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International Competition and Industrial Evolution: Evidence from the Impact of Chinese Competition on Mexican Maquiladoras*

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Abstract

Effects of the competition between the two South locations (Mexico and China) in the Northern market (U.S.) is analyzed. By employing a new plant-level data set that covers the universe of Mexican export assembly plants (maquiladoras) from 1990 to 2006 and exploiting the exogenous acceleration of Chinese imports in conjunction with the WTO accession of China, the empirical analysis reveals substantial effect of intensified Chinese competition on maquiladoras. In particular, competition from China has negative and significant impact on employment and plant growth, both through the intensive and the extensive margin, on the most unskilled labor intensive sectors of those threatened by competition from China, leading to sectoral reallocation. No major effect is found through reallocative channels within industries, but significant increases in plant productivity and skill intensity are quantified in maquiladoras attributable to competition from China. The results lend substance to field studies and anecdotal evidence on industrial upgrading in Mexican Maquiladoras in response to competition with low-wage locations such as China.

JEL Classification: F14; F61; L25; L60

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1 Introduction

China's size, rapid economic growth and trade performance is being felt across the globe. Especially so in Mexico which has been a main competitor of China in the United States markets for manufactured products. By 2003 China had surpassed Mexico as the second most important import supplier to the Unites States and ranked just after Canada. China's accelerated trade growth accompanying its WTO accession provides us with an exogenous source of variation to analyze the impact of international competition in general. Similarity in export baskets between Chinese and Mexican manufacturers to the US market makes the competition between Mexico and China even more intense, and the analysis more revealing.

Maquiladoras are export assembly plants historically specialized in labor-intensive products such as apparel, footwear, electronics and toys. Since 1965, long before The North American Free Trade Agreement (NAFTA), favorable duty regulations with the United States have been in place for maquiladoras. Since then, close proximity to the US market and relatively cheap labor made Mexico one of the most favorable offshore destinations for US companies for a long time. In 2006 the Maquiladora industry in Mexico generated more than 25 billion dollars in foreign exchange, and accounted for 44 percent of total Mexican manufacturing exports. 94 percent of the Maquiladora export in that year went to the US.[1] Together with enormous growth potential the sector also faces a significant hazard of shrinking due to its sensitivity to decisions of US firms to source from elsewhere.[2]

Many developing countries with cheap and abundant labor establish export processing zones (EPZs)[3] or programs to attract multinational firms hoping to increase export, create jobs, and generate foreign exchange. More importantly developing countries hope that such foreign investment incentive programs, rather than being a short-run solution to unemployment and a trap of low-value added facilities with significant vulnerability to shocks, will evolve towards higher value-added production facilities and eventually gain from foreign direct investment through the transfer of technologies and

[1]Authors' calculation using the data from Trade Statistics Specialized Technical Committee, formed by Banco de Mexico, Instituto Nacional Estadística y Geografía (INEGI), Servicio de Administración Tributaria (SAT) and the Secretaria de Economia.

[2]Hanson (2002) stresses that the Maquiladora sector with its impressive growth rates experienced in the 1990s (real value added grew at an annual growth rate of 10 %) and its role in Mexico's export boom is an important opportunity for Mexico's economic development. But it also poses a challenge as it is characterized by footloose industry.

[3]EPZs as defined by the International Labour Office (ILO) (2003) report are "industrial zones with special incentives to attract foreign investment, in which imported materials undergo some degree of processing before being exported again."

skill. According to the International Labour Office (ILO) (2003) report, the number of countries with export processing programs grew from 25 in 1975 to 116 in 2002, employing 43 million people, of whom 30 million are employed in China.[4] For many countries exports from these programs account for a sizeable portion of their export earnings, especially so for Mexico and China. As global competition for jobs and foreign investment intensifies, it is an important question how Maquiladora industries in Mexico, established as part of an American supply chain, are affected by the intensified competition with China and whether they can survive this competition possibly by moving to higher value-added processes thereby continuing to contribute to development of the Mexican host economy.

We investigate the impact of the competition from China on the evolution of the Maquiladora industry. Relying on an instrumental variable strategy that exploits exogenous intensification of Chinese imports in the world and the fact that not all plants are exposed to the competition to the same degree, we first show the first order effects of competition on employment and sales. We then move to the analysis of the evolution of this industry with respect to plants' growth, entry, exit and possible moving up. We employ data from a plant-level survey that covers the universe of Mexican maquiladoras. The sample starts in 1990 where China's share in manufacturing trade in the World was 1.74 % and covers until 2006 where China's share became 8.37 %.[5]

The impact of China's trade on both developing and developed economies has recently received significant academic attention. Hanson and Robertson (2008) estimate the impact of increase in manufacturing export from China on the demand for export from 10 other developing countries, including Mexico, covering the period between 1995 and 2005. Based on gravity equation estimates they conclude that the impact is small but bigger on labor intensive industries. Analyzing the labor market outcomes in the US in response to the Chinese competition, Autor et al. (2012) quantify significant employment loss in the manufacturing sector. Firm-level studies also quantify significant impact of Chinese penetration in the developed markets and point out the importance of trade in firms' decisions and industrial development. Bloom et al. (2011) use a panel of establishments from European countries to test the impact of Chinese imports on the use of Information Technology equipment and innovation, finding a positive relationship between the two. Bugamelli et al. (2010) test the pro-competitive effect of Chinese imports on Italian firms, finding a significant effect. These studies point out a heterogenous impact of Chinese competition within industries which leads to reallocation. This could be because firms with relatively less sophisticated technologies are more exposed to competition from China and

[4]The Mexican Maquiladora program has changed from a typical EPZ as the program has matured as described in the next section. However, the majority of the plants under this program are owned by foreign companies and work for them as downstream offshore plants.

[5]Authors' calculation using World Economic Indicators (WDI) database from the World Bank.

probably produce products that are more substitutable with Chinese products while others already utilize the global chain of production with more focus on sophisticated technologies at home. In this paper, we analyze the competition in the developed country with Chinese products for the plants that, in the light of these findings, can be expected to be impacted the most: relatively labor-intensive offshore plants.[6]

In contrast to previous studies we analyze the competition between two South locations in the third, Northern, market. Doing this helps to mute endogeneity problems, but does not remove them altogether. It also provides an additional perspective to the literature on the effects of low-wage competition in advanced countries. We focus entirely on export assembly plants in Mexico that are tied to the US manufacturing sector. We expect competition between Mexican Maquila and Chinese plants in the US market, and the competition is perhaps more direct because Mexican and Chinese plants have very similar export baskets as identified by several studies.[7] In addition, we exploit the exogenous intensification of Chinese imports in the world at the time of the WTO accession of China to identify the causal impact of competition on the Mexican plants. This paper also provides a comprehensive analysis of Mexican Maquiladoras using plant-level panel data and thus contributes a deeper understanding of this important offshore industry; and it sheds light on the future of export processing programs or labor intensive offshore locations as global competition intensifies.

Concern is not entirely unjustified that intensified Chinese competition will destroy Maquiladoras as they are footloose establishments that can easily be relocated. There is much anecdotal evidence suggesting that maquiladora plants move operations from Mexico to China.[8] At the intensive margin, we find that both employment and plant growth are negatively affected by Chinese competition. More specifically, after controlling for aggregate factors among which the US depression, a one standard deviation increase in China's share of the import penetration rate in the U.S. is found to be associated with a 23 percentage points decrease in the logarithm of plant employment and a 10 percentage points

[6]Studies that analyze the impact of intensified competition from China on Mexican Maquiladoras, including Mollick and Wvalle-Vazquez (2006), and Mendoza (2010) use aggregate data on employment and wages, and identify Chinese competition as an important factor contributing to Maquiladora slow-down. There are also recent studies that analyze the impact of Chinese competition on Mexican manufacturing plants which mostly sell to domestic market, see for example, Iacovone et al. (2010).

[7]In 2001, the export structure of Mexico is found to be the most similar to China's export among any Latin American countries (Devlin, Estevadeordal and Rodriguez-Clare (2006)). The same conclusion is also derived from Lall and Weiss (2004) and Gallagher and Porzecanski (2007) among others.

[8]Royal Philips Electronics moved its operation from Cuidad Juarez to China in 2002. Arnases de Juarez moved its operation to China in 2002. Sanyo Electric Co. closed two of its six Tijuana plants in 2001 and moved to China and Indonesia (Canas and Coronado (2002)).

decrease in annual plant growth. At the extensive margin, Chinese competition is also found to cause plant exits and to discourage entry as the number of entrants and survival probabilities decrease with intensified Chinese competition.

We find evidence partially supporting the commonly expressed opinion by policy makers in Mexico, that Chinese competition compels the Maquiladora industry to evolve away from low-tech, labor intensive manufacturing processes towards higher value added, more technology intensive processes. Reallocation between industries is found to be very important with significant reshuffling of resources from 'old' industries, such as apparel, towards more skill-intensive sectors. We also document an increase in the intensity of skilled labor associated with competition and provide suggestive evidence for significant within plant productivity improvement of maquiladoras due to heightened competition from China. Auxiliary data also show substantial increases in the implementation of productivity enhancing management practices and capacity utilization among maquila plants in the period spanning the WTO accession of China. The results highlight the importance of international trade in shaping the development of industries.

In the next section we describe the environment of maquiladora industry and the data used. Motivational thoughts are presented in section 3. In section 4 the empirical model is outlined, and results are interpreted in section 5 followed by concluding remarks in section 6.

2 Data Overview

2.1 Mexican Maquiladoras

A typical maquiladora plant imports inputs mostly from the United States, processes them, and then ships them back. The maquiladora program started in 1965 with the purpose of reducing unemployment in the border region; it permits tariff-free transaction of the inputs and the machinery between 'a maquiladora plant' and the foreign companies and it also allows 100 % foreign ownership. Upon the return of the goods, the shipper pays duties only on the value added by manufacture in Mexico (Gruben (2001)). In order to benefit from the maquiladora program, a plant has to be registered as a maquiladora plant.[9]

Since its introduction, the maquiladora industry moved from consisting of only low-skilled labor intensive plants focusing on simple assembly jobs to more advanced manufacturing processes, like machinery

[9] The bureaucratic steps necessary for registration were simplified significantly with the 1983 reform.

and automotive.[10] Although initially restricted to the border states and the Baja California free trade zone, maquiladoras can be established anywhere in Mexico since 1989.

The implementation of NAFTA required Mexico to change certain provisions for the maquiladora industry, such as eliminating certain tariff benefits. Most importantly, on January of 2001, duty-free imports from non-NAFTA countries were eliminated because these countries intended to subsequently re-export to another NAFTA country. These changes were based on the rules of origin that were established under the treaty, where goods traded between NAFTA countries are allowed duty free treatment only when the goods satisfy a minimum percentage of North American content. Due to complaints from leaders of the maquiladora industry, the Mexican government revised its regulations of the maquiladora sectors and created a sectoral promotion program to protect the duty-free status of maquiladora imports and thus allowed the maquiladora program to continue to use non-NAFTA content imports.[11] NAFTA also contributed to maquiladoras being allowed to sell their output domestically, but this option is rarely exercised.[12] Even after 2001 there is no incentive for a foreign company not to register as being a maquiladora, if it is part of a foreign chain of production re-exporting its goods to the US. This is also due to the tax provision (APA) that allows maquiladoras not to pay income taxes in the same way as the domestic manufacturing industry (Truett and Truett (2007), Canas and Coronado (2002)).

