Assortative Matching of Exporters and Importers*

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Abstract

This paper studies the matching mechanism of exporters and importers in Mexican textile/apparel exports to the US. A surge in Chinese exports to the US after the end of the Multifibre Arrangement in 2005 caused re-matching of incumbent US importers and Mexican exporters that is systematically related with firm's pre-liberalization trade volume. We show the observed re-matching is consistent with a model combining Becker-type positive assortative matching of final producers and suppliers by their capability with the standard Melitz-type model. The model suggests the observed re-matching brought new gains from trade associated with two-sided heterogeneity of exporters and importers.

Keywords: Firm heterogeneity, assortative matching, two-sided heterogeneity, trade liberalization

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1 Introduction

Over the past decade, a growing body of research has focused on heterogeneous firms and trade. A robust finding that only firms with high capability (productivity/quality) engage in exporting and importing has spurred new theories emphasizing new gains from trade (Melitz, 2003; Bernard, Eaton, Jensen, and Kortum, 2003).[1] Trade liberalization improves industry performance by shifting resources to more capable firms within industries (e.g., Pavcnik, 2002; Trefler, 2004). These new theories have been applied to various issues and centered in trade research over the last decade.[2]

In contrast to our current knowledge regarding the firms that trade, we have little information regarding the process of matching between exporters and importers in a product market. Do exporters and importers match based on their respective capabilities? Does trade liberalization change matching in any systematic way? Does matching matter for the aggregate gains from trade liberalization? This paper is one of the first attempts to answer these questions empirically.

This paper studies the mechanism of exporter-importer matching by investigating how matching changes in response to trade liberalization. We assembled matched exporter-importer data of Mexican textile/apparel exports to the US during 2004-07 that documents the information of exporter, importer, HS 6 digit product code, unit price and trade volume at the transaction level. Mexico-US textile/apparel trade is particularly suitable for our purpose. First, Mexico and the US are well integrated in textile/apparel trade. In 2004, the US is the largest market for Mexico, while Mexico is the second largest source for the US.[3] Second, at the

[1] See, for example, Bernard and Jensen (1995, 1999) for such findings that motivated the theories.

[2] See survey papers e.g., Bernard, Jensen, Redding, and Schott (2007; 2012) and Redding (2011) for additional papers in the literature.

[3] 91.9 % of Mexican exports are shipped to the US and 9.5% of US imports are from Mexico.

disaggregate product (HS 6 digit) level, matching of Mexican exporters and US importers are approximately one-to-one relationships in a given year. Even though some firms trade one product with multiple partners, they trade more than 80% of product trade volume with their single main partners. This allows us to analyze the change in matching by simply tracking the change in firms' main partners over time. Finally, Mexico-US textile/apparel trade experienced a drastic change in the level of trade protection at the end of the Multifibre Arrangement (MFA) in 2005. Until 2004, the US imposed import quota on countries outside the NAFTA for some textile/apparel products, which effectively protected Mexican exports to the US, notably from competition with China.

To analyz how firms choose their main partners, we develop a model combining a canonical matching model of Becker (1973) with a Melitz-type model of heterogeneous firms and trade. The model has final producers (importers) and suppliers (exporters) in Mexico and China, both of whom are heterogeneous in capability. A final producer and a supplier form a team under perfect information. These teams compete in the US final good market in a monopolistically competitive way. Since team members' capabilities exhibit complementarity within teams, stable matching becomes positively assortative matching (PAM) by capability. High capability exporters match with high capability importers, while low capability exporters match with low capability importers.

Using this model, we analyze the end of the MFA that allowed more Chinese supplier at various capability levels to enter the US. Existing matching becomes unstable as some final producers switch to these new Chinese suppliers. This in turn induces existing firms to systematically change partners so that the resulting new matching becomes PAM under the new capability distribution. While final producers switch to partners with higher capability, incumbent suppliers switch to partners with lower capability and those with low capability exit. These rematching

toward PAM leads to an efficient use of technology exhibiting complementarity and lowers the consumer price index. This new gain from trade arises from two-sided firm heterogeneity.

We test the model's predictions on rematching of incumbent US importers and Mexican exporters in our data. Using firms' pre shock trade volumes in 2004 as a proxy for capability, we identify three findings for the rematching toward PAM. First, US importers more frequently switched from their Mexican main partner to one with higher capability, whereas Mexican suppliers more frequently switched from their US main partner to one with lower capability. We do not find systematic partner changes in the other direction. Second, Mexican exporters with low capability stop exporting to the US.We identify these two facts by comparing products subject to US binding quotas on imports from China (the treatment group) and other textile/apparel products (the control group). Finally, among those who switched main partners, the rank of the new partners is positively related with the capability of the old partners. These findings strongly support the existence of Becker-type positive assortative matching. In addition, we present numerous additional analyses to support the robustness of our results and to reject possible alternative explanations.

Our finding of PAM of exporters and importer supports the matching approach to modeling international trade pioneered by James Rauch and his coauthors. Casella and Rauch (2002), Rauch and Casella (2003), and Rauch and Trindade (2003) modeled international trade as buyer-seller matching to analyze information frictions that complicate matching.[4] While these models emphasize horizontally differentiated firms, we find vertically differentiated firms by capability (e.g., Antras, Garicano and Rossi-Hansberg, 2006; Sugita 2015). The vertical differentiation implies

[4]Chaney (2014) and Eaton, Jinkins, Tybout and Xu (2015) present buyer-supplier matching models emphasizing informational frictions.

that importers with high capability are "good importers" with whom all exporters prefer to trade, but only those with high capability can in fact trade with them. This finding supports policy discussions emphasizing the importance of encouraging domestic firms not only to start exporting but also to export to high capable importers.

Our paper is also related to the growing body of empirical literature that uses customs transaction data to examine matching between exporters and importers. As pioneering studies, Blum, Claro, and Horstmann (2010, 2011) and Eaton, Eslava, Jinkins, Krizan, and Tybout (2012) document characteristics of exporter–importer matching in Chile–Colombia trade, Argentina–Chile trade, and Colombia–US trade, respectively. Bernard, Moxnes, and Ulltveit-Moe (2016), Carballo, Ottaviano, and Volpe Martincus (2013), Eaton, Kortum and Kramatz (2016) analyze the Norwegian customs data, the customs data of Costa Rica, Ecuador, and Uruguay, and the French customs data to examine exports from one country to multiple destinations. Benguria (2014) and Dragusanu (2014) find positive correlations for firm-level variables (employment, revenue, etc.) of exporters and importers for France–Colombia trade and India–US trade, respectively. However, none of these studies relates observed correlations to the Becker-type positive assortative matching. Regarding dynamic characteristics of matching, Eaton et al. (2012) and Machiavello (2010) conduct pioneering studies on how new exporters acquire or change buyers in Colombian exports to the US and in Chilean wine exports to the UK, respectively. Monarch (2015) analyze partner changes in Chinese exports to the US. While these studies consider steady state dynamics, we focus on how matching changes in response to trade liberalization. The above-mentioned empirical studies propose different theoretical mechanisms to explain their findings, but none propose Becker-type positive assortative matching. Note that our treatment–control group comparison can identify only the existence of the Becker-type mechanism; however, it is silent about the existence of other mechanisms.

The rest of the paper is organized as follows. Section 2 discusses our data and Mexico-US textile/apparel trade. Section 3 develops a model of matching of exporters and importers and derives predictions that will be confirmed in later sections. Section 4 explains our empirical strategies. Section 5 presents the main empirical results together with additional results for checking the robustness of the main results. Section 6 report results using alternative capability measures and additional results to reject alternative explanations for the main results. Section 7 concludes the paper.

2 Mexico-US Textile Apparel Trade

2.1 Matched Exporter Importer Data

We construct matched exporter–importer data for Mexican textile/apparel exports to the US from Mexico's customs records. The dataset covers years from June 2004 to December 2011 and products whose the first two digit HS codes range from HS50 to HS63. For each pair of Mexican exporter and US importer that trade in a HS 6 digit product in a year, the dataset contains the following information: (1) exporter-ID; (2) importer-ID; (3) year; (4) the 6 digit HS product code; (5) value of annual shipment (in US dollars); (6) quantity and unit; and (7) an indicator of a duty free processing reexport program (the Maquiladora/IMMEX program); and other information.

Data cleaning drops some information. Appendix explains the construction of the dataset. First, we drop exports by individuals or couriers (e.g. FedEx) to focus on firm-to-firm matching. Second, we drop products traded by only one exporter or only one importer in any year as these products have no matching problem.[5] Third,

[5]These dropped products constitute 3-7% of total textile/apparel trade volume in each year.

since the customs records for 2004 are available only from June to December, we drop observations from January to May for other years to make each year's information comparable. We obtain similar results when including January-to-May data. Third, we drop exporters who do not report importers for most transactions. Information of importers is missing for some records under the Maquiladora/IMMEX program where exporters do not need to report importer information for each shipment.[6] For a given HS6 product and a given year, we drop exporters if their export value lacking importer information constitute more than 20 percent of the exporter's annual export value. This results in dropping approximately 30–40 percent of exporters and 60–70 percent of export value. To address a potential selection problem from dropping Maquiladora/IMMEX exporters, we compare Maquiladora/IMMEX exporters and other normal exporters in almost all empirical analyses below.

2.2 Approximately One-to-one Matching at Product Level

Table 1 reports mean and median statistics about matching of Mexican exporters and US importers in one HS 6 digit product market. Rows (1) and (2) show how many exporters and importers exist, respectively, while Rows (3) and (4) show how many partners an exporter and an importer actually trade with, respectively. If all exporters trade with all importers as the love of variety model predicts, Row (1) should equal to (3) and Rows (2) should do to (4), respectively, but the actual numbers of partners in Rows (3) and (4) are extremely small. While on average 11–15 exporters and 15–20 importers exist in one product market, the majority of

[6]The Maquiladoras program started in 1986 and was replaced by the IMMEX (Industria Manufacturera, Maquiladora y de Servicios de Exportation) program in 2006. In the Maquiladoras/IMMEX program, firms in Mexico can import materials and equipments duty free if the firms export products assembled using them. To be eligible for the program, exporters must register the foreign buyers' information in advance but do not need to report it for each shipment.

firms trade with only one partner in one year.[7] Counting just the number of partners masks the concentration of trade volume to few partners. For each product–year combination, we identify each firm's "main partner," i.e., the partner with whom the firm trades the most. Rows (5) and (6) in Figure 1 show that even firms who trade with multiple partner concentrates more than 70% of trade volume with their main partners.

To assess how overall transactions in one product are concentrated to few-to-few relationship, we develop a new measure. We define "main-to-main trade" as trade in which the exporter is the main partner of the importer and simultaneously the importer is the main partner of the exporter. Then, we define "main-to-main share" as the share of main-to-main trade out of the total trade volume. If matching is one-to-one in each product market, this share takes the maximum value, which is one. Even if some firms trade with multiple partners, the main-to-main share is still close to one when these firms concentrate their trade with their respective main partners.

Column (1) in Table 2 reports the main-to-main share for Mexico's textile/apparel exports to the US. The main-to-main share is approximately 80 percent, which is stable across years. Trade between one-to-one matches of the main partners constitutes 80% of textile/apparel trade volumes. Two panels in Figure 1 draw the distribution of main-to-main share across product-year combinations. A histogram in the left panel strikingly shows that main-to-main shares exceed 0.9 for most combinations with the median 0.97 and the 25 percentile 0.86. The right panel in Figure 1 plots main-to-main shares against the maximum of the number of importers (n_m)

[7] Numbers in Rows (1) to (4) in Table 1 appear smaller than those in other studies such as Blum et al. (2010, 2011), Bernard et al. (2013), and Carballo et al. (2013). This is probably because they report matches at the country level in their main tables, while we report matches at the product–country level, which identifies fewer partners for firms trading multiple products. When a match is defined at the country level, the numbers in Rows (1) to (4) in Table 1 increase and become similar to other studies.

and that of exporters (n_x), $\max\{n_m, n_x\}$.[8] An estimated Lowess curve is above 0.80 and almost horizontal, which implies that main-to-main share is not related with the number of firms.

Columns (2) to (5) in Table 2 investigate whether high main-to-main share is due to two unique features of Mexico-US textile/apparel trade. First, Mexico-US trade contains a large amount of processing reexports through the Maquiladora/IMMEX program. Under the program, exporters must register importers in advance and these registration costs might lead firms to trade with only a small number of partners. Columns (2) and (3) report the main-to-main shares of Maquiladora/IMMEX trade and other normal trade, respectively.[9] They are very similar, so high main-to-main share is not likely to be specific to processing reexports. Second, Mexico-US textile/apparel trade experienced a drastic change in the level of trade protection. Until 2004, the US imposed quota on some textile/apparel products imported from countries outside the NAFTA, notably China. Columns (4) and (5) report main-to-main shares for products for which Chinese exports to the US were subject to binding quotas until 2004 and other textile/apparel products, respectively. Because both columns reports similar numbers, neither high trade barriers nor their removal is likely to cause high main-to-main shares.

In short, most of textile/apparel products exported from Mexico to the US flow one-to-one matching of the main partners. Therefore, understanding how firms choose the main partners is crucial for understanding product trade.

[8]For instance, the love of variety model with symmetric firms predicts main-to-main share equals $1/\max\{n_m, n_x\}$. Figure 1 remains similar when the vertical axis expresses either n_m or n_x.

[9]To calculate columns (2) and (3), we treat Maquiladora/IMMEX trade and other normal trade in a given HS 6 digit product as two different products. This means that numbers in column (1) does not necessarily fall between numbers in columns (2) and (3).

