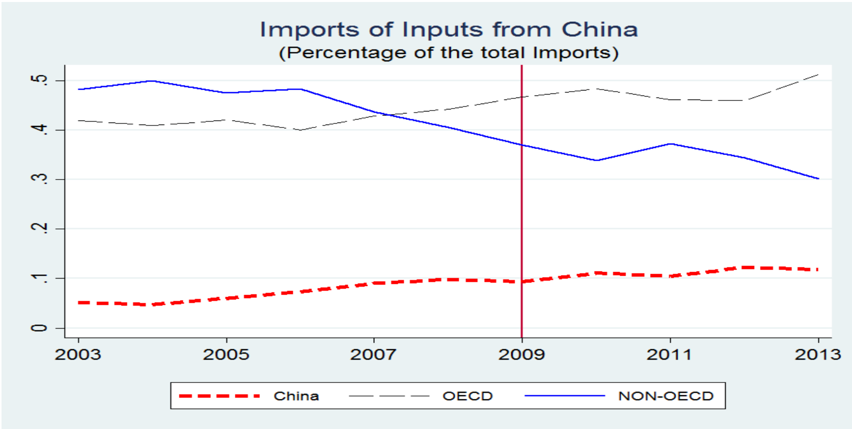
Peruvian firms' access to lower prices of intermediate inputs after the FTA with China reduced the cost of their products. Particularly, low-cost Chinese intermediate inputs are also associated with low-quality products. According to Linder (1961) and supply-side theory, there is a positive relationship between per capita income and quality production. Schott (2004) shows that export unit values are positively related with exporter per capita income and relative endowments of physical and human capital. Along the same line, Schott (2008), using information on U.S. imported products from 1972 to 2001, finds that Chinese varieties are priced lower than OECD varieties, and these relative prices fell in some industries.[28]

There is some firm-level evidence in the literature that high-income countries, e.g. OECD countries, consume higher quality products at higher prices compared to low-income countries. Manova and Zhang (2012), using data from Chinese exporting firms, find that more successful exporters use higher quality inputs to produce higher quality goods and sell them at higher prices. Additionally, firms vary the quality of their products across destinations by using inputs of different quality. Peruvian firms exporting to non-OECD countries are more intensive in the use of low-quality inputs, compared to those firms exporting to OECD countries, and then more likely to use Chinese intermediate

[27] The complete list of OECD and non-OECD countries is reported in Table 12

[28] The author supports that "the competition between China and the world's most developed economies might be attenuated since OECD economies might be responding to the emergence of China and other low-wage countries by raising the quality of their exports or stopping production of the least-sophisticated varieties from their export bundle."

Figure 13: **Imports of Inputs from China**



inputs. Figure 14 shows that firms exporting mainly to non-OECD countries increased the use of intermediate inputs from China faster than firms exporting mainly to OECD countries.[29]

Figure 14: **Share of Imported Inputs from China**

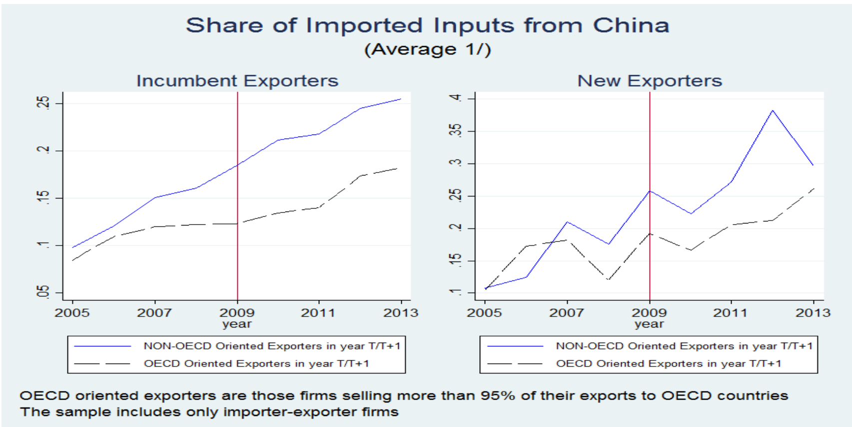
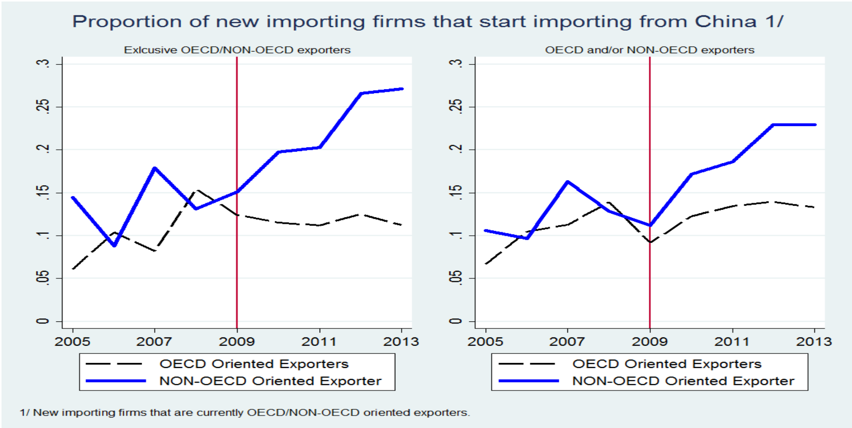


Figure 15 shows the proportion of new importing Peruvian firms, which are exporting either to OECD or Non-OECD countries, that start sourcing intermediate inputs from China. The left hand side of Figure 15 shows that the proportion of new importers which are also non-OECD oriented exporters, i.e. Peruvian exporters that sell more than 95% of their exports in non-OECD countries, start sourcing from China considerably more than

[29] There is theory and empirical evidence that more productive firms show a better performance because of the use of higher quality inputs to sell higher quality products. See Baldwin and Harrigan (2011), Brambilla et al. (2012), Kugler and Verhoogen (2012), Sutton (2007), Hallak and Sivadasan (2008), Kneller and Yu (2008), Melitz and Ottaviano (2008), Verhoogen (2007).

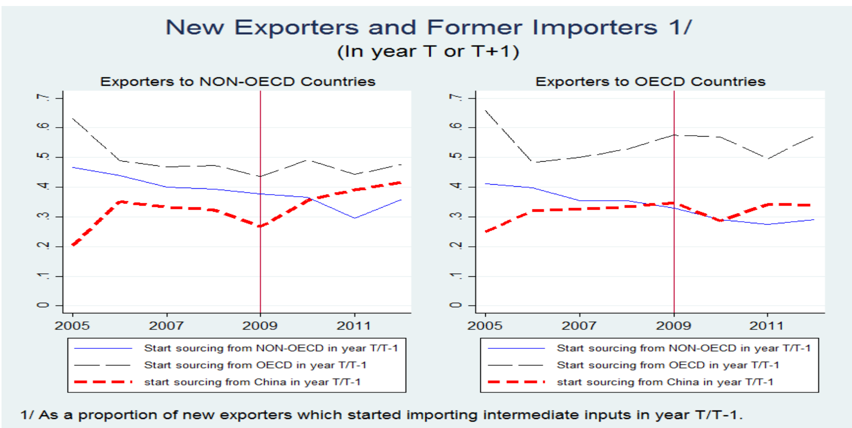
new importers that are exporting mainly to the OECD markets, particularly after 2009.

Figure 15: **Proportion of firms starting Importing from China**



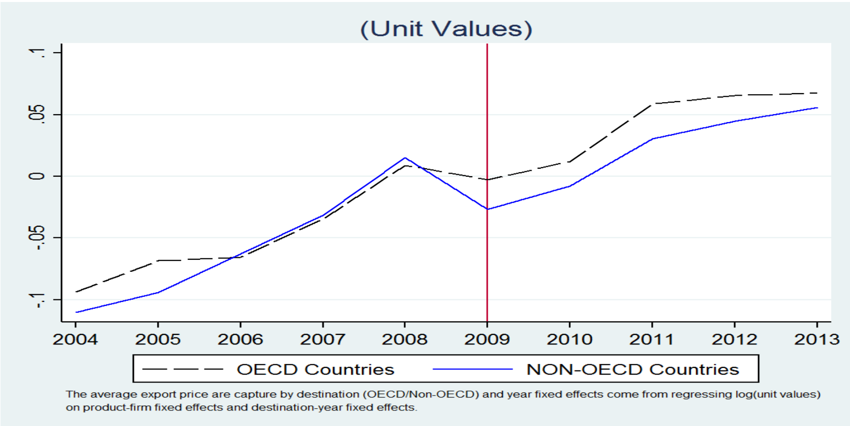
The access to cheaper inputs allows firms to reduce the cost of their product, increasing their competitiveness and also the probability that non-exporters become exporters. Figure 16 reports the proportion of new exporters in periods t or $t+1$ conditional on beginning to import intermediate inputs one or two years before becoming exporters. The left graph of Figure 16 shows that the proportion of new exporters to non-OECD countries that started importing intermediate inputs from China became larger than those sourcing intermediate inputs from a non-OECD after 2009. This pattern is different from new exporters to OECD countries, depicted on the graph on the right side of Figure 16, where the proportion of firms sourcing from China remains relatively stable.

Figure 16: **New Exporters and Former Importers**



In general, for new and incumbent exporters, the access to low-cost intermediate inputs allows them to reduce the cost of their products, particularly for those who export to non-OECD countries, since they are more intensive in the use of intermediate inputs from China. Figure 17 depicts that, after controlling for product-firm fixed effects, the average price of goods exported to non-OECD countries increased at a slower rate compared to goods exported to OECD countries after 2009. The fact that firms charge higher prices in richer destinations is consistent with Manova and Zhang (2012), Hallak (2006), and also suggests the presence of non-homothetic preferences.[30]

Figure 17: **Averge Export Price by Destination**



2.3 Model

In this subsection I describe a partial equilibrium model with four countries: two of them, China and non-OECD, producing low-quality inputs, and a third country, OECD, producing a high-quality input. Additonally, there is a fourth country, T, which uses these inputs to produce and export low and high-quality varieties of a final good to two destinations: OECD and non-OECD.

2.3.1 Consumer's Problem

Consumers in OECD (O) and non-OECD (N) countries can choose among a set of low- and high-quality differentiated goods which can be grouped into low-and high-quality

[30] Papers that incorporates non-homothetic preferences include: Verhoogen (2007); Fajgelbaum et al. (2011); and Simonovska (2010).

indices Q_L and Q_H, respectively, with the corresponding price indexes P_L and P_H. Preferences are identical and non-homothetic in both countries, and are described by a Stone-Geary utility function:

$$U_c = (Q_L - a)^{\gamma}(Q_H)^{\gamma},$$

where the set of Q_K, for K=L,H is given by:

$$Q_K = \Big(\int_{k\epsilon K} q_k(\omega_k)^{\frac{\sigma_K}{\sigma_K - 1}} d\omega_k\Big)^{\frac{\sigma_K - 1}{\sigma_K}}, for\ K = L, H,$$

and without loss of generality I assume that $\sigma_K = \sigma_L = \sigma_H$.

I solve the consumer's problem in two steps: First, I calculate the shares of income spent on the low-and high-quality variety indices, and then I calculate the demand for each variety $q_k(\omega_k)$ for $k \ \epsilon \ K$, and $K = L, H$. From the consumer's maximization problem the corresponding optimal composite indices Q^*_L and Q^*_H are, respectively:

$$Q^*_L = \frac{\gamma I}{P_L} + a(1 - \gamma);$$

$$Q^*_H = \frac{(I - aP_L)(1 - \gamma)}{P_H}\ if\ I > aP_L;$$

$$Q^*_H = 0\ if\ I < aP_L.$$

As a second step, I calculate the demand for each variety $q_k(\omega_k)$ for $k \ \epsilon \ K$, and $K = L, H$:

$$q_k(\omega_k) = p(\omega_k)^{-\sigma_K} P_K{}^{\sigma_K - 1} I_K.$$ [31]

Proportion of low- and high-quality varieties in total expenditure.

Different from a set-up with consumers having homothetic preferences, under non-homothetic preferences the share of the expenditure on the low-quality varieties is decreasing with the level of income:

[31] For details see Appendix 2.6.1

$$\frac{P_L Q_L^*}{I} = \gamma + \frac{a(1-\gamma)P_L}{I}.$$

Richer countries spend more of their income on high-quality varieties than poor countries.

$$\frac{\partial(\frac{P_L Q_L^*}{I})}{\partial I} = -\frac{a(1-\gamma)P_L}{I^2} < 0$$

For simplicity I assume that the level of income of a representative consumer in each country, I_O and I_N, is greater than aP_L. This implies a positive level of consumption of both quality indexes. Relative demand $\frac{Q_L^*}{Q_H^*}$ is then defined as:

$$\frac{Q_L^*}{Q_H^*} = \frac{\frac{\gamma I_C}{P_L} + a(1-\gamma)}{\frac{(I_C - aP_L)(1-\gamma)}{P_H}} = \frac{\frac{\gamma I_C P_H}{P_L} + a(1-\gamma)P_H}{(I_C - aP_L)(1-\gamma)}.$$

Proposition 1: an increase in the relative price $\frac{P_H}{P_L}$ increases relative demand $\frac{Q_L^*}{Q_H^*}$ more when the level of income is lower.

Proof: (see Appendix 2.6.2)

Based on proposition 1, if P_L decreases or P_H increases, the positive change in relative demand, $\frac{Q_L^*}{Q_H^*}$, is smaller in high income countries. Using the fact that the average price in any country c, $\overline{Price_c}$, for $c = O, N$, is given by:

$$\overline{Price_c} = \frac{P_H Q_{H,c}^* + P_L Q_{L,c}^*}{Q_{H,c}^* + Q_{L,c}^*},$$

if P_H increases, the average price $\overline{Price_c}$ increases more in richer countries because $\frac{Q_L^*}{Q_H^*}$ is decreasing in income (or per-capita income). Equivalently, when P_L decreases, the average price $\overline{Price_c}$ decreases even more in countries with lower income. In that sense, assuming that OECD is richer than non-OECD ($I_O > I_N > aP_l$), an increase in the relative price, $\frac{P_H}{P_L}$, increases the average price in country O more than in country N.

2.3.2 Producer's Problem

In this sub-section I present the producer's problem. Given the intensive use of subscripts, I use lower case subscripts to distinguish intermediate inputs from final goods (upper case subscripts).

Each firm in country T can produce two varieties, a low-and a high-quality variety, of a final good q_i, for $i = H, L$, using the following CES production technology:

$$q_i = \left[(\alpha_{l,i} l)^{\frac{\sigma_i - 1}{\sigma_i}} + (\alpha_{h,i} h)^{\frac{\sigma_i - 1}{\sigma_i}}\right]^{\frac{\sigma_i}{\sigma_i - 1}},\ i = H, L$$

where l and h represent a composite low-quality and high-quality input, respectively. The price of a high-quality input w_h, is given by $w_h = (1 + \tau_{oecd})(w^*_{h,oecd})$, where τ_{oecd} is the tariff for importing high-quality inputs and $w^*_{h,oecd}$ is the unit cost of that input in the origin country. The production function of the composite low-quality input l is:

$$l = \left[(l_{non\_oecd})^{\frac{\sigma - 1}{\sigma}} + (l_{chn})^{\frac{\sigma - 1}{\sigma}}\right]^{\frac{\sigma}{\sigma - 1}}$$

where $l_{non-oecd}$ and l_{chn} are imported inputs from non-OECD and China, respectively, and the corresponding prices of these inputs are $w_{l,non-oecd}$ and $w_{l,chn}$, respectively. Therefore, the cost of each unit of l is given by:

$$w_l = \left[(w_{l,non\_oecd})^{1-\sigma} + (w_{l,chn})^{1-\sigma}\right]^{\frac{1}{1-\sigma}},$$ [32]

where $w_{l,non-oecd} = (1 + \tau_{non-oecd})(w^*_{l,non-oecd})$ and $w_{l,chn} = (1 + \tau_{chn})(w^*_{l,chn})$. τ_{chn} and $\tau_{non-oecd}$ are the corresponding import tariffs of inputs $l_{non-oecd}$ and l_{chn}. Without loss of generality, I set $w^*_{l,tchn}$=1, and $w^*_{l,chn} < w^*_{l,non-oecd} < w^*_{h,oecd}$, given that wages are on average higher in OECD countries. Based on the stylized facts of Peruvian exporters presented in subsection 2.2 (figures 14 and 15), I assume that the elasticity of substitution between $l_{non-oecd}$ and l_{chn} in the production of the composite low-quality input l is larger than the elasticity of substitution between l and h in the production of the low and high-quality varieties ($\sigma_H < \sigma_L < \sigma$).