2.2 Plant-level Data

The maquiladora industry data-set is from Instituto Nacional Estadstica y Geografa (INEGI). INEGI has conducted a monthly survey of the universe of plants registered under the maquiladora program until 2007, called the Estadstica de la Industria Maquiladora de Exportacion (EIME).[13] The observa-

[10]In 1969, 147 companies and 17,000 workers were registered under the Border Industrialization Program. Among the first companies were RCA (electronics), Convertors (industrial tapes), Sylvania (electronics), Acapulco Fashion (apparel) and Ampex (electronics) (Canas and Coronado (2002)).

[11]The sectoral promotion program that allow for each maquiladora sector to continue to have the tariff-free entry of non-NAFTA components was established in December 2000 just before the implementation of the rule of origin law, so the maquiladora industry has not been affected by it.

[12]As of 2001 restrictions on domestic sales for maquila plants were removed. If a maquila plant sells into the domestic market, it will not benefit from the income tax provisions specific to maquiladoras and must pay the applicable Mexican import duties on imported raw materials used in the production depending on their specific tariff classification and customs value, as well as any other charges or taxes that are applicable.

[13]In 2007 a regulatory change was enacted that merges the maquiladora program with an export oriented program for domestic companies known as the Program for Temporary Imports to Promote Exports (PITEX). The new program is called Maquiladora Manufacturing Industry and Export Services (IMMEX). As a result,

tion unit for the industry is a maquiladora establishment, or plant. The data contains firm id's as well as plant id's so that it is possible to identify multi-plant and single-plant firms. INEGI constructed an annual data set from the monthly surveys, which is the data set used here. The annual panel data set covers the period between 1990 and 2006 for eleven manufacturing maquiladora industries and one service industry. For the purpose of this analysis we exclude the service industry.

The majority of the plants are owned by US companies. The ownership status at the plant level can not be identified due to confidentiality issues, but aggregate capital investment data by country of ownership in maquiladora industry can be used to get an idea about the distribution of the ownership by countries. Figure A-1 shows the evolution of capital investment in maquiladora by country of ownership for selected countries. In 1994 the US share of capital equipment investment was 92.4 %. The next biggest investor was Japan, with a share of 2.5 %. In 2006 the US share was 88.1 % followed by Canada and Switzerland both having 1.4 % shares (Source: Banco de Mexico). In terms of sales, maquiladoras' export to the US was 99.7 % of the total maquiladora export in 1993. In 2006 94 % of the total maquiladora sales was to the US followed by Canada with a share of 1.7 % (Source: INEGI). INEGI dropped establishments, which did not respond to the monthly surveys or did not report output measures, from the data set.[14] Thus, the final data set consist of 27,548 plant year observations that consist of 3,769 plants and 1,455 firms (1655 plants on average per year). See Table 1 for the descriptive statistics. A comparison of the nation-wide maquiladora export value added from INEGI to the aggregate export value added as reported by the plants in the EIME data-set is presented in Figure A-2. Figure A-2(a) shows the comparison in level (thousand USD) and A-2(b) shows it in growth rates. As suggested by the graphs, the plant-level data is very comprehensive and closely follows the aggregate trend.

INEGI stopped reporting maquiladora data after March 2007 and the data has been merged in to the IMMEX data.

[14]Every plant operating under the maquiladora program was legally required to answer the questionnaire. Our data set reveals that plants which did not answer the questionnaire (although legally required to) are mostly located in the interior regions of Mexico where the maquiladora concentration is very small. Further characterization of non-responsive and removed plants is being pursued in correspondence with INEGI.

Table 1: Descriptive Statistics of the Plant Level Data Set

	Mean	Standard Deviation	Median	Observation
1990				
Unskilled Workers (head count)	226	475	71	1194
Skilled Workers (head count)	58	142	13	1194
Materials	89722	339306	12500	1194
Capital	1949	4409	495	1194
Value Added	28988	61407	8131	1194
Gross Output	121769	391755	22618	1194
1995				
Unskilled Workers (head count)	258	552	80	1425
Skilled Workers (head count)	61	154	13	1425
Materials	164188	635639	16599	1425
Capital	3499	10317	992	1425
Value Added	35417	76766	10198	1425
Gross Output	205730	717517	28121	1425
2000				
Unskilled Workers (head count)	327	770	88	1995
Skilled Workers (head count)	83	202	18	1995
Materials	193324	693715	15319	1995
Capital	4095	9347	1096	1995
Value Added	54800	128617	12807	1995
Gross Output	252991	806776	31073	1995
2005				
Unskilled Workers (head count)	345	747	104	1678
Skilled Workers (head count)	94	213	24	1678
Materials	289591	982330	29733	1678
Capital	5546	10827	1731	1678
Value Added	76162	167276	21402	1678
Gross Output	370876	1092718	56792	1678
Total				
Unskilled Workers (head count)	288	658	82	27548
Skilled Workers (head count)	75	186	17	27548
Materials	187436	724009	16754	27548
Capital	3867	9668	998	27548
Value Added	50703	123993	12581	27548
Gross Output	242821	818302	31962	27548

Note: Values are expressed in thousand 2002 Mexican peso. Skilled workers are administrators and technicians. Source: Plant-level Survey of Maquiladoras (INEGI). Authors' calculation.

In the data-set there is plant-level information for the 9 states of Baja California, Coahuila, Chihuahua, Distrito Federal, Jalisco, Estado de México, Nuevo León, Sonora, and Tamaulipas. Among them Baja California, Coahuila, Chihuahua, and Tamaulipas are the states where the maquiladora concentration is the highest. For each plant there is an information on hours worked and the number of employees by job category (administrators, technicians, and workers), wages paid by job category as well as plant expenditures/inputs, export sales, and value-added. Plants also report rental expenditures on different capital items, namely machinery, equipment, buildings and office space.[15] Our correspondence with

[15] The original questionnaire correspondences of our rental capital measure are 'alquiler de maquinaria, equipo y transporte en el pais/rental expenditure of machinery, equipment and transportation equipment in the country' and 'alquiler de bienes inmuebles/rental expenditure of real estate'.

INEGI reveals that rental equipment which includes precision and resistance instruments, rotation bands, forklifts, trucks with special containers (temperature and toxic waste) etc.. is mostly rented domestically, although the survey does not collect information on owned imported capital equipment. The capital variable is proxied by rental capital expenditures. All nominal values are expressed in thousand 2002 Mexican peso. The separate industry deflators (industry classification for deflators approximately corresponds to 3-digit SICs) for each maquiladora sector are used to deflate revenues and material expenditures. Energy deflators are used to deflate fuel and electricity, a machinery rental deflator to deflate the rental expenditures in machinery and equipment and a building rental deflator to deflate the building rental expenditures. The deflators are provided by Banco de México. Average expenditure shares of labor, rental capital, materials and energy are 27.3, 6.5, 63.7 and 2.7 percents respectively. Reflecting the downstream position of maquiladoras within industries, the share of imported materials constitute by far the most important expenditure item. 11 manufacturing sectors are matched with the corresponding US industries in order to construct the industry-level aggregate variables. Table C-1 presents these 11 industries and corresponding 1997 NAICS codes. The details of the aggregate data construction is given in the appendix. Plant TFP used in this paper is calculated as a KLEM index for each industry separately where skilled and unskilled labor are treated as separate inputs. The details of constructing TFP is described in section C.1 in the Appendix.

3 Theoretical Channels

Studies that analyze the trade compositions of the two main offshore destinations for the US manufacturing sector, Mexico and China, find significant similarity between imports from them in the US market. China's recent trade performance in conjunction with its accession to WTO would be expected to have direct and strong effect on Mexican export assembly plants. Figure 1 below shows the import shares of China versus Mexico in the US in those manufacturing industries where maquila plants operate.[16] As China's increasing import share accelerates from 2001, Mexico is loosing share.

Both China and Mexico have a comparative advantage in labor-intensive products compared to the US. However, China has a comparative advantage in unskilled labor in comparison to Mexico. In 1999, approximately 13 % of the Latin American population had post-secondary education, compared to 3 % in China (Devlin, Estevadeordal and Rodriguez-Clare (2006)). Factor content theory suggests that as trade liberalizes in China, industries that disproportionately employ unskilled workers will shrink in Mexico and the opposite will occur in China. This can happen through the intensive margin,

[16] These industries are provided in the appendix in Table C-1.

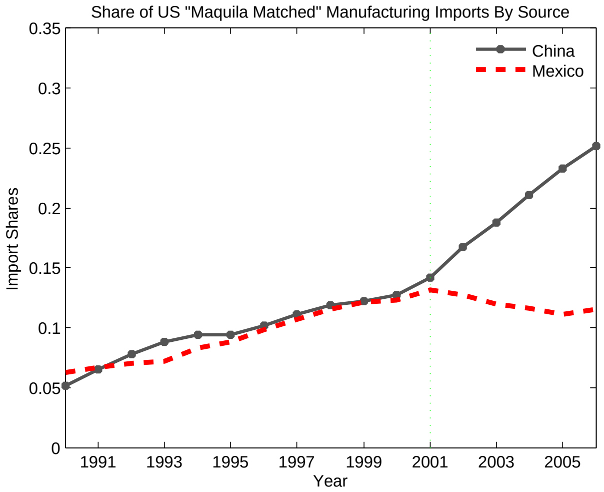

Figure 1: Chinese and Mexican Import Shares in the US

that export assembly plants operating in Mexico shrink. It can also happen through the extensive margin that plant exits occur as a result of the competition and/or that heightened competition discourages entry of new plants in those sectors where China's comparative advantage is the most. Since maquiladoras are offshore plants, such developments may also be driven by multinationals that, as they offshore more labor-intensive tasks to China in response to a fall in trade costs with China, they may deploy relatively more skill-intensive parts to Mexico or parts in which the relative proximity of an offshore plant is a more important determinant than labor costs. The former may also give rise to productivity improvement as in the spirit of Grossman and Rossi-Hansberg (2008).[17]

Product market competition will lead Mexican plants to loose market share in the US market. Typ-

[17]Grossman and Rossi-Hansberg(2008) show that improvements in the technology for offshoring low-skill tasks are isomorphic to (low-skilled) labor augmenting technological progress, and that also causes an increase in real wage of low-skilled workers. But the net effect on real wages depend on the relative magnitudes of the relative price effect (like in Stolper-Samuelson) and the labor supply effect (the need of re-absorption of low-skilled workers in the economy).

ical industrial organization theories with differentiated products predict a negative relationship between competition and innovation/upgrading, since competition will decrease the rents of innovating/upgrading for innovators upon innovation.[18] This is the Schumpeterian effect that the incentive to innovate decreases as competition increases. However, the innovation/upgrading decision is also affected by the difference between the pre-innovation and post-innovation rents (Aghion et al. (2005)). If the pre-innovation rent disproportionately decreases due to intensified competition, then firms upgrade or innovate to be able to survive or 'escape' from the competition as much as possible. It is shown in Aghion et al. (2005) that such an escape competition effect is stronger when the market structure is such that technological differences between firms are small. Export assembly industries both in China and Mexico are mostly based on labor-intensive technologies with no large technological gaps between plants, so one may expect to see a stronger escape competition effect on plants' incentive to upgrade their technologies.[19]

Another possible channel that can strengthen the escape competition effect is through a parent-subsidiary relationship. Consider two competing offshore destinations. In response to lower trade costs in one of the offshore destinations, a parent with a subsidiary in another location would make a 'credible' threat of relocating the subsidiary and thus increase the incentive for the manager of the subsidiary to increase effort and decrease X-inefficiencies.[20] Schmidt (1997) shows in a principal-agent setting that the threat of liquidation can decrease managerial slack and decrease X-inefficiencies. In our context, the threat of liquidation can be thought of in terms of relocating the subsidiary (or, in case of subcontracting, the threat of ending the contract and switching to a lower cost partner). Such a threat should carry greater weight to maquiladoras, many of which are footloose industries.