2.3 End of the Multifibre Arrangement

The Mexico-US textile/apparel trade experienced a large scale trade liberalization in 2005, the end of the Multifibre Arrangement (MFA). The MFA and its successor, the Agreement on Textile and Clothing, are agreements on quota restrictions regarding textile/apparel imports among GATT/WTO member countries. At the GATT Uruguay round, the US (together with Canada, the EU, and Norway) promised to abolish their quotas in four steps (1995, 1998, 2002, and 2005). At each removal, liberalized products constituted 16, 17, 18, and 49% of imports in 1990, respectively. The end of the MFA in 2005 is the largest liberalization.

There are several studies on the impact of the 2005 quota removal. We highlight three facts from previous studies.

Surge in Chinese Exports to the US According to Brambilla, Khandelwal, and Schott (2010), US imports from China disproportionally increased by 271% in 2005, whereas imports from almost all other countries decreased. Following Brambilla et al. (2010), we classify each HS-10 digit textile/apparel product in two groups. The first "treatment group" consists of products for which Chinese exports to the US are subject to binding quota in 2004, while the second "control group" consists of other textile/apparel products. The left panel in Figure 2 displays Chinese exports to the US form 2000 to 2010 for the treatment group with a dashed line and the control group with a solid line. After the 2005 quota removal, Chinese exports of the treatment group increased much faster than the control group.[10]

[10]Seeing this substantial surge in import growth, the US and China had agreed to impose new quotas until 2008, but imports from China never dropped back to the pre-2005 levels. This reflects the fact that (1) new quota system covered fewer product categories than the old system (Dayaranta-Banda and Whalley, 2007), and (2) the new quotas levels were substantially greater than the MFA levels (see Table 2 in Brambilla et al., 2010).

Exports by New Chinese Entrants with Various Capability Levels Using Chinese customs transaction data, Khandelwal, Schott, and Wei (2013) decompose the increases in Chinese exports to US, Canada, and the EU after the quota removal into intensive and extensive margins. They find that increases in Chinese exports of the treatment group were mostly driven by the entry of Chinese exporters who had not previously exported these products. Furthermore, these new exporters are much more heterogeneous in capability than incumbent exporters, with many new exporters being more capable than incumbent exporters.[11]

Mexican Exports Face Competition from China Mexico already had tariff- and quota-free access to the US market through the North American Free Trade Agreement (NAFTA).[12] With the MFA's end, Mexico lost its advantage to third-country exporters, thus facing increased competition with Chinese exporters in the US market. The right panel in Figure 2 shows Mexican exports to the US from 2000 to 2010 for the treatment group (dashed line) and for the control group (solid line). The figure shows that the two series had moved in parallel before 2005, whereas the treatment group significantly declined after 2005. The parallel movement of the two series before 2005 suggests that the choice of products for quota removal in 2005 was exogenous to Mexican exports to the US.

[11] Khandelwal et al. (2013) offer two pieces of evidence. First, while incumbent exporters are mainly state-owned firms, new exporters include private and foreign firms. Private and foreign firms are typically more productive than state-owned firms. Second, the distribution of unit prices for new entrants has a lower mean but a greater support than that of unit prices of incumbent exporters. Khandelwal et al. (2013) show that these findings contradict with predictions of optimal quota allocation and suggest inefficient quota allocations as the cause.

[12] The NAFTA liberalized the US market to Mexican exports in 1994, 1999, and 2003.

3 The Model

3.1 A Matching Model of Exporters and Importers

We develop a matching model of team production.[13] The model includes three types of continuum of firms, namely, US final producers, Mexican suppliers, and Chinese suppliers. A US final producer matches with a supplier from either Mexico or China to form a team that produces one variety of differentiated final goods. Once teams are formed, suppliers tailor intermediate goods for a particular variety of final goods; therefore, firms transact intermediate goods only within their team. Each firm joins only one team.

Firms' capabilities are heterogeneous. Capability reflects either productivity or quality, depending on the model's other parameters. Let x and y be the capability of final producers and suppliers, respectively. There is a fixed mass M_U of final producers in the US, M_M of suppliers in Mexico, and M_C of suppliers in China. The cumulative distribution function (c.d.f.) for the capability of US final producers is $F(x)$ with continuous support $[x_{min}, x_{max}]$. The capability of Mexican and Chinese suppliers follows an identical distribution, and the c.d.f. is $G(y)$ with continuous support $[y_{min}, y_{max}]$. The maximums x_{max} and y_{max} may be positively infinite (e.g., F and G may be Pareto distributions). For simplicity, a Chinese supplier is a perfect substitute for a Mexican supplier of the same capability. An identical capability distribution of Chinese and Mexican suppliers is assumed for the graphical expositions of comparative statics results and not essential for the main predictions.

Teams' capabilities are heterogeneous. Team capability $\theta(x, y)$ is an increasing function of team members' individual capability, $\theta_1 \equiv \partial\theta(x, y)/\partial x > 0$ and

[13] Our model is a partial equilibrium version of Sugita (2015) wherein firm entry is endogenous and international matching arises from Ricardian comparative advantage in a two-country general equilibrium model.

$\theta_2 \equiv \partial\theta(x,y)/\partial y > 0$. The model has two stages. In Stage 1, teams are formed under perfect information. Matching endogenously determines the distribution of team capability. In Stage 2, teams compete in the US final good market in a monopolistically competitive fashion.

The US representative consumer maximizes the following utility function:

$$U = \frac{\delta}{\rho}\ln\left[\int_{\omega\in\Omega}\theta(\omega)^{\alpha}q(\omega)^{\rho}d\omega\right] + q_0 \text{ s.t. } \int_{\omega\in\Omega}p(\omega)q(\omega)d\omega + q_0 = I.$$

where Ω is a set of available differentiated final goods, ω is a variety of differentiated final goods, $p(\omega)$ is the price of ω, $q(\omega)$ is the consumption of ω, $\theta(\omega)$ is the capability of a team producing ω, q_0 is consumption of a numeraire good, I is an exogenously given income. $\alpha \geq 0$ and $\delta > 0$ are given parameters. Consumer demand for a variety with price p and capability θ is derived as $q(p,\theta) = \delta\theta^{a\sigma}P^{\sigma-1}p^{-\sigma}$, where $\sigma \equiv 1/(1-\rho) > 1$ is the elasticity of substitution and $P \equiv \left[\int_{\omega\in\Omega}p(\omega)^{1-\sigma}\theta(\omega)^{\alpha\sigma}d\omega\right]^{1/(1-\sigma)}$ is the price index.

Production technology is of Leontief type. When a team produces q units of final goods, the team supplier produces q units of intermediate goods with costs $c_y\theta^{\beta}q + f_y$; then, using them, the final producer assembles these goods into final goods with costs $c_x\theta^{\beta}q + f_x$. The total costs for a team with capability θ producing q units of final goods are

$$c(\theta,q) = c\theta^{\beta}q + f, \tag{1}$$

where $c \equiv c_x + c_y$ and $f \equiv f_x + f_y$. Each firm's marginal costs are assumed to depend on the entire team's capability. This assumption is mainly for simplicity, but it also expresses externality within teams that makes firms' marginal costs to depend on their partner's capability and their own capability.[14]

[14] An example of a within-team externality is costs of quality control. Producing high quality final goods might require extra costs of quality control at each production stage because even one de-

Team capability θ may represent productivity and/or quality, depending on parameters α and β. For instance, when $\alpha = 0$ and $\beta < 0$, all teams face symmetric demand functions, while a team with high θ has lower marginal costs. Teams behave as firms in the Melitz model, and accordingly, θ may be called productivity. When $\alpha > 0$ and $\beta > 0$, a team with high capability faces a large demand at a given price and simultaneously pays high marginal costs. Teams behave as firms in e.g. Baldwin and Harrigan (2011), Johnson (2012), and Verhoogen (2008) and θ may be called quality.

We obtain an equilibrium by backward induction. Calculations are given in Appendix.

Stage 2 Team's optimal price is $p(\theta) = c\theta^{\beta}/\rho$. Hence, a team revenue $R(\theta)$, total costs $C(\theta)$, and joint profits $\Pi(\theta)$ are

$$R(\theta) = \sigma A\theta^{\gamma},\ C(\theta) = (\sigma - 1) A\theta^{\gamma} + f,\ \text{and}\ \Pi(\theta) = A\theta^{\gamma} - f. \tag{2}$$

where $A \equiv \frac{\delta}{\sigma}\left(\frac{\rho P}{c}\right)^{\sigma-1}$ summarizes factors that (infinitesimal) individual teams take as given. We assume $\gamma \equiv \alpha\sigma - \beta(\sigma - 1) > 0$ so that team profits increase in team capability. Furthermore, since comparative statics on parameters α, β, and σ is not our main interest, we normalize $\gamma = 1$ by choosing the unit of θ. This normalization greatly simplifies the calculations below.

Since production requires fixed costs, there is a cutoff for team capability θ_L such that only teams with $\theta \geq \theta_L$ produce outputs. Let M and $H(\theta)$ be the mass and capability distribution of active teams. Let $\Theta \equiv M \int_{\theta_L} \theta dH(\theta)$ be the aggregate

fective component can destroy the whole product (Kremer, 1993). Another example is productivity spillovers. Through teaching and learning (e.g. joint R&D) within a team, each member's marginal cost depends on the entire team capability.

capability of active teams. The cutoff team capability is determined by

$$A\theta_L = \frac{\delta\theta_L}{\sigma\Theta} = f. \tag{3}$$

Stage 1 Firms choose their partners and decide how to split team profits, taking A as given. Profit schedules, $\pi_x(x)$ and $\pi_y(y)$, and matching functions, $m_x(x)$ and $m_y(y)$, characterize equilibrium matching. A final producer with capability x matches with a supplier having capability $m_x(x)$ and receives the residual profit $\pi_x(x)$ after paying profits $\pi_y(m_x(x))$ to the partner. Let $m_y(y)$ be the inverse function of $m_x(x)$ where $m_x(m_y(y)) = y$ and a supplier with capability y matches with a final producer with capability $m_y(y)$.

We focus on stable matching that satisfies the following two conditions: (i) *individual rationality*, wherein all firms earn non-negative profit, $\pi_x(x) \geq 0$ and $\pi_y(y) \geq 0$ for all x and y and (ii) *pair-wise stability*, wherein each firm is the optimal partner for the other team member[15]

$$\begin{aligned}
\pi_x(x) &= A\theta(x, m_x(x)) - \pi_y(m_x(x)) - f = \max_y A\theta(x,y) - \pi_y(y) - f \\
\pi_y(y) &= A\theta(m_y(y), y) - \pi_x(m_y(y)) - f = \max_x A\theta(x,y) - \pi_x(x) - f.
\end{aligned} \tag{4}$$

The first order conditions for the maximization in (4) are

$$\pi_y'(m_x(x)) = A\theta_2(x, m_x(x)) > 0 \text{ and } \pi_x'(m_y(y)) = A\theta_1(m_y(y), y), \tag{5}$$

which proves that profit schedules are increasing in capability. Thus, capability cutoffs x_L and y_L exist such that only final producers with $x \geq x_L$ and suppliers with

[15] Roth and Sotomayor (1990) and Browning, Chiappori and Weiss (2014) are excellent textbooks of matching models.

$y \geq y_L$ engage in international trade. These cut-offs satisfy

$$\pi_x(x_L) = \pi_y(y_L) = 0 \text{ and } M_U[1 - F(x_L)] = (M_M + M_C)\,[1 - G(y_L)]\,. \tag{6}$$

The second condition in (6) indicates that the number of suppliers in the matching market is equal to the number of final producers.

Differentiating the first order condition (5) by x, we obtain

$$m_x'(x) = \frac{A\theta_{12}}{\pi_y'' - A\theta_{22}}, \text{ where } \theta_{12} \equiv \frac{\partial^2\theta}{\partial x \partial y} \text{ and } \theta_{22} \equiv \frac{\partial^2\theta}{\partial y^2}.$$

Since the denominator is positive from the second order condition, the sign of cross derivatives θ_{12} determines the sign of $m_x'(x)$, i.e. the sign of sorting in stable matching (e.g. Becker, 1973). For simplicity, we consider three cases where the sign of θ_{12} is constant for all x and y: (1) Case C (Complement) $\theta_{12} > 0$; (2) Case I (Independent) $\theta_{12} = 0$; (3) Case S (Substitute) $\theta_{12} < 0$.[16] In Case C, we have positive assortative matching (PAM) ($m_x'(x) > 0$): high capability firms match with high capability firms whereas low capability firms match low capability firms. In Case S, we have negative assortative matching (NAM) ($m_x'(x) < 0$): high capability firms match low capability firms. In Case I, we cannot determine a matching pattern (i.e. $m_x(x)$ cannot be defined as a function) because each firm is indifferent about partner's capability. Therefore, we assume matching is random in Case I.

We focus on Case C and Case I in the main text of the paper and discuss Case S in Appendix for two reasons. First, our empirical analysis supports Case C but rejects Case I and Case S. Second, Case I is a useful benchmark because it nests

[16] In Case C and Case S, θ is also called strict supermodular and strict submodular, respectively. An example for Case C is the complementarity of quality of tasks in a production process (e.g. Kremer, 1993). For instance, a high-quality car part is more useful when combined with other high-quality car parts. An example for Case S is technological spillovers through learning and teaching. Gains from learning from high capable partners might be greater for low capability firms. See e.g. Grossman and Maggi (2000) for further examples on Case C and Case S.

traditional models where firm heterogeneity exists only in one side of the market, i.e. either among exporters ($\theta_1 = \theta_{12} = 0$) or among importers ($\theta_2 = \theta_{12} = 0$).