Defining w_h and w_l as the factor prices of each unit of inputs h and l, respectively, the per-unit cost, c_i, of producing each variety of the final good q_i is:

$$c_i = \left[(\frac{w_l}{\alpha_l})^{1-\sigma_i} + (\frac{w_h}{\alpha_h})^{1-\sigma_i}\right]^{\frac{1}{1-\sigma_i}}, \tag{6}$$

[32] for the derivations see the details in Appendix 2.6.3

and substituting w_l into the previous equation we obtain the per-unit cost as a function of the input factor prices $w_h, w_{l,chn}$ and w_{l,n_oecd}:

$$c_i = \Big[\Big(\frac{((w_{l,non\_oecd})^{1-\sigma} + (w_{l,chn})^{1-\sigma})^{\frac{1}{1-\sigma}}}{\alpha_l}\Big)^{1-\sigma_i} + \Big(\frac{w_h}{\alpha_h}\Big)^{1-\sigma_i}\Big]^{\frac{1}{1-\sigma_i}}. \tag{7}$$

Proposition 2a: The degree of substitution between Chinese intermediate inputs is higher with respect to non-OECD than to OECD intermediate inputs.

Proof: This result seems intuitive because of the definition of the corresponding production functions of q_L and q_H and the assumption that the elasticity of substitution $\sigma > \sigma_i$, for $i = H, L$. To formally prove this, I show that the elasticity of the high-quality input with respect to $w_{l,chn}$, $\varepsilon_{h_i,w_{l,chn}} = \frac{\partial h_i}{\partial w_{l,chn}} \frac{w_{l,chn}}{h_i}$, is smaller than $\varepsilon_{l_{non\_oecd,i},w_{l,chn}}$, the corresponding elasticity for the low-quality input sourced from non-OECD with respect to $w_{l,chn}$.

I obtain the Marshallian demands h_i and l_{non_oecd} using Shepard's Lemma and then calculate the elasticities.[33] To simplify the algebra and without loss of generality, I assume that $a_{l.i} = a_{h.i} = 1$, and then the difference of these two elasticities is given by:

$$\varepsilon_{l_{non\_oecd,i},w_{l,chn}} - \varepsilon_{h_i,w_{l,chn}} = -\frac{(w_{l,chn})^{1-\sigma}(\sigma_i - \sigma)}{(w_{l,non\_oecd})^{1-\sigma} + (w_{l,chn})^{1-\sigma}} > 0,$$

because by assumption $\sigma > \sigma_i$. Notice that if $\sigma = \sigma_i$ the model reduces to one where all the inputs are equally substitutable.

Proposition 2b: A reduction in $w_{l,chn}$ has a higher impact on the per-unit cost of the low-quality variety, c_L, than on the high-quality variety, c_H.

This proposition also seems intuitive because the elasticity of substitution between the composite inputs l and h, σ_i, in the production of the low-quality variety, σ_L, is higher than σ_H, the elasticity of substitution of inputs in the production of the high-quality variety. This implies that the initial share of non-OECD intermediate inputs, and therefore the share of the composite intermediate input l, is higher in the production of the low-quality variety than in the high-quality variety. Using this fact, the substitution in absolute terms of Chinese intermediate inputs for non-OECD intermediate inputs is

[33]for the details see Appendix 2.6.4

also larger in the low-quality variety after a reduction in $w_{l,chn}$, driving a higher cost reduction in the production of this variety. For a formal proof see (Apendix 2.6.5).

2.3.3 Heterogeneous Firms

In this model each firm incurs a sunk cost, F, to know its level of productivity, φ. The firm also incurs a fixed cost for each type of variety that it decides to export, F_L and/or F_H. Finally, there is an extra fixed cost for exporting both varieties at the same time, which is decreasing in the level of productivity, and captures the presence of diseconomies of scope.[34] Using the derivation from the previous section, the marginal cost of delivering one unit of q_i, for $i = L, H$, is:

$$(1+\tau_j)c_i(\varphi),$$

where τ_j is the tariff for final goods paid in country j, for $j = O$, N, and $c_i(\varphi)$ is defined as:

$$c_i(\varphi) = \frac{c_i}{\varphi}.$$

Therefore, a firm with productivity φ maximizes its profits:

$$\Pi(\varphi) = \big(p_{_L}(\omega) - (1+\tau_L)c_{_L}(\varphi)\big)q_{_L}(\omega) + \big(p_{_H}(\omega) - (1-\tau_H)c_{_H}(\varphi)\big)q_{_H}(\omega)$$
$$-F_L - F_H - \Phi(\varphi)F_L F_H,$$

where F_L and F_H represents the fixed cost of exporting low-and high-quality varieties, respectively, and $\Phi(\varphi)$ is a decreasing function of φ, which is bounded between 0 and 1. Therefore, the values of q_L, q_H that maximize firm's profits are:[35]

$$q_{_L} = \Big(\frac{\sigma_{_L}(1+\tau_L)}{\sigma_{_L}-1}\frac{c_{_L}}{\varphi}\Big)^{-\sigma_L} P_{_L}^{\sigma_L - 1} I_{_L},\ where\ I_{_L} = \gamma I + a(1-\gamma)P_{_L}$$

[34]Arkolakis and Muendler (2010) find the presence of diseconomies of scope in product introduction costs for Brazilian exporters. Rawley and Simcoe (2010) study how diseconomies of scope, caused by diversification or expansion, make firms to use outsourcing or vertical dis-integration.

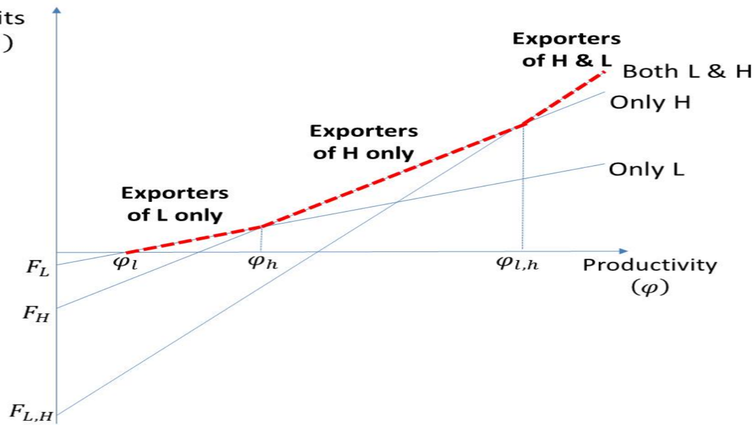
[35]For the derivations see Appendix 2.6.6

$$q_H = \Big(\frac{\sigma_H(1+\tau_H)}{\sigma_H - 1}\frac{c_H}{\varphi}\Big)^{-\sigma_H} P_H^{\sigma_H - 1} I_H. \; where \; I_H = (I - aP_L)(1-\gamma)$$

Thresholds. Figure 18 depicts profits of producing (only) low, (only) high, and both quality varieties for different levels of productivity. The following conditions: $\Pi(\varphi_L) = 0; \Pi(\varphi_H) = \Pi(\varphi_L)$, and $\Pi(\varphi_H) = \Pi(\varphi_{L,H})$ determine the cut-off productivities for low-quality producer's (only),φ^*_L, high-quality producer's (only), φ^*_H, and producers exporting both varieties, $\varphi^*_{L,H}$, respectively.

In that sense, firms with productivity levels higher than φ_L but lower than φ_H export the low-quality variety whereas firms with productivity higher than φ_H but lower than $\varphi_{L,H}$ export the high-quality variety. Finally, firms for which productivity is higher than $\varphi_{L,H}$ export both varieties.

Figure 18: **Heterogeneous Firms: Productivity and Variety Production**



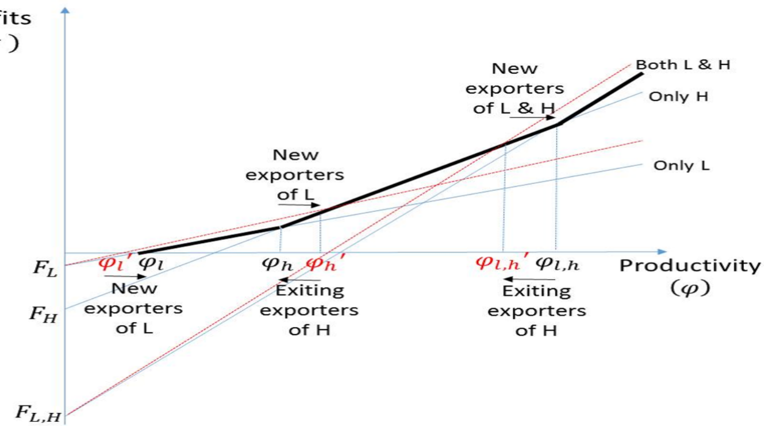
2.3.4 Effect of a Reduction of the Tariff for Chinese Intermediate Inputs

In this subsection I analyze the effect of a lower tariff for Chinese intermediate inputs on the intensive and extensive margin.

Extensive Margin. A lower tariff for Chinese inputs, τ_{chn}, reduces both $w_{l,chn}$ and the cost of the composite input w_l. This reduction increases the profits of producing the low-quality variety and also reduces the minimum threshold φ_L to $\varphi_L^{'}$, as shown in Figure 19, increasing the number of firms exporting the low-quality variety.[36]

[36]As a simplification I assume in Figure 19 that only c_L decreases after a tariff reduction of Chinese

Figure 19: **Heterogeneous Firms: Effect of a Lower Tariff for Inputs from China**



Higher profits for producing low-quality varieties make some firms switch from producing high-quality to low-quality varieties. This is reflected in the higher threshold $\varphi_H^{'}$. Finally, higher profits of producing low-quality varieties reduces the threshold for producing both varieties at the same time from $\varphi_{L,H}^{'}$ to $\varphi_{L,H}^{'}$, as shown in Figure 19, increasing the number of firm exporting both varieties.

Intensive margin. From Proposition 2b, a reduction of τ_{chn} implies a higher reduction in the per-unit cost of a low-quality variety, c_L, than the higher quality variety, c_H, as well as on prices of the corresponding varieties, $p_L(\omega)$ and $p_H(\omega)$.[37] This is consistent with Figure 17, where the average price of products exported to non-OECD countries increased at lower rates than the average price of products exported to OECD countries between 2009 and 2013.

2.4 Estimation and Results

In this subsection I empirically test three main predictions of the model using import-export firm-product level data collected by Peruvian Customs in 2009 and 2013. The data contains information on unit values, f.o.b. values and quantities of each shipment, of both exports and imports, at the product-country-firm level.

intermediate inputs. In fact, both c_L and c_H decrease but as I prove in proposition 2b, c_L decreases more than c_H.

[37]A proportional change in prices, $\widehat{p_L(\omega)}$, is proportional to a change in the per-unit cost $\widehat{c_L(\omega)}$, so $\widehat{p_L(\omega)} > \widehat{p_H(\omega)}$ because $\widehat{c_L(\omega)} > \widehat{c_H(\omega)}$.

Data cleaning process. The data excludes all the registered Peruvian imports of inputs with a value lower than \$1,000, and excludes firms registered as retailers since they are not actually producing other goods.

Testing Propositions

Proposition 2a: The degree of substitution between Chinese intermediate inputs is higher with respect to non-OECD than to OECD intermediate inputs.

The following two equations describe the impact of Chinese intermediate inputs on non-OECD and OECD imports, respectively.

$$Imp_{N,p,f,t} = \beta_n Imp_{C,p,f,t} + \alpha_t + \alpha_p + \alpha_f + \upsilon_{p,f,t}, \tag{8}$$

and

$$Imp_{O,p,f,t} = \beta_o Imp_{C,p,f,t} + \gamma_t + \gamma_p + \gamma_f + \xi_{p,f,t}, \tag{9}$$

where $Imp_{S,p,f,t}$ for $S = N, O, C$ represents the imported input from source country S,where $N = non{-}OECD; O = OECD$ and $C = China$, and $\alpha_t, \alpha_p, \alpha_f$ are time, product and firm fixed effects, respectively. Then, substracting equation 9 from equation 8 I get:

$$Imp_{N,p,f,t} - Imp_{O,p,f,t} = \beta_1 Imp_{C,p,f,t} + \delta_t + \delta_p + \delta_f + e_{p,f,t}, \tag{10}$$

where $\beta_1 = \beta_n - \beta_o$; $\delta_t = \alpha_t - \gamma_t$; $\delta_p = \alpha_p - \gamma_p$; $\delta_f = \alpha_f - \gamma_f$; and $e_{p,f,t} = \upsilon_{p,f,t} - \xi_{p,f,t}$.

A negative β_1 in equation 10 implies that firms are buying fewer intermediate inputs from non-OECD countries relative to inputs imported from OECD when they import intermediate inputs from China.

Time-varying shocks in $e_{p,f,t}$ might be correlated with the level of intermediate inputs sourced from China $Imp_{C,p,f,t}$. Therefore, I use the tariff for Chinese products, $tariff\ Chn_p$, as an instrument for the level of intermediate imports sourced from China to address endogeneity issues in equation 10. I use $tariff\ Chn_p \times w_{f,p-2009}$ as an instrument, where $w_{f,p-2009}$ represents the share of product p in firm's f total imports in 2009, in those regressions that controls for product fixed effects.[38]

[38] I have to use a firm-level instrument since the product-level instrument $tariff\ Chn_p$ is absorbed by the product fixed effect.

Estimates of equation 10 are reported in columns (1) - (6) of Table (9). All of the estimates of β_1 except the one reported in column (6) are negative and statistically significant, in line with proposition 2a. Nevertheless, even though the IV estimates in columns (2) and (4) are statistically significant, we must be aware of the validity of the instruments since the F-statistic of the first stage of both regressions is not greater than 10.[39] The estimates in column (2) imply that for each dollar that a firm spends on Chinese intermediate inputs, the firm is spending 2 dollars less on inputs from non-OECD relative to inputs from OECD countries. The IV point estimate in column (2) is more negative than the corresponding OLS estimate of β_1 in column (1), which would suggest a positive correlation between firm's productivity (a pressumed omitted variable) and the amount of imported input from China.

In columns (7) - (12) I report estimates of equation 10 including a time-varying coefficient of $Imp_{C,p,f,t}$ considering that the Great Trade Collapse (2008-2009) could have some different effect on firms during 2009 and not during 2013. Most of these results are similar to those reported in columns (1) - (6), considering the overall effect of buying intermediate inputs from China.

[39]A rule of thumb is that the F-statistic should be above 10 (Stock et al. (2002)).

Table 9: **Substitution of non-OECD vs OECD inputs (All importers). Dependent Variable: Non-OECD intermediate inputs - OECD intermediate inputs**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	(OLS)	(IV)	(OLS)	(IV)	(OLS)	(IV)	(OLS)	(IV)	(OLS)	(IV)	(OLS)	(IV)
Imports from China (levels)	-0.104***	-2.000**	-0.107***	-1.514**	-0.113***	-0.277	-0.266*	-2.119**	-0.274*	-1.811**	-0.261	-0.548
	(0.027)	(0.822)	(0.026)	(0.690)	(0.035)	(0.387)	(0.154)	(0.837)	(0.156)	(0.813)	(0.161)	(1.940)
Time*Imports from China (levels)							0.201	0.243	0.204	0.629	0.176	0.420
							(0.183)	(0.787)	(0.188)	(0.700)	(0.206)	(2.669)
Observations	32,118	32,118	32,118	32,118	32,118	32,118	32,118	32,118	32,118	32,118	32,118	32,118
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product FE	No	No	No	No	Yes	Yes	No	No	No	No	Yes	Yes
Firm FE	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
F-statistic (1st stage)		9.00		6.82		39.95		6.72		7.15		0.99
Kleibergen-Paap rk Wald F-statistic		9.05		6.95		40.85		3.33		3.58		0.47

Notes: Clustered standard errors in parentheses at the firm level, with ***,** ,* respectively denoting significance at the 1%, 5% and 10% levels. The instrument in columns (2),(4),(8) and (10) is $tariff\ Chn_p$. The instrument in columns (6) and (12) is $tariff\ Chn_p \times w_{f,p-2009}$, where $w_{f,p-2009}$ indicates the share of product p in firm's f total imports in the initial period (2009). The use of this instrument is because of the inclusion of product fixed effects in column (4)).