In a field study conducted in Reynosa, Sargent and Matthews (2006) identify plant manager or subsidiary-driven upgrading motives as an important source of technology upgrading in maquiladoras.

[18]Arrow (1962), on the other hand shows that the incentive to do cost-reducing innovation is higher for a perfectly competitive firm than for a monopolist in the homogeneous product markets due to "replacement" or market size effect; that for a monopolist, innovation simply replaces one profitable investment with another.

[19]Indeed, we find the dispersion is quite low among Maquiladora plants as measured by interquartile measure which is around 0.20 for the overall industry; it is lower, for example, than for Taiwanese plants as reported by Aw, Chen and Roberts (1997).

[20]Principal-agent problems are especially relevant to our context as we focus on the performances of subsidiaries. Papers analyzing the competition and within firm productivity from a principal-agent problem perspective also include Hart (1983), Scharfstein (1988), and Hermalin (1992) among others. In Hart (1983) and Scharfstein (1988), competition affects the informational structure and changes the possibilities that principal can make inferences about the manager's action. In Hermalin (1992) competition changes the manager's incentive through the income effect.

”Due to cost pressures, the parent began sourcing from China rather than Reynosa. [...] Given their rapidly shrinking character, the plant manager first brought the president of the parent to Reynosa. The plant manager sold this individual on the idea that while it didn’t make sense to continue with their existing product line, they had a great management team and perhaps the Reynosa plant could produce for other divisions.....This effort has been successful; six production lines were sent to Reynosa and they successfully filled up the plant” (Sargent and Matthews (2006))

We now turn to the empirical model.

4 Empirical Model

Several developments, internal and external to China, contributed to the significant acceleration in Chinese imports into the US shown in Figure 1, the WTO accession of China being readily identifiable among them. The concrete changes that WTO membership brought to China include removing uncertainties about MFN rates[21], providing China with a way to challenge frequent anti-dumping measures to its products, and agreeing on TRIMs and TRIPs as part of the WTO membership which can be seen as a strong signal of commitment by China to the global economic area.[22] Significant market reforms undertaken by China came about as part of the WTO membership negotiation (Branstetter and Lardy (2006)).

A measure of Chinese competition for Maquiladoras is constructed as the Chinese share of the import penetration for the matched US industry, following Bernard, Jensen and Schott (2006).[23]

$$IMPCH_{jt} = \frac{M_{jt}^{CH}}{M_{jt} + Q_{jt} - X_{jt}} \tag{1}$$

[21] Before the WTO accession, China’s access to American markets with MFN status had been conditional on an annual vote in the US Congress that could be swayed partly by China’s human-rights record.

[22] Another concrete change that WTO membership brought to China is in the textile and clothing industry. The Multi Fibre Arrangement (MFA) that imposes textile quotas on the amount that developing countries export to developed countries were set to gradual expiration starting from 1995. However, being outside of WTO, China was ineligible for the quota reductions. With the WTO membership, China experienced significant quota reductions in 2002. See Brambilla et al. (2009) for a detailed analysis of the impact of the MFA quota abolishment in the US market and Utar (2012) for a firm and product level analysis of the impact of quota expiration on Danish textile and apparel industry. Unfortunately due to lack of product-level data at the plant-level, it is not possible to utilize the quota relaxation experience in the present analysis.

[23] An alternative would be the ratio of total imports coming from China to the relevant US industry to total imports in the US industry as used in Bloom et al. (2011). We use both of them. The results are qualitatively the same.

where M_{jt}^{CH} denotes the value of imports of industry j products coming from China to the US at period t. M, Q and X denote total US imports, US production and US exports respectively.

Our identification strategy is based on the fact that some of the maquiladora sectors are not affected by intensified Chinese imports associated with its accession to WTO as much as sectors with a strong Chinese comparative advantage. Across sector variation in the degree of Chinese competition can be due to structural reasons such as transportation costs, or relative skill-intensity of the production processes. The two maquiladora sectors with the lowest share of skilled employees (administrators and technicians) over total employment are Apparel and Toys industries. The sectors with the highest share of skilled employees are Food and Transportation Equipment industries. Various reasons for the variation in the Chinese comparative advantage will be reflected in the Chinese share of the import-penetration rate. Based on the first and last quartiles of the Chinese share of import penetration in the US market before China's WTO accession in 1999, we identify low threat industries where minimum Chinese presence and threat is expected, and high threat industries where a high degree of Chinese threat is expected. The low threat industries are Chemicals, Transportation (Auto Parts) and Food products (Ecogroups 5, 6, and 1); high threat industries are Apparel, Footwear and Leather, and Toys and Sporting goods (Ecogroups 2, 3, and 10).[24] Note that two of the three industries that are most exposed to competition from China have the lowest skill-intensity rates among all maquiladora industries, while two of the three industries that are least exposed to the competition are ranked highest in terms of skill-intensity.

The figure below shows the (maquila) employment weighted averages of the Chinese share of the import penetration rate (IMPCH) among all Ecogroups, as well as among high threat, and low threat industries.

Both the sectoral variation but also the variation across time in the slope, as seen in the figure, will help to identify the Chinese competition effect.

We use the Chinese share of the import-penetration in the US market, not in Mexico, so it is expected to be independent from the macroeconomic changes in Mexican industry. However, Maquiladoras are

[24]The first quartile of the Chinese share of the import penetration rate in 1999 is 0.006 and the sectors that have $IMPCH$ value lower than the first quartile are Ecogroups 5, 6, and 1. The third quartile of the Chinese share of the import penetration rate in 1999 is 0.071 and the sectors that have a $IMPCH$ value higher than the third quartile are Ecogroups 2, 3, and 10. The sectors that do not belong to any of these groups can then be said to be intermediately exposed to Chinese competition. These are Furniture and Wood products, Metal products and non-electrical machinery parts, Electrical machinery and equipment assembly, Electronics and Miscellaneous manufacturing (Ecogroups 4, 7, 8, 9, and 11).

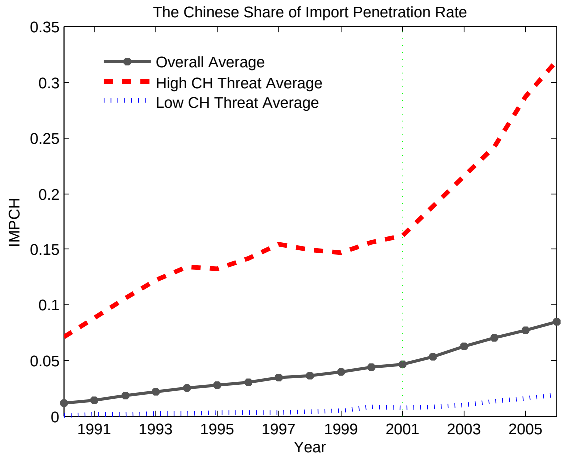

Figure 2: The Chinese Share of Import Penetration Rate

integrated into the US sectors as they are part of the US production chain. Thus unobserved demand or technology shocks for particular products or industries in the US market can still be correlated with both Maquiladora sales and the Chinese sales in the US markets. In order to 'extract' exogenously driven acceleration of the Chinese imports in the US market an instrumental variable approach is used.[25]

The empirical approach is presented in more detail below.

[25] Alternatively, one can also use the sectoral grouping in exposure to Chinese competition together with the WTO accession of China in an difference-in-difference strategy. The results are robust and available upon request.

4.1 Regression Equations

Consider the following specification:

$$lnY_{ijst} = \alpha_0 + \alpha_1 X_{ijst} + \alpha_2 Z_{jt} + \alpha_3 IMPCH_{jt} + \alpha_4 IMPCH_{jt} * x_{ijst} + \sum_{ts} \delta_{ts}^{YS} Year_t * State_s + u_i + \epsilon_{ijst} \quad (2)$$

where Y_{ijst} refers to the variable of interest (total employment as measured by head count, total sales, value-added, employment growth, total factor productivity index) at plant i in industry j located in state s at year t. By utilizing the panel aspect of our data, we allow for unobserved heterogeneity u_i, which may be correlated with regressors, and estimate equation 2 using OLS. Interactive state-by-year fixed effects are added to control for aggregate shocks that may affect the variable of interest across all sectors, but may vary across different states due, for example, to local labor market conditions. The standard errors are clustered by each industry in each year to account for correlation of shocks within each industry-year cell as suggested by Moulton (1990). Vector X includes relevant time varying plant-level controls; these are a multi-plant dummy, and age dummies.[26] Vector Z includes time varying industry-wide controls; in general these are industry aggregate variables for the matched US industries that may affect the demand for a particular maquiladora sector: import-penetration rate of the corresponding US industry calculated without the imports from China and Mexico, IMP_{jt}, the industry hourly wages relative to the corresponding measure in the matched US industry, $RelWage_{jt}$, and the logarithm of the production index of the matched US industries to control for the sector specific business cycles, $lnUSPI_{jt}$.[27] The Chinese competition measure is also interacted with several variables of interests x_{ijst} (productivity, skill-intensity, capital-labor ratio); to see if trade between the US and China has a disproportionate effect on any particular type of export-assembly plants in Mexico.

If there is an increase in demand for particular products in the US, which triggers disproportionate increase in Chinese imports in those categories, perhaps due to the production content of those products (labor intensity), then it is likely that this will have the same effect on Mexican Maquiladora sales in those product categories and for the same reason. This is also true for unobservable technology shocks, say new innovations on labor cost saving technology. This type of endogeneity bias should work against finding any impact of Chinese competition, because both Mexican and Chinese imports

[26] Since INEGI does not ask what year a plant was established, three age dummies are constructed according to the number of years that plants have been in the sample since 1990 as follows: young (Age Dummy1: $1-4$ years), mid-age (Age Dummy2: $5-9$ years), and old (Age Dummy3: $>= 10$ years). Age Dummy 3 is excluded from the regressions.

[27] Details of these data are given in the appendix.

are expected to react to these types of unobservable shocks in the same direction. This correlation between Chinese and Mexican imports, driven by unobservable shocks, must be stronger for products that are more substitutable (or where both China's and Mexico's comparative advantages are high in comparison to the US) hence muting the competition effect.