In Case C, the matching function $m_x(x)$ is determined to satisfy the following "matching market clearing" condition.

$$M_U \left[1 - F(x)\right] = \left(M_M + M_C\right) \left[1 - G\left(m_x(x)\right)\right] \text{ for all } x \geq x_L, \tag{7}$$

The left hand side of (7) is the mass of final producers that have higher capability than x and the right hand side is the mass of suppliers who match with them. Under PAM, these are suppliers with higher capability than $m_x(x)$. Figure 3 describes how matching function $m_x(x)$ is determined for a given $x \geq x_L$. The width of the left rectangle equals the mass of US final producers, whereas the width of the right rectangle equals the mass of Mexican and Chinese suppliers. The left vertical axis expresses the value of $F(x)$ and the right vertical axis indicates the value of $G(y)$. The left gray area is equal to the mass of final producers with higher capability than x and the right gray area is the mass of suppliers with higher capability than $m_x(x)$. The matching market clearing condition (7) requires the two areas to have the same size for all $x \geq x_L$.

An equilibrium is obtained as follows (see Appendix for calculation). In Case C, matching function $m_x(x)$ derived from (7) determines the aggregate capability $\Theta(x_L) = M_U \int_{x_L}^{\infty} \theta(x, m_x(x))\, dF(x)$ and the team capability cutoff $\theta_L(x_L) = \theta(x, m_x(x_L))$ as functions of x_L. In Case I, let $\theta(x, y) \equiv \theta^x(x) + \theta^y(y)$. Condition (6) determines $y_L(x_L)$ as a function of x_L. The aggregate capability $\Theta(x_L) = M_U \int_{x_L}^{\infty} \theta^x(x)\, dF(x) + (M_M + M_C) \int_{y_L(x_L)}^{\infty} \theta^y(y) dG(y)$ and the team capability cutoff $\theta_L(x_L) = \theta^x(x_L) + \theta^y(y_L(x_L))$ become functions of x_L. Finally, in both Case C and Case I, the team cutoff condition (3) determines a unique x_L since $\Theta(x_L)$ is decreasing and $\theta_L(x_L)$ is increasing in x_L

3.2 Consequences of Chinese Entries

Using this model, we analyze the impact of Chinese entries at the end of the MFA on matching between US final producers and Mexican suppliers. As discussed in section 2.3, the end of the MFA induced the entry of new Chinese exporters with various capability levels into the US market. Thus, we model this event as an exogenous increase in the mass of Chinese suppliers ($dM_C > 0$) in the US market. For simplicity, we assume positive but negligible costs for switching partners so that a firm changes its partner only if it strictly prefers the new match over the current match.

Case C

Figure 4 shows how matching functions change from $m_x^0(x)$ to $m_x^1(x)$ for given capability x. Area A expresses US importers with capabilities higher than x. They initially match with suppliers in areas $B+C$ who have higher capability than $m_x^0(x)$. After the entry of Chinese exporters, the original matches become unstable because some US importers are willing to switch their partners to new Chinese exporters. In the new matching, final producers in area A matches with suppliers in areas $B + D$ who have higher capability than $m_x^1(x)$. A US final producer with a capability x switches its main partner from the one with capability $m_x^0(x)$ to the one with the higher capability $m_x^1(x)$. We call this change "partner upgrading" by US final producers. This in turn implies "partner downgrading" by Mexican suppliers. Mexican suppliers with capability $m_x^1(x)$ used to match with final producer with strictly higher capability than x prior to the entry of Chinese suppliers. Finally, not all Mexican suppliers can match with new US partners. Mexican suppliers with low capability must exit from the US market, which is formally proved in Appendix.

We summarize predictions that can be identified in exporter-importer matched

data of Mexico's textile/apparel exports to the US. Since the data covers only Mexico-US trade, we focus on firms engaging in Mexico-US trade both before and after the event of the MFA end. We call these firms *US continuing importers* and *Mexican continuing exporters*. Then, we summarize four predictions for Case C.

C1 US continuing importers switch their Mexican partners to those with higher capability (partner upgrading).

C2 Mexican continuing exporters switch their US partners to those with lower capability (partner downgrading).

C3 PAM hold both before and after China's entry.

C4 Mexican exporters with low capability exit form the US market.

Case I

In Case I, firms are indifferent about their partner's capability. Even negligible switching costs prohibit any change in matching. Continuing exporters and importers do not change their partners because all incumbent firms are indifferent to them. Facing the increase in Chinese exporters, low capability Mexican suppliers must exit from the US market, which is shown in Appendix.

I1 US continuing importers do not change their Mexican partners.

I2 Mexican continuing exporters do not change their US partners.

I3 Matching is random before and after China's entry.

I4 Mexican exporters with low capability exit form the US market.

Rematching Gain from Trade The entry of Chinese exporters causes two types of adjustments. First, new suppliers with high capability replace low capability suppliers. Second, in Case C, it causes rematching among incumbent firms. We show each of these two adjustments lowers the price index and benefits the consumer.

To see the effect of each adjustment, we consider a "no-rematching" equilibrium where no rematching occurs among incumbents and firms switch their partners only if their partners exit from the market. Label variables in this no-rematching equilibrium by "NR", those before the entry by "B", and those after the entry by "A". Then, the effect of the entry of new Chinese exporters on the price index $P^B - P^A$ is decomposed into the replacement effect $P^B - P^H$ and the rematching effect $P^H - P^A$ in the following lemma.

Lemma 1. *In Case C,* $P^A < P^{NR} < P^B$*, while in Case I,* $P^A = P^{NR} < P^B$*.*

The proof is given in Appendix. The rematching effect is zero in Case I because matching is irrelevant in Case I, while the rematching effect creates an additional consumer gain in Case C. This consumer gain comes from the increase in aggregate capability. Since the price index can be written as $P = c/\left(\rho\Theta^{1/(\sigma-1)}\right)$, the aggregate capability index also satisfies $\Theta^A > \Theta^{NR} > \Theta^B$ in Case C. The reason for the aggregate capabilty gain comes from a classic theorem in the matching theory that a stable matching i.e. PAM maximizes the aggregate payoffs of the participants (i.e. $A\Theta - Mf$ for given A) (Koopmans and Beckmann, 1957; Shapley and Shubik, 1972; Gretsky, Ostroy and Zame, 1992). In the rest of the paper, we examines whether data conforms rematching and other predictions.

4 Empirical Strategies

4.1 Proxy for Capability Rankings

To test predictions C1-C4 and I1-I4 need data on capability of US importers and that of Mexican exporters. Estimating capability measures such as total factor productivity (TFP) at the firm-product level is one strategy but extremely difficult. Instead, we create proxy for firm capability, using a property of our model.

The basic idea is that a firm's trade volume increases in its capability in Case C and Case I. Thus, we can use the ranking of firm's trade volume as proxy for the ranking of capability in Case C and Case I. To see this point, note that trade volume within a match $T(x, y)$ is equal to supplier's costs plus supplier's profit: $T(x, y) = \left[\frac{c_x}{c} C(\theta(x, y)) + f_x\right] + \pi_y(y)$. From (2) with $\gamma = 1$, $T(x, y)$ turns to be increasing in member's capability:

$$\frac{\partial T}{\partial x} = \frac{c_x}{c}(\sigma - 1) A\theta_1 > 0 \text{ and } \frac{\partial T}{\partial y} = \frac{c_x}{c}(\sigma - 1) A\theta_2 + \pi_y'(y) > 0. \tag{8}$$

In Case C, from $m_x'(x) > 0$ and $m_y'(y) > 0$, both import volumes by US importers $I(x) = T(x, m_x(x))$ and export volumes by Mexican suppliers $X(y) = T(m_y(y), y)$ increase in their own capabilities, respectively. In Case I, we consider expected import volumes by US importer with given capability x, $\bar{I}(x) = \int_{y_L}^{y_{max}} T(x, y) dG(y)$, and expected export volumes by Mexican exporters with given capability y, $\bar{X}(y) = \int_{x_L}^{x_{max}} T(x, y)\, dF(x)$. From (8), both increase in their own capabilities.

For each product we create a ranking of US continuing importers by their imports from their main partner in 2004. From the monotonicity of import volumes and capability ($I'(x) > 0$), this ranking should agree with the true capability ranking of US continuing importers in Case C and on average so in Case I. Similarly,

for each product we rank Mexican continuing exporters by their exports to their main partner in 2004, which should also agree with the true capability ranking of Mexican exporters in Case C and on average in Case I.

We assume that the capability ranking in a fixed set of firms is stable during our sample period 2004–2007. Thereafter, we use the rank measured from 2004 data for the same firm throughout our sample period 2004–2007. We measure the capability rankings only for Mexican continuing exporters and US continuing importers that engaged in the Mexico–US trade between 2004 and 2007. As a robustness check, we also create rankings based on total product trade volumes in 2004 aggregated across partners and rankings based on unit prices.

4.2 Specifications

Partner Changes (C1, C2, I1, and I2)

To test predictions on partner changes (C1, C2, I1, and I2), we estimate the following regressions:

$$\begin{aligned} Up^c_{igs} &= \beta^c_U Binding_{gs} + \lambda_s + \varepsilon^c_{Uigs} \\ Down^c_{igs} &= \beta^c_D Binding_{gs} + \lambda_s + \varepsilon^c_{Digs}, \end{aligned} \tag{9}$$

where c, i, g, and s index a country (US and Mexico), a firm, a HS6 digit product, and a sector (HS2 digit level), respectively. Dummy variable Up^c_{igs} equals one if during 2004-07, firm i in country c switched its main partner for product g to a firm with a higher capability rank. Dummy variable $Down^c_{igs}$ equals one if the firm switched to a firm with a lower capability rank. By construction, Up^c_{igs} and $Down^c_{igs}$ are defined only for US continuing importers and Mexican continuing exporters. We choose the sample period of 2004-07 because the 2008 Lehman crisis, which

greatly reduced Mexican exports to the US, potentially confounds the impact of the MFA's end. Dummy variable $Binding_{gs}$ equals one if Chinese exports of product g to the US faced a binding quota in 2004, which is constructed from Brambilla et al. (2010). λ_s represents HS-2 digit-level sector fixed effects. u^c_{igs} and ε^c_{ijs} are error terms. We drop HS 2 sectors (HS 50, 51, 53, 56, 57, and 59) in which there is no variation of the binding dummy at HS 2 digit level. Appendix explains the construction of the binding dummy and other variables.

The coefficients of interest in (9) are β^c_U and β^c_D. With HS-2 digit product fixed effects, these coefficients are identified by comparing the treatment and control groups within the same HS-2 digit sector level. The treatment is the removal of binding quotas on Chinese exports to the US ($Binding_{gs} = 1$). The coefficients β^c_U and β^c_D estimate its impact on the probability that firms will switch their main partner to ones with higher or lower capabilities.

Prediction I1 and I2 for random matching predicts that in response to the entry of Chinese exporters, continuing US importers and Mexican exporters would not change their partners. In reality, other shocks inducing partner changes may exist. A virtue of our treatment-control group comparison is that we can distinguish the effect of the MFA's end from the effects of these other shocks if the latter symmetrically affected both groups. Considering this point, we reformulate the prediction for Case I: no difference should exist in the probability of partner changes in any direction between treatment and control groups. In our regressions (9), this prediction corresponds to $\beta^{US}_U = \beta^{US}_D = \beta^{Mex}_U = \beta^{Mex}_D = 0$.

Prediction C1 and C2 for PAM predicts that in response to the entry of Chinese exporters, all continuing US importers upgrade whereas all continuing Mexican exporters downgrade their main partners. Though the model with frictionless matching predicts all firms will change their partners, other factors such as transaction costs are likely to exist that prevent some firms from changing partners, at least in

the short run. Again, our treatment-control group comparison can control for these other factors as long as they symmetrically affect both groups. Accordingly, we reformulate the prediction for Case C: US importers' partner upgrading and Mexican exporters' partner downgrading will occur more frequently in the treatment group than in the control group. In our regressions (9), this prediction corresponds to $\beta_U^{US} > 0$, $\beta_D^{US} = \beta_U^{Mex} = 0$, and $\beta_D^{Mex} > 0$.

PAM before and after Shock (C3 and I3)

To test predictions C3 and I3, we compare old partners in 2004 and new partners in 2007 in terms of their ranks for firms who switch their partners. To make products comparable, we divide firm ranks by the possible maximum rank of the product (i.e. the number of firms) so as to fall in $[0, 1]$. Then, we estimate the following regression for firm's who switch their partners between 2004 and 2007:

$$NewPartnerRank_{ig}^c = \alpha^c + \gamma^c OldPartnerRank_{ig}^c + \varepsilon_{ig}^c, \tag{10}$$

where $OldPartnerRank_{ig}^c$ and $NewPartnerRank_{ig}^c$ are the normalized ranks of firm i's main partners in 2004 and 2007, respectively. Note that both ranks are based on trade volume in 2004. Case C PAM predicts a positive correlation $\gamma^c > 0$, while Case I random matching predicts no correlation $\gamma^c = 0$.

There are two remarks. First, if we run (10) only for firms that do not change partners, then β_R^c equals to one by construction. To avoid this mechanical correlation, we estimate (10) only for firms who change partners. Second, regression (10) combines both the treatment and control groups since PAM should hold for both groups. For instance, if there exists any industry-wide shock such as exchange rate appreciation that induces Mexican exporter's partner downgrading in both treatment and control groups, the model with PAM predicts $\gamma^c > 0$ for both groups.