Proposition 2b: A reduction in $w_{l,chn}$ has a higher impact on the cost of the low-quality variety, c_L, than on the high-quality variety, c_H.

In the empirical subsection I assume that non-OECD oriented exporters are producing on average low-quality varieties whereas OECD oriented exporters produce on average high-quality varieties. The theoretical model predicts that the substitution of Chinese intermediate inputs for non-OECD inputs will be higher on firms producing low-, L, rather than high-, H, quality varieties. To test this, I estimate the following equation:

$$\begin{aligned} Imp_{N,p,f,t} - Imp_{O,p,f,t} = \beta_1 Imp_{C,p,f,t} + \beta_2 Imp_{C,p,f,t} * Non\_OECD\_Exp\_Inten_f \\ +\delta_t + \delta_p + \delta_f + e_{p,f,t}, \end{aligned} \tag{11}$$

where $Non\_OECD\_Exp\_Inten_f$ is an indicator variable that takes the value of 1 if firm's exports to non-OECD markets were more than 50% of their total exports in 2009. The IV estimates reported in columns (2) of Table (10) show a negative and statistically significant estimate of β_2, implying that the degree of substitution of Chinese for non-OECD intermediate inputs is higher on firms exporting to non-OECD markets (the low-quality variety). On average, for each dollar that an exporter spends on Chinese intermediate inputs, the firm is spending 4.5 dollars less on inputs from non-OECD relative to inputs from OECD countries, when most of the firm's exports are sold in non-OECD countries. Column (3) includes the interaction of $Non\_OECD\_Exp\_Inten_f$*$TimeFE$ as a control variable. This accounts for different time-varying shocks in non-OECD and OECD countries, i.e. different aggregated demand shocks, and the estimates of β_2 are still statistically significant at the 10% level. As a robustness check, I report in columns (4)-(6) the estimates of equation 11 using the proportion of exports to non-OECD countries in 2009 rather than the indicator variable. These results reinforce the previous findings of columns (2) and (3) and the initial evidence reported in Figure 14, where the share of imports imported from China increased faster in non-OECD than OECD oriented exporters.

Table 10: **Substitution of non-OECD vs OECD inputs (Importer & Exporter)**
Dependent Variable: Non-OECD intermediate inputs - OECD intermediate inputs

	(1)	(2)	(3)	(4)	(5)	(6)
	(OLS)	(IV)	(IV)	(OLS)	(IV)	(IV)
Imports from China (levels)	-0.143	0.184	0.701	-0.162	-0.413	-0.261
	(0.131)	(1.008)	(1.413)	(0.146)	(1.049)	(1.112)
Imp. from China*Non-OECD Exp. Inten. (binary)	0.018	-3.629**	-4.547*			
	(0.140)	(1.727)	(2.566)			
Imp. from China*Non-OECD Exp. Inten. (continuous)				0.041	-2.888*	-3.189*
				(0.157)	(1.656)	(1.925)
Observations	15,290	15,290	15,290	15,290	15,290	15,290
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Non-OECD Exp. Inten.* Time FE	No	No	Yes	No	No	Yes
Product FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic (1st stage)		11.74	8.85		12.63	11.60
Kleibergen-Paap rk Wald F-statistic		5.51	4.15		5.89	5.41

Notes: Clustered standard errors in parentheses at the firm level, with ***,** ,* respectively denoting significance at the 1%, 5% and 10% levels. The instrument in columns (2),(3), (5) and (6) is $tariff\ Chn_p \times w_{f,p-2009}$, where $w_{f,p-2009}$ indicates the share of product p in firm's f total imports in 2009. The use of this instrument is because of the inclusion of product fixed effects.

Extensive Margin.

A lower tariff on Chinese intermediate inputs reduces the cost of the composite input w_l and the per-unit cost, c_l, increasing the profits of producing the low-quality variety and reducing the cut off for exporting to non-OECD countries, from ϕ_l to $\phi_l^{'}$. To test this prediction I estimate the following equation using a subset of firms that have been importing inputs for at least two years but have never exported before:

$$Pr(Export_{non\_OECD,f}) = F(Start\ China_f, FirmSize_f, Exp_{OECD,f}), \tag{12}$$

where the dependent variable, $Export_{non\_OECD,f}$, takes the value of 1 if firm f exports to a non-OECD country in period t or $t+1$ and 0 otherwise. $Start\ China_f$ is an indicator variable that takes the value of 1 if the firm started sourcing from China in period t or $t-1$ and 0 otherwise. $FirmSize_f$ is a proxy for a firm's productivity and is calculated using the maximum annual imported value of all inputs by the firm during the 2007-2013 sample. This is the best proxy for firm's productivity because the available information is limited to custom data.

The dataset for this regression contains three cohorts: 2011, 2012 and 2013. Each cohort includes firms that have been importing inputs from any destination, except China, for at least two years. Also, the dataset only includes firms that were not exporting before period $t-1$. Whether a firm starts exporting or starts importing from China, it only appears in one of the three cohorts to avoid double or triple counting.

According to the theoretical model, access to cheaper Chinese inputs allows firms to reduce their cost and start exporting. Empirically this implies a positive effect of $Start\ China_f$ on the probability of exporting to non-OECD countries. Columns (1) and (3) of Table (11) report OLS estimates of equation 12 using the indicator variable $Start\ China_f$. It also includes the share of imports from China when the firm starts to import from China, as a continuous measure of start sourcing from China. These results show that when a firm starts sourcing from China, there is a statistically significant positive impact on the probability of becoming an exporter.[40]

[40] I also estimate equation 12 using a logistic model and these results (not reported) are similar.

Table 11: **Extensive Margin and Access to Chinese Intermediate Inputs**
Dependent Variable: Start Exporting
Method of Estimation: Linear Probability Model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	(Prob exp. to non-OECD)				**(Prob exp. to OECD)**				**(Prob exp. to non-OECD | exporter)**			
	(OLS)	(IV)	(OLS)	(IV)	(OLS)	(IV)	(OLS)	(IV)	(OLS)	(IV)	(OLS)	(IV)
Start Sourcing from China [1 if starts]	0.022***	0.222*			0.018***	0.038			0.063	1.060**		
	(0.006)	(0.121)			(0.006)	(0.093)			(0.043)	(0.485)		
Start Sourcing from China (Share. of Int. Imp.)			0.021*	0.624*			0.011	0.173			0.109	4.364*
			(0.012)	(0.337)			(0.010)	(0.235)			(0.124)	(2.520)
Firm Size (logs)	0.014*	0.019**	0.013*	0.025***	0.022***	0.022***	0.021***	0.024***	-0.140*	-0.054	-0.145**	-0.143
	(0.007)	(0.008)	(0.007)	(0.010)	(0.007)	(0.007)	(0.007)	(0.008)	(0.074)	(0.136)	(0.074)	(0.141)
Firm Size Square (logs)	-0.000	-0.001**	-0.000	-0.001*	-0.001***	-0.001***	-0.001***	-0.001***	0.007**	0.002	0.007**	0.007
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.006)	(0.003)	(0.006)
Observations	9,232	9,232	9,232	9,232	9,232	9,232	9,232	9,232	622	622	622	622
2-digit FE Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic (1st stage)		20.11		14.92		20.11		14.92		8.11		4.50
Kleibergen-Paap rk Wald F-statistic		10.66		7.75		10.66		7.75		3.93		2.10

Notes: Robust standard errors in parentheses at the firm level, with ***,** ,* respectively denoting significance at the 1%, 5% and 10% levels. The instrument in columns (2), (4), (6),(8), (10) and (12) is the weighted average tariff of Chinese goods between $t-2$ and t of firm f, $Weighted\ tariff\ Chn_f$.

Endogeneity. The decision to start importing from China or from any other source is not random or exogenous to the firm's characteristics, i.e. the firm's productivity. Even though I use the firm size to reduce this possible source of endogeneity, I use the change in the weighted average tariff of Chinese goods between $t-2$ and t for each firm as an instrument:

$$Weighted\,tariff\ Chn_f = \sum_p w_{f,p} * \Delta tariff\ Chn_p$$

where the weights $w_{f,p}$ are defined as the proportion that each good represents in the firm's total imports at time $t-2$:

$$w_{f,p} = \frac{imports_{f,p,t-2}}{imports_{f,t-2}}.$$

Columns (2) and (4) of Table (11) report the IV estimates of equation 12. In both cases the parameter associated to $Start\ China_f$ is positive and statistically significant. According to the estimates reported in column (2), a non-exporting firm that starts sourcing intermediate inputs from China increases in 22 percent its chances of exporting to a non-OECD country for the first time. In the same line and based on estimates of column (4), a firm increases in 6.2 percent its chances of exporting to a non-OECD market when its proportion of intermediate inputs sourced from China in its total imported intermediate inputs increases in 10 percent.

In columns (5)-(8) I report the estimates of equation 12, but using $Export_{OECD,f}$ as a dependent variable. The idea is to verify that the access to Chinese intermediate inputs is not necessarily related with a higher probability of access to OECD markets. In fact, different from the IV estimates reported in column (2) and (4), the estimates in columns (6) and (8) suggest a positive but not statistically significant effect of buying intermediate inputs from China on the probability of exporting to OECD markets.[41]

Current Exporters to OECD countries. The model also predicts that the cut off for exporting both varieties at the same time decreases from $\phi_{l,h}$ to $\phi'_{l,h}$ after a reduction

[41] An alternative empirical strategy is a two-step estimator which in the first stage predicts whether or not a firm starts exporting and in the second stage predicts whether the exports are shipped to OECD or non-OECD countries or both. This implies to account for three possible cases in the second stage, suggesting the estimation of a multinomial-IV-heckman two stage estimator.

of the tariff on Chinese intermediate inputs. To formally test this prediction I estimate the following equation using a subset of firms which have been importing inputs for at least two years and exporting to OECD markets:

$$Pr(Export_{non\_OECD,f}) = F(Start\ China_f, FirmSize_f, exporter_{OECD} = 1). \qquad (13)$$

This equation is similar to equation 12, but the sample is conditioned on firms that have been exporting to OECD countries. The theoretical model predicts that access to cheaper Chinese intermediate inputs allow firms to reduce their cost of producing low-quality varieties and to start exporting them to non-OECD countries. Empirically, this implies a positive effect of $Start\ China_f$ on the probability of exporting to non-OECD countries. The IV estimate of equation 12 reported in columns (10) and (12) of Table (11) shows a positive and statistically significant effect of both variables: starting to source from China, $Start\ China_f$; and the share of imports from China when the firm starts to import from China, on the probability of becoming an exporter to a non-OECD country, given that the firm was already exporting to an OECD market. In particular, an estimate of 1.06 reported in column 10 implies that a firm exporting only to OECD markets increases in a 100 percent its probability of exporting to non-OECD markets for the first time when it starts sourcing from China. Nevertheless, the magnitude of this estimate and the one reported in column (12), 4.36, might be affected by the relative small sample size, 652 observations, and the relevance of the instrument for these regressions. The corresponding f-statistic of the first stage of both regressions are both lower than 10, which implies that the instrument might be not enough relevant in these regressions.[42]

2.5 Conclusion

In this chapter I find empirical evidence that the FTA subscribed between Peru and China changed Peruvian firms' relative demand for inputs sourced from non-OECD and OECD countries. Using firm-level data and the FTA as exogenous variation, I find that Peruvian firms bought fewer intermediate inputs from non-OECD countries relative to

[42] A rule of thumb is that the F-statistic should be above 10 (Stock et al. (2002)).

inputs imported from OECD countries when they imported intermediate inputs from China during 2009 and 2013. This substitution pattern was higher for Peruvian exporters that were selling mainly in non-OECD countries. Additionally, I also find evidence that exporters to OECD countries that started sourcing intermediate inputs from China had higher chances of exporting for the first time to non-OECD markets. Finally, there is also evidence that non-exporters started exporting to non-OECD countries once they started sourcing intermediate inputs from China. This research confirms the existence of heterogeneous responses across firms to a common policy shock.

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2.6 Appendix

2.6.1 Consumer demand

From the consumer maximization problem, the corresponding FOC are:

$$q(\omega_1)^{\frac{-1}{\sigma_K}} = \lambda p(\omega_1)$$

$$q(\omega_2)^{\frac{-1}{\sigma_K}} = \lambda p(\omega_2)$$

Dividing ($1a$) and ($2a$) and rearranging

$$q(\omega_1) = q(\omega_2)\left(\frac{p(\omega_1)}{p(\omega_2)}\right)^{-\sigma_K}$$

Multiplying the previous equation by $p(\omega_1)$ and taking the integral over varieties:

$$\int_{1\epsilon K} p(\omega_1)q(\omega_1)d(\omega_1) = \int_{1\epsilon K} p(\omega_1)q(\omega_2)d(\omega_1)\left(\frac{p(\omega_1)}{p(\omega_2)}\right)^{-\sigma_K}$$

where $\int_{1\epsilon K} p(\omega_1)q(\omega_1)d(\omega_1) = I_K$

$$I_K = q(\omega_2)p(\omega_2)^{-\sigma_K}\int_{1\epsilon K} p(\omega_1)^{1-\sigma_K}d(\omega_1)$$

Defining $\int_{1\epsilon K} p(\omega_1)^{1-\sigma_K}d(\omega_1) = {P_K}^{\sigma_K - 1}$ and generalizing for any variety (ω):

$$q(\omega) = p(\omega)^{-\sigma_K}{P_K}^{\sigma_K-1}I_K$$

2.6.2 Proposition 1

Using the demand for the 'composite' indexes Q_L^* and Q_H^*, I calculate the change in the relative consumption of both goods when there is an increase in the price index of the high-quality varieties.

$$\frac{\partial(\frac{Q_H^*}{Q_L^*})}{\partial P_H} = \frac{\gamma I_C + a(1-\gamma)P_L}{P_L(I_C - aP_L)(1-\gamma)} > 0$$

To calculate if this change in the relative consumption is decreasing in income, I take the derivative of the previous equation with respect to income:

$$\frac{\partial}{\partial I_C}\left(\frac{\partial(\frac{Q_H^*}{Q_L^*})}{\partial P_H}\right) = \frac{-a}{(I_C - aP_L)(1-\gamma)} < 0$$