Since we are interested in capturing accelerating Chinese imports in the wake of the WTO accession, the instruments should capture this 'China' driven component unrelated to the US demand factors. One choice of instrument for the Chinese share of import penetration rate could be the worldwide Chinese imports (exports from China) as a share in total world imports interacted with the 1999 Chinese import penetration rate in the corresponding US NAICS for each Maquiladora sector, $IMPCH_{j99} * \frac{CHIMP_t}{WIMP_t}$. $CHIMP_t$ denotes the worldwide merchandise imports from China and $WIMP_t$ denotes the total merchandise imports. The worldwide Chinese imports must be exogenous from the perspective of Mexican/US plants as it is expected to be driven by China itself. By interacting it with the cross-sectional shares before China's accession to the WTO, we get the cross-industry variation in the degree of Chinese comparative advantage.[28]

While this instrument should be free from most of the endogeneity concerns by construction and should extract exogenously driven growth component in Chinese imports in the world, it is still possible that it will be sensitive to possible correlation between the initial conditions of the US industries and the future technology or demand shocks. To address this, an improved version of that instrument is constructed using the 1999 shares of Chinese imports in other advanced/high income countries and is used as the default instrument.[29] That is, the default instrument used in the analysis is $\frac{OAdvCHIMP_{j99}}{OAdvTOTIMP_{j99}} * \frac{CHIMP_t}{WIMP_t}$ where $OAdvCHIMP_{j99}$ is the total imports into 8 high-income countries from China excluding the US in the corresponding industry j at year 1999 and $OAdvTOTIMP_{j99}$ denotes the total imports in the corresponding industry j at year 1999. Since a possible left-over bias should mute the competition effect due to Chinese and Mexican production content relative to the US, as explained above, to the extent that the cross-sectional shares of the market penetration by Chinese goods in US industries is correlated with the unobservable shocks, $IMPCH_{j99} * \frac{CHIMP_t}{WIMP_t}$ is expected to produce lower negative magnitudes compared to $\frac{OAdvCHIMP_{j99}}{OAdvTOTIMP_{j99}} * \frac{CHIMP_t}{WIMP_t}$.

For the purpose of comparison, we also follow Autor, Dorn and Hanson (2012) and perform the

[28]A similar instrumenting strategy for the Chinese import growth in Europe is also used in Bloom et al. (2011).

[29]The comparative advantage of Chinese industries with respect to American industries must be similar to the comparative advantage that they have against other high income countries' industries. The 8 countries chosen are the same countries used in Autor et al. (2012). These countries are Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain and Switzerland.

analysis by instrumenting the Chinese share of import penetration rate with the Chinese import shares in other high-income countries, $\frac{OAdvCHIMP_{jt}}{OAdvTOTIMP_{jt}}$.[30] The instruments should capture the supply side driven growth component of Chinese imports independent from the US demand factors.

The import penetration rate without Chinese and Mexican imports, defined below, is also used as an industry-level control variable.

$$IMP_{jt} = \frac{M_{jt} - M_{jt}^{CH} - M_{jt}^{MX}}{M_{jt} + Q_{jt} - X_{jt}} \tag{3}$$

Here M_{jt}^{MX} denotes the value of imports of industry j products coming from Mexico to the US at period t. In order to instrument the import penetration rate calculated without Chinese and Mexican imports, IMP, the instruments used are the industry specific exchange rates for the US industry, where the weights for each trading partner's currency are lagged shares of imports of each particular trading partner, lnMERlag, and lagged values of import-penetration rates constructed without Mexican and Chinese imports, LagIMP,.[31]

5 Results

5.1 First Order Effects

If the competition with China in the US market is felt significantly among Maquiladoras then one expects to see the impact on maquila sales, export value-added and employment levels. We first quantify these 'first order effects' before moving on to the dynamic effects of the competition on the evolution of the Maquiladora industry in plant growths, entry, exit and possible moving up.

5.1.1 Maquila Exports

The effects of Chinese competition on the sales and export value-added of Mexican maquiladoras are presented in Table 2. In Panel A the dependent variable is the logarithm of plant sales. In column 1 of Panel A, the coefficient of the Chinese share of import penetration rate is negative and significant

[30] We choose the same countries chosen by Autor et al. (2012) but we had to exclude Denmark because there was missing data in 1997 in certain HS-categories in the UN-Comtrade database. So $\frac{OAdvCHIMP_{jt}}{OAdvTOTIMP_{jt}}$ include the 7 high-income countries which are Australia, Finland, Germany, Japan, New Zealand, Spain and Switzerland. This instrument starts in 1991 instead of 1990 because data from unified Germany is only available starting from 1990.

[31] The sources of these data are stated in the Appendix.

at the 1 percent level. The import penetration rate calculated without the imports from China and Mexico, IMP, is controlled for in column 2, and the coefficient increases its magnitude and keeps its significance. In column 3 additional industry-level controls are included; the Chinese share of import-penetration keeps its significance at the 1 percent level. The coefficient in column 3 indicates that a one standard deviation increase in the Chinese share of import penetration rate (7 percentage point increase) is associated with a 0.08 standard deviation (18 percentage point) decrease in log sales. Both the US production index and the relative wages are also found to be statistically significant, confirming the close ties of the maquiladora industry to the US production process. The magnitudes indicate that a one standard deviation increase in the logarithm of the US production index in the corresponding industry is associated with a 0.02 standard deviation increase in log sales. A one standard deviation increase in the relative wages is, on the other hand, associated with a 0.04 standard deviation decrease in log sales. The instrumental variable results are presented in columns 4 and 5. The instrument for the Chinese share is the worldwide Chinese share of import interacted with the 1999 cross-sectional shares of the Chinese import shares in other advanced countries, $\frac{OAdvCHIMP_{j99}}{OAdvTOTIMP_{j99}} * \frac{CHIMP_t}{WIMP_t}$. The instrument is strongly correlated with $IMPCH$ and the IV coefficient is larger in magnitude. As discussed in the previous section, this suggests that unobservable shocks bias the OLS coefficients downward. The results are in line with the previous findings about the strong substitutability between the Chinese and Mexican export bundles in the US market.

In Panel B of Table 2 the results for export value-added are presented.[32] The results are quite similar to the sales results with slightly lower magnitudes for the coefficient estimate of Chinese competition.[33] The coefficient in column 3 indicates that a one standard deviation increase in the Chinese penetration in the US market is associated with a 0.09 standard deviation (16 percentage points) decrease in log value-added. Similarly, the magnitudes of the industry-level control variables indicate that a one standard deviation increase in the logarithm of the US production index in the corresponding industry and the relative wages are associated with a 0.02 standard deviation increase and a 0.04 standard deviation decrease in log export value-added respectively. The IV coefficient is significant and larger

[32] Although the survey, EIME, records this variable as 'export value added' it is essentially total value-added. Historically all maquilas' sales are exported. Although NAFTA allowed maquilas to sell their products domestically as of 2001, this option has rarely been used due to tax disadvantages as discussed in section 2.1. Hence INEGI did not ask a separate question about the plants' domestic sales in the EIME survey. INEGI included a question about domestic sales in another survey (ENESTyC) conducted among a sample of maquila plants in 2005. The percentage of domestic sales among maquila plants surveyed by INEGI as part of the ENESTyC in 2005 is 3 %.

[33] Similar results are obtained when the dependent variable is the logarithm of profit; they are available upon request.

than the respective specification with OLS, indicating that the instrumenting variable strategy is correcting the bias resulting from shocks that lead both Maquiladora and Chinese sales in the US to move in the same direction. The results are robust.

5.1.2 Employment

The estimation results of employment are presented in Table 3. The coefficient of the Chinese share of the import penetration rate is found to be significant at the 1 percent level in every specification, and the magnitude increases in the IV specifications. The magnitude in column 2 indicates that a one standard deviation increase in the Chinese share of the import penetration rate in the US market is associated with a 0.14 standard deviation (25 percentage points) decrease in the logarithm of employment. The coefficient of IMP is only significant at the 10 percent level in column 2, the magnitude indicates a 0.07 standard deviation decrease in the logarithm of employment as a result of a one standard deviation increase in the general import penetration rate. In column 3 all industry level controls are included. The coefficient of $IMPCH$ is still significant at the 1 percent level with a magnitude which indicates a 23 percentage points decline in the logarithm of employment in response to a one standard deviation increase $IMPCH$.

In columns 4 and 5, the IV results are presented with the default instrument, the worldwide Chinese share of import interacted with the 1999 cross-sectional import share from China in other advanced countries. The results are robust, and they confirm that Chinese imports in the US market are associated with lower employment in Maquiladora industries. Note the lower coefficient estimates for sales and value-added compared to the coefficient estimates for employment, indicating a possible increase in labor productivity.

For the purpose of comparison, results obtained with alternative instruments, which are the worldwide Chinese imports relative to the total world imports interacted with the 1999 shares of IMPCH and the share of Chinese imports in other advanced countries (in the spirit of Autor et al. (2012)), are shown in appendix B column 1 of Table B-1 and Table B-2. The first stage coefficients indicate a strong correlation of the instruments with IMPCH (Panel B). While in all specifications the Chinese penetration in the US market is found to be negative and significant at the 1 percent level, the magnitude difference between column 1 of Table B-1 and column 4 of Table 3 is in line with the hypothesis that possible correlation between the initial conditions of the US industries and future demand shocks leads to a muted negative competition effect (but it is still bigger than the corresponding OLS results).

5.2 Dynamic Effects

5.2.1 Plant Growth

Estimation results of the employment growth equation are presented in Table 4.[34] The coefficient of the Chinese penetration in the US market is found to be negative and significant in every specification. The magnitude in column 2 indicates that a one standard deviation increase in the Chinese share of import penetration rate (6.4 percentage point increase) is associated with a decrease in annual plant employment growth of 0.16 standard deviation or 12 percentage points. The coefficient of the import penetration rate, IMP, is also found to be negative and significant at the 5 % level in column 2, indicating a negative association between the general import penetration rate in the US market and plant growths in Maquiladoras. When other industry level controls, namely Mexican industry hourly wages relative to the US counterpart, and the US industry production index are added in column 3, the coefficient in front of the Chinese share of import penetration is still significant at the 5 % level. The coefficient of the US production index is found to be positive and significant at the 10 % level, confirming the close ties of maquila plants with US manufacturing. It also indicates the importance of the US economic crisis in the Mexican economy through its maquiladora sector. Bergin et al. (2009) documents excess volatility of maquiladoras in comparison to the US counterparts, which may imply that the US firms respond to shocks more strongly in their offshore plants than in their home plants. The magnitudes in column 3 imply that a one standard deviation increase in the Chinese penetration and in the logarithm of the US production index are associated with a decrease in annual plant employment growth of 0.13 standard deviation (10 percentage points) and an increase of 0.05 standard deviation (3 percentage points) respectively.