Small Exporter's Exit after Shock (C4 and I4)

Finally, we test predictions C4 and I4 about the impact of liberalization on Mexican exporters' exit from the US. To control for intrinsic differences between treatment and control groups, we conduct a difference-in-difference comparison of firm exit rates between groups for two periods of pre-liberalization (2001-04) and post liberalization (2004-07). Since Mexican customs data before 2004 have no information on importers, we use Mexican exporter's total product export volume as proxy for capability, which is highly correlated with exports with the main partners in 2004-07 data. Then, we estimate the following regression:

$$\begin{aligned} Exit_{igsr} = \delta_1 Binding_g + \delta_2 Binding_g * After_r + \delta_3 After_r + \delta_4 \ln Exports_{igr} \\ + \delta_5 After_r * \ln Exports_{igr} + \lambda_s + \delta_Z Z_{igrs} + u_{igsr}. \end{aligned} \tag{11}$$

Dummy variable $Exit_{igsr}$ equals one if Mexican firm i who exports product g to the US in the initial year of period r stops exporting during period r. Dummy variable $Binding_{gs}$ equals one if Chinese exports of product g to the US faced a binding quota in 2004. Dummy variable $After_r$ equals one if period r is 2004-07 (after the end of the MFA). $\ln Exports_{igr}$ is the log of firm $i's$ total export volume of product g in the initial year of period r. Z_{igrs} is a collection of control variables. λ_s represents HS-2 digit-level sector fixed effects. u^c_{igs} and ε^c_{ijs} are error terms.

The above specification is motivated by a simple threshold model of exit. Suppose that Mexican supplier i receives a random i.i.d. shock ε_{ir} to its profits in each period r, which captures idiosyncratic factors inducing firm exit. The firm chooses to exit if ε_{ir} is below a threshold $\bar{\varepsilon}_{ir}(y)$, that is, firm i's exit probability is $\Pr(\varepsilon < \bar{\varepsilon}_{ir}(y))$. The models in Case C and in Case I have two predictions. First, threshold $\bar{\varepsilon}_{ir}(y)$ is a decreasing function in the firm's capability y. Second, Chinese

entries at the end of the MFA as well as other negative shocks increase threshold $\bar{\varepsilon}_{ir}(y)$. Based on positive correlations between firm's capability and trade volume, these two predictions are expressed as: (1) $\delta_4 < 0$ and $\delta_4 + \delta_5 < 0$, i.e. small low capability firms are more likely to exit; (2) $\delta_2 > 0$, i.e. Chinese entries at the end of the MFA increase exit probability for a given capability level.

5 Results

5.1 Partner Changes

Table 3 report regressions for partner changes during 2004–07 using linear probability models.[17] Columns with odd numbers reports estimates of β_U^{US}, β_D^{US}, β_U^{Mex}, and β_D^{US} from baseline regressions (9). We find that β_U^{US} in Column (1) and β_D^{Mex} in Column (7) are positive and statistically significant, while β_D^{US} in Column (3) and β_U^{Mex} in Column (5) are close to and not statistically different from zero. The removal of binding quotas from Chinese exports increased the probability of US importers upgrading partners by 5.2 percentage points and the probability of Mexican exporters downgrading partners by 12.7 to 15 percentage points. These effects are quantitatively large when compared with the probability of partner changes in the overall sample: 3 percentage points for the US importer upgrading and 15 percentage points for the Mexican exporter downgrading. On the other hand, no difference exists in probabilities of partner downgrading byUS importers and partner upgrading by Mexican exporters between treatment and control groups. These signs of the estimates support PAM Case C and reject random matching Case I.

Columns with even numbers in Table 3 report regressions adding the firm's normalized rank in 2004 ($OwnRank$) and its interaction with the Binding dummy

[17] Probit regressions provide very similar results for all regressions.

to investigate whether partner changes are concentrated into high or low capability firms. The coefficients of interaction terms are estimated small and statistically insignificant, while the coefficients of the binding dummy remain similar to the baseline estimates. This means that both large and small switch their partners, consistently with the model of Case C.

Panel A in Table 4 reports estimates of β_D^{US} and β_U^{Mex} by changing the end year to 2006, 2007, or 2008. This exercise shows two things. First, β_D^{US} and β_U^{Mex} remain statistically significant, showing that our findings are not sensitive to the choice of end year. Second, estimates of β_D^{US} and β_U^{Mex} in later periods such as 2004-07 and 2004-08 are larger than those in an early period 2004-06. This suggests partner changes occur gradually over time, probably due to certain partner switching costs.

Panel B in Table 4 examines our assumption that the treatment and control groups would exhibit similar patterns in partner changes in absence of the treatment. To compare partner changes between the two groups before 2004 is one way to check this assumption, but not feasible since our data contain information only from June 2004.[18] Instead, we compare partner changes of the two groups in later period, 2007-11 and 2009-11. If the economy largely completes the transition from an old to new equilibrium by 2007, we should not observe any difference in partner changes between the two groups. For each period with a different initial year from 2007 to 2009, we construct a capability ranking based on trade volume in the new initial year and recreate the upgrading/downgrading dummies.

Panel B in Table 4 report very small and insignificant estimates of β_D^{US} and β_U^{Mex} for 2007–2011 [Columns (7) and (10)] and 2009–2011 [Columns (9) and (12)]. These results support our assumption. The period 2008–2011 [Columns (8) and (11)] shows a very different pattern from other two periods. One possible

[18] At the aggregate level, Figure 2 demonstrates the absence of differential time trends in the aggregate export volumes before the MFA quota removal in 2005.

reason is the effect of the Lehman crisis and the Great Trade Collapse of 2008-09. As exports from other countries, Mexican exports declined by a huge amount in the second half of 2008. This shock might introduce noise into the rankings. Overall, we find no evidence that potential differential trends across product groups account for our baseline results.

Finally, Table 5 controls for product and firm characteristics in 2004 before liberalization. In Appendix, we examine whether product and firm characteristics significantly differ between the treatment and control groups that might affect partner changes. Table 5 includes characteristics that are statistically different between the two groups within HS two digit products. Panel A includes product-level characteristics: the number of exporters and importers ($\#Exporters$ and $\#Importers$, respectively), the log of product level trade volume ($lnTotalTrade$), and product type dummies on whether products are for men, women, or not specific to gender and those on whether products are made of cotton, wool, or man-made (chemical) textiles. Panel B includes firm-product level characteristics: a log of firm's product trade volume with the main partner($lnTrade$), the share of Maquladora/IMMEX trade in firm's product trade ($Maquiladora$), the number of partners ($\#Partners$), and a dummy on whether a US importer is an intermediary firm such as wholesalers and retailers ($US\ Intermediary$). With these additional controls, estimates of β_D^{US} and β_U^{Mex} remain statistically significant and similar in magnitude.

5.2 PAM among New Partners

Figure 5 report regressions (10) with corresponding scatter plots. The left panel draws the normalized ranks of old partners in the horizontal axis and those of new partners in the vertical axis for those US importers who change their main partners between 2004 and 2007. The right panel draw a similar plot for Mexican exporters.

The lines represents OLS regressions (10). Figure 5 and regressions show significant positive relationships. This means that firms who match with relatively high capable partners in 2004 switch to relatively high capable partners in 2007. This result again supports Case C PAM and rejects Case I random matching.

5.3 Small Exporter Exit

Table 6 report regressions (11) testing whether the end of the MFA increases the capability cutoff of Mexican suppliers (C4 and I4). Columns (1), (3), and (5) reports baseline regressions using three different lengths of the two periods, respectively. Columns (2), (4), and (6) include additional control variables and their interactions with the After dummy. We choose control variables by the same criterion used for Table 5: product and firm characteristics in 2004 that are statistically different between the treatment and control groups within HS two digit products.[19]

Estimated coefficients from all specifications confirm C4 and I4. First, estimates of δ_4 and $\delta_4 + \delta_5$ are both negative and statistically significant, which means that small exporters are more likely to exit. Second, estimates of δ_2 are positive and statistically significant. Thus, Chinese entries at the end of the MFA increase exit probability for a given capability level. These patterns are stable across different specifications and robust to inclusions of control variables.

[19]They are as follows: the share of Maquiladora/IMMEX trade in the firm's trade in the product with the main partner in the initial year of each period, the log of total trade volume of the product in the initial year of each period, the number of exporters in the initial year of each period, and product type dummies on whether products are for men, women, or not specific to gender and those on whether products are made of cotton, wool, or man-made (chemical) textiles.

6 Discussion

6.1 Alternative Capability Rankings

We create alternative rankings using two capability measures: the total product-level trade volume of a firm aggregated over partners and the unit price of the product's trade with the main partner. The first one is used for a robustness check since some firms have multiple partners in data. The second one is for investigating whether the source of capability is quality or productivity. If the exporter size is mainly explained by their quality rather than productivity, the unit price rankings may agree with the true capability ranking of exporters. On the other hand, if exporter size is mainly explained by productivity, unit price rankings may become the exact reversal of exporters' true capability rankings.

Table 2 report examine partner changes in Panel A and rank correlations of new and old main partners in Panel B. Since price data before 2004 are very noisy, we do not estimate the exit regression. Columns labeled "Baseline", "Total Trade" and "Price" report estimate using our baseline rankings, total volume rankings, and price rankings, respectively.[20] First of all, baseline rankings and total volume rankings give very similar results. Second, price rankings give the same signs for all regressions. This is consistent with previous studies on exporters that high quality is an important determinant of firm exports.[21] In addition to this previous find-

[20]Using unit prices poses the difficulty that even within a narrowly defined product category, different firms may report their quantities in different units of measurement (square meters, kg, pieces, etc.). Since one exporter consistently uses the same unit for one product in our data, we treat transactions of one product reported in one unit and those of the same product reported in a different unit as transactions of two different products.

[21]See e.g., Kugler and Verhoogen (2012) and Manova and Zhang (2012) for studies using firm-level data and Baldwin and Harrigan (2011), Bernard et al. (2007), Helble and Okubo (2008), and Johnson (2012) for studies using product-level data. In terms of the data, our study is close to that of Manova and Zhang (2012), who investigate positive correlations between export volumes and unit prices across exporters and products. We also find a positive correlation between them in our data.

ing, our results suggest that exporters need to produce high quality products to match with highly capable importers. Third, regressions using price rankings report smaller coefficients than those using baseline rankings. This difference might reflect that exporters being differentiated by productivity or quality is not universal across data, but heterogeneous across products (e.g., Baldwin and Ito, 2011; Mandel, 2009). Differentiating firms mainly by productivity in some products would reduce the size of coefficients in regressions.

6.2 Alternative Explanations

This section discusses alternative hypotheses for our findings and presents additional evidence to show that these alternative hypotheses do not fully explain our results.

6.2.1 Negative Assortative Matching (NAM)

In Appendix, we examine Case S of NAM and find two differences between Case C and Case S. First, firm's trade volume may not be monotonically increasing in its capability. The import volume of US importers with capability x, $I(x)$, and the export volume of Mexican exporters with capability y, $X(y)$, satisfy $X(m_x(x)) = I(x)$. Since $X'(m_x(x))m'_x(x) = I'(x)$ and $m'_x(x) < 0$, $I'(x)$ and $X'(y = m_x(x))$ must have the opposite signs. Thus, it is impossible that preshock trade ranking agrees with true capability ranking both for exporters and for importers. Second, if the end of the MFA increases the mass of US importers, then another monotocity breaks down. The direction of US importer's partner change depends on the firm's capability. There exists a threshold capability $\tilde{x}$ such that high capability US importers with $x > \tilde{x}$ upgrade Mexican partners, while low capability US importers with $x < \tilde{x}$ downgrade Mexican partners. With these two types of non-monotonicity, it

is theoretically possible but very unlikely that NAM explains the observed systematic relationships between rematching and preshock trade ranking.

6.2.2 Segment Switching

Another explanation for US importer's partner upgrading and Mexican exporter's partner downgrading is a model of product segment switching inspired by Holmes and Stevens (2014). Even one HS-6 digit product category may have two different segments. One "standardized" segment is produced on a large scale and sold with low markups, while the other "custom" segment is produced on a small scale but sold with high markups. Suppose that large US importers produce "standardized" products, while small US importers produce "custom" products. Suppose that Chinese exporters enter mainly in "standardized" products. If Mexican exporters switched from "standardized" to "custom" products to escape competition from China, this change might be observed as Mexican exporters' partner downgrading and US importers' partner upgrading.[22]

If this hypothesis mainly explains our findings, small firms and large firms should respond to the end of the MFA in heterogeneous ways. As small "custom" US importers should become more attractive to Mexican exporters and able to match more capable Mexican exporters, small US importers should upgrade partners more frequently than large US importers. However, Table 3 shows that both small and large US importer upgrade partners in a similar way.[23]

[22]The existence of multiple segments within one product category does not change the interpretation of our main regressions if Mexican firms do not switch segments. In the case of PAM, it still holds that Mexican exporters downgrade and US importers upgrade their main partners in the "standardized" segment, while firms do not change partners in the "custom" segment. On the other hand, the existence of multiple segments might help to explain why not all firms changed partners even in the treatment group.

[23]In Appendix A.7, we also examine whether imports by initially small "custom" US importers show higher growth rates than those by large "standardized" US importers. We actually find the import growth by small US importers, but this pattern holds more strongly in the control group

6.2.3 Production Capacity

Another hypothesis is that firm's trade volume mainly reflects the size of Mexican supplier's production capacity instead of its productivity and quality. Since production capacity can be regarded as an element of firm's capability, this hypothesis is still consistent with PAM of exporters and importers by capability. However, we believe that the mere demand for production capacity is unlikely to be the main reason for the observed partner upgrading. In Appendix A.7, we report that the import growth rate of US importers during 2004-07 is not correlated with either whether the firms belong to the treatment group or whether the firms upgrade Mexican partners.

7 Conclusion

The heterogeneous firm trade literature have successfully documented the heterogeneity of exporters and importers in terms of capability, but our knowledge about how heterogeneous importers and exporters trade with each other has been still limited. We have identified a simple mechanism determining exporter and importer matching at the product level: Becker-type positive assortative matching by capability. We have found that when trade liberalization enables foreign suppliers to enter a market, existing firms change partners so that matching becomes positively assortative under a new environment. Our model combining Becker (1973) and Melitz (2003) shows that this rematching brings additional gains from trade.