2.6.3 Per-unit cost of the composite low-quality input w_l

From the firm's cost minimization problem:

$$Min : w_l = w_{l,non\_oecd}(l_{non\_oecd}) + w_{l,chn}(l_{chn})$$

s.t. $l = \left[(l_{non\_oecd})^{\frac{\sigma-1}{\sigma}} + (l_{chn})^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$

$$w_{l,non\_oecd} = \lambda\frac{\sigma}{\sigma-1}\left[(l_{non\_oecd})^{\frac{\sigma-1}{\sigma}} + (l_{chn})^{\frac{\sigma-1}{\sigma}}\right]^{\frac{1}{\sigma-1}}\frac{\sigma-1}{\sigma}(l_{non\_oecd})^{\frac{-1}{\sigma}}$$

$$w_{l,chn} = \lambda\frac{\sigma}{\sigma-1}\left[(l_{non\_oecd})^{\frac{\sigma-1}{\sigma}} + (l_{chn})^{\frac{\sigma-1}{\sigma}}\right]^{\frac{1}{\sigma-1}}\frac{\sigma-1}{\sigma}(l_{chn})^{\frac{-1}{\sigma}}$$

$$l_{chn} = (\frac{w_{l,non\_oecd}}{w_{l,chn}})^{\sigma} l_{non\_oecd}$$

and replacing this in the production function:

$$l_{non\_oecd} = l[(w_{l,non\_oecd})^{-\sigma}]\left[(w_{l,non\_oecd})^{1-\sigma} + (w_{l,chn})^{1-\sigma}\right]^{\frac{\sigma}{1-\sigma}}$$

$$l_{chn} = l[(w_{l,chn})^{-\sigma}]\left[(w_{l,non\_oecd})^{1-\sigma} + (w_{chn})^{1-\sigma}\right]^{\frac{\sigma}{1-\sigma}}$$

replacing this in the cost function:

$$\begin{aligned} w_{l,non\_oecd}l_{non\_oecd} + w_{l,chn}l_{chn} = l[(w_{l,non\_oecd})^{1-\sigma}]\left[(w_{l,non\_oecd})^{1-\sigma} + (w_{l,chn})^{1-\sigma}\right]^{\frac{\sigma}{1-\sigma}} \\ + l[(w_{l,chn})^{1-\sigma}]\left[(w_{l,non\_oecd})^{1-\sigma} + (w_{chn})^{1-\sigma}\right]^{\frac{\sigma}{1-\sigma}} \end{aligned}$$

then the per-unit cost of a composite low-quality input,w_l, is :

$$w_l = \frac{w_{l,non\_oecd} l_{non\_oecd} + w_{l,chn} l_{chn}}{l} = \left[(w_{l,non\_oecd})^{1-\sigma} + (w_{l,chn})^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$$

2.6.4 Proposition 2.a

The cross elasticity of h_i with respect to $w_{l,chn}$ is defined by:

$$\frac{\partial h_i}{\partial w_{l,chn}} \frac{w_{l,chn}}{h_i} = [\frac{\partial (\frac{\partial c_i}{\partial w_h})}{\partial w_{l,chn}}] \frac{w_{l,chn}}{\frac{\partial c_i}{\partial w_h}}$$

I recover the factor demand h_i using the Shepard's lemma:

$$h_i = \frac{\partial c_i}{\partial w_h} = \left[\left(\frac{\left[(w_{l,non\_oecd})^{1-\sigma} + (w_{l,chn})^{1-\sigma} \right]^{\frac{1-\sigma_i}{1-\sigma}}}{\alpha_{l,i}^{1-\sigma i}} \right) + \frac{w_h}{\alpha_{h,i}} \right]^{\frac{\sigma_i}{1-\sigma_i}} (\frac{1}{\alpha_{h,i}})^{1-\sigma_i} w_h^{-\sigma_i}.$$

Therefore, the corresponding elasticities $\varepsilon_{h_i, w_{l,chn}}$ and $\varepsilon_{l_{non\_oecd,i}, w_{l,chn}}$ are, respectively:

$$\varepsilon_{h_i, w_{l,chn}} = \left[\frac{(w_{l,chn})^{1-\sigma} \left[(w_{l,non\_oecd})^{1-\sigma} + (w_{l,chn})^{1-\sigma} \right]^{\frac{1-\sigma_i}{1-\sigma}}}{\left[(w_{l,non\_oecd})^{1-\sigma} + (w_{l,chn})^{1-\sigma} \right]^{\frac{1-\sigma_i}{1-\sigma}} + w_h^{1-\sigma_i}} \right] \sigma_i$$

and

$$\varepsilon_{l_{non\_oecd,i}, w_{l,chn}} = \left[\frac{(w_{l,chn})^{1-\sigma} \left[(w_{l,non\_oecd})^{1-\sigma} + (w_{l,chn})^{1-\sigma} \right]^{\frac{1-\sigma_i}{1-\sigma}}}{\left[(w_{l,non\_oecd})^{1-\sigma} + (w_{l,chn})^{1-\sigma} \right]^{\frac{1-\sigma_i}{1-\sigma}} + w_h^{1-\sigma_i}} \right] \sigma_i - \frac{(w_{l,chn})^{1-\sigma} (\sigma_i - \sigma)}{(w_{l,non\_oecd})^{1-\sigma} + (w_{l,chn})^{1-\sigma}}.$$

2.6.5 Proposition 2.b

$$\varepsilon_{c_i, w_l} = (\frac{\partial c_i}{\partial_{w_l}}) \frac{w_l}{c_i} = \frac{(\frac{w_l}{\alpha_{l,i}})^{1-\sigma_i}}{(\frac{w_l}{\alpha_{l,i}})^{1-\sigma_i} + (\frac{w_h}{\alpha_{h,i}})^{1-\sigma_i}}$$

The composite input-cost elasticity with respect to the price of l_{chn} is:

$$\varepsilon_{w_l, w_{l,chn}} = \frac{\partial w_l}{\partial_{w_{l,chn}}} \frac{w_{l,chn}}{w_l} = \frac{{w_{l,chn}}^{1-\sigma}}{(w_{l,non\_oecd})^{1-\sigma} + (w_{l,chn})^{1-\sigma}}$$

Then the cost-elasticity of the variety q_i with respect to the price of input $w_{l,chn}$ is:

$$\varepsilon_{c_i,w_{l,chn}} = \varepsilon_{c_i,w_l} * \varepsilon_{w_l,w_{l,chn}} = \frac{{w_{l,chn}}^{1-\sigma}}{(w_l)^{1-\sigma_i} + (w_h \frac{\alpha_{l,i}}{\alpha_{h,i}})^{1-\sigma_i}}$$

and replacing w_l in the previous equation:

$$\varepsilon_{c_i,w_{l,chn}} = \frac{{w_{l,chn}}^{1-\sigma}}{(w_{l,non\_oecd})^{1-\sigma} + (w_{l,chn})^{1-\sigma} + (w_h \frac{\alpha_{l,i}}{\alpha_{h,i}})^{1-\sigma_i}} \tag{14}$$

Then, a reduction of $w_{l,chn}$ has a larger impact in the production of the low-quality variety. The elasticty $\varepsilon_{c_L,w_{l,chn}}$ is larger than $\varepsilon_{c_H,w_{l,chn}}$, since by assumption $|\sigma_H| < |\sigma_L|$, then, even for the case where $\frac{\alpha_{l,H}}{\alpha_{h,H}} = \frac{\alpha_{l,L}}{\alpha_{h,L}} = 1$:

$$(w_h \frac{\alpha_{l,H}}{\alpha_{h,H}})^{1-\sigma_H} > (w_h \frac{\alpha_{l,L}}{\alpha_{h,L}})^{1-\sigma_L}$$

and replacing this in equation (14) shows that:

$$\varepsilon_{c_L,w_{l,chn}} > \varepsilon_{c_H,w_{l,chn}}$$

intuitively, a reduction in a tariff for Chinese inputs, τ_{chn}, makes firms substitute inputs from China for inputs previously imported from Non-OECD countries, but this substitution is higher in the production of the low-quality variety, L.

2.6.6 Producer's optimal quantities of low and high-quality varieties

$$\begin{aligned}\Pi(\varphi) = &\left(p_L(\omega) - (1+\tau_L)\frac{c_L}{\varphi}\right)p_L(\omega)^{-\sigma_K}{P_L}^{\sigma_K-1}I_L \\ &+\left(p_H(\omega) - (1-\tau_H)\frac{c_H}{\varphi})\right)p_H(\omega)^{-\sigma_K}{P_H}^{\sigma_K-1}I_H \\ &-F_L - F_H - F - \Phi(\varphi)F_L F_H,\end{aligned}$$

From first order conditions of the previous equation with respect $p_L(\omega)$ and $p_H(\omega)$, respectively:

$$p^*_L(\omega) = \frac{\sigma_K(1+\tau_L)}{\sigma_K - 1}\frac{c_L}{\varphi}$$

$$p^*_H(\omega) = \frac{\sigma_K(1+\tau_H)}{\sigma_K - 1}\frac{c_H}{\varphi}$$

and replacing them in the consumer's demand for low and high-quality varieties, I have:

$$q_{_L}^*(\omega) = \left(\frac{\sigma_K(1+\tau_L)}{\sigma_K - 1} \frac{c_{_L}}{\varphi} \right)^{-\sigma_K} {P_{_L}}^{\sigma_K - 1} I_{_L}$$

$$q_{_H}^*(\omega) = \left(\frac{\sigma_K(1+\tau_H)}{\sigma_K - 1} \frac{c_{_H}}{\varphi} \right)^{-\sigma_K} {P_{_H}}^{\sigma_K - 1} I_{_H}$$

where $I_{_L} = \gamma I + a(1-\gamma)$ and $I_{_H} = (I - aP_{_L})(1-\gamma)$.

Table 12: List of Countries

OECD Countries			
Australia	France	Korea, Rep.	Slovenia
Austria	Germany	Luxembourg	Spain
Belgium	Greece	Mexico	Sweden
Canada	Hungary	Netherlands	Switzerland
Chile	Iceland	New Zealand	Turkey
Czech Republic	Ireland	Norway	United Kingdom
Denmark	Israel	Poland	United States
Estonia	Italy	Portugal	
Finland	Japan	Slovak Republic	

Non-OECD Countries			
Albania	El Salvador	Macao	Singapore
Argentina	Eritrea	Malaysia	Solomon Islands
Bangladesh	French Polynesia	Micronesia, Fed. Sts.	South Africa
Bhutan	Guam	Morocco	Sri Lanka
Bolivia	Guatemala	Nicaragua	Thailand
Brazil	Guinea-Bisau	Pakistan	Tonga
Bulgaria	Honduras	Panama	Trinidad and Tobago
Cambodia	India	Papua New Guinea	Tunisia
Colombia	Indonesia	Paraguay	Tuvalu
Comoros	Iran, Islamic Rep.	Puerto Rico	Ukraine
Costa Rica	Kiribati	Qatar	United Arab Emirates
Croatia	Korea, Dem Rep.	Romania	Uruguay
Djibouti	Lao PDR	Russian Federation	Vanuatu
Dominican Republic	Latvia	Rwanda	Venezuela
Ecuador	Liechtenstein	Samoa	Yemen, Rep.
Egypt, Arab Rep.	Lithuania	Saudi Arabia	

Chapter 3: Contractual Imperfections and the Impact of Crises on Trade

Co-authored with Jorge Salas, University of Maryland.

3.1 Introduction

Recent papers document the negative impact of crises on international trade. For example, Abiad et al. (2014) find empirically that financial crises are associated with significant declines in exports to the crisis country. In this research, we argue that contractual imperfections are important to understand the causality between crises and trade disruptions. Our main finding is that exports to destinations in crisis are disproportionately affected in industries that are more contractually vulnerable. In this way, we provide evidence on a new mechanism that has been thus far ignored in the existing literature on crises and trade.

We first propose a simple model of trade to explain the relevance of industries' contractual dependence during crises.[43] Our theory builds on the intuition that when international transactions are arranged in post shipment terms (i.e., exporters are paid by importers after delivery of the goods), the risk of default of importers matters (Schmidt-Eisenlohr, 2013). Importers are presumably less likely to honor their contracts when the state of their country's economy is weak—as would be the case if the economy were hit by a recession or if it entered into a financial crisis. But the probability of repayment under post shipment terms can also be affected by industry-specific characteristics. In particular, when goods are more complex and/or customized, contracts that involve them become harder to verify in court.[44] Therefore exporters in some industries are more contractually vulnerable than in others. We then show that when an importing country suffers an adverse aggregate shock, a complementarity between contract enforcement at the country level and contract dependence at the industry level gives rise to a larger de-

[43] Along this chapter we use the expressions "contractual vulnerability" and "contractual dependence" interchangeably.

[44] Some important references in the literature on incomplete contracts include Williamson (1979), Williamson (1985), Grossman and Hart (1986), and Hart and Moore (1999). See Berkowitz et al. (2006) for an early study of the relationship between product complexity, contracting institutions, and trade.

cline in imports in more contractually vulnerable industries. This is our key theoretical insight.

Using disaggregated bilateral trade data, we quantify the importance of contractual dependence at the industry level during crises. Our empirical approach exploits the variation in the occurrence of recessions, or alternatively, financial crises across 118 importing countries from 1989 to 2000, and the variation in contractual vulnerability across (up to) 351 SIC manufacturing industries. We confirm the negative average effects of crises on trade flows found in previous papers, but we also show that trade declines disproportionately in more contract-dependent industries. These sectoral effects are statistically and economically significant. This finding constitutes the central contribution of this research.

According to one of our estimates, a recession is associated with a 6.1% larger drop in imports in an industry that is highly contract dependent relative to an industry that exhibits little dependence. To put this result in perspective, we find that the *average* impact of a recession on sectoral imports is close to −10%, while the analogous estimate in the case of a financial crisis is nearly −6%.[45]

Our main empirical findings are robust to the following exercises: (i) extending the sample period since 1980, (ii) controlling for industry measures of financial vulnerability, and (iii) controlling for industry measures of cyclicality (or durability). We also show that in countries with lower institutional quality (proxied by the rule of law) the amplification effect of contractual vulnerability on sectoral imports is greater. In addition, we report that conditional on a crisis in the importing country, a longer distance between trading partners further magnifies the trade effects of contractual imperfections.

We use three industry measures of contractual vulnerability. Two of them are standard in the literature. The first one is the Nunn (2007) index of contract-intensity of goods, measured by the value share of inputs that Nunn identifies as relationship-specific. Levchenko (2007) provides us with a second indicator, which he constructs as an index of input-use concentration. Levchenko explicitly points out that his index represents a measure of product complexity; in our research, as in Krishna and Levchenko (2012) and Hoefele et al. (2013), we make a similar assumption in terms of the Nunn index.

[45]Our definition of recessions is based on the methodology of Braun and Larrain (2005) and our definition of financial crises relies on Laeven and Valencia (2013).

We introduce an additional novel measure of contractual vulnerability, which we call the "uncollectible index". By quantifying the share of total account receivables uncollected compared to what was available to collect in a given period, the uncollectible index directly reflects payment defaults in business-to-business transactions. We obtain the data to construct this indicator from the National Summary of Domestic Trade Receivables, a proprietary quarterly survey of large U.S. firms. Our results are robust to the use of the Nunn, the Levchenko, and the uncollectible indices.

This research is related to the literature on the impact of financial crises and recessions on trade (Abiad et al., 2014; Bems et al., 2013; Berman et al., 2012; Bricongne et al., 2012; Chor and Manova, 2012; Eaton et al., 2011; Levchenko et al., 2010). A large part of this literature analyzes the so-called Great Trade Collapse of 2008-09. These papers have documented the role of several mechanisms, such as composition effects, protectionism, supply chains, credit constraints, and exchange rate dynamics. Our work contributes to this literature by emphasizing a new mechanism—contractual imperfections—that helps explain the important effects of crises on trade, and the heterogeneous impact across industries.

Our theoretical mechanism heavily relies on the role of default risk in trade. Other recent papers also study the implications of importers' repayment probability, but they mainly focus on a different problem, namely how this risk affects the choice of financing terms that support international trade (Ahn, 2014; Antràs and Foley, forthcoming; Hoefele et al., 2013; Schmidt-Eisenlohr, 2013).

Finally, this chapter is connected to the literature on contracting institutions and trade (see Antràs, 2015 and Nunn and Trefler, 2014 for comprehensive reviews). The bulk of this research has studied the relationship between domestic institutions and comparative advantage; Nunn (2007) and Levchenko (2007) constitute seminal contributions to that literature. Our use of the contractual-vulnerability indices introduced in those two papers to analyze the effects of crises on trade is new relative to previous work.

3.2 A simple framework of trade and contractual imperfections

To fix ideas, we propose a static, partial equilibrium model of trade. The model incorporates contractual frictions in a reduced-form way, which reflect contracting imperfections affecting the outputs produced by different industries. We then use the model to derive our main testable implications.[46]

3.2.1 Setup

Basic assumptions. Our framework is in line with the traditional monopolistic competition models of trade. In each country, a continuum of firms produce differentiated goods in multiple industries (sectors), indexed by s, using labor (supplied inelastically). A numeraire sector produces a freely-traded homogeneous good under constant returns to scale. Relative wages are pinned down by productivity in this numeraire sector. Preferences are identical across countries and are described by a Cobb-Douglas utility function. For country i, the utility function is $U_i = \prod_s C_{is}^{\mu_s}$, defined over CES consumption indices $C_{is} = \left(\int_{\Omega_{is}} x_{is}(\omega)^{(\sigma-1)/\sigma} d\omega\right)^{\sigma/(\sigma-1)}$, where ω is a variety, Ω_{is} is the set of available varieties, $\sigma > 1$ is the elasticity of substitution, and μ_s is the sectoral expenditure share.