Instrumental variable regression results presented in columns 4 to 5 confirm the finding that Chinese imports in the US market lead to lower employment growth in Maquiladora industries.[35]

Although both plant TFP and size are important determinants of plant growth, we do not control for them in these regressions since they are expected to respond to intensified competition from China. If plants get smaller as a result of Chinese competition (as already shown) and/or increase their performance (will be shown) as a result of Chinese competition, we expect bigger OLS coefficients

[34] Employment growth is defined as the change in the logarithm of the total number of employees from one year to the next among continuing plants (exclusive of entry and exit).

[35] The average annual aggregate employment growth in the Maquiladora industry between 1990 and 2000 was 10.6 percent, and it declined to -1.2 percent between 2001 and 2006. Our estimates indicate (crudely) that close to half of the decline in employment growth after 2001 can be attributed to Chinese competition.

once plant TFP and size dummies are controlled for. In Table B-3 in appendix B we repeat the analysis additionally controlling for plant TFP and crude size dummies.[36] The OLS coefficients are found to be bigger. The results are robust.[37]

In Table 5 in columns 1, 2 and 3 the Chinese competition proxy is interacted with plant TFP, skill intensity as measured by the ratio of skilled workers to unskilled workers and capital-labor ratio as measured by the rental expenditures of machinery, equipment and building to total wages respectively. None of the interaction terms are significant.[38] So there is no indication that intensified Chinese competition as proxied with the Chinese share of the import penetration rate in the US causes a disproportionate decrease in employment growth, especially in the group of low-productivity plants, low-skill intensive plants or low capital-intensive plants within an industry.[39] Chinese exports to the US should not be expected to exhibit significantly higher substitutability with the lower end of the distribution of maquiladora products in comparison to the upper end for a given industry, since offshore plants within the same 3-4 digit industries should be relatively homogeneous as they are utilized mainly for labor intensive processes. It is more plausible to think, on the other hand, that imports from China to Europe compete more with European firms' products located at the low end of the distribution as documented by Bloom et al. (2011) and Bugamelli et al. (2010).

5.2.2 Plant Shutdowns

A probit model is used to analyze the impact of Chinese competition on maquiladora exit. The exit variable, χ_{it}, is a dummy variable that takes 1 if plant i exits at period t+1. In these regressions aggregate shocks and industry specific factors are controlled for using the full set of state by year and industry fixed effects. The results, presented in Table 6, show significant effect of Chinese competition on maquiladora exit.

Column 2 magnitudes indicate that a marginal change in the Chinese penetration, $IMPCH$, from the average of 6 % leads to a 27 % increase in probability of plant exits while a marginal change in

[36]Five dummies are constructed for plant size, measured by the number of employees, for each of the ranges 1-50, 51-100, 101-500, 501-1000 and 1000+. The smallest size category is excluded from the regression.

[37]The plant-level coefficients in all of the regressions are significant and they all have the expected signs. Employment growth decreases with age and size and increases with productivity. It is usual to find that younger and smaller firms and plants grow faster conditional on survival (Dunne et al. (1989)). Jovanovic (1982) provides a theoretical foundation through learning. We also find that on average employment growth is higher in plants that belong to an entity which owns other maquiladora plants (multi-plant firms).

[38]The results are similar, when plant fixed effects are replaced with industry fixed effects.

[39]Note that including all plant characteristics and interactions at the same time does not change the results.

the general import penetration, IMP, is associated with a 15 % increase. The economic downturn of the US in 2001 is probably captured with IMP, and when additional industry level controls including the industry-specific business cycle variable, $lnUSPI$, and the relative wages, $RelWage$, are added in column 3, the coefficient of the Chinese penetration rate is still significant and positive. The IV results are presented in columns 4 to 5 and the results are robust.

Some of the plant-level factors that are important in determining an exit decision, but that are potentially endogenous to the competition such as TFP and size are not included at first. So as an additional check, both TFP and employment variables are included in Table B-4 in the Appendix. The coefficient of the Chinese penetration in the US market is positive and significant in all of the specifications. The coefficients of the plant-level variables indicate a significant and negative relationship between exit and size as well as between exit and productivity. We also find evidence of non-linearities in the relationship between productivity and exit. The impact of productivity on exit diminishes with productivity (the coefficient of productivity square is negative and significant).

5.2.3 Plant Births

Since the plant-level data does not provide much insight into the potential entrants' decision other than the number of realized entries, we aggregate the plant-level data to industry-level and estimate the equation

$$ENTRY_{jt} = \gamma_0 + \gamma_1 Z_{jt} + \gamma_2 IMPCH_{jt} + \sum_t \delta_t^Y Year_t + \sum_j \delta_j^I Industry_j + \epsilon_{jt} \tag{4}$$

to analyze the impact of Chinese competition on plant entry. $ENTRY_{jt}$ is the total number of entrants in industry j at period t. To control for industry-specific factors that affect entry, such as different levels of sunk entry costs associated with starting up a plant, say, in the apparel sector versus in auto parts, industry fixed effects are included. The year dummies in this regression will control for aggregate shocks, such as exchange rate, that may affect the entry decision to maquiladoras in the same way across sectors as it affects the relative production costs between Mexico and the US. Z_{jt} denotes other industry-level controls. If intensified Chinese competition discourages entry of new maquila plants in Mexico, we expect γ_2 to be negative. Due to the count data nature of the dependent variable, equation 4 is estimated using Poisson and negative binomial regressions. The dependent variable exhibits over-dispersion so we opted for the negative binomial model.[40] The results are presented in Table 7. A

[40] In this specification the dependent variable, conditional on the regressors, is assumed to be distributed

negative and significant effect of the Chinese share of import penetration is found on entry. Can this effect be generalized to imports from everywhere else? Or is it especially true for Chinese competition? The import penetration rate is added in column 2. A weakly significant effect of import penetration in the US market is found on entry of offshore plants in Mexico. Another potential factor that may affect entry decisions is cost of labor in Mexico relative to the US. Industry hourly wages of unskilled workers in the Mexican maquiladora sectors relative to the corresponding US industries are included in column 3. The coefficient of the relative wage is negative and weakly significant. A measure of the 'general level of competitiveness' of the US market is used in the fourth column, namely the industry-specific exchange rate, $lnMER$,. An increase in this measure reflects the appreciation of the US dollar. We find a negative and significant effect indicating that a decrease in the level competitiveness of the US industry is associated with a lower rate of entry to Mexican maquiladoras. But the Chinese share of import penetration rate keeps its sign and significance in column 4. In column 5, all of the controls are included. The coefficient of the Chinese share of import penetration rate is still significant at the 1 percent level. Intensified Chinese competition associated with China's WTO accession is found to deter entry to Mexican maquiladoras.[41] The results also indicate that labor cost saving motives and demand in the US markets are important factors in affecting entry to the Maquiladora industry.

Since exit is analyzed at the micro level and entry is analyzed at the aggregate level, an analysis of entry and exit rates (the number of entrants and exiting plants at period t over the total number of plants at period t) are presented in Table 8 for the purpose of comparison, and the results are robust.

5.3 Moving Up?

The analysis so far reveals a sizable negative impact of intensified Chinese competition on employment, plant growth, entry and exit of Mexican maquiladoras. As sectors that are most exposed to the competition are found to be shrinking, the competition with China is also found to trigger significant sectoral reallocation towards generally more skill-intensive sectors. On the other hand the reallocation within sectors triggered by competition is not found to be contributing to possible moving up. However, even in the traditionally labor-intensive apparel sector Bair and Gereffi (2003) identify recent industrial upgrading from purely garment assembly to full production facilities with cutting rooms, industrial

with Negative Binomial distribution. It is a Poisson-like distribution but, unlike Poisson, equi-dispersion (that is, mean equals variance $Var(y_i|x_i) = exp(x_i^{'}\beta)$) is not imposed. The variance is assumed to be $Var(y_i|x_i) = exp(x_i^{'}\beta) + \alpha * (exp(x_i^{'})^2$ where α is an over-dispersion parameter, y is $ENTRY$, and x is the vector of regressors.

[41] The results are robust to the IV approach with the dependent variable being the logarithmic transformation of 1 plus the number of entry $ln(ENTRY + 1)$. The results are available upon request.

laundries and finishing plants. In order to understand if competition with China triggers ascending in the global production chain for maquiladoras, the effect of the competition on within plant productivity and skill-intensity is presented in this section, starting with an analysis of a potential link between the competition and plant productivity.

5.3.1 Productivity

Before presenting productivity results, some qualification is necessary: Capital equipment owned by the multinational and made available for the maquila plants is not included in the capital expenditure item collected by INEGI. This can potentially contribute to the productivity results if those plants that are threatened most by the competition have increased capital intensities, for example because the type of production line changes, requiring an upgrade in capital equipments. However, such possible changes would still constitute moving up.

Productivity results are presented in Table 9. The first two columns of Table 9 present OLS results with no entry and exit controls. The coefficient estimates of the Chinese penetration in the US is significant and positive at the 1 percent level while the coefficient estimate of IMP is negative and insignificant. The magnitude of the Chinese penetration coefficient in column 2 indicates that a one standard deviation increase in the Chinese import penetration in the US market increases the logarithm of plant productivity by 0.11 standard deviation unit or by 3 percentage points. In columns 3 and 4 entry and exit dummies as well as the interaction variable between entry and exit with the Chinese penetration are included, and the Chinese penetration coefficient is still positive and significant. Since plant fixed effects are controlled for, entry and exit dummies will capture productivity changes within plants in comparison to the time when they enter and when they shut down rather than capturing cross-sectional differences. The negative and significant coefficient on the exit dummy in column 3 then indicates that the productivity levels of those plants are on average 2 % lower at the last year of their participation in comparison to the previous years. Note that it may still be the case that plants that exit have negative productivity shocks in the year that they exit, which is not observable. Does the competition have effect on productivity through entry and exit? The coefficient of the interaction between exit and the Chinese imports is positive, indicating that exit is not contributing to the positive impact of competition on productivity[42],[43]. The IV results are presented in columns 5 to 6 and the OLS results presented in columns 1 and 2 are robust.[44] We also conduct an analysis of productivity using the balanced sample excluding all plants that enter and/or exit during the sample period, and the results, presented in Table B-5, show robust and significant productivity improvement attributable to the competition.

The productivity estimates are based on a constant returns to scale assumption. If the underlying scale elasticities are less than one, we may be capturing a scale effect. Alternatively productivity is estimated using Levinsohn and Petrin with imported materials as a proxy variable. It is also estimated using the fixed effect model.[45] The fixed effect model is known to underestimate the scale. The scale elasticities are found to be on average 0.9, which justifies the use of index methodology. The results on the impact of Chinese competition are robust to both Levinsohn-Petrin and fixed effect estimates of the productivity measures. In Table B-6 the productivity regression is presented with the dependent variables being the alternative TFP measure derived from the fixed effect model.

Most available plant-level data do not contain plant-level physical quantities and prices, and the one used here is no exception. This gives rise to the concern that markups may be captured by the productivity measure as they are also expected to respond to heightened competition. In this case, however, markups should go down as competition intensifies more so for those plants facing the toughest competition, causing downward bias in the estimates.[46] Additionally, price variation between

[42]In order to allow productivity comparisons between a group of entrants/exiters with continuing plants, the OLS analysis with entry and exit dummies is repeated replacing the plant fixed effects with industry fixed effects. The interactions between entry and exit dummies and the Chinese imports variable are still found to be positive and insignificant, confirming the findings obtained using the plant-fixed effects. These results are available upon request.