The Becker model has been applied to various topics in other fields of economics, but its application for exporter–importer matching remains limited. We believe this model is potentially useful for thinking of several questions that anony-

rather than in the treatment group, which is inconsistent with the hypothesis.

mous market models fail to address. For instance, our finding suggests that many suppliers are willing to trade with highly capable final producers, but only highly capable suppliers can engage in such trade. This view that all importers are not equally available for all exporters seems relevant for policy discussions that often encourage domestic firms to export, particularly to highly capable foreign buyers.

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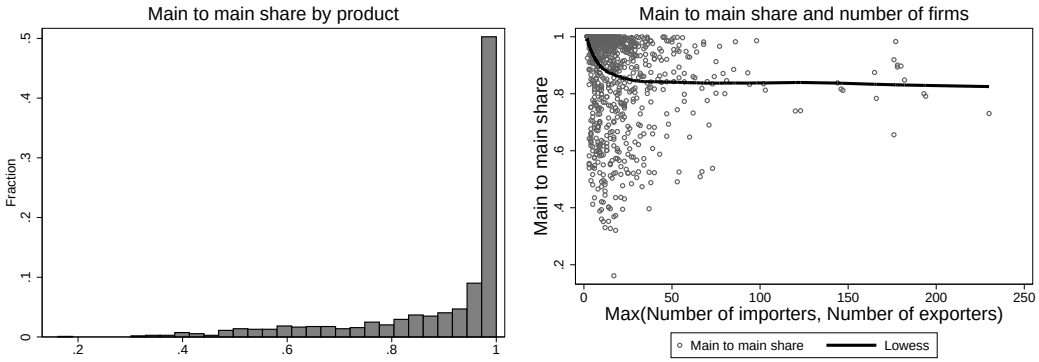
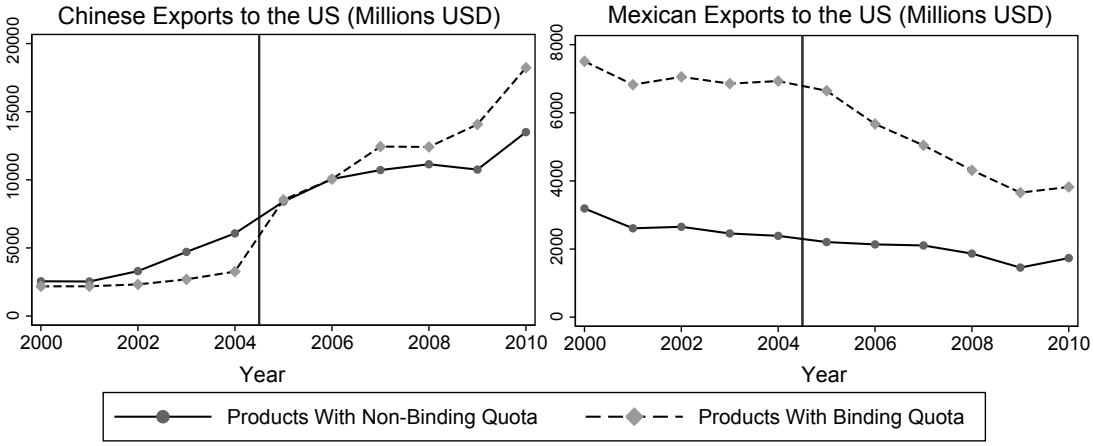
Figure 1: Main-to-Main Shares for HS 6 Digit Textile/Apparel Products



Note: Both panels draw main-to-main share across product-year combinations of HS 6 digit textile/apparel products and years 2004-2007. The left panel draws a histogram. The right panel plots main-to-main shares against the maximum of the numbers of exporters and importers.

Figure 2: Impacts of the end of the MFA on Chinese and Mexican textile/apparel exports to the US



Note: The left panel shows export values in millions of US dollars from China to the US for the two groups of textile/apparel products from 2000 to 2010. The dashed line represents the sum of export values of all products upon which US had imposed binding quotas against China until the end of 2004, and the solid line represents that of the products with non-binding quotas. The right panel expresses the same information for exports from Mexico to the US.

Figure 3: Case C: Positive Assortative Matching (PAM)

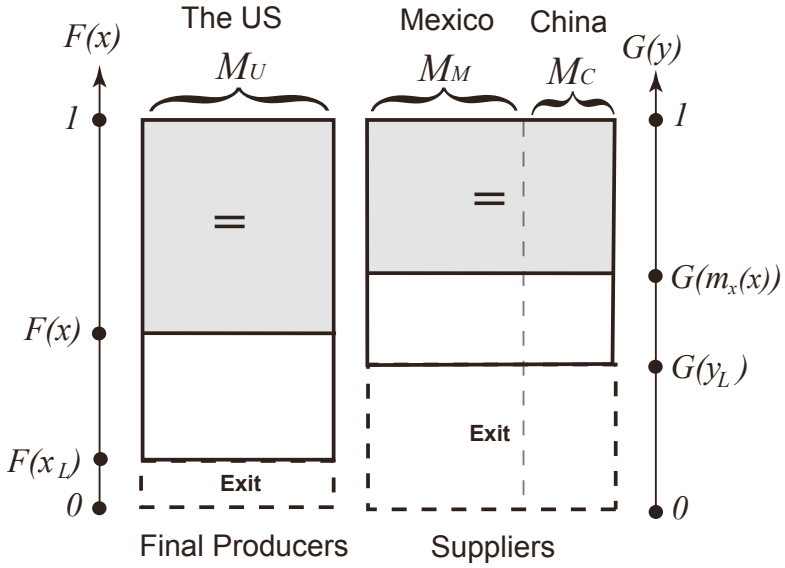


Figure 4: Case C: the Response of Matching to an Entry of Chinese Exporters ($dM_C > 0$)

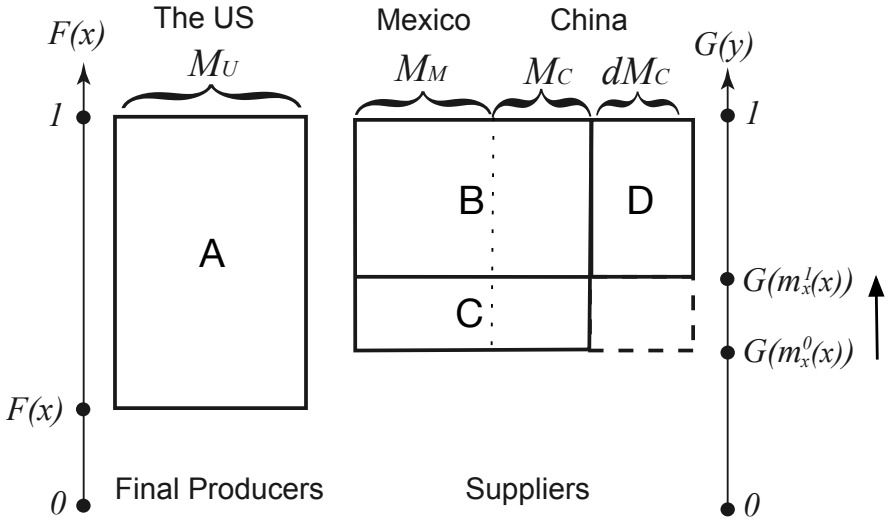
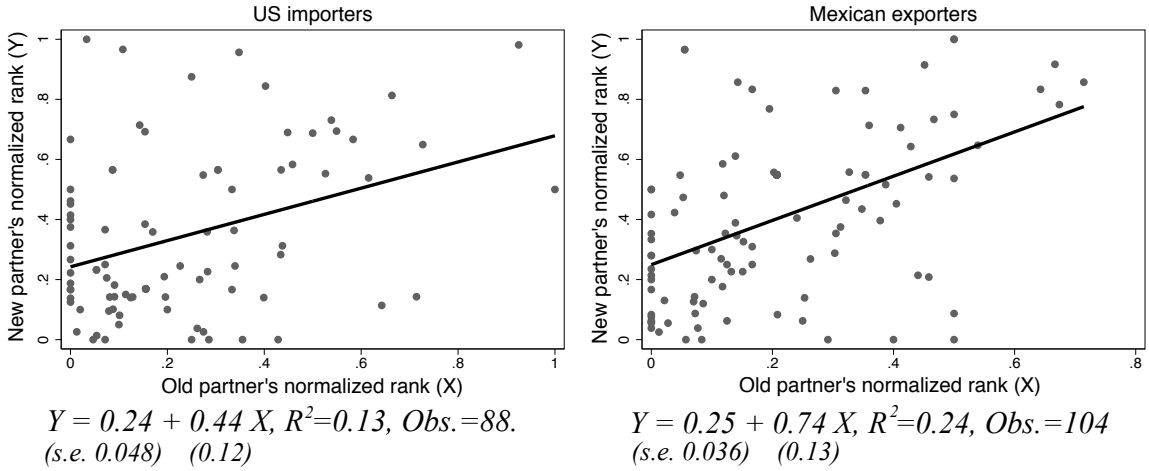


Figure 5: Normalized ranks of 2004 and 2007 partners



Note: The left panel draws the normalized ranks of main partners in 2004 and 2007 for those US importers who change their main partners between 2004 and 2007. The right panel draws similar partner ranks for Mexican exporters. The lines represent OLS fits.

Table 1: Summary Statics for Product-Level Matching

HS6 digit level statistics, mean (median)	2004	2005	2006	2007
(1) N of Exporters	14.7 (8)	14.1(7)	11.7 (6)	11.3 (6)
(2) N of Importers	19.6 (11.5)	18.7 (10)	15.5 (9)	14.9 (9)
(3) N of Exporters Selling to an Importer	1.1 (1)	1.1 (1)	1.1 (1)	1.1 (1)
(4) N of Importers Buying from an Exporter	1.5 (1)	1.5 (1)	1.5 (1)	1.4 (1)
(5) Value Share of the Main Exporter (N of Exporters>1)	0.77	0.77	0.76	0.77
(6) Value Share of the Main Importer (N of Importers>1)	0.74	0.75	0.77	0.76

Note: Each row reports mean of indicated variables with median in parenthesis. Rows (1) and (2): the numbers of Mexican exporters and US importers of a given product, respectively. Row (3): the number of Mexican exporters selling a given product to a given US importer. Row (4): the number of US importers buying a given product from a given Mexican exporter. Statistics in Rows (5) and (6) are calculated only for firms with multiple partners. Row (5): the share of imports from the main Mexican exporters in terms of the importer's product import volume. Row (6): the share of exports to the main US importers in terms of the exporter's product export volume.

Table 2: Main-to-Main Shares in Mexico's Textile/Apparel exports to the US

	Main-to-Main Share				
Year	All	Maquila	Non-Maquila	Quota-bound	Quota-free
	(1)	(2)	(3)	(4)	(5)
2004	0.79	0.79	0.80	0.78	0.80
2005	0.81	0.82	0.81	0.82	0.79
2006	0.81	0.83	0.83	0.81	0.82
2007	0.84	0.85	0.84	0.84	0.85

Note: Each column reports main-to-main shares in Mexico's textile/apparel exports to the US for types of transactions. All: all textile/apparel products. Maquila: Maquiladora/IMMEX transactions. Non-Maquila: the other normal transactions. Quota-bound: products for which Chinese exports to the US were subject to binding quotas; Quota-free: the other products.

Table 3: Partner Changes during 2004-07

	Liner Probability Models							
	Up^{US}		$Down^{US}$		Up^{Mex}		$Down^{Mex}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Binding	0.052**	0.041*	-0.017	0.004	-0.003	-0.000	0.127***	0.130***
	(0.021)	(0.023)	(0.027)	(0.042)	(0.020)	(0.018)	(0.035)	(0.049)
OwnRank		-0.001		-0.074*		0.004		-0.087
		(0.024)		(0.042)		(0.014)		(0.054)
Binding*		0.034		-0.070		-0.007		-0.018
OwnRank		(0.049)		(0.074)		(0.026)		(0.087)
HS2 FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	718	718	718	718	601	601	601	601

Note: The dependent variables Up^c_{igs} and $Down^c_{igs}$ are dummy variables indicating whether during 2004-07 firm i in country c switched the main partner of HS-6 digit product g in country c' to the one with a higher capability rank and to the one with a lower capability rank, respectively. $Binding_{gs}$ is a dummy variable indicating whether product g from China faced a binding US import quota in 2004. $OwnRank_i$ is the noramalized rank of firm i in 2004. All regressions include HS-2 digit product fixed effects. Standard errors are in parentheses and clustered at the HS-6 digit product level. Significance: * 10 percent, ** 5 percent, *** 1 percent.

Table 4: Partner Changes in Different Periods

A: Gradual Partner Changes

	Partner Changes in Different Periods: Linear Probability Models					
	Up^{US}			$Down^{Mex}$		
	2004-06	2004-07	2004-08	2004-06	2004-07	2004-08
	(1)	(2)	(3)	(4)	(5)	(6)
Binding	0.036**	0.052**	0.066**	0.056*	0.127***	0.121***
	(0.015)	(0.021)	(0.027)	(0.031)	(0.035)	(0.032)
HS2 FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	964	718	515	767	601	442

B: Placebo Checks

	Partner Changes in Different Periods: Linear Probability Models					
	Up^{US}			$Down^{Mex}$		
	2007-11	2008-11	2009-11	2007-11	2008-11	2009-11
	(7)	(8)	(9)	(10)	(11)	(12)
Binding	-0.001	0.027**	-0.000	-0.008	0.047	0.005
	(0.018)	(0.011)	(0.006)	(0.036)	(0.031)	(0.020)
HS2 FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	449	575	747	393	499	655

Note: The dependent variables Up^c_{igs} and $Down^c_{igs}$ are dummy variables indicating whether during the period indicated by each column, firm i in country c switched the main partner of HS-6 digit product g in country c' to the one with a higher capability rank and to the one with a lower capability rank, respectively [c=Mexico and c'=US in (1)-(3) and (7)-(9); c=US and c'=Mexico in (4)-(6) and (10)-(12)]. $Binding_{gs}$ is a dummy variable indicating whether product g from China faced a binding US import quota in 2004. All regressions include HS-2 digit (sector) fixed effects. Standard errors are shown in parentheses and clustered at the HS-6 digit product level. Significance: * 10 percent, ** 5 percent, *** 1 percent.