Production technology in the differentiated sectors exhibits increasing returns to scale. A firm from sector s in country e that sell x_{eis} units of a good to an importer in country i faces the cost function $\frac{w_e}{\tau_{ei}} x_{eis} + f_{ei}$, where w_e is the wage rate, $\tau_{ei} > 1$ is an iceberg trade cost, and f_{ei} is a fixed cost in units of the numeraire.

Post shipment payment. We assume that exporters are risk neutral and use open account contracts, meaning that they are paid by importers after delivery of the goods. (Importers can be thought as wholesalers who sell to domestic consumers.) Using trade data at the transaction level, Antràs and Foley (forthcoming) (U.S.) and Ahn (2014) (Chile and Colombia) show that in terms of payment methods, open account contracts comprise the majority of international transactions, both by number and by value. Asmundson et al. (2011) report a similar finding for worldwide trade based on survey data.[47]

Contractual frictions. Importers in country i are assumed to honor their contractual obligations (i.e., pay in full and on time to exporters) with probability λ_i. We assume that this probability increases with aggregate real expenditure in the importing country, Y_i. That is, λ_i is procyclical: $\lambda_i = \lambda(Y_i)$, with $\lambda'(Y_i) \equiv \frac{\partial \lambda_i}{\partial Y_i} > 0$.

[46] For simplicity the model is written in terms of final goods, but its key implications can be generalized for transactions involving intermediate inputs as well.

[47] Payment under open account terms typically occurs between one and three months after the goods arrive to the importer's location.

A simple way to interpret this assumption is that in the wake of an adverse aggregate demand or financial shock in country i, some importing firms become insolvent or illiquid and are be unable to pay in full and/or on time. In support of this argument, Mora and Powers (2011) document the increased perception of counterparty risk among international traders during the 2008 financial crisis, evidenced by the fact that exporters raised their demand for low-risk financing. Similarly, Auboin and Engemann (2014) use a comprehensive database of export credit insurance covering 91 countries and find that the risk of international trade, as proxied by claims paid on insured credit extended to finance overseas transactions, steadily increased during the acute phase of the 2008 crisis. Additionally, Jacobson et al. (2013) use data on Swedish businesses and document that the output gap is a good predictor of firm insolvency.

In the context of models of trade financing terms, Schmidt-Eisenlohr (2013) and Antràs and Foley (forthcoming) propose a related setup in which λ_i represents instead a structural index of quality of contracting institutions in country i. In one of our empirical exercises below, we take that modeling approach into account by dividing our sample of importing countries into two groups: countries with weak and strong rule of law.

We also assume that contract enforcement has an additional industry-specific dimension, captured by the index $z_s \in [0, 1]$. A higher value of z_s implies that the good s is more *contract dependent*, in the sense that is more complex and hence more sensitive to imperfect contracting. Intuitively, complex goods require a high share of relationship-specific inputs and often involve customization. Moreover, the quality of a complex good can be difficult to verify in court. Importers of this type of goods are thus more likely to renege on the initial contract due to disagreement on the quality of the delivered products.[48]

As in Hoefele et al. (2013), we assume a complementarity between contract enforcement at the importing-country level and contract dependence at the industry level. In particular, we assume that the probability of enforcement in country i and sector s is given by $\overline{\lambda_{is}} = \lambda_i^{z_s}$. For a certain λ_i, higher values of z_s associated with more complex goods imply a lower effective probability of contract enforcement in country i. For the

[48]According to Boissay and Gropp (2013), a typical trade credit insurance contract covers against defaults due to insolvency, but not due to disagreement. In their analysis of trade credit defaults among French firms, Boissay and Gropp (2013) document that the most prevalent reason for defaulting on trade credit is disagreement, followed by illiquidity and insolvency.

least contract dependent product, $z_s = 0$, the importer in country i honors the contract with probability $\overline{\lambda_{is}} = 1$.[49]

The exporter's problem. An exporter in country e and sector s maximizes her expected profits from selling to country i, which are given by:

$$\pi_{eis} = \overline{\lambda_{is}} p_{eis} x_{eis} - w_e \tau_{ei} x_{eis} - f_{ei} \tag{15}$$

Since exporters recognize the risk of default, they will choose a price that is incentive compatible. Following Antràs and Foley (forthcoming), equation (15) assumes that importers have no wealth and are protected by limited liability, so that they cannot pay beyond the market value of the purchased goods.

The exporter decides on the optimal price p_{eis}, taking as given the demand for her varieties, $x_{eis} = \left(\frac{p_{eis}}{P_{is}}\right)^{-\sigma} \frac{\mu_s P_i Y_i}{P_{is}}$, where Y_i, P_i and $P_{is} = \left(\int_{\Omega_{is}} p_{is}(\omega)^{1-\sigma} d\omega\right)^{1/(1-\sigma)}$ are specific to the importer's country, and represent aggregate real expenditure (or, with balanced trade, real GDP), the overall consumer price index, and the price index in sector s, respectively. We treat Y_i, P_i and P_{is} as exogenous and solve for the optimal sectoral export price and quantity decisions in partial equilibrium.

3.2.2 Main theoretical predictions

In equilibrium, the export value in sector s is given by:

$$p_{eis} x_{eis} = \left[\frac{\sigma}{\sigma - 1} \frac{1}{\overline{\lambda_{is}}} w_e \tau_{ei}\right]^{1-\sigma} \frac{\mu_s P_i Y_i}{P_{is}^{1-\sigma}} \tag{16}$$

Equation (16) shows that the export value is a function of standard variables (constant markup over marginal cost, relative price, and sectoral expenditure), but is also an increasing function of the probability of contract enforcement $\overline{\lambda_{is}}$. Intuitively, the riskiness of the transaction acts as wedge on the price, and this wedge increases when the exporter is more likely to face a default. Therefore, the lower $\overline{\lambda_{is}}$, the higher is the optimal price

[49] Hoefele et al. (2013) and Demir and Javorcik (2014) find empirically that for a given quality of institutions in the importing country, more complex goods are less likely to be exported on open account terms, and more likely to be exported on cash in advance or bank-intermediated terms. Yet, using detailed exports data, Ahn (2014) (Chile and Colombia) and Demir and Javorcik (2014) (Turkey) report that the share of complex goods traded on open account terms is very high—around 70 to 80 percent.

p_{eis} and the lower is the quantity exported to country i, x_{eis}. The model thus predicts that for a given industry s, a "crisis" in country i (represented by a decline in Y_i) reduces the export value to that country, $p_{eis}x_{eis}$, because of the assumed procyclical movement of λ_i (and hence of $\overline{\lambda_{is}}$; first term in equation (16)). This mechanism works on top of a direct demand effect (second term in (16)).

Furthermore, the impact of a crisis in the importing country on $p_{eis}x_{eis}$ is amplified in more contract-dependent industries. Formally, consider the effect of the industry measure of contractual vulnerability z_s on the export value response to a decline in Y_i. The elasticity of the sectoral export value with respect to Y_i is:

$$\varepsilon_{px,s} \equiv -\frac{\partial p_{eis}x_{eis}}{\partial Y_i}\frac{Y_i}{p_{eis}x_{eis}} = (1-\sigma)\, z_s \frac{\lambda'(Y_i)Y_i}{\lambda_i} - 1 \tag{17}$$

Since $1-\sigma < 0$, equation (17) shows that $\varepsilon_{px,s} < 0$. The first term on the right-hand side of (17) again indicates that sectoral exports fall as macroeconomic conditions in the destination country i deteriorate and the country-specific probability of contract enforcement λ_i decreases. But crucially, a higher value of z_s magnifies the decline in exports in industry s to country i. This prediction constitutes our main testable implication. Meanwhile, the second term on the right-hand side of (17) implies a unit demand elasticity, common to all industries, which naturally follows from our CES demand assumption.

In the absence of firm or consumer heterogeneity, the predictions of the model are directly applicable to country-industry trade flows.

3.3 Empirical strategy

In this subsection we explain our empirical methodology and describe the data to be used in the regression analysis. The sources of all of our data are summarized in Table 13.

3.3.1 Methodology

We estimate the following equation to test the hypothesis that the negative trade effects of a crisis in the destination country are amplified in industries with higher contractual

Table 13: **Data sources**

Trade and country-level data	
Variable	**Source**
World export and import data	The Center for International Data
US export data	The Center for International Data
World export price index	IFS database
Real GDP in US Dollars	WDI database
Bilateral real exchange rate	Penn World Table 8.1
Free trade agreements	de Sousa (2012)
Bilateral geographic distance	CEPII distance database
Private credit to GDP ratio	Financial Development and Structure database
Rule of law	Worldwide Governance Indicators database
Banking crisis dates	Laeven and Valencia (2013)
Sovereign debt crisis dates	Laeven and Valencia (2013)

Industry data	
Variable	**Source**
Complexity index	Chor (2010) (based on Nunn, 2007)
Concentration index	Chor (2010) (based on Levchenko, 2007)
Collection Effectiveness Index	Credit Research Foundation
External finance	Compustat (based on Rajan and Zingales, 1998)
Cash conversion cycle	Compustat
Asset tangibility	Compustat (based on Braun, 2003)
Cyclicality	Durability classification by Gomes et al. (2009)

vulnerability:

$$\begin{aligned} lnX_{eist} = \alpha_1 Crisis_{it} + \alpha_2 Crisis_{it} \times z_s + \\ \beta \Upsilon_{it} + \delta \Theta_{et} + \varphi \Psi_{eit} + \gamma_{eis} + \gamma_t + \varepsilon_{eist}, \end{aligned} \tag{18}$$

where lnX_{eist} represents the log of exports of country e to the importing country i in industry s at time t. $Crisis_{it}$ is an indicator variable that takes the value of 1 if the importing country suffers a recession (or alternatively, a financial crisis) and 0 otherwise. In line with the model, we expect the coefficient associated with this variable to be negative ($\alpha_1 < 0$). This coefficient captures the average effect of a crisis on industry exports to the crisis country.

We also add an interaction term of $Crisis_{it}$ with z_s, an index that represents the degree of contractual vulnerability of industry s, to identify the possible amplification effect of a crisis in industries with higher contractual vulnerability. Our model's key prediction is that the coefficient associated with this interaction term is negative ($\alpha_2 < 0$). That is, imports of the crisis country decline disproportionately in more contract-dependent industries. We identify α_2 by relying on the variation of contractual vulnerability across industries, and the occurrence (or not) of crises in importing countries across years.

Additionally, equation (18) includes a first set of control variables, Υ_{it}, that contains the log of real GDP (as a proxy for market size) and the degree of financial development of the importing country. A second set of controls, Θ_{et}, includes the log of real GDP and the degree of financial development of the exporting country. The final set of controls, Ψ_{eit}, includes the log of the bilateral real exchange rate and a dummy variable that captures whether the trading partners have a free trade agreement at time t.

We add proxies for financial development in the estimating equation for three reasons. First, financing conditions at the country level affect decisions on trade finance terms (e.g., using open account or cash in advance), as documented in Antràs and Foley (forthcoming) and Hoefele et al. (2013). Second, trade is intensive in working capital, and as such it depends on financial conditions (Manova, 2013). Third, financial development might reflect to some extent the general contractual environment.[50] The regression also includes an interaction term of financial development of both the exporting and importing country, under the consideration that the less financial developed the exporting country is, the higher may be the relevance of the importing country as a source of financing for trade, and vice versa.

Equation (18) also includes fixed effects at the exporter-importer-industry level, γ_{eis}, and at the year level, γ_t. The inclusion of γ_{eis} in equation (18) accounts for the time-invariant bilateral characteristics such as distance, common language, contiguity or colonial links, and any specific relationship between any pair of trading partners at the industry level.[51] Additionally, γ_{eis} also accounts for the time-invariant component of multilateral trade resistance effects (Anderson and van Wincoop, 2003). Finally, γ_t capture factors that affect all countries in the same period, such a global recessions or changes in commodity prices. We compute clustered standard errors at the importing country-year level.

3.3.2 Data

Country-industry trade flows. We use annual data on bilateral trade flows obtained from the Feenstra et al. (2005) World Trade Flows database. These data are originally

[50] Measures of contractual enforcement at the country level are typically unavailable for a wide range of countries *and* for a long span of years. Some indicators included in the International Country Risk Guide may constitute an exception, but unfortunately these data are not publicly available.

[51] By specific relationship we mean, for example, a situation in which the exporter may not be not selling exactly the same product to every destination, or using the same payment method to sell a product across different destinations (to the extent that payment methods remain relatively stable over time).

organized by the 4-digit Standard International Trade Classification (SITC), Revision 2. Since our key industry variables are constructed for 4-digit U.S. Standard Industrial Classification (SIC) industries, we convert the trade data to this format by replicating the concordance method from Cuñat and Melitz (2012).[52]

Our sample excludes zero trade flows, nonmanufacturing industries, and the oil sector represented by the SIC code 2911. We deflate the export flows (originally reported in current U.S. dollars) by using the world export price index from the International Financial Statistics database. The results presented below, however, are robust to using nominal trade values instead of real ones. Our final sample covers the period 1989-2000 and it includes 127 exporting countries, 118 importing countries, and (in most of our regressions) 351 SIC industries.[53] We show a list of the countries included in the sample in Table 14.

Table 14: **List of countries**

Albania	Czech Republic	Kenya	Portugal
Angola	Denmark	Korea, Rep.	Russian Federation
Argentina	Dominican Republic	Kuwait	Rwanda
Armenia	Ecuador	Kyrgyz Republic	Saudi Arabia*
Australia	Egypt, Arab Rep.	Lao PDR	Senegal
Austria	El Salvador	Latvia	Singapore
Azerbaijan	Equatorial Guinea	Lithuania	Slovak Republic
Bahamas *	Estonia*	Macao*	Slovenia*
Bahrain*	Ethiopia	Madagascar	South Africa
Bangladesh	Fiji	Malawi	Spain
Barbados	Finland	Malaysia	Sri Lanka
Belarus	France	Mali	St. Kitts and Nevis*
Belgium	Gabon	Malta*	Sudan
Belize	Gambia	Mauritania	Suriname
Benin	Georgia	Mauritius	Sweden
Bolivia	Germany	Mexico	Switzerland
Brazil	Ghana	Moldova	Syrian Arab Republic
Bulgaria	Greece	Mongolia	Tanzania
Burkina Faso	Guatemala	Morocco	Thailand
Burundi	Honduras	Mozambique	Togo
Cambodia	Hong Kong	Nepal	Trinidad and Tobago
Cameroon	Hungary	Netherlands	Tunisia
Canada	Iceland	New Zealand	Turkey
Central African Republic	India	Niger	Uganda
Chad	Indonesia	Nigeria	Ukraine
China	Iran, Islamic Rep.	Norway	United Kingdom
Colombia	Ireland	Pakistan	United States
Congo, Rep.	Israel	Panama	Uruguay
Costa Rica	Italy	Paraguay	Vietnam
Cote d'Ivoire	Japan	Peru	Yemen, Rep.
Croatia *	Jordan	Philippines	Zambia
Cyprus	Kazakhstan	Poland	

Notes: An asterisk (*) indicates countries that appear in the sample only as exporters.

Recessions and financial crises. We identify crisis periods in importing countries as

[52] We add up the value of disaggregated 10-digit Harmonized System (HS) U.S. annual exports for the period 1989-2000, using the dataset constructed by Feenstra et al. (2002). Since this dataset includes a concordance between HS, SITC and SIC categories, we are able to derive concordance weights to map the SITC codes into SIC categories. A similar procedure is also employed in Chor (2010).