[43]Sargent and Matthews (2009) survey managers of about 100 maquila plants and they find no relationship between the use of just-in-time inventory practices, technology-intensive production systems and total quality management practices and the recently observed plant deaths. The present results with the extensive data-set confirm their finding.

[44]While entry and exit dummies are not included in the IV regressions in Table 9 as they are potentially endogenous to competition, IV results including entry and exit dummies are also robust and available upon request.

[45]Unfortunately we cannot estimate the production function using Olley and Pakes methodology due to lack of investment data. One drawback of the L-P approach in this context is related to the assumption of the evolution of capital. Since we only have information about rental capital, it may be arguable to treat the capital variable as a state variable, so we think the fixed effect model is more reliable.

[46]The analysis on plant profit confirms this insight by revealing a weakly significant negative effect of the Chinese penetration; it is available upon request.

maquiladora plants must be limited compared to the manufacturing industries; maquiladora plants mainly focus on downstream processes within 3-4 digit manufacturing sectors.

5.3.2 Skill Intensity

The construction of the TFP index, as explained in the appendix, takes skilled versus unskilled employees (technicians and administrative versus workers) as separate inputs. Thus changes in skill intensity should not drive the productivity result. Still it is interesting to look at the evolution of the skill intensities in their own right. Looking at the average skill intensity (the ratio of administrators and technicians to unskilled workers) of the entrants (Table A-2) we find that the mean skill-intensity of entrants increased from 0.34 to 0.61 after 2001. Since the mean size of entrants also increases slightly in comparison to the pre-2001 level, this increase among entrants is not driven by size changes. The increase in skill intensity is in line with the Heckscher-Ohlin theory, which would suggest growth in skill-intensive jobs in Mexico as a result of competition from less skill intensive China. Skill-intensity also increases among continuing plants from 0.28 to 0.38 on average after 2001.

Utar (2012) shows that both sales and employment of Danish Textile and Clothing (T&C) firms decline significantly in response to the MFA quota abolishment for Chinese T&C products in conjunction with China's accession to WTO. The decline in employment happens mostly in the low-skill part of the production process, leading to compositional changes in the organization of the Danish T&C firms towards higher skill intensity. While the data in the present analysis does not provide education and specific occupation information of the individual employees, broad occupation categories are used to examine for a similar response among Maquiladoras as shown in Table 10 and Table 11.[47] In Table 10 the dependent variable is the logarithm of the ratio of the number of skilled employees (technicians and administrators) to the number of unskilled employees (workers). In column 1, the coefficient of the Chinese penetration is positive but insignificant. In column 2 the general import penetration rate is included and the coefficient of $IMPCH$ is found to be positive and significant at the 5 percent level. Since the sectors that are most exposed to the competition from China are relatively less skill intensive sectors, it is possible that the unobservable shocks that are correlated with both Mexican and Chinese imports in the US market are accentuated. In response to positive demand shocks to, for example, electronics goods both Chinese penetration and Maquiladora sales are expected to increase in the US. If maquila plants hire additional and maybe temporary unskilled workers to meet the excess demand, this may cause downward bias in the OLS coefficient for skill-intensity. In columns 3 and 4, the IV

[47] If there is an increase in relative demand for skilled workers, relative skill intensity should increase as long as the relative skilled labor supply is not perfectly inelastic.

results indicate that the Chinese competition triggers an increase in skill intensities.

In Table 11 the dependent variable is the logarithm of the ratio between the average wages of skilled employees versus unskilled employees. The coefficients of Chinese penetration in the US market are found to be positive and significant in OLS specifications. Similar results are obtained with the instrumental variable approach as presented in columns 3 and 4 of Table 11. Note that wages are measured as average per person wages without controlling for workers' experience and education levels (since they are not available in the data-set), so any increase in education level among skilled employees may also contribute to the positive effect.[48] The positive effect could also be driven by downward pressure on wages of unskilled workers due to competition with China. The results altogether show that maquila plants increase their skill-intensities probably because they lay off unskilled workers disproportionately as a result of the competition with China. The results are also in line with a general industrial upgrading triggered by the competition.

5.3.3 Additional Analysis and Potential Sources of Productivity Gain

In order to remove a possible differential effect of the 1994 peso crisis and the implementation of NAFTA on maquiladora industries as well as any other non-Chinese competition effect, and to ensure that the main source of identification comes from the acceleration of the Chinese imports around the time of China's WTO accession, the full-set of results are reproduced with the 1999-2006 sample and presented in Appendix B in Tables B-7 and B-8.[49] The results are robust.

We decompose aggregate productivity growth between 1999 and 2006 into components of within-plant, between plants within industry, turnover and between sectors reallocation.[50] Table A-3 presents the results. Between 1999 and 2006 the aggregate productivity increase in Maquiladoras is calculated to 7.8 %. A significant role of between sector reallocation is found, in that 50 % of the observed growth can be attributed to reallocation between Maquiladora sectors. Confirming our findings, only 3.8 % of the total growth is due to reallocation between continuing plants within industries while more than 30 % of the observed growth is due to within-plant productivity improvement.

The plant-level survey (EIME) does not allow a deeper analysis of the sources of within-plant pro-

[48] Feenstra and Hanson (1997) show that an increase in the relative skilled wages in Mexico during the 1980s is associated with an increase in FDI activities in the Maquiladora sector.

[49] See for example Verhoogen (2008) for an excellent work that shows differential impact of the 1994 peso crisis on Mexican manufacturing plants' quality upgrading motives. This work, however, is concerned with differential impact across exporters versus non-exporters. All plants in our data-set are by definition exporters.

[50] The details of the decomposition analysis is presented in the appendix.

ductivity gain, but INEGI also conducts technology surveys, called ”Encuesta Nacional De Empleo, Salarios, Tecnologìa Y Capacitaciòn, ENESTyC” (National Survey of Employment, Wages, Technology and Training).[51] This survey was also conducted among a sample of maquiladoras in 1999, 2001 and 2005. Information regarding operational and technological capabilities of maquiladoras from this survey is presented in Tables A-4 to A-7, and gives insight into potential sources of productivity gain.[52] [53] Summary statistics indicate that surveyed maquila plants are mainly large foreign (US) owned plants. 589, 675 and 791 maquila plants are surveyed in 1999, 2001 and 2005 respectively. When we compare 1999 with 2005 results, we see that the number of plants that report performing research and development increases from 39 to 46 %. Plants that report performing product development increases from 21 to 32 %. Table A-6 presents percentage capacity utilization among maquila plants as well as among non-maquila manufacturing plants. The average capacity utilization increases substantially from 81 to 86 % among maquilas. Interestingly, there is no comparable increase in capacity utilization among non-maquila manufacturing plants. In Table A-7, we present information on management techniques that is derived from ENESTyC 2005.[54] Approximately 20 % of 642 plants implements Just in Time inventory methods before 2000 and this increases to 41 % in the beginning of 2005. Similarly the percentage of firms implementing other productivity enhancing management techniques such as Total Quality Management, Job Rotation, Process Re-engineering, Re-arrangement of Equipment[55] also doubles or more than doubles between 2000 and 2005.

[51] The survey covers all plants with 100 or more employees and a sample of smaller plants.

[52] ENESTyC surveys are designed as separate cross-sections. Because of this, assigned plant identification numbers are not unique across time. Close to 700 continuously surveyed plants are identified by INEGI, constructing a balanced panel, which does not, however, contain any maquila plants. It is still possible to match plants but only through company names and addresses. We have not been able to access this info so far, due to confidentiality. So for maquila plants, plant identifications were not possible across time nor between EIME and ENESTyC data-sets. Industry affiliation information for maquila plants in 2005 is not yet available to us, so we are unable to provide sector-specific information at this time.

[53] While innovative activities are generally thought to be reflected in measured productivity, Teshima (2010), among others, documents an increase in research and development expenditures among Mexican manufacturing plants without significant effect on plant TFPs in response to trade liberalization.

[54] This question (Section 12, question 6 in ENESTyC 2005) asks whether a specified organization technique has been implemented and the starting year of the implementation.

[55] Re-arrangement of Equipment is defined in the survey as ”management and organization of machinery, equipment and facilities to carry out more efficient production and decrease the possibility of occupational hazards”. The other productivity enhancing management concepts are well-known and their definitions follows standard management literature.

6 Conclusion

We analyze the impact of competition with China in the United States market on offshore plants of US companies specializing in similar processes as Chinese plants. We exploit the exogenous intensification of the market penetration by China around the time of its accession to WTO and the fact that not all plants are exposed to the competition to the same degree, e.g. apparel or electronic plants are more vulnerable than auto parts or food plants.

We find that employment in Mexican Maquiladoras is negatively affected by the competition with China in the US market. Plant growths, entry and survival probabilities are also found to be responding negatively to the Chinese competition. While there is no evidence found that Chinese competition affects plants' growth or exit disproportionately within the same industry classifications so as to lead to welfare enhancing reallocation, competition is found to especially affect the most unskilled labor-intensive sectors among the ones that are threatened most by Chinese competition, leading to significant sectoral reallocation.

The results on skill-intensity and plant productivity point to within plant changes in response to the competition. Together with auxiliary results on capacity utilization, productivity enhancing management strategies, and product development, they also suggest industrial upgrading in Mexican Maquiladoras in response to competition with low-wage locations such as China.

Overall, the results show a substantial role of competition from China in the recent slowdown of the Mexican Maquiladora industry. The results also give reason to open a discussion about whether and how competition from lower wage locations can compel traditionally labor intensive industries in low wage countries to move up in the global production chain.