Table 5: Partner Change duing 2004-07 with Additional Controls

A: HS 6 digit Product Level Controls: Linear Probability Models

	Up^{US}				$Down^{Mex}$			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Binding	0.043**	0.44*	0.049**	0.042*	0.122***	0.125***	0.123***	0.130***
	(0.022)	(0.022)	(0.022)	(0.024)	(0.035)	(0.037)	(0.038)	(0.037)
#Exporters	0.001***				0.000			
	(0.000)				(0.000)			
#Importers		0.0003**				0.000		
		(0.0001)				(0.000)		
LnTotalTrade			0.007***				0.002	
			(0.002)				(0.007)	
Product type				Yes				Yes
HS2 FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	718	718	718	718	601	601	601	601

B: Firm-Product Level Controls: Linear Probability Models

	Up^{US}				$Down^{Mex}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Binding	0.049**	0.053**	0.051**	0.049**	0.123***	0.127***	0.103***	0.104***
	(0.022)	(0.022)	(0.021)	(0.019)	(0.038)	(0.035)	(0.037)	(0.034)
LnTrade	0.002				0.002			
	(0.004)				(0.007)			
Maquiladora		-0.015				-0.025		
		(0.017)				(0.024)		
#Partners			0.007***				0.036***	
			(0.002)				(0.009)	
US Intermediary				0.011				0.034
				(0.013)				(0.031)
HS2 FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	718	718	718	629	601	601	601	489

Note: The dependent variables Up^c_{igs} and $Down^c_{igs}$ are dummy variables indicating whether during 2004-07 firm i in country c switched the main partner of HS-6 digit product g in country c' to the one with a higher capability rank and to the one with a lower capability rank, respectively. $Binding_{gs}$ is a dummy variable indicating whether product g from China faced a binding US import quota in 2004. $\#Exporters_g$ and $\#Importers_g$ are the numbers of exporters and importers of product g in 2004, respectively. $LnTotalTrade_g$ is the log of trade volume of product g in 2004. Product Types are a collection of dummy variables indicating whether products are Men's, Women's, cotton, wool and man-made (chemical). $LnTrade_{ig}$ is the log of firm i's trade volume of product g in 2004. $Maquiladora_{ig}$ is the share of Maquiladora/IMMEX trade in firm i's trade of product g in 2004. $\#Partners_{ig}$ is the number of firm i's partner in product g in 2004. $US\ Intermediary$ is a dummy variable indicating whether either US importer or US main partner is an intermediary firm. All regressions include HS 2 digit fixed effects. Standard errors are shown in parentheses and clustered at the HS-6 digit product level. Significance: * 10 percent, ** 5 percent, *** 1 percent.

Table 6: Trade Ranks and Exit from the US market

Mexican Exporter's Exit from the US market: OLS

	$Exit_{igsr}$					
Period 1	2001-04		2002-04		2000-04	
Period 2	2004-07		2004-06		2004-08	
	(1)	(2)	(3)	(4)	(5)	(6)
Binding	-0.040***	-0.035***	-0.037**	-0.019	-0.019	-0.017
(δ_1)	(0.014)	(0.013)	(0.015)	(0.015)	(0.013)	(0.013)
Binding	0.076***	0.099***	0.044**	0.064***	0.032**	0.054***
*After (δ_2)	(0.016)	(0.020)	(0.018)	(0.021)	(0.014)	(0.02)
After	-0.361***	-0.331***	-0.454***	-0.427***	-0.262***	-0.184***
(δ_3)	(0.042)	(0.069)	(0.049)	(0.081)	(0.030)	(0.068)
$\ln Export$	-0.058***	-0.059***	-0.078***	-0.076***	-0.045***	-0.046***
(δ_4)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$\ln Export$*	0.020***	0.026***	0.031***	0.036***	0.012***	0.017***
After (δ_5)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.002)
Controls		Yes		Yes		Yes
HS2 FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	22625	22624	20655	20655	24474	24474

Note: The dependent variable $Exit_{igsr}$ is a dummy variables indicating whether Mexican firm i stops exporting product g to the US in period r. $Binding_{gs}$ is a dummy variable indicating whether product g from China faced a binding US import quota in 2004. $After_r$ is a dummy variable indicating whether period r is after 2004. $lnExport_{igr}$ is the log of firm i's export of product g in the initial year of period r. Columns (2), (4) and (6) include the following control variables of the initial year opand their interactions with $After_r$: the share of Maquiladora/IMMEX trade in firm i's trade of product g in the initial year; the log of trade volume of product g; the number of exporters of product g; a collection of dummy variables indicating whether products are Men's, Women's, cotton, wool and man-made (chemical). All regressions include HS-2 digit (sector) fixed effects. Standard errors are shown in parentheses and clustered at the HS-6 digit product level. Significance: * 10 percent, ** 5 percent, *** 1 percent.

Table 7: Alternative Capability Rankings

A: Partner Changes during 2004-07: Linear Probability Models

	Up^{US}			$Down^{US}$		
	Baseline	Total Trade	Price	Baseline	Total Trade	Price
	(1)	(2)	(3)	(4)	(5)	(6)
Binding	0.052**	0.052**	0.047**	-0.017	-0.017	0.006
	(0.021)	(0.021)	(0.018)	(0.027)	(0.027)	(0.023)
HS2 FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	718	718	672	718	718	672
	Up^{Mex}			$Down^{Mex}$		
	Baseline	Total Trade	Price	Baseline	Total Trade	Price
	(7)	(8)	(9)	(10)	(11)	(12)
Binding	-0.003	0.001	0.037	0.127***	0.123***	0.069**
	(0.020)	(0.019)	(0.031)	(0.035)	(0.035)	(0.028)
HS2 FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	601	601	559	601	601	559

B: Old and New Partners 2004-07: OLS

	New Partner Rank					
	US Importers			Mexican Exporters		
	Baseline	Total Trade	Price	Baseline	Total Trade	Price
	(13)	(14)	(15)	(16)	(17)	(18)
Old Partner	0.44***	0.44***	0.17*	0.74***	0.68***	0.47***
Rank	(0.12)	(0.13)	(0.10)	(0.13)	(0.13)	(0.12)
Constant	0.24***	0.24***	-0.44***	0.25***	0.25***	0.30***
	(0.05)	(0.04)	(0.06)	(0.04)	(0.04)	(0.07)
R^2	0.13	0.15	0.04	0.24	0.21	0.14
Obs.	88	88	80	104	104	98

Note: Ranking is based on the firm's product trade with the main partner in 2004 in "Baseline", the firm's product total trade in 2004 in "Total Trade", and the firm's unit price of product in 2004 in "Price". Significance: * 10 percent, ** 5 percent, *** 1 percent. (Panel A) The dependent variables Up^c_{igs} and $Down^c_{igs}$ are dummy variables indicating whether during 2004-07 firm i in country c switched the main partner of HS-6 digit product g in country c' to the one with a higher capability rank and to the one with a lower capability rank, respectively. $Binding_{gs}$ is a dummy variable indicating whether product g from China faced a binding US import quota in 2004. All regressions include HS-2 digit (sector) fixed effects. Standard errors are shown in parentheses and clustered at the HS-6 digit product level. (Panel B) Regressions are run for firm i in country c who switch their main partners of product g during 2004-07. The dependent variable $NewPartnerRank^c_{ig}$ is the normalized rank of firm i's new main partner of product g in 2007. $OldPartnerRank^c_{ig}$ is the normalized rank of firm i's old main partner of product g in 2004.

Appendix

A1. Solving the Model

Consumer Maximization

The consumer maximization problem is equivalent with maximizing

$$U = \frac{\delta}{\rho}\ln\left[\int_{\omega\in\Omega}\theta(\omega)^{\alpha}q(\omega)^{\rho}d\omega\right] - \int_{\omega\in\Omega}p(\omega)q(\omega)d\omega + I.$$

The first order conditions are

$$\frac{\delta\theta\left(\omega\right)^{\alpha}q\left(\omega\right)^{\rho-1}}{\int_{\omega'\in\Omega}\theta(\omega')^{\alpha}q(\omega')^{\rho}d\omega'} = p\left(\omega\right) \text{ for all } \omega\in\Omega. \tag{12}$$

The first order conditions for two varieties $\omega, \omega' \in \Omega$, imply

$$\begin{aligned}
\left(\frac{\theta\left(\omega'\right)}{\theta\left(\omega\right)}\right)^{\alpha}\left(\frac{q(\omega')}{q\left(\omega\right)}\right)^{\rho-1} &= \frac{p(\omega')}{p(\omega)} \\
\left(\frac{\theta\left(\omega'\right)}{\theta\left(\omega\right)}\right)^{\alpha\frac{\rho}{\rho-1}}\left(\frac{q(\omega')}{q\left(\omega\right)}\right)^{\rho} &= \left(\frac{p(\omega')}{p(\omega)}\right)^{\frac{\rho}{\rho-1}} \\
\left(\frac{\theta\left(\omega'\right)}{\theta\left(\omega\right)}\right)^{\alpha(1-\sigma)}\left(\frac{q(\omega')}{q\left(\omega\right)}\right)^{\rho} &= \left(\frac{p(\omega')}{p(\omega)}\right)^{1-\sigma} \\
\theta(\omega')^{\alpha}q(\omega')^{\rho} &= \left(\frac{p(\omega')}{p(\omega)}\right)^{1-\sigma}\frac{\theta\left(\omega'\right)^{\alpha\sigma}}{\theta\left(\omega\right)^{\alpha(\sigma-1)}}q(\omega)^{\rho}
\end{aligned}$$

Integrating both sides with respect to $\omega' \in \Omega$, we obtain

$$\begin{aligned}
\int_{\omega'\in\Omega}\theta(\omega')^{\alpha}q(\omega')^{\rho}d\omega' &= \frac{q(\omega)^{\rho}}{\theta(\omega)^{\alpha(\sigma-1)}p\left(\omega\right)^{1-\sigma}}\int_{\omega'\in\Omega}\theta(\omega')^{\alpha\sigma}p(\omega')^{1-\sigma}d\omega'. \\
&= \frac{q(\omega)^{\rho}}{\theta(\omega)^{\alpha(\sigma-1)}p\left(\omega\right)^{1-\sigma}}P^{1-\sigma},
\end{aligned}$$

where $P \equiv \left[\int_{\omega\in\Omega} p(\omega)^{1-\sigma}\theta\left(\omega\right)^{\alpha\sigma} d\omega\right]^{1/(1-\sigma)}$ is the price index. Substituting this into (12), we obtain the demand function:

$$\begin{aligned}
\frac{\delta\theta\left(\omega\right)^{\alpha} q\left(\omega\right)^{\rho-1}}{\int_{\omega'\in\Omega}\theta(\omega')^{\alpha}q(\omega')^{\rho}d\omega'} &= p\left(\omega\right) \\
\delta\theta\left(\omega\right)^{\alpha} q\left(\omega\right)^{\rho-1}\left(\frac{\theta(\omega)^{\alpha(\sigma-1)}p\left(\omega\right)^{1-\sigma}}{q(\omega)^{\rho}P^{1-\sigma}}\right) &= p\left(\omega\right) \\
q(\omega) &= \frac{\delta\theta\left(\omega\right)^{\alpha\sigma}}{P^{1-\sigma}}p(\omega)^{-\sigma}. \qquad (13)
\end{aligned}$$

Stage 2: Team profit maximization

Facing the demand function (13), teams choose prices under monopolistic competition. Let $A \equiv \frac{\delta}{\sigma}\left(\frac{\rho P}{c}\right)^{\sigma-1}$and $\gamma \equiv \alpha\sigma - \beta\left(\sigma-1\right)$. Since a team with capability θ has marginal costs $c\theta^{\beta}$, it chooses the optimal price $p(\theta) = \frac{c\theta^{\beta}}{\rho}$. Team's output $q\left(\theta\right)$, revenue $R(\theta)$, costs $C(\theta)$, and profits $\Pi(\theta)$ become

$$\begin{aligned}
q\left(\theta\right) &= \delta P^{\sigma-1}\left(\frac{\rho}{c}\right)^{\sigma}\theta^{(\alpha-\beta)\sigma}; \\
R(\theta) &= p(\theta)q\left(\theta\right) \\
&= \delta\left(\frac{\rho P}{c}\right)^{\sigma-1}\theta^{(\alpha-\beta)\sigma+\beta} \\
&= \sigma A\theta^{\gamma}; \\
C(\theta) &= c\theta^{\beta}q\left(\theta\right) + f \\
&= \frac{\delta}{\rho}\left(\frac{\rho P}{c}\right)^{\sigma-1}\theta^{(\alpha-\beta)\sigma+\beta} + f \\
&= \left(\sigma-1\right)A\theta^{\gamma} + f; \\
\Pi\left(\theta\right) &= R(\theta) - C(\theta) = A\theta^{\gamma} - f.
\end{aligned}$$

Normalize $\gamma = 1$. From the optimal price, the price index is

$$\begin{aligned} P &= \left[\int_{\omega\in\Omega} p(\omega)^{1-\sigma}\theta\left(\omega\right)^{\alpha\sigma} d\omega\right]^{1/(1-\sigma)} \\ &= \frac{c}{\rho}\left[\int_{\omega\in\Omega} \theta\left(\omega\right)^{\gamma} d\omega\right]^{1/(1-\sigma)} \\ &= \frac{c}{\rho}\left[\int_{\omega\in\Omega} \theta\left(\omega\right) d\omega\right]^{1/(1-\sigma)}. \\ &= \frac{c}{\rho}\Theta^{1/(1-\sigma)}, \end{aligned}$$

where $\Theta \equiv \int_{\omega\in\Omega} \theta\left(\omega\right) d\omega$ is a measure of the aggregate capability. Then, the index A becomes

$$A = \frac{\delta}{\sigma}\left(\frac{\rho P}{c}\right)^{\sigma-1} = \frac{\delta}{\sigma\Theta}.$$

Stage 1

The mass of active final producers equals to that of active suppliers:

$$M_U[1 - F(x_L)] = (M_M + M_C)\left[1 - G(y_L)\right]$$

This equation determine $y_L(x_L)$ as an increasing function of x_L.The lowest capability $\theta_L(x_L)$ becomes a fiction of x_L: $\theta_L(x_L) = \theta\left(x_L, y_L(x_L)\right)$.