[53] The endpoint in our sample period is determined by data availability, as the World Trade Flows database is constructed until the year 2000. We start the analysis in 1989 because our concordance method relies on the SITC to SIC-87 mapping that is readily available in the Feenstra et al. (2002) dataset only since 1989 (see footnote 52). Our sample captures several clusters of recessions and crises during the 1990s, as detailed below. We also report a sensitivity analysis using data since 1980.

years when these countries experience either recessions or financial crises. In line with the spirit of the theoretical model, we think of these events as periods of increasing importers' risk of default.

We use real GDPs (obtained from the World Development Indicators database) and the methodology of Braun and Larrain (2005) to construct indicators for recessions. A recession in a given country is defined following a peak-to-trough criterion—a trough occurs when cyclical GDP is more than one standard deviation below zero; a local peak associated with a trough is a year in which cyclical GDP is higher than in both the previous and the posterior years.[54] We checked that our results are not affected by using other definitions of recessions, such as years of negative GDP growth rates.

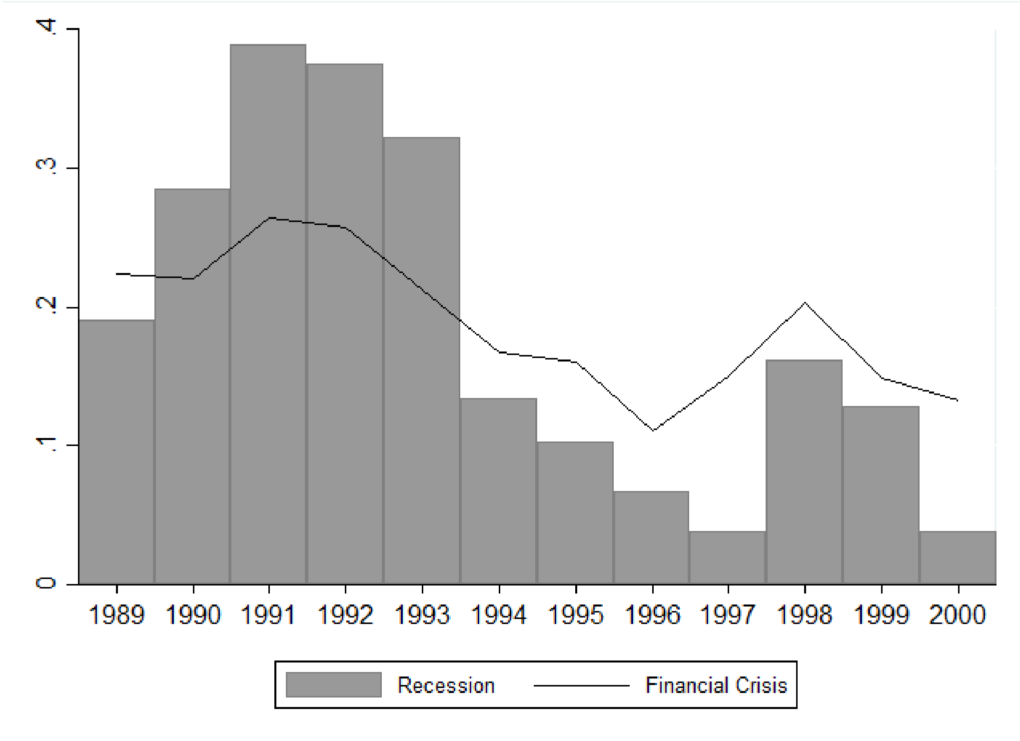
We also define an indicator for financial disruptions. Following Abiad et al. (2014), we identify financial crisis episodes as periods of banking or sovereign debt crises, based on the Laeven and Valencia (2013) database that covers 129 countries from 1970 to 2011. Laeven and Valencia's objective criteria to define a systemic banking crisis are: (i) significant signs of distress in the banking sector, such as liquidations, losses, and/or bank runs; and (ii) significant banking policy intervention measures in response to losses in the banking system. Laeven and Valencia also report sovereign debt crises as episodes of sovereign debt default and/or restructuring. Importantly, their data shows a marked increase in the number of crises during the 1990s, a period that we fully cover in our analysis.[55]

Of the 118 importing countries in our sample, 78 (63) suffered a recession (financial crisis) at some point between 1989 and 2000. The mean duration of a recession is close to 2 years, and the mean duration of a financial crisis is almost 4 years. As depicted in Figure 20, the share of our observations characterized by a recession reaches a peak of 40% in the early 1990s, while the maximum share of financial crisis episodes in our sample period is around 25%. Not surprisingly, the graph also reveals a close comovement over time between the occurrence of recessions and financial crises, although the share of recessions in any given year is greater than that of financial crises.

[54] The cyclical component of GDP is computed using the Hodrick-Prescott filter with a lambda parameter value of 6.25 (Ravn and Uhlig, 2002). Whenever available, the cyclical component of GDP is constructed using data from 1960 to 2012.

[55] Countries of different levels of income experienced financial crises during the 1990s (e.g., Sweden, Malaysia, Mexico, Indonesia, and Kenya). Other spikes in the number of crises (which are not covered by our sample period) are found in the early 1980s and during the Great Recession, particularly in 2008.

Figure 20: **Share of observations with crises, by year**



Notes: Recessions are identified using the Braun and Larrain (2005) methodology. Financial crises are identified as banking or sovereign debt crises, using the Laeven and Valencia (2013) dataset.

Contractual vulnerability across industries. We need to identify industry measures of contractual vulnerability as proxies for the industry-specific components of contract enforcement described in the model.[56] We first follow the literature and use the Nunn (2007) and Levchenko (2007) indices. These are available for our desired level of sectoral disaggregation and are constructed with U.S. data. As is standard in related papers, we assume that the ranking of industries remains quite stable across countries. This is a plausible assumption to the extent that both of these indices reflect technological factors.[57]

Nunn (2007) aims to measure the contract intensity of industries, which he defines as the fraction of an industry's intermediate inputs that are relationship-specific (i.e., that are either not traded on an organized exchange or for which no reference price exists). A higher value of the Nunn (2007) index reflects a higher degree of an industry's sensitivity

[56]To our knowledge, there are no publicly available comprehensive datasets on firm defaults on international transactions for disaggregated industries.

[57]We thank Davin Chor for kindly sharing his data on the Nunn and the Levchenko indices at the 4-digit SIC level.

to imperfect institutions.[58] Some of the most contract intensive industries include Motor Vehicles and Passenger Car Bodies, Electronic Computers, and Electromedical and Electrotherapeutic Apparatus; some of the least contract intensive industries are Poultry Slaughtering and Processing, Primary Smelting and Refining of Copper, and Rice Milling. These examples are useful to illustrate the relationship between product complexity and contract dependence described in the model.

The Levchenko (2007) index measures the sensitivity of an industry to institutions such as contract enforcement and property rights. This index equals one minus the Herfindahl index of an industry's intermediate input use—an inverse measure of the concentration mix of inputs, and hence a direct measure of exposure to hold-up problems in the production process. Among the most institutionally intensive industries we find Fluid Power Pumps and Motors, Small Arms Ammunition, and Surgical Appliances and Supplies; among the least institutionally intensive industries we find Meat Packing Plants, Creamery Butter, and Setup Paperboard Boxes.

We also use a novel measure of uncollected credit sales, labeled as "uncollectible index", as an additional index of industry contractual vulnerability. The source of these data is the National Summary of Domestic Trade Receivables (NSDTR), a proprietary quarterly survey of large U.S. firms compiled by the Credit Research Foundation (CRF).[59] As detailed in Appendix 3.6.1, we construct our index as $1 - CEI$, where CEI stands for the NSDTR's Collection Effectiveness Index. The CEI is acknowledged by the CRF as the most effective measure of credit and collection performance. Our uncollectible index captures the share of total account receivables uncollected compared to what was available to collect over a quarter. The CEI is originally reported in the NSDTR as a median value for every 4-digit SIC industry that registers at least 3 respondent firms.

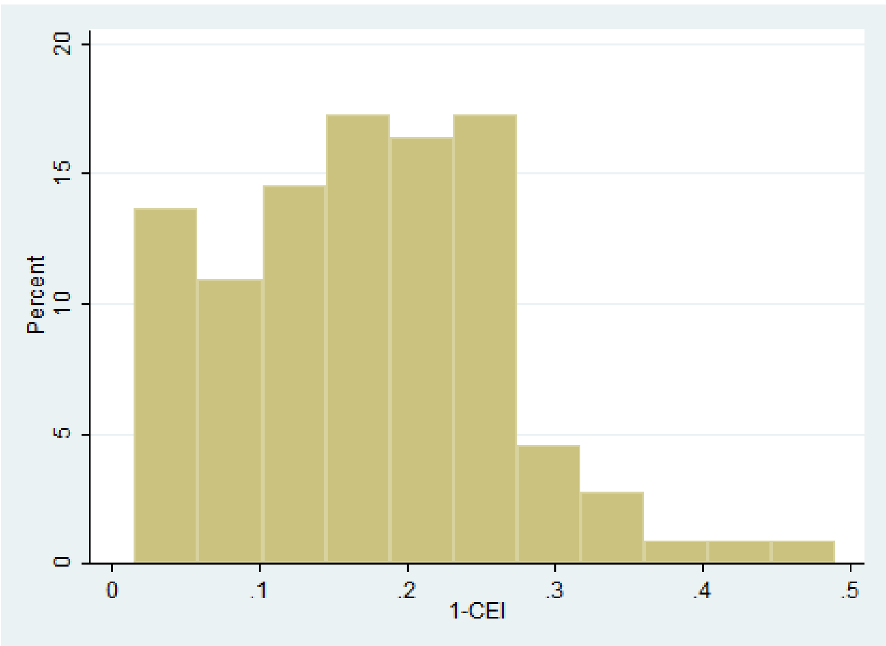
[58] In our analysis, the index corresponds to the z^{rs1} measure specified in Nunn (2007). We use the Nunn index that relies on the Rauch (1999) conservative classification for its construction. For more details, see Chor (2010) and its supplementary appendix.

[59] The CRF (`http://www.crfonline.org/`) is a non-profit, member-run organization. Its members include a large number of Fortune 1000 corporations. The NSDTR constitutes a unique data source of performance indicators of domestic accounts receivable, defined as claims against customers for goods sold domestically on credit, based on the answers of hundreds of Fortune 1000 U.S. firms from a broad cross section of industries. To our knowledge, the NSDTR has not been used in recent academic literature. In the early years of the survey, however, Seiden (1964) used it in his pioneering study of the quality of trade credit, and Nadiri (1969) employed it to calculate the delinquency rate on manufacturing accounts receivable and payable.

The uncollectible index is advantageous for our purposes as it reflects, by construction, payment defaults in business-to-business transactions at the industry level. To isolate the structural component of this index we take industry medians across quarters (period 2006q1-2010q4). A ranking of industries based on the uncollectible index is displayed in Appendix Table A1.

In using the uncollectible index for our empirical analysis, we assume that domestic receivable performance can proxy for the quality of collection of foreign receivables. We also believe that since large firms are dominant in international trade, the sample of Fortune 1000 firms surveyed by the CRF are representative of firms engaged in overseas transactions. That said, we acknowledge that the uncollectible index may not be, as desired, completely exogenous from the perspective of firms. Another limitation is that we only have available data to construct this index for 110 industries. Figure 21 shows the distribution of the index. Over one third of the industries fail to collect around 10% of their receivables or less. On the opposite extreme, only about 10% of industries fail to collect 30% of their receivables or more.

Figure 21: **Distribution of the uncollectible index**



Notes: The bars represent the histogram of the uncollectible index. The uncollectible index is constructed as $1-CEI$, where CEI is the Collection Effectiveness Index reported in the Credit Research Foundation's National Summary of Domestic Trade Receivables. We calculate (4-digit SIC) industry medians over the period 2006q1-2010q4, and divide them by 100 to express them as decimals.

Table 15 summarizes some descriptive statistics of our contractual vulnerability indices. In this Table, the Nunn index is reported as "complexity" and the Levchenko index appears as "concentration". We maintain this notation in our regression analysis below. As shown in Table 16, our three indices are positively and significantly correlated at the 1% level. We find the highest correlation coefficient between the complexity and the concentration indices. (Tables 15 and 16 also report statistics and pairwise correlations for other industry indicators that will be described below.)

Table 15: **Summary statistics: indicators of contractual and financial vulnerability, at industry level**

Variable	Obs.	Mean	Std.Dev.	Min	Max
Complexity	351	0.56	0.25	0.00	0.98
Concentration	351	0.86	0.11	0.21	0.97
Uncollectible	110	0.17	0.09	0.02	0.49
ExtFin	351	0.06	0.88	-2.17	7.63
CashCycle	351	0.94	0.34	0.30	2.06
Tang.Assets	351	0.40	0.15	0.14	0.88

Notes: Industries are classified by 4-digit SIC. *Complexity* is the input relationship-specificity index from Nunn (2007). *Concentration* is the input concentration index from Levchenko (2007). The source for both of these indices is Chor (2010). *Uncollectible* is the account receivables' collection ineffectiveness index, based on survey data from the Credit Research Foundation's National Summary of Domestic Trade Receivables. *ExtFin* is the Rajan and Zingales (1998) index of external finance dependence. *CashCycle* is a measure of the time elapsed between the moment a firm pays for its materials until the collection on its sales (reported in hundred of days). *Tang.Assets* is a measure of tangible assets developed by Braun (2003). The last three measures are constructed using data from Compustat. See text for further details.

Table 16: **Pairwise correlation coefficients: indicators of contractual and financial vulnerability**

	Complexity	Concentration	Uncollectible	ExtFin	CashCycle
Concentration	**0.52**				
	(0.00)				
Uncollectible	**0.45**	**0.26**			
	(0.00)	**(0.01)**			
ExtFin	**0.13**	-0.01	-0.06		
	(0.02)	(0.91)	(0.50)		
CashCycle	**0.50**	**0.36**	**0.43**	-0.05	
	(0.00)	**(0.00)**	**(0.00)**	(0.35)	
Tang.Assets	**-0.57**	**-0.30**	**-0.18**	**-0.24**	**-0.44**
	(0.00)	**(0.00)**	**(0.07)**	**(0.00)**	**(0.00)**

Notes: For definitions of the variables, see notes of Table 15. Correlations are computed across 4-digit SIC industries, with *p*-values reported in parentheses. Coefficients that are statistically significant at the 10% level or lower are indicated in bold.

Country-level data. As part of our set of control variables, we use information on Free Trade Agreements (FTA) from de Sousa (2012). The bilateral real exchange rate is constructed using data from the Penn World Table 8.1 (Feenstra et al., forthcoming). Finally, financial development is proxied by the ratio of private credit by banks and other financial institutions to GDP (Beck et al., 2000).

Table 17 displays summary statistics for all of our country-level variables, including GDPs and our indicators of recessions and financial crises. (The Table also includes statistics for other variables which will be introduced as additional controls in our sensitivity analysis below.)

Table 17: **Summary statistics: Trade and country-level data**

Variable	Obs.	Mean	Std.Dev.	Min	Max
Recession	5517661	0.17	0.37	0.00	1.00
Fin. Crisis	5517661	0.18	0.38	0.00	1.00
Ln BRER	5517661	4.72	0.76	1.92	7.23
Ln GDP Imp.	5517661	25.77	2.00	18.80	30.08
Ln GDP Exp.	5517661	26.64	1.62	18.80	30.08
Fin. Develop.	5517661	0.65	0.47	0.00	2.28
FTA	5517661	0.22	0.42	0.00	1.00
Contract Enforcement	5517661	0.69	0.46	0.00	1.00
Ln Distance	5517661	8.34	1.00	4.09	9.89

Notes: *Ln* denotes natural logarithm and the variable names correspond to those employed in the regression analysis. *Recession* and *Fin. Crisis* are dummy variables at the importing-country level; *BRER* is the bilateral real exchange rate; *GDP Imp.* and *GDP Exp.* are the real GDPs in importing and exporting countries, respectively; *Fin. Develop.* is the ratio of private credit to GDP; *FTA* denotes free trade agreement (dummy variable); *Contract Enforcement* is measured by the rule of law; *Distance* is the bilateral geographical distance. See text and Table 13 for further details.