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7 Tables and Figures

Table 2: The Impact of Chinese Competition : First Order Effects

Panel A: Sales					
	(1)	(2)	(3)	(4)	(5)
Specification	OLS	OLS	OLS	IV SS	IV FS
Dependent Variable	$lnSales$	$lnSales$	$lnSales$	$lnSales$	$IMPCH_{jt}$
$IMPCH_{jt}$	-2.399***	-3.055***	-2.582***	-4.454***	
	(0.511)	(0.652)	(0.621)	(1.095)	
IMP_{jt}		-1.375*	-0.684		
		(0.671)	(0.627)		
$lnUSPI_{jt}$			0.132**		
			(0.047)		
$RelWage_{jt}$			-1.447**		
			(0.492)		
AgeDummy 1	0.444***	0.443***	0.439***	0.439**	0.001
	(0.070)	(0.070)	(0.071)	(0.069)	(0.002)
AgeDummy 2	0.385***	0.391***	0.392***	0.383***	-0.001
	(0.045)	(0.045)	(0.045)	0.045)	(0.001)
Multi-plant Dummy	-0.119***	-0.120***	-0.115***	-0.122**	-0.001
	(0.028)	(0.028)	(0.028)	(0.028)	(0.001)
$\frac{OAdvCHIMP_{j99}}{OAdvTOTIMP_{j99}} * \frac{CHIMP_t}{WIMP_t}$					6.858***
					(0.553)
Plant Fixed Effects	✓	✓	✓	✓	✓
Year by State Fixed Effects	✓	✓	✓	✓	✓
Number of Plants	3769	3769	3769	3769	3769
Number of Observations	27548	27548	27548	27548	27548
R^2	0.059	0.060	0.062		0.323
F-test of excluded instruments					153.99
Panel B: Export Value Added					
Specification	OLS	OLS	OLS	IV SS	IV FS
Dependent Variable	$lnXVAD$	$lnXVAD$	$lnXVAD$	$lnXVAD$	$IMPCH_{jt}$
$IMPCH_{jt}$	-1.960***	-2.774***	-2.418***	-4.205***	
	(0.434)	(0.582)	(0.582)	(1.049)	
IMP_{jt}		-1.707**	-1.174*		
		(0.621)	(0.587)		
$lnUSPI_{jt}$			0.096		
			(0.049)		
$RelWage_{jt}$			-1.329**		
			(0.475)		
AgeDummy 1	0.404***	0.403***	0.400***	0.398**	0.001
	(0.062)	(0.063)	(0.063)	(0.061)	(0.002)
AgeDummy 2	0.341***	0.348***	0.349***	0.338***	-0.001
	(0.040)	(0.040)	(0.040)	(0.040)	(0.001)
Multi-plant Dummy	-0.076**	-0.076**	-0.073**	-0.079	-0.001
	(0.026)	(0.026)	(0.026)	(0.026)	(0.001)
$\frac{OAdvCHIMP_{j99}}{OAdvTOTIMP_{j99}} * \frac{CHIMP_t}{WIMP_t}$					6.858***
					(0.553)
Plant Fixed Effects	✓	✓	✓	✓	✓
Year by State Fixed Effects	✓	✓	✓	✓	✓
Number of Plants	3769	3769	3769	3769	3769
Number of Observations	27548	27548	27548	27548	27548
R^2	0.095	0.097	0.099		0.323
F-test of excluded instruments					153.99

Note: The dependent variable in Panel A is the logarithm of sales. The dependent variable in Panel B is the logarithm of export value-added. Robust standard errors are reported in parentheses. They are clustered for each industry in each year. *, ** and *** indicate significance at the 10 %, 5% and 1% levels respectively. First stage IV coefficients are presented in column 5. The instrument in the IV regression is the worldwide Chinese imports (exports from China) as a share in total world imports interacted with the 1999 shares of Chinese imports in other advanced/high income countries' corresponding US NAICS. In IV regressions state by year fixed effects are partialled out. A constant term is included but not reported.

Table 3: The Impact of Chinese Competition on Employment

Panel A

	(1)	(2)	(3)	(4)	(5)
Specification	OLS	OLS	OLS	IV	IV
Dependent Variable	lnE	lnE	lnE	lnE	lnE
$IMPCH_{jt}$	-2.984***	-3.630***	-3.354***	-4.859***	-4.077***
	(0.467)	(0.587)	(0.596)	(1.036)	(0.822)
IMP_{jt}		-1.354*	-0.957		-1.416*
		(0.586)	(0.572)		(0.652)
$lnUSPI_{jt}$			0.078		
			(0.046)		
$RelWage_{jt}$			-0.755		
			(0.415)		
Age Dummy 1	0.446***	0.446***	0.444***	0.442***	0.447***
	(0.074)	(0.075)	(0.075)	(0.073)	(0.075)
Age Dummy 2	0.433***	0.438***	0.439***	0.431***	0.443***
	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)
Multi-plant Dummy	-0.102***	-0.103***	-0.100***	-0.105***	-0.126***
	(0.027)	(0.027)	(0.027)	(0.027)	(0.026)
Plant Fixed Effects	✓	✓	✓	✓	✓
Year by State Fixed Effects	✓	✓	✓	✓	✓
Number of Plants	3769	3769	3769	3769	3721
Number of Observations	27548	27548	27548	27548	26354
R^2	0.068	0.069	0.070		
Panel B: First Stage IV					
				$IMPCH_{jt}$	$IMPCH_{jt}$
$\frac{OAdvCHIMP_{j99}}{OAdvTOTIMP_{j99}} * \frac{CHIMP_t}{WIMP_t}$				6.858***	7.929***
				(0.553)	(0.684)
LagIMP					-0.407***
					(0.048)
lnMERLag					0.031
					(0.023)
R^2				0.323	0.564
F-test of excluding instruments				153.99	70.09
					IMP_{jt}
$\frac{OAdvCHIMP_{j99}}{OAdvTOTIMP_{j99}} * \frac{CHIMP_t}{WIMP_t}$					0.045
					(0.394)
LagIMP					0.893***
					(0.030)
lnMERLag					-0.034
					(0.021)
R^2					0.850
F-test of excluding instruments					258.78
Hansen J Test (P-value)					0.157

Note: The dependent variable is the logarithm of employment as measured by head count. Robust standard errors are reported in parentheses. They are clustered for each industry in each year. *, ** and *** indicate significance at the 10 %, 5% and 1% levels respectively. For IV regressions the instrument for $IMPCH$ in columns (4) and (5) is the worldwide Chinese imports (exports from China) as a share in total world imports interacted with the 1999 shares of Chinese imports in other advanced/high income countries. In column (6), the instruments for IMP are the industry specific exchange rate for the US industry where the weights for each trading partner's currency are the lagged share of imports of that particular trading partner (lnMERLag), and lagged values of import-penetration rates constructed without Mexican and Chinese imports (LagIMP). In IV regressions state by year fixed effects are partialled out. A constant term is included but not reported.

Table 4: The Impact of Chinese Competition on Employment Growth I

Panel A					
	(1)	(2)	(3)	(4)	(5)
Specification	OLS	OLS	OLS	IV	IV
Dependent Variable	ΔlnE	ΔlnE	ΔlnE	ΔlnE	ΔlnE
$IMPCH_{jt}$	-0.887*	-1.825***	-1.502**	-4.881***	-3.898***
	(0.445)	(0.543)	(0.548)	(1.221)	(0.845)
IMP_{jt}		-1.732**	-1.332*		-2.311***
		(0.542)	(0.551)		(0.676)
$RelWage_{jt}$			-0.074		
			(0.317)		
$lnUSPI_{jt}$			0.105*		
			(0.045)		
Age Dummy 1	-0.651***	-0.649***	-0.648***	-0.655***	-0.645***
	(0.096)	(0.096)	(0.096)	(0.096)	(0.094)
Age Dummy 2	-0.608***	-0.599***	-0.597***	-0.608***	-0.591***
	(0.057)	(0.056)	(0.055)	(0.057)	(0.055)
Multi-plant Dummy	0.077***	0.076***	0.079***	0.071***	0.080***
	(0.019)	(0.019)	(0.019)	(0.020)	(0.020)
Plant Fixed Effects	✓	✓	✓	✓	✓
Year by State Fixed Effects	✓	✓	✓	✓	✓
Number of Plants	3540	3540	3540	3540	3509
N	23743	23743	23743	23743	22597
R^2	0.156	0.158	0.159		
Panel B: First Stage IV					
				$IMPCH_{jt}$	$IMPCH_{jt}$
$\frac{OAdvCHIMP_{j99}}{OAdvTOTIMP_{j99}} * \frac{CHIMP_t}{WIMP_t}$				6.994***	8.377***
				(0.715)	(0.861)
LagIMP					-0.421***
					(0.048)
lnMERLag					0.033
					(0.022)
R^2				0.278	0.560
F-test of excluding instruments				95.61	50.38
					IMP_{jt}
$\frac{OAdvCHIMP_{j99}}{OAdvTOTIMP_{j99}} * \frac{CHIMP_t}{WIMP_t}$					0.149
					(0.650)
LagIMP					0.886***
					(0.030)
lnMERLag					-0.033
					(0.022)
R^2					0.837
F-test of excluding instruments					175.33
Hansen J Test (P-value)					0.502

Note: The dependent variable is the change in the logarithm of employment between two consecutive periods excluding entrants and exiting plants. Robust standard errors are reported in parentheses. They are clustered for each industry in each year. *, ** and *** indicate significance at the 10 %, 5% and 1% levels respectively. For IV regressions the instrument for $IMPCH$ in column (4) and (5) is the worldwide Chinese imports (exports from China) as a share in total world imports interacted with the 1999 shares of Chinese imports in other advanced/high income countries. In column (5), the instruments for IMP are the industry specific exchange rate for the US industry where the weights for each trading partner's currency are the lagged share of imports of that particular trading partner, and lagged values of import-penetration rates constructed without Mexican and Chinese imports. In IV regressions state by year fixed effects are partialled out. A constant term is included but not reported.

Table 5: The Impact of Chinese Competition on Employment Growth II

	(1)	(2)	(3)
Dependent Variable	ΔlnE	ΔlnE	ΔlnE
$IMPCH_{jt}$	-1.598**	-1.737***	-1.709***
	(0.494)	(0.491)	(0.499)
IMP_{jt}	-1.598**	-1.681**	-1.721***
	(0.521)	(0.509)	(0.504)
$lnTFP_{ijt}$	0.204***	0.168***	0.172***
	(0.051)	(0.043)	(0.043)
Skill Intensity $(\text{NP/P})_{ijt}$		0.025	
		(0.020)	
Capital-Labor Ratio $(\text{K/L})_{ijt}$			0.053
			(0.028)
$IMPCH_{jt} * lnTFP_{ijt}$	-0.768		
	(0.727)		
$IMPCH_{jt} *$ Skill Intensity $(\text{NP/P})_{ijt}$		-0.066	
		(0.119)	
$IMPCH_{jt} *$ Capital Labor Ratio $(\text{K/L})_{ijt}$			-0.276
			(0.359)
Plant-Level Controls	Yes	Yes	Yes
Year by State Fixed Effects	✓	✓	✓
Plant Fixed Effects	✓	✓	✓
Number of Plants	3068	3062	3050
Number of Observations	18222	18206	18159
R^2	0.156	0.157	0.160

Note: The dependent variable is the change in the logarithm of employment between two consecutive periods excluding entrants and exiting plants. Robust standard errors are reported in parentheses. They are clustered for each industry in each year. *, ** and *** indicate significance at the 10 %, 5% and 1% levels respectively. Plant-level controls are a multi-plant dummy and age dummies. A constant term is included but not reported.