In Case C, the matching market clearing condition

$$M_U[1 - F(x)] = (M_M + M_C)\left[1 - G(m_x(x))\right] \text{ for } x \geq x_L.$$

determines matching fucntion $m_x(x)$. Then, Θ is obtained as a decreasing function

of x_L:

$$\Theta(x_L) = \begin{cases} M_U \int_{x_L}^{\infty} \theta\left(x, m_x(x)\right) dF(x) & \text{for Case C} \\ M_U \int_{x_L}^{\infty} \theta^x(x) dF(x) + (M_M + M_C) \int_{y_L(x_L)}^{\infty} \theta^y(y) dG(y) & \text{for Case I,} \end{cases}$$

where $\theta\left(x, y\right) = \theta^x\left(x\right) + \theta^y\left(y\right)$ for additive separable Case I.

The cutoff team capability is determined by

$$\theta_L(x_L) = \frac{f}{A} = \frac{\sigma f}{\delta} \Theta(x_L).$$

Since $\theta_L(x_L)$ is increasing and $\Theta(x_L)$ is decreasing in x_L, the last equation uniquely determine x_L.

A.2 Proofs

This section proves Lemma 1 and that $dM_C > 0$ implies $dy_L > 0$. Both predictions are derived from a classic theorem in the matching theory with transferable payoffs.

Theorem 1. *Among feasible matchings, a stable matching maximizes the aggregate payoffs of participants in a frictionless matching market.*

Theorem 1 was developed by Koopmans and Beckmann (1957) and Shapley and Shubik (1972) for the case with finite agents and by Gretsky, Ostroy and Zame (1992) for the case with continuums of agents. In the current model, the aggregate payoff of firms is $A\Theta - Mf$ and individual firms take A as given so that a stable matching maximizes the aggregate profits $A\Theta - Mf$ for given A.

We compare equilibriums of two different environments I and J (e.g. before and after the end of the MFA). Label variables in the corresponding equilibrium by "I" and "J", respectively. Then, we establish the following lemma from Theorem 1.

Lemma 2. *Suppose equilibrium matching of environment J is feasible in environment I. If $M^I \geq M^J$, then $\Theta^I > \Theta^J$ and $\theta_L^I > \theta_L^J$.*

Proof. Since equilibrium matching of environment J is feasible in environment I, equilibrium matching of environment I maximizes the aggregate profits under A^I: $A^I\Theta^I - M^I f > A^I\Theta^J - M^J f$. Since $M^I \geq M^J$, this implies $\Theta^I > \Theta^J$. From $A\theta_L = \frac{\sigma f}{\delta}\Theta$ in (3), we have $\theta_L^I > \theta_L^J$. □

Proof for $dy_L > 0$ for Cases C, I, and S

Call the environment after the MFA end *A-environment* and the environment before the MFA end *B-environment*. Label equilibrium variables in A-environment by "A" and those in B-environment by "B".

Lemma 3. *If $dM_C > 0$, then $dy_L > 0$ in Case C, Case I, and Case S.*

Proof. Suppose $y_L^A \leq y_L^B$. This means that the mass of produced varieties and active final producers increase: $M^A > M^B$ and $x_L^A < x_L^B$. Since equilibrium matching of B-environment is feasible in A-environment, Lemma 2 implies $\theta_L^A > \theta_L^B$.

In Case C and Case I, $\theta_L = \theta(x_L, y_L)$, $x_L^A < x_L^B$ and $y_L^A < y_L^B$ imply $\theta_L^A < \theta_L^B$. Contradiction.

In Case S, there are three cases on who are in the least capable teams: (1) $\theta_L = \theta\left(x_L, y_{max}\right)$, (2) $\theta_L = \theta\left(x_{max}, y_L\right)$, and (3) $\theta_L = \theta\left(x_m, m_x(x_m)\right)$ for some interior $x_m \in (x_L, x_{min})$. In Case (1) and Case (2), $\theta_L^A \leq \theta_L^B$ holds from $y_L^A \leq y_L^B$ and $x_L^A < x_L^B$. Contradiction. In Case (3), the envelop theorem $d\theta_L = \theta_2 dm_x(x_m)$ implies $dm_x(x_m) > 0$ must hold to satisfy $d\theta_L > 0$. At $x = x_m$, the matching market clearing condition is

$$M_U[1 - F(x_m)] = (M_M + M_C)\left[G\left(m_x(x_m)\right) - G(y_L)\right].$$

Totally differentiating this, we obtain

$$0 = \left[G\left(m_x(x_m)\right) - G(y_L)\right] dM_C + \left(M_M + M_C\right)\left[g\left(m_x(x_m)\right) dm_x(x_m) - g(y_L) dy_L\right].$$

From $dM_C > 0$ and $dy_L < 0$, the last equation implies $dm_x(x_m) < 0$. Contradiction. □

Proof for Lemma 1

Call the environment after the MFA end *A-environment,* the environment of the no-rematching equilibrium *NR-environment*, and the environment before the MFA end *B-environment*.

Claim 1. $\Theta^A = \Theta^{NR}$ in Case I.

Proof. An equilibrium of NR-environment is the same as an equilibrium of A-environment because no rematching occurs after the MFA end in Case I. □

Claim 2. $y_L^{NR} > y_L^B$ in Case C and Case I.

Proof. Suppose $y_L^{NR} < y_L^B$. This means $x_L^{NR} < x_L^B$ and $M^{NR} > M^B$. Since $\theta_L = \theta(x_L, y_L)$ holds in Case C and Case I, $y_L^{NR} < y_L^B$ and $x_L^{NR} < x_L^B$ imply $\theta_L^{NR} < \theta_L^B$.

Since equilibrium matching of B-environment is feasible under NR-environment, Lemma 2 and $M^{NR} > M^B$ imply $\theta_L^{NR} > \theta_L^B$. Contradiction. □

Claim 3. $y_L^A > y_L^{NR}$ in Case C.

Proof. Suppose $y_L^A < y_L^{NR}$. This means $x_L^A < x_L^{NR}$ and $M^A > M^{NR}$. Since $\theta_L = \theta(x_L, y_L)$ holds in Case C and Case I, $y_L^A < y_L^{NR}$ and $x_L^A < x_L^{NR}$ imply $\theta_L^A < \theta_L^{NR}$.

Since equilibrium matching of NR-environment is feasible under A-environment, Lemma 2 and $M^A > M^{NR}$ imply $\theta_L^A > \theta_L^{NR}$. Contradiction. □

Claim 4. $\Theta^{NR} > \Theta^B$ in Case C and Case I.

Proof. Suppose $\Theta^{NR} < \Theta^B$, which implies $\theta_L^{NR} < \theta_L^B$ from (3). Since equilibrium matching of B-environment is feasible under NR-environment, Lemma 2 implies $M^{NR} < M^B$. From $M = M_U[1 - F(x_L)]$, this means $x_L^{NR} > x_L^B$.

In Case C and Case I, $\theta_L = \theta(x_L, y_L)$, $y_L^{NR} > y_L^B$ from Claim 2, and $\theta_L^{NR} < \theta_L^B$ imply $x_L^{NR} < x_L^B$. Contradiction. □

Claim 5. $\Theta^A > \Theta^{NR}$ in Case C and Case I.

Proof. Suppose $\Theta^A < \Theta^{NR}$, which implies $\theta_L^A < \theta_L^{NR}$ from (3). Since equilibrium matching of NR-environment is feasible under A-environment, Corollary 2 implies $M^A < M^{NR}$. From $M = M_U[1 - F(x_L)]$, this means $x_L^A > x_L^{NR}$.

In Case C and Case I, $\theta_L = \theta(x_L, y_L)$, $y_L^A > y_L^{NR}$ from Claim 2, and $\theta_L^A < \theta_L^{NR}$ imply $x_L^A < x_L^{NR}$. Contradiction. □

From $P = c/\left(\rho\Theta^{1/(\sigma-1)}\right)$, Claim 1, Claim 4 and Claim 5 prove Lemma 1.

A.3 Negative Assortative Matching

In Case S, the market clearing condition becomes

$$M_U[1 - F(x)] = (M_M + M_C)\left[G\left(m_x\left(x\right)\right) - G(y_L)\right]. \tag{14}$$

The left hand side is the mass of final producers with capabilities higher than x and the right hand side is the mass of suppliers with lower capability than $m_x(x)$.

Assumption 1. *If the mass of Chinese suppliers M_C increases, then the total mass of suppliers in the US $(M_C + M_M)[1 - G(y_L)]$ increases and the capability cutoff for importing x_L falls.*

Under this assumption, we show the direction of US importer's partner change is heterogeneous.

Lemma 4. *Under Assumption 1, there exists a threshold capability $\tilde{x} \in (x_L, x_{max})$ such that when the mass of Chinese supplier increases, continuing US final producers with $x > \tilde{x}$ switch their Mexican partners to those with higher capability (partner upgrading), while continuing US final producers with $x < \tilde{x}$ switch their Mexican partners to those with lower capability (partner downgrading).*

Proof. Totally differentiating (14), we obtain the partner change of importers with capability x:

$$dm_x(x) = \frac{\Gamma(x)}{g(m_x(x))}, \Gamma(x) \equiv g(y_L)dy_L - \frac{G(m_x(x)) - G(y_L)}{(M_M + M_C)} dM_C. \tag{15}$$

Since $dy_L > 0$, $dM_C > 0$, and $m'_x(x) < 0$, $\Gamma(x)$ is increasing in x and $\Gamma(x_{max}) = g(y_L)dy_L > 0$ since $y_L = m_x(x_{max})$. Since Assumption 1 implies

$$d(M_C + M_M)[1 - G(y_L)] = [1 - G(y_L)]dM_C - (M_C + M_M)g(y_L)dy_L > 0,$$

$\Gamma(x_L) \equiv g(y_L)dy_L - \frac{1-G(y_L)}{(M_M+M_C)}dM_C < 0$. Since $\Gamma(x)$ is continuous, there exists $\tilde{x} \in (x_L, x_{max})$ such that $\Gamma(x) > 0$ for $x > \tilde{x}$ and $\Gamma(x) < 0$ for $x < \tilde{x}$. □

To understand the intuition for this lemma, it is useful to consider how firms with maximum capabilities change partners. Suppose x_L falls from x_L^0 to x_L^1 and y_L rises from y_L^0 to y_L^1. Since final producers with maximum capability x_{max} always match with suppliers with the cutoff capability, they upgrade suppliers with y_L^0 to y_L^1. On

the other hand, since suppliers with maximum capability y_{max} always match with final producers with the cutoff capability, they downgrade final producers from x_L^0 to x_L^1. This in turn means that final producers with x_L^0 downgrade suppliers. Since a matching function is continuous, there is a threshold $\hat{x}$ of the lemma.

A.4 Data Construction

Customs transaction data Our primary data set is a Mexican customs transaction data set for Mexican textile/apparel exports to the US. The data set is created from the administrative records held on every transaction crossing the Mexican border from June 2004 to December 2011. The Mexican customs agency requires both individuals and firms who ship goods across the border to submit a customs form (pedimento aduanal in Spanish) that must be prepared by an authorized agent. The form contains information on: (1) total value of shipment (in US dollars); (2) 8 digit HS product code (we use from HS50 to HS63); (3) quantity; (4) name, address, and tax identification number of the Mexican exporter; (5) name, address, and tax identification number (employment identification number, EIN) of the US importer, and other information.

Assign firm IDs We assigned identification numbers to both Mexican exporters and US importers (exporter-ID and importer-ID) throughout the data set. It is straightforward to assign exporter-IDs for Mexican exporters since the Mexican tax number uniquely identifies each Mexican firm. However, a challenge arises in assigning importer-IDs for US firms. It is known that one US firm often has multiple names, addresses, and EINs. This happens because a firm sometimes uses multiple names or changes names, owns multiple plants, and changes tax numbers. Therefore, simply matching firms by one of three linking variables (names, addresses,

and EINs) would wrongly assign more than one ID to one US buyer and would result in overestimating the number of US buyers for each Mexican exporter.

We used a series of methods developed in the record linkage research for data cleaning to assign importer-ID.[24] First, as the focus of our study is firm-to-firm matching, we dropped transactions for which exporters were individuals and courier companies (e.g., FedEx, UPS, etc.). Second, a company name often included generic words that did not help identify a particular company such as legal terms (e.g., "Co.", "Ltd.", etc.) and words commonly appearing in the industry (e.g., "apparel"). We removed these words from company names. Third, we standardized addresses using the software, ZP4, which received a CASS certification of address cleaning from the United States Postal Services. Fourth, we prepared lists of fictitious names, previous names and name abbreviations, a list of addresses of company branches, and a list of EINs from data on company information, Orbis made by Bureau van Dijk, which covered 20 millions company branches, subsidiaries, and headquarters in the US. We used Orbis information for manufacturing firms and intermediary firms (wholesalers and retailers) due to the capacity of our workstation. For each HS2 digit industry, we matched names within customs data and names between customs data and name lists from Orbis mentioned above; we conducted similar matches for addresses and EINs. In conducting our matching, we used fuzzy matching techniques allowing small typographical errors.[25] Fifth, using matched relations and software using network theory, we created clusters of information (names, addresses, EINs) in which one cluster identifies one firm. We identified a cluster basically under a rule that each entry in a cluster fuzzy matches

[24] An excellent textbook for record linkage is Herzog, Scheuren, and Winkler (2007). A webpage of "Virtual RDC@Cornell" (http://www2.vrdc.cornell.edu/news/) at Cornell University is also a great source of information on data cleaning. We particularly benefitted from lecture slides on "Record Linkage" by John Abowd and Lars Vilhuber.