3.4 Results

This subsection shows the results of estimating our baseline regression and different robustness exercises. The total number of data points in most of our regressions is above 5 million. When we use the uncollectible index as our contractual-vulnerability measure, the number of observations decreases because fewer industries feature values for this index relative to Nunn's (2007) complexity and Levchenko's (2007) concentration indices.[60]

3.4.1 Baseline results

Table 18 presents the results of the OLS estimation of equation (18), using our two measures of crises and our three industry indices of contractual dependence. We first note that the coefficients on most of the control variables are significant and have the expected signs. Although the coefficient associated with financial development in the exporting country is rarely statistically significant, it is always positive, as expected.

[60] Our panel is unbalanced since not all countries trade in all industries and years. Moreover, not all of our country variables are available for the entire sample period.

Table 18: **Effects of crises and contractual vulnerability on trade across countries and industries. Dependent variable: Ln(bilateral sectoral exports)**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Recession	-0.097***	-0.006	0.178***	-0.040**				
	(0.014)	(0.016)	(0.031)	(0.015)				
Recession × Complexity		-0.158***						
		(0.020)						
Recession × Concentration			-0.317***					
			(0.036)					
Recession × Uncollectible				-0.332***				
				(0.046)				
Fin. Crisis					-0.057***	-0.010	0.088**	-0.024
					(0.018)	(0.016)	(0.037)	(0.018)
Fin. Crisis × Complexity						-0.082***		
						(0.028)		
Fin. Crisis × Concentration							-0.167***	
							(0.049)	
Fin. Crisis × Uncollectible								-0.152**
								(0.065)
Ln BRER	-0.340***	-0.341***	-0.340***	-0.351***	-0.332***	-0.332***	-0.332***	-0.342***
	(0.032)	(0.032)	(0.032)	(0.033)	(0.033)	(0.033)	(0.033)	(0.034)
Ln GDP Imp.	0.814***	0.815***	0.814***	0.845***	0.859***	0.859***	0.860***	0.894***
	(0.067)	(0.067)	(0.067)	(0.069)	(0.070)	(0.070)	(0.070)	(0.072)
Ln GDP Exp.	1.465***	1.464***	1.465***	1.568***	1.470***	1.470***	1.470***	1.573***
	(0.043)	(0.043)	(0.043)	(0.045)	(0.043)	(0.043)	(0.043)	(0.046)
FTA	0.275***	0.275***	0.275***	0.283***	0.274***	0.274***	0.274***	0.282***
	(0.025)	(0.025)	(0.025)	(0.025)	(0.026)	(0.026)	(0.026)	(0.025)
Fin. Develop. Imp.	0.378***	0.379***	0.379***	0.426***	0.331***	0.332***	0.331***	0.375***
	(0.054)	(0.054)	(0.054)	(0.055)	(0.054)	(0.054)	(0.054)	(0.055)
Fin. Develop. Exp.	0.045	0.045	0.045	0.055*	0.018	0.018	0.018	0.031
	(0.029)	(0.029)	(0.029)	(0.031)	(0.029)	(0.029)	(0.029)	(0.031)
Fin. Develop. Imp×Exp	-0.181***	-0.181***	-0.181***	-0.195***	-0.156***	-0.156***	-0.156***	-0.171***
	(0.031)	(0.031)	(0.031)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)
Observations	5,517,661	5,517,661	5,517,661	2,061,100	5,517,661	5,517,661	5,517,661	2,061,100
R-squared	0.087	0.088	0.088	0.102	0.087	0.087	0.087	0.101
Importer-Exporter-Industry FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors in parentheses, clustered at importing country-year level, with ***,** ,* respectively denoting significance at the 1%, 5% and 10% levels. The "Recession" and "Fin. Crisis" variables are associated with the importing countries.

In columns 1 and 5, we show that when a country is hit by a recession or a financial crisis, industry exports to that country decline on average 9.3% ($exp(-0.972) - 1$) and 5.5% ($exp(-0.057) - 1$), respectively. Following the notation of equation (18), we thus confirm our first theoretical prediction that $\alpha_1 < 0$.[61,62]

Once we include the interaction of the crisis variables with our industry measures of contractual vulnerability, we observe that the estimated coefficients on these interaction terms are negative and statistically significant (columns 2-4 and 6-8 in Table 18). This result is robust to the occurrence of a recession or a financial crisis in the importing country, and to the use of the complexity, concentration or uncollectible indices. In short, we confirm our key theoretical hypothesis that imports in more contract-dependent industries are disproportionately affected by a crisis ($\alpha_2 < 0$).

To quantify the amplification effect induced by contractual vulnerability at the industry level, we use our estimates for α_1 and α_2 from Table 18 (columns 2-4 and 6-8). We then compare the overall impact of a crisis on trade for two specific industries. We define an industry in the 25^{th} percentile of each contractual-vulnerability index as a 'slightly contract-dependent' industry. Similarly, we define an industry in the 75^{th} percentile of each contractual-vulnerability index as a 'highly contract-dependent' industry. Table 19 summarizes the results. Focusing on the complexity index, the overall impact of a recession on imports is 6.1 percentage points ($exp(-0.064) - 1$) larger in the highly contract-dependent industry (Printed Circuit Boards, SIC 3672) than in the slightly contract-dependent industry (Steel Works, Blast Furnaces, and Rolling Mills, SIC 3312). For the uncollectible index, the industry with high contract dependence exhibits a 4.3 percentage points ($exp(-0.044)-1$) larger drop in imports than the industry with low dependence (Construction Machinery and Equipment, SIC 3531; and Paper Mills, SIC 2621, respectively). All the reported differences between the 75^{th} and the 25^{th} percentiles are statistically significant at the 1% level. Noticeably also, the amplification effects con-

[61] Laeven and Valencia (2013) document that more than 60% of the banking crises in their dataset start in the last quarter of the year. This fact may be inducing a downward bias in our estimate of α_1 when we use the financial crisis indicator. In effect, in an alternative regression (not reported) we replace the original financial crisis indicator with its first lag, and the estimated coefficient increases from -0.057 to -0.075.

[62] In their baseline results, Abiad et al. (2014) and Berman et al. (2012) report somewhat higher quantitative effects of financial crises and banking crises, respectively, on imports of the crisis country. It is worth noting, however, that when those papers exclude the Great Recession period from their estimation samples, their results become closer to ours. (Recall that our sample period ends in 2000.)

ditional on a recession are larger than those associated with a financial crisis, roughly by a factor of 2.

Table 19: **Overall effects of crises on industry imports for different degrees of contractual vulnerability**

	Recession			Financial Crisis		
	25^{th}	75^{th}	$75^{th}-25^{th}$	25^{th}	75^{th}	$75^{th}-25^{th}$
Complexity	-0.062***	-0.126***	-0.064***	-0.039**	-0.072***	-0.033***
	(0.014)	(0.015)	(0.008)	(0.015)	(0.021)	(0.011)
Concentration	-0.084	-0.118*	-0.034***	-0.05	-0.068	-0.018***
	(0.059)	(0.063)	(0.004)	(0.076)	(0.081)	(0.005)
Uncollectible	-0.074***	-0.118***	-0.044***	-0.040**	-0.060***	-0.020***
	(0.014)	(0.015)	(0.006)	(0.017)	(0.019)	(0.007)

Notes: The results are based on the estimates reported in Table 18 (columns 2-4 and 6-8), with ***,**,* respectively denoting significance at the 1%, 5% and 10% levels. The terms 25^{th} and 75^{th} refer to the percentiles in the distribution of each industry measure of contractual vulnerability.

3.4.2 Sensitivity analysis

To check the robustness of our results we consider different sensitivity exercises. In the interest of brevity, we only show the results for recession as the crisis indicator. The results for the case of financial crises are qualitatively similar.

For the remainder of this subsection, all of the regressions include the same control variables as the baseline estimation, but to save space they are omitted in some of the tables.

3.4.3 Contract enforcement (rule of law) at the country level

We first test if the decline of imports among industries with higher contractual dependence is more pronounced in countries with lower *structural* levels of contractual enforcement. This would be a reasonable outcome if, independently of the industry, importing firms were more likely to default in countries with worse institutional quality (see, e.g., Schmidt-Eisenlohr, 2013); or alternatively, if poor institutions disproportionately exacerbated the risk of default of more contract-dependent industries. To measure a country's ability to enforce contracts we use the rule of law from Kaufmann et al. (2010). We then split the sample according to whether importing countries are above or below the median value of this indicator. The results are shown in Table 20.

We find that, indeed, the amplification effect due to contractual vulnerability at the industry level is significantly larger in countries with low contract enforcement (columns 2-4 and 6-8). Illustratively, the estimated coefficient attached to the interaction of the

Table 20: **Effects of crises and contract vulnerability on trade across countries and industries: contract enforcement at importing-country level Dependent variable: Ln(bilateral sectoral exports)**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Below median (Low enforcement)				Above median (High enforcement)			
Recession	-0.186***	-0.062**	0.112*	-0.120***	-0.049***	0.029	0.203***	0.007
	(0.031)	(0.028)	(0.058)	(0.031)	(0.013)	(0.018)	(0.036)	(0.016)
Recession × Complexity		-0.213***				-0.135***		
		(0.040)				(0.022)		
Recession × Concentration			-0.340***				-0.291***	
			(0.070)				(0.040)	
Recession × Uncollectible				-0.388***				-0.301***
				(0.087)				(0.053)
Observations	1,698,743	1,698,743	1,698,743	660,148	3,818,918	3,818,918	3,818,918	1,400,952
R-squared	0.081	0.081	0.081	0.092	0.094	0.094	0.094	0.112
Importer-Exporter-Industry FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors in parentheses, clustered at importing country-year level, with ***,** ,* respectively denoting significance at the 1%, 5% and 10% levels. The "Recession" variable is associated with the importing countries. We use the rule of law index from Kaufmann et al. (2010) to compute country averages for the period 1996-2012. We then calculate the median value across countries and split the sample according to whether importing countries are below or above that median (reported in the Table as "Low enforcement" and "High enforcement", respectively). All of the regressions in this table also include the same control variables of the baseline estimation (see Table 18).

recession indicator and the complexity index is almost 60% higher (in absolute value) in the low-enforcement sample than in the high-enforcement sample (-0.213 and -0.135, respectively).

Furthermore, a recession has a much larger average impact on sectoral imports of countries with low contract enforcement (columns 1 and 5). The estimated drop in imports for this group of countries is 17.0% ($exp(-0.186)-1$), compared to 4.7% ($exp(-0.049)-1$) for countries with high enforcement.

3.4.4 Extending the sample period

We next evaluate the robustness of our results to the use of data since 1980. The estimates reported in Table 21 show that the amplification effect due to contractual vulnerability at the industry level is even larger when we use this extended sample period. This conclusion holds for our three industry measures. Particularly, for the case of the uncollectible and complexity indices, the estimated coefficients on the relevant interaction terms are more than 50 percent larger (in absolute value) than in our baseline results.

Table 21: **Effects of crises and contract vulnerability on trade across countries and industries: ext. sample period (1980-2000). Dependent variable: Ln(bilateral sectoral exports)**

	(1)	(2)	(3)	(4)
Recession	-0.075***	0.056***	0.219***	0.036*
	(0.014)	(0.020)	(0.037)	(0.021)
Recession × Complexity		-0.231***		
		(0.029)		
Recession × Concentration			-0.338***	
			(0.042)	
Recession × Uncollectible				-0.588***
				(0.105)
Ln BRER	-0.394***	-0.394***	-0.394***	-0.376***
	(0.024)	(0.024)	(0.024)	(0.025)
Ln GDP Imp.	1.378***	1.378***	1.378***	1.477***
	(0.054)	(0.054)	(0.054)	(0.057)
Ln GDP Exp.	1.844***	1.843***	1.844***	2.012***
	(0.035)	(0.035)	(0.035)	(0.037)
FTA	0.397***	0.397***	0.397***	0.421***
	(0.027)	(0.027)	(0.027)	(0.028)
Fin. Develop. Imp.	0.310***	0.311***	0.311***	0.358***
	(0.059)	(0.059)	(0.059)	(0.063)
Fin. Develop. Exp.	0.066*	0.066*	0.066*	0.117***
	(0.034)	(0.034)	(0.034)	(0.035)
Fin. Develop. Imp×Exp	-0.192***	-0.192***	-0.192***	-0.213***
	(0.040)	(0.040)	(0.040)	(0.041)
Observations	7,816,325	7,816,325	7,816,325	2,907,893
R-squared	0.212	0.212	0.212	0.238
Importer-Exporter-Industry FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

Notes: Robust standard errors in parentheses, clustered at importing country-year level, with ***,** ,* respectively denoting significance at the 1%, 5% and 10% levels. The "Recession" variable is associated with the importing countries.

3.4.5 Controlling for financial vulnerability

Although our use of controls and fixed effects aims to mitigate concerns about omitted variables, we allow for the possibility that our industry measures of contractual vulnerability may pick up the effect of financial dependence. A financially dependent industry could be affected by credit constraints as a result of facing high fixed costs or significant working capital needs. In this exercise, we separately include interaction terms of our recession indicator with three standard measures of financial dependence, which are based on data from Compustat's annual industrial files (period 1995-2012).

The first industry measure of financial vulnerability is the Rajan and Zingales (1998) index of external finance dependence (ExtFin), calculated as the ratio of the difference between capital expenditures and cash flow over capital expenditures. The second one is a measure of asset tangibility (TangAssets), namely the share of net property, plant and equipment in total book-value assets (Braun, 2003). The third one is the cash conversion cycle (CashCycle), a proxy for short term financial needs to cover net working capital, defined as the period between a firm's payment for materials and the collection of its sales (Raddatz, 2006). Industries with higher values of ExtFin and CashCycle, and with lower values of TangAssets are more financially dependent.[63] Table 15 shows some summary statistics for these variables. As reported in Table 16, there are some statistically significant correlations between the contractual and the financial vulnerability indicators. Notably, the complexity index exhibits a moderately high negative correlation with TangAssets and a positive correlation with CashCycle.

The results reported in Table 22 show that the inclusion of the financial vulnerability indicators does not substantially change our baseline results. Moreover, the coefficients on the interaction of these variables with the recession indicator have the expected signs in almost all cases (the only exception is for ExtFin in column 1). The interaction terms involving CashCycle and TangAssets tend to exhibit strong statistical significance. In line with Chor and Manova (2012), these results imply that trade in more financially-dependent industries is worse affected during recessions.

[63] We drop firm-year observations with negative or missing values on sales and assets from the Compustat sample. To reduce the effect of outliers, we first proceed as in Rajan and Zingales (1998) by summing each firm's use of external finance over the sample period and then dividing by the sum of capital expenditure over the sample period in order to construct ExtFin. An analogous procedure is followed to aggregate over time the ratios involved in the construction of TangAssets and CashCycle. We then trim both 1% tails of the firm distributions for each of the three measures and calculate industry medians. To gain observations, whenever a median value is not available for a SIC-4 industry, we impose the median value computed for the immediately higher level of aggregation (SIC-3).

Table 22: **Effects of crises and contract vulnerability on trade across countries and industries: controlling for financial vulnerability**
Dependent variable: Ln(bilateral sectoral exports)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Recession	-0.005	0.178***	-0.037**	0.003	0.177***	0.001	-0.015	0.102***	-0.107***
	(0.016)	(0.032)	(0.016)	(0.016)	(0.031)	(0.019)	(0.015)	(0.026)	(0.021)
Recession × Complexity	-0.160***			-0.146***			-0.152***		
	(0.020)			(0.020)			(0.017)		
Recession × Concentration		-0.317***			-0.273***			-0.274***	
		(0.036)			(0.033)			(0.030)	
Recession × Uncollectible			-0.338***			-0.248***			-0.288***
			(0.047)			(0.041)			(0.042)
Recession × ExtFin	0.004*	-0.004	-0.008***						
	(0.002)	(0.002)	(0.003)						
Recession × CashCycle				-0.016*	-0.039***	-0.059***			
				(0.009)	(0.010)	(0.014)			
Recession × Tang.Assets							0.015	0.099***	0.151***
							(0.020)	(0.025)	(0.036)
Observations	5,517,661	5,517,661	2,061,100	5,517,661	5,517,661	2,061,100	5,517,661	5,517,661	2,061,100
R-squared	0.088	0.088	0.102	0.088	0.088	0.102	0.088	0.088	0.102
Importer-Exporter-Industry FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors in parentheses, clustered at importing country-year level, with ***,** ,* respectively denoting significance at the 1%, 5% and 10% levels. The "Recession" variable is associated with the importing countries. All of the regressions in this table also include the same control variables of the baseline estimation (see Table 18).