Table 6: The Impact of Chinese Competition on Maquiladora Exits

Panel A

Specification	(1) Probit	(2) Probit	(3) Probit	(4) IV	(5) IV
Variables	χ	χ	χ	χ	χ
IMPCH	1.701**	2.248***	2.046***	3.624***	2.306**
	(0.602)	(0.590)	(0.605)	(0.992)	(0.782)
IMP		1.232**	1.000		0.939*
		(0.452)	(0.555)		(0.464)
RelWage			1.114*		
			(0.502)		
lnUSIP			-0.034		
			(0.068)		
Age Dummy 1	0.031	0.026	0.026	0.036	0.019
	(0.046)	(0.046)	(0.046)	(0.046)	(0.040)
Age Dummy 2	0.161***	0.153**	0.150**	0.163***	0.149***
	(0.048)	(0.048)	(0.048)	(0.048)	(0.039)
Multi-plant Dummy	0.051	0.050	0.050	0.055	0.038
	(0.034)	(0.034)	(0.034)	(0.034)	(0.033)
Year by State Fixed Effects	✓	✓	✓	✓	✓
Industry Fixed Effects	✓	✓	✓	✓	✓
Pseudo R^2	0.11	0.11	0.11		
N	25559	25559	25559	25559	24365

Panel B: First Stage IV

				(4)	(5)
				$IMPCH_{jt}$	$IMPCH_{jt}$
$\frac{OAdvCHIMP_{j99}}{OAdvTOTIMP_{j99}} * \frac{CHIMP_t}{WIMP_t}$				6.718***	8.745***
				(0.778)	(0.049)
LagIMP					-0.422***
					(0.003)
lnMERlag					0.051***
					(0.003)
					IMP_{jt}
$\frac{OAdvCHIMP_{j99}}{OAdvTOTIMP_{j99}} * \frac{CHIMP_t}{WIMP_t}$					0.270***
					(0.032)
LagIMP					0.922***
					(0.002)
lnMERlag					-0.036***
					(0.002)

The dependent variable is the indicator variable that takes 1 if the plant does not participate the next period (t+1). Robust standard errors are reported in parentheses. They are clustered for each industry in each year. *, ** and *** indicate significance at the 10 %, 5% and 1% levels respectively. A constant term is included but not reported. For IV regressions the instrument for $IMPCH$ in column (4) and (5) is the worldwide Chinese imports (exports from China) as a share in total world imports interacted with the 1999 Chinese share of imports in other advanced/high income countries. In column (5), the instruments for IMP are the industry specific exchange rate for the US industry where the weights for each trading partner's currency are the lagged share of imports of that particular trading partner, and lagged values of import-penetration rates constructed without Mexican and Chinese imports.

Table 7: The Impact of Chinese Competition on Entry to Mexican Offshoring Industry I

Specification Variables	(1) Negative Binomial *ENTRY*	(2) Negative Binomial *ENTRY*	(3) Negative Binomial *ENTRY*	(4) Negative Binomial *ENTRY*	(5) Negative Binomial *ENTRY*
IMPCH	-4.798***	-5.709***	-4.752***	-4.311***	-4.929***
	(1.102)	(1.070)	(1.064)	(1.060)	(1.034)
IMP		-2.057*			-1.659*
		(0.822)			(0.837)
RelWage ($\frac{MXWage_{jt}}{USWage_{jt}}$)			-2.789*		-2.723*
			(1.086)		(1.091)
Industry Specific Exchange Rate ($lnMER_{jt}$)				-3.950***	-3.920***
				(0.971)	(0.953)
$ln(\alpha)$ (over-dispersion parameter)	-2.860***	-2.937***	-2.882***	-3.088***	-3.207***
	(0.235)	(0.250)	(0.237)	(0.270)	(0.292)
Industry Fixed Effects	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓
N	176	176	176	176	176
χ^2	978.266	1081.993	1112.863	1114.511	1347.349

The dependent variable is the total number of entrants at period t and industry j. Robust standard errors are reported in parentheses. *, ** and *** indicate significance at the 10 %, 5% and 1% levels respectively. A constant term is included but not reported.

Table 8: The Impact of Chinese Competition on Entry and Exit Rates

Specification Variables	(1) Fractional Logit *EXITRATE*	(2) Fractional Logit *ENTRYRATE*	(3) Fractional Logit *EXITRATE*	(4) Fractional Logit *ENTRYRATE*	(5) Fractional Logit *EXITRATE*	(6) Fractional Logit *ENTRYRATE*
IMPCH	2.649***	-1.990*	4.541***	-2.714*	4.693***	-2.774***
	(0.266)	(0.957)	(0.401)	(1.155)	(0.581)	(0.778)
IMP			2.447***	-1.045	2.664***	-1.115
			(0.337)	(0.931)	(0.564)	(0.660)
RelWage					3.069***	-3.801**
					(0.908)	(1.279)
Industry Fixed Effects	✓	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓
N	176	176	176	176	176	176

EXITRATE is the total number of exiting plants over the total number of plants at period t and industry j. *ENTRYRATE* is the total number of entering plants over the total number of plants at period t and industry j. The results are obtained using the generalized linear model with binomial family, logit link and robust standard errors. Robust standard errors are reported in parentheses, and they are clustered by industry. *, ** and *** indicate significance at the 10 %, 5% and 1% levels respectively. A constant term is included but not reported.

Table 9: The Impact of Chinese Competition on Productivity

Panel A

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	OLS	OLS	IV	IV
Dependent Variable	lnTFP	lnTFP	lnTFP	lnTFP	lnTFP	lnTFP
IMPCH	0.456***	0.411***	0.442***	0.393**	0.462**	0.563***
	(0.101)	(0.100)	(0.124)	(0.124)	(0.165)	(0.162)
IMP		-0.106		-0.110		-0.132
		(0.092)		(0.097)		(0.098)
Age Dummy 1	-0.015	-0.015	-0.016	-0.016	-0.015	-0.015
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Age Dummy 2	-0.014*	-0.014*	-0.012	-0.011	-0.014*	-0.013*
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Multi-plant Dummy	0.013*	0.013*	0.012	0.012	0.013*	0.015*
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Entrant Dummy			0.012	0.012		
			(0.007)	(0.007)		
Entrant*IMPCH			0.030	0.024		
			(0.081)	(0.081)		
Exit Dummy			-0.021*	-0.021		
			(0.011)	(0.011)		
Exit*IMPCH			0.168	0.168		
			(0.095)	(0.094)		
R^2	0.065	0.065	0.062	0.062		
Number of Plants	3257	3257	3062	3062	3257	3169
N	20742	20742	18572	18572	20742	19942
Year by State Fixed Effects	✓	✓	✓	✓	✓	✓
Plant Fixed Effects	✓	✓	✓	✓	✓	✓

Panel B: First Stage IV

	(5)	(6)
	$IMPCH_{jt}$	$IMPCH_{jt}$
$\frac{OAdvCHIMP_{j99}}{OAdvTOTIMP_{j99}} * \frac{CHIMP_t}{WIMP_t}$	6.593***	7.626***
	(0.549)	(0.671)
R^2	0.339	0.537
F-test of excluding statistics	144.16	66.73
		IMP_{jt}
$\frac{OAdvCHIMP_{j99}}{OAdvTOTIMP_{j99}} * \frac{CHIMP_t}{WIMP_t}$		-0.063
		(0.377)
LagIMP		0.898***
		(0.029)
lnMERlag		-0.035
		(0.022)
R^2		0.832
F-test of excluding statistics		273.83

Note: The dependent variable is the logarithm of plant TFP. Calculation of TFP indices are explained in section C.1 in the appendix. Robust standard errors are reported in parentheses and they are clustered for each industry in each year. *, ** and *** indicate significance at the 10 %, 5% and 1 % levels respectively. A constant term is included but not reported. For IV regressions the instrument for $IMPCH$ in column (5) and (6) is the worldwide Chinese imports (exports from China) as a share in total world imports interacted with the 1999 shares of Chinese imports in other advanced/high income countries in the corresponding US NAICS for each Maquiladora sector. In column (6) the instruments for IMP are the lagged values of import-penetration rates constructed without Mexican and Chinese imports and the industry specific exchange rate for the US industry where the weights for each trading partner's currency are the lagged share of imports of that particular trading partner.

Table 10: The Impact of Chinese Competition on Skill Intensity

Dependent Variable	(1) OLS Skill Intensity	(2) OLS Skill Intensity	(3) IV Skill Intensity	(4) IV Skill Intensity
IMPCH	0.228	0.660**	1.810***	1.357***
	(0.217)	(0.206)	(0.339)	(0.264)
IMP		0.901***		1.088***
		(0.157)		(0.146)
Age Dummy 1	0.013	0.013	0.017	0.014
	(0.024)	(0.024)	(0.025)	(0.024)
Age Dummy 2	0.012	0.008	0.013	0.006
	(0.018)	(0.018)	(0.019)	(0.018)
Multi-Plant Dummy	0.014	0.015	0.017	0.023
	(0.016)	(0.016)	(0.016)	(0.015)
Year by State Fixed Effects	✓	✓	✓	✓
Plant Fixed Effects	✓	✓	✓	✓
R^2	0.034	0.035		
Number of Plants	3638	3638	3638	3583
N	26369	26369	26369	25227
F-test of excluding statistics			156.96	69.20/256.49

Note: The dependent variable is the logarithm of the number of administrators and technicians over workers. It is defined for plants employing more than 1 person. Robust standard errors are reported in parentheses. They are clustered for each industry in each year. *, ** and *** indicate significance at the 10 %, 5% and 1 % levels respectively. The constant is included but not reported. For IV regressions the instrument for $IMPCH$ is the worldwide Chinese imports (exports from China) as a share in total world imports interacted with the 1999 import share from China in the corresponding US NAICS for each Maquiladora sector in other advanced countries. In column (4), the instruments for IMP are the industry specific exchange rate for the US industry where the weights for each trading partner's currency are the lagged share of imports of that particular trading partner, and lagged values of import-penetration rates constructed without Mexican and Chinese imports.

Table 11: The Impact of Chinese Competition on Relative Skilled Wages

Dependent Variable	(1) OLS Relative Skilled Wages	(2) OLS Relative Skilled Wages	(3) IV Relative Skilled Wages	(4) IV Relative Skilled Wages
IMPCH	0.468**	0.459**	0.431*	0.468**
	(0.161)	(0.151)	(0.190)	(0.176)
IMP		-0.017		-0.104
		(0.120)		(0.144)
Age Dummy 1	-0.089***	-0.089***	-0.090***	-0.090***
	(0.014)	(0.014)	(0.014)	(0.014)
Age Dummy 2	-0.078***	-0.078***	-0.078***	-0.078***
	(0.009)	(0.009)	(0.009)	(0.009)
Multi-Plant Dummy	0.016	0.016	0.016	0.015
	(0.011)	(0.011)	(0.011)	(0.011)
Year by State Fixed Effects	✓	✓	✓	✓
Plant Fixed Effects	✓	✓	✓	✓
R^2	0.033	0.033		
Number of Plants	3441	3441	3441	3391
N	24706	24706	24706	23644
F-test of excluding statistics			153.07	67.59/251.52

Note: The dependent variable is the logarithm of the average wages of skilled employees (administrators and technicians) over average wages of unskilled employees (workers). Robust standard errors are reported in parentheses. They are clustered for each industry in each year. *, ** and *** indicate significance at the 10 %, 5% and 1 % levels respectively. A constant term is included but not reported. For IV regressions the instrument for $IMPCH$ is the worldwide Chinese imports (exports from China) as a share in total world imports interacted with the 1999 import share from China in the corresponding US NAICS for each Maquiladora sector in other advanced countries. In column (4), the instruments for IMP are the industry specific exchange rate for the US industry where the weights for each trading partner's currency are lagged share of imports of that particular trading partner, and the lagged values of import-penetration rates constructed without Mexican and Chinese imports.

APPENDIX

A Descriptive Statistics Tables and Figures