[25] We used the Jaro-Winkler metric in the Record Linkage package of R and other methods, which will be explained in the next version.

with some other entries in the cluster through two of three linking variables (names, addresses, EINs). Finally, we assigned importer-IDs for each cluster.

Data Cleaning Some information was dropped from the dataset. First, we dropped exporters who are individuals or courier companies (e.g., FedEx, UPS, etc.) because we focus on firm to firm matching. Second, as the dataset contains information only from June to December for 2004, we dropped observations from January to May for other years to make each year's information comparable.[26] Third, we dropped one product where the number of importers unreasonably fluctuates, suggesting low data quality.[27] Finally, we dropped transactions by exporters who do not report importer information for most transactions. For a given HS6 product and a given year, we dropped an exporter from the final data if the total value of transactions without importer information constituted more than 20 percent of the exporter's annual export value. This resulted in dropping approximately 30–40 percent of exporters and 60–70 percent of export values.

A5. Variable Construction (Incomplete)

Dummy variable $Binding_{gs}$ equals one if Chinese exports of product g to the US faced a binding quota in 2004, which we construct from Brambilla et al. (2010). Brambilla et al. (2010) constructed an indicator for binding quotas on Chinese exports to the US for each HS-10 digit category. Since HS product categories of Mexico and the US are the same only up to the first 6 digits, we aggregated their indicator up to the HS-6 digit level. A quota is defined as binding if the fill rate, i.e. the realized import value over the quota value, is greater than 0.8. Our results

[26] We conducted our main analysis (Tables 2 and 3) without conducting the latter two operations and obtained similar results.

[27] We dropped hs code 570210 where the number of US importers were 5 in 2004, 4 in 2005, 254 in 2006, 532 in 2007, 3 in 2008 and 123 in 2009.

are robust to the choice of other cut-offs. We constructed our indicator as follows. Let x^m_{g2004} be US imports of HS-10 digit product g from Mexico in 2004. Let j be a HS-6 digit product and $G(j)$ be the set of US HS-10 digit products in category j. Thereafter, we constructed a dummy variable indicating whether Chinese exports of HS-6 digit product j to the US faced binding quotas in 2004 as:

$$Binding_j = I\left\{\frac{\sum_{g\in G(j)} x^m_{g2004} I\{g \in \text{binding quota in 2004}\}}{\sum_{g\in G(j)} x^m_{g2004}} \geq 0.5\right\}, \quad (16)$$

where the indicator function $I\{X\} = 1$ if X is true and $I\{X\} = 0$ otherwise. We chose the cut-off value as 0.5 but the choice of this cut-off is unlikely to affect the results because most of values inside the indicator function are close to either one or zero.

A6. Summary Statistics and Treatment Control Group Comparison

Table 8 document summary statics of product level characteristics. Row (1) reports means and standard deviations of each product level characteristics with the number of observations in Row (2). Row (3) and Row (4) report the difference in each characteristics between the treatment and control groups. We regress each characteristics on a treatment group dummy and report the OLS coefficient of the dummy in Row (3). Row (4) reports the OLS coefficient of the dummy from a similar regression with HS 2 digit fixed effects. Row (5) reports the number of observations for the regressions for Rows (3) and (4). Though a simple comparison shows that the two groups differ in many characteristics, with HS 2 digit fixed effects the difference becomes smaller and insignificant for many characteristics. Because the control group mainly consists of products that were already liberalized before 2002,

the treatment group that were protected in 2004 show more exporters and importers and greater trade volume.

Table 8: Treatment Control Group Comparison: Product Level

Product-level Characteristics in 2004					
	Control	Obs.	b	b (w. HS2 FE)	Obs.
	(1)	(2)	(3)	(4)	(5)
#Exporters	7.89	230	8.065***	6.028***	375
[s.d.](s.e.)	[15.11]		(2.110)	(1.687)	
#Importers	10.47	230	9.986***	8.742***	375
	[15.11]		(2.789)	(2.395)	
#Importers/	1.49	230	-0.195*	0.105	375
#Exporters	[1.27]		(0.104)	(0.103)	
LnTotalTrade	11.84	230	1.334***	1.254***	375
	[2.58]		(0.291)	(0.312)	
Main to Main share	0.89	230	0.006	-0.015	375
	[0,18]		(0.017)	(0.018)	
Men	0.07	230	0.172***	0.054	375
	[0.25]		(0.039)	(0.040)	
Woman	0.11	230	0.273***	0.080*	375
	[0.32]		(0.046)	(0.046)	
Wool	0.03	230	0.013	-0.030	375
	[0.18]		(0.022)	(0.027)	
Cotton	0.18	230	0.160***	0.066*	375
	[0.38]		(0.047)	(0.039)	
Manmade	0.33	230	0.046	0.136***	375
	[0.47]		(0.051)	(0.041)	

Note: For each characteristics, Columns report the followings: Column (1): mean and standard deviation for the control group of products for which imports from China did not face binding US quota in 2004; Column (2): the number of products in the control group; Column (3): the coefficient of a treatment group dummy in a regression of the characteristics on the dummy; Column (4):the coefficient of a treatment group dummy in a regression of the characteristics on the dummy and HS 2 digit fixed effects; Column (5) the number of observations in regressions for Columns (3) and (4). Significance: * 10 percent, ** 5 percent, *** 1 percent. Definitions of the Characteristics: $\#Exporters_g$ and $\#Importers_g$ are the numbers of exporters and importers of product g in 2004, respectively. $LnTotalTrade_g$ is the log of trade volume of product g in 2004. Main to Main share is the main to main share of the product in 2004. Men, Women, Wool, Cotton, and Manmade are dummy variables indicating whether products are Men's, Women's, cotton, wool and man-made (chemical).

Table 9 report similar summary statistics for importer-product level character-

istics. Even with HS 2 digit fixed effects, the treatment group shows more trade volume and a higher share of processing trade (Maquiladora/IMMEX).

Table 9: Treatment Control Group Comparison: Importer-Product Level

Importer-Product Level Characteristics in 2004

Own Characteristics					
	Control	Obs.	b	b (w. HS2 FE)	Obs.
	(1)	(2)	(3)	(4)	(5)
US Intermediary	0.33	1570	-0.002	-0.033	3429
[s.d.](s.e.)	[0.47]		(0.016)	(0.022)	
LnTrade	7.86	2408	0.785***	0.571***	5374
	[3.24]		(0.093)	(0.119)	
N of Partners	1.12	2408	0.013	0.012	5374
	[1.32]		(0.027)	(0.034)	
Maquiladora	0.25	2408	0.198***	0.130***	5374
	[0.42]		(0.013)	(0.016)	
Main Partner Share	0.76	124	0.012	-0.011	396
	[0.21]		(0.020)	(0.027)	
Main Partner's Characteristics					
	Control	Obs.	b	b (w. HS2 FE)	Obs.
Northern State	0.15	2408	-0.027***	0.002	5374
	[0.36]		(0.010)	(0.012)	

Note: For each characteristics, Columns report the following: Column (1): mean and standard deviation for the control group of products for which imports from China did not face binding US quota in 2004; Column (2): the number of products in the control group; Column (3): the coefficient of a treatment group dummy in a regression of the characteristics on the dummy; Column (4):the coefficient of a treatment group dummy in a regression of the characteristics on the dummy and HS 2 digit fixed effects; Column (5) the number of observations in regressions for Columns (3) and (4). Significance: * 10 percent, ** 5 percent, *** 1 percent. Definitions of the Characteristics: $LnTrade_{ig}$ is the log of firm i's trade volume of product g in 2004. $Maquiladora_{ig}$ is the share of Maquiladora/IMMEX trade in firm i's trade of product g in 2004. $\#Partners_{ig}$ is the number of firm i's partner in product g in 2004. $US\ Intermediary$ is a dummy variable indicating whether either US importer or US main partner is an intermediary firm. $NorthanState_{ig}$ is a dummy indicating whether firm i's Mexican main partner of product g is located in a northan state in Mexico.

Table 10 report similar summary statistics for exporter-product level characteristics. Even with HS 2 digit fixed effects, Mexican exporters in the treatment group export more with more partners, have a higher share of processing trade

(Maquiladora/IMMEX) and trade more likely with non-intermediary firms.

Table 10: Treatment Control Group Comparison: Exporter-Product Level

Exporter-Product Level Characteristics in 2004					
Own Characteristics					
	Control	Obs.	b	b (w. HS2 FE)	Obs.
	(1)	(2)	(3)	(4)	(5)
Maquiladora	0.33	1818	0.122***	0.093***	4131
	[0.46]		(0.015)	(0.019)	
Northern State	0.24	1818	-0.103***	0.002	4131
Dummies	[0.43]		(0.012)	(0.015)	
LnTrade	7.60	1818	1.562***	0.963***	4131
	[3.52]		(0.109)	(0.139)	
N of Partners	1.5	1818	-0.036	0.213***	4131
	[2.01]		(0.056)	(0.072)	
Main Partner Share	0.73	296	0.018	-0.014	724
	[0.21]		(0.016)	(0.022)	
Main Partner's Characteristics					
	Control	Obs.	b	b (w. HS2 FE)	Obs.
US Intermediary	0.31	1219	0.020	-0.053**	2833
	[0.46]		(0.018)	(-0.024)	

Note: For each characteristics, Columns report the following: Column (1): mean and standard deviation for the control group of products for which imports from China did not face binding US quota in 2004; Column (2): the number of products in the control group; Column (3): the OLS coefficient β of a dummy indicating the treatment group when the characteristics is regressed on the dummy; Column (4): the OLS coefficient β of a dummy indicating the treatment group when the characteristics is regressed on the dummy and HS 2 digit fixed effects; Column (5) the number of observations in regressions for Columns (3) and (4). Significance: * 10 percent, ** 5 percent, *** 1 percent. Definitions of the Characteristics: $LnTrade_{ig}$ is the log of firm i's trade volume of product g in 2004. $Maquiladora_{ig}$ is the share of Maquiladora/IMMEX trade in firm i's trade of product g in 2004. $\#Partners_{ig}$ is the number of firm i's partner in product g in 2004. $US\ Intermediary_{ig}$ is a dummy variable indicating whether firm i's US main partner of product g is an intermediary firm. $NorthanState_i$ is a dummy indicating whether firm i is located in a Northern state in Mexico.

A.7. Import Growth of US Importers

Table 11 presents the analyses on the import growth rate of US importers that were mentioned when rejecting alternative explanations in Section 6.2. Row (2) rejects

the segment switching hypothesis in Section 6.2.2. The hypothesis predicts small sized US importers with higher ranks should grow more than large sized US importers and this heterogeneous growth should be stronger in the treatment group than in the control group. To test this hypothesis, Row (1) regresses US importer's import growth on the binding dummy and firm's normalized rank and Row (2) adds the interaction of firm's normalized rank with the binding dummy. Though Row (1) shows small sized US importers grow more than large US importers, Row (2) shows this heterogeneous effect is almost the same between the treatment and control groups.

Row (3) and Row (4) reject the production capacity hypothesis. If US importers in the treatment switch to Mexican exporters with greater preshock exports mainly to seek greater production capacity, we should observe that US importers in the treatment group show greater import growth than those in the control group and that the difference is driven by US importers in the treatment group who actually upgrade partners. To test this hypothesis, Row (3) regress US importer's import growth on the binding dummy and Row (4) adds the partner upgrading dummy and its interaction with the binding dummy. Row (3) and Row (4) show that the import growth of US importers is not correlated with either whether the firms belong to the treatment group or whether the firms actually upgrade partners. Thus, the demand for production capacity is unlikely to explain partner upgrading.

Table 11: Import Growth of US Importers during 2004-2007

	$\Delta \ln Import_{igs}$			
	(1)	(2)	(3)	(4)
Binding	-0.034	-0.019	-0.127	-0.140
	(0.222)	(0.289)	(0.256)	(0.259)
OwnRank	3.069***	3.088***		
	(0.367)	(0.382)		
OwnRank*Binding		-0.042		
		(0.782)		
Up_{igs}^{US}				-0.191
				(1.062)
Up_{igs}^{US}*Binding				0.374
				(1.238)
Constant	-2.035***	-2.042***	-0.547	-0.551
	(0.750)	(0.737)	(0.782)	(0.792)
HS2 FE	Yes	Yes	Yes	Yes
R^2	0.144	0.144	0.014	0.014
Obs.	718	718	718	718

Note: The dependent variable $\Delta \ln Import_{igs}$ is the log difference of US firm i's import volume of product g with the main partner during 2004-07. $Binding_{gs}$ is a dummy variable indicating whether product g from China faced a binding US import quota in 2004. $OwnRank_i$ is the noramalized rank of firm i in 2004. Up_{igs}^{US} is a dummy variable indicating whether during 2004-07 US firm i switched the main partner of HS-6 digit product g in Mexico to the one with a higher capability rank. All regressions include HS-2 digit product fixed effects. Standard errors are in parentheses and clustered at the HS-6 digit product level. Significance: * 10 percent, ** 5 percent, *** 1 percent.