3.4.6 Controlling for cyclicality

Compositional effects and durability play a role in explaining trade collapses in the aftermath of recessions and financial crises (see, e.g., Levchenko et al., 2010, and Eaton et al., 2011). This is because international trade is intensive in certain product categories, such as investment and durable consumption goods, that are more sensitive to cyclical fluctuations than other goods. We next evaluate the robustness of our results to the inclusion of interaction terms of the recession indicator with dummy variables representing (loosely speaking) cyclical and noncyclical goods.

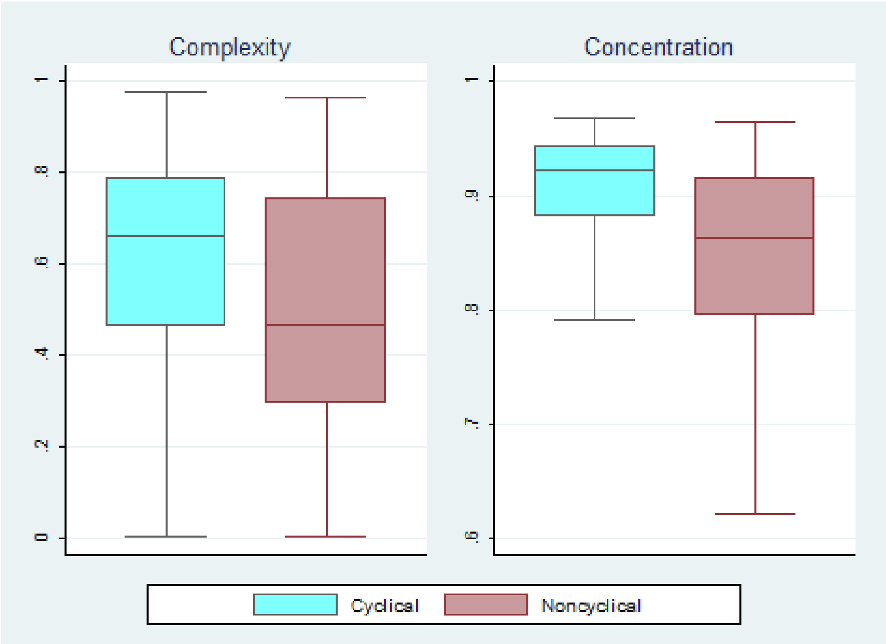
We construct two dummy variables using the mapping of 4-digit SIC industries to categories of final demand from Gomes et al. (2009). Our first dummy variable (labeled as "Cyclical (exc. NX)" in Table 23) takes the value of 1 (cyclical) if the industry is categorized by Gomes et al. (2009) as *durable consumption* or *investment*; and takes the value of 0 (noncyclical) if the industry is categorized as *nondurable consumption*, *government consumption and investment*, *consumption of services*, or *net exports*. Alternatively, a second dummy variable (labeled as "Cyclical (with NX)" in Table 23) is constructed in the same way except that the category *net exports* is included within the cyclical group.[64]

To examine the relationship between contract dependence and cyclicality, we use our first dummy variable to split the sample of industries according to whether they are more or less cyclical. In Figure 22 we plot the distributions of the complexity and the concentration indices for each subsample. (Using the second dummy variable to split the sample yields relatively similar plots.) It is visually apparent that cyclical industries tend to be more contractually vulnerable than noncyclical industries. This pattern is particularly strong if we observe the plots for the concentration index. More concretely, the median values of the complexity and the concentration indices are higher for cyclical industries than for noncyclical ones—the differences between medians are statistically significant at the 1% level according to the adjusted median chi-square and the Kruskal-Wallis tests.

As observed in Table 23, the baseline econometric results are essentially unaffected when we account for the fact that recessions have a larger negative impact on more cyclical

[64]Gomes et al's (2009) classification covers the majority of SIC-4 industries. However, to gain observations, whenever a certain SIC-4 industry is not categorized by them, we impose the category of final demand corresponding to the immediately higher level of aggregation (SIC-3).

Figure 22: **Distribution of complexity index and concentration index, by cyclicality of industries**



Notes: The box-and-whisker plots show the interquartile range, the median, and the most extreme values that are within 3/2 times the interquartile range of the 1st and 3rd quartiles. *Complexity* is the input relationship-specificity index from Nunn (2007). *Concentration* is the input concentration index from Levchenko (2007). Based on Gomes et al's (2009) classification of 4-digit SIC industries by final demand, our *cyclical* industries include durable consumption and investment goods; *noncyclical* industries include nondurable consumption, government consumption and investment, consumption of services, and net exports of goods and services. Only manufacturing industries are considered.

goods. If anything, the magnitudes of the interaction coefficients for the contractual-dependence measures decline slightly. Further, our estimates indicate that recessions disproportionately reduce trade in cyclical goods relative to noncyclical goods, by roughly 5 percentage points.[65] Using either of our two dummy variables for cyclicality does not change these conclusions.

3.4.7 Controlling for both financial vulnerability and cyclicality

Building on previous exercises, Table 24 shows the results of simultaneously including two extra interaction terms as control variables in our baseline regressions. These interaction terms aim to capture the larger effect of recessions on trade in cyclical industries (Cycli-

[65]This result is consistent with previous evidence in the literature. For example, Abiad et al. (2014) find that the recent Great Trade Collapse caused an additional average drop of 10% in trade in capital and durable goods than in consumer nondurable goods.

Table 23: **Effects of crises and contract vulnerability on trade across countries and industries: controlling for cyclicality**
Dependent variable: Ln(bilateral sectoral exports)

	(1)	(2)	(3)	(4)	(5)	(6)
Recession	0.002	0.167***	-0.024	0.007	0.170***	-0.025
	(0.016)	(0.031)	(0.016)	(0.017)	(0.031)	(0.016)
Recession × Complexity	-0.137***			-0.139***		
	(0.018)			(0.018)		
Recession × Concentration		-0.278***			-0.279***	
		(0.033)			(0.033)	
Recession × Uncollectible			-0.281***			-0.283***
			(0.043)			(0.042)
Recession × Cyclical (exc. NX)	-0.043***	-0.048***	-0.052***			
	(0.006)	(0.006)	(0.007)			
Recession × Cyclical (with NX)				-0.042***	-0.045***	-0.046***
				(0.006)	(0.006)	(0.007)
Observations	5,517,661	5,517,661	2,061,100	5,517,661	5,517,661	2,061,100
R-squared	0.088	0.088	0.102	0.088	0.088	0.102
Importer-Exporter-Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors in parentheses, clustered at importing country-year level, with ***,** ,* respectively denoting significance at the 1%, 5% and 10% levels. The "Recession" variable is associated with the importing countries. All of the regressions in this table also include the same control variables of the baseline estimation (see Table 18).

cal (exc. NX)) and in industries with higher working capital necessities (CashCycle). We observe that the inclusion of these additional control variables slightly reduces the magnitude, but not the statistical significance, of the key point estimates in our baseline regressions. This conclusion holds regardless of whether we use recessions or financial crises as the crisis indicator.

Table 24: **Effects of crises and contract vulnerability on trade across countries and industries: controlling for financial vulnerability and cyclicality**
Dependent variable: Ln(bilateral sectoral exports)

	(1)	(2)	(3)	(4)	(5)	(6)
Recession	0.009	0.167***	-0.008			
	(0.017)	(0.031)	(0.018)			
Recession × Complexity	-0.129***					
	(0.019)					
Recession × Concentration		-0.246***				
		(0.031)				
Recession × Uncollectible			-0.249***			
			(0.041)			
Recession × CashCycle	-0.012	-0.030***	-0.027**			
	(0.009)	(0.009)	(0.013)			
Recession × Cyclical (exc. NX)	-0.042***	-0.045***	-0.046***			
	(0.006)	(0.006)	(0.007)			
Fin. Crisis				-0.008	0.086**	-0.028
				(0.018)	(0.036)	(0.020)
Fin. Crisis × Complexity				-0.078***		
				(0.026)		
Fin. Crisis × Concentration					-0.146***	
					(0.040)	
Fin. Crisis × Uncollectible						-0.158***
						(0.055)
Fin. Crisis × CashCycle				-0.001	-0.012	0.010
				(0.012)	(0.012)	(0.015)
Fin. Crisis × Cyclical (exc. NX)				-0.006	-0.009	-0.009
				(0.007)	(0.008)	(0.009)
Observations	5,517,661	5,517,661	2,061,100	5,517,661	5,517,661	2,061,100
R-squared	0.088	0.088	0.102	0.087	0.087	0.101
Importer-Exporter-Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors in parentheses, clustered at importing country-year level, with ***,** ,* respectively denoting significance at the 1%, 5% and 10% levels. The "Recession" and "Fin. Crisis" variables are associated with the importing countries. All of the regressions in this table also include the same control variables of the baseline estimation (see Table 18).

3.4.8 The role of distance

Berman et al. (2012) document that longer distances between trading partners (or, more precisely, longer shipping times) magnify the negative impact of financial crises on trade. In our final empirical exercise, we analyze if this effect of the interaction between crises and distance increases with contractual vulnerability at the industry level. To do so, we modify our baseline regression (with recession as the crisis variable) by introducing triple interaction terms between the recession indicator, the geographical distance between exporting and importing countries, and our industry indices of contractual dependence.[66]

The first two rows of results in Table 25 confirm the findings of Berman et al. (2012), namely the overall negative effect of a recession on trade increases with the distance between trading partners. Meanwhile, the estimated coefficients on the triple interaction terms are negative and statistically significant, indicating that contractual vulnerability at the industry level amplifies the *sectoral* effects of distance on trade during recessions. For illustrative purposes, consider the case of Argentinean imports from the U.S. in two sectors: a highly contract-dependent industry such as Printed Circuit Boards (75^{th} percentile of the complexity index), relative to a slightly contract-dependent industry such as Steel Works, Blast Furnaces, and Rolling Mills, (25^{th} percentile of the complexity index). Given that the distance between the capitals of Argentina and the U.S. is 9.04 log km. (8403 km. $\approx$ 5221 miles), our results from column 2 imply that if Argentina enters in a recession, then imports in the highly contract-dependent industry decline by 6.6 percentage points ($exp(-0.018 * 9.04 * (0.761 - 0.359)) - 1$) more than those in the slightly contract-dependent industry.[67]

Interestingly, Antràs and Foley (forthcoming) emphasize that the effects of contractual imperfections on trade increase with distance. They argue that at least in some industries, when the importer defaults, exporters' main recourse involves shipping the goods back to their home country, but those costs rise with distance. In light of this argument, another

[66] Bilateral distance is measured as the distance between the capitals of two countries. The data is taken from the CEPII distance database.

[67] In the calculation reported in parenthesis, 0.761 is the value for the 75^{th} percentile and 0.359 is the value for the 25^{th} percentile of the complexity index. By using the results reported in column 1 of Table 25, we also conclude that the overall effect of a recession on bilateral trade is negative for 99% of the trading partners in our sample. This is because for that share of countries, the distance between their capitals is at least 6.26 log Km.

Table 25: **Effects of crises and contract vulnerability on trade across countries and industries: the role of distance**
Dependent variable: Ln(bilateral sectoral exports)

	(1)	(2)	(3)	(4)
Recession	0.270***	0.257***	0.262***	0.245***
	(0.075)	(0.075)	(0.075)	(0.078)
Recession × Distance	-0.044***	-0.032***	-0.010	-0.034***
	(0.009)	(0.009)	(0.009)	(0.009)
Recession × Distance × Complexity		-0.018***		
		(0.002)		
Recession × Distance × Concentration			-0.038***	
			(0.004)	
Recession × Distance × Uncollectible				-0.038***
				(0.005)
Observations	5,517,661	5,517,661	5,517,661	2,061,100
R-squared	0.088	0.088	0.088	0.102
Importer-Exporter-Industry FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

Notes: Robust standard errors in parentheses, clustered at importing country-year level, with ***,** ,* respectively denoting significance at the 1%, 5% and 10% levels. The "Recession" variable is associated with the importing countries. All of the regressions in this table also include the same control variables of the baseline estimation (see Table 18).

possible way to interpret our findings from this exercise is as follows: a longer bilateral distance magnifies the losses in imports stemming from the interaction of a crisis in the destination country and contractual dependence at the industry level.

3.5 Conclusion

In this chapter we provide evidence on a mechanism that has been ignored in the existing literature on crises and trade. We document empirically that when countries experience a recession or financial crisis, their imports fall disproportionately in more contract-dependent industries. Put differently, contractual imperfections at the product level exacerbate the negative impact of crises on international trade. This mechanism operates on top of other relevant sources of heterogeneity across industries, such as financial dependence and degree of cyclicality. Moreover, the estimated amplification effect of contractual vulnerability on sectoral imports strengthens if the crisis country has weak rule of law.

We argue that these findings can be rationalized by two considerations. First, a large share of cross-border transactions rely on post shipment payment. Second, the risk of default of importers is affected by macroeconomic conditions and worsens in industries which are more sensitive to the quality of contracting institutions.

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3.6 Appendix

Appendix

3.6.1 Data from the National Summary of Domestic Trade Receivables

The National Summary of Domestic Trade Receivables (NSDTR) data are in readable PDF format, so we first transcribe these files to machine-readable format. The NSDTR's Collection Effectiveness Index (CEI) is constructed as follows:

$$\text{CEI} = \frac{\text{Beginning total receiv. + (Quarterly credit sales/3) - Ending total receiv.}}{\text{Beginning total receiv. + (Quarterly credit sales/3) - Ending current receiv.}}$$

where:

'Beginning (Ending) total receiv.': Receivables balance at beginning (end) of 3-month period being reported. Considers all domestic open invoices and notes receivable, deferred billings or datings, past-due billings, credits, unapplied cash, suspense accounts, charge backs, invoice deductions, bankruptcies, claims, disputes, litigation and accounts placed for collections.

'Quarterly credit sales': Total invoiced receivable for the 3-month period reported. Includes freight, taxes, and containers.

'Ending current receiv.': Portion of receivables (domestic open accounts and notes) not yet due as of end of period according to terms, including datings and deferred items.

We take median values across quarters by 4-digit SIC industry. On each quarter, the survey includes only industries that report a minimum of 3 responding firms. For more detailed information about the NSDTR, see `http://www.crfonline.org/surveys/surveys.asp`.

Table A1 summarizes the 10 most and 10 least collection-effective industries.

Table A1: **Uncollectible index: the ten highest and lowest ranked industries**

Best collection performance			Worst collection performance		
SIC	Description	1-CEI	SIC	Description	1-CEI
2873	Nitrogenous Fertilizers	0.02	3678	Electronic Connectors	0.28
2421	Sawmills and Planing Mills, General	0.02	3585	Refrigeration and Heating Equipment	0.30
2842	Speciality Clean., Polish., and Sanitary Preparations	0.02	3829	Measuring and Controlling Devices, NEC	0.30
2032	Canned Specialties	0.03	3569	General Industrial Machinery and Equipm., NEC	0.31
2676	Sanitary Paper Products	0.03	3069	Fabricated Rubber Products, NEC	0.32
2874	Phosphatic Fertilizers	0.03	3563	Air and Gas Compressors	0.33
2834	Pharmaceutical Preparations	0.03	3273	Ready-Mixed Concrete	0.33
3275	Gypsum Products	0.04	3444	Sheet Metal Work	0.39
2021	Creamery Butter	0.04	2399	Fabricated Textile Products, NEC	0.41
2023	Dry, Condensed, and Evaporated Dairy Products	0.04	3561	Pumps and Pumping Equipment	0.49

Notes: The uncollectible index is constructed as $1 - CEI$. See text for further details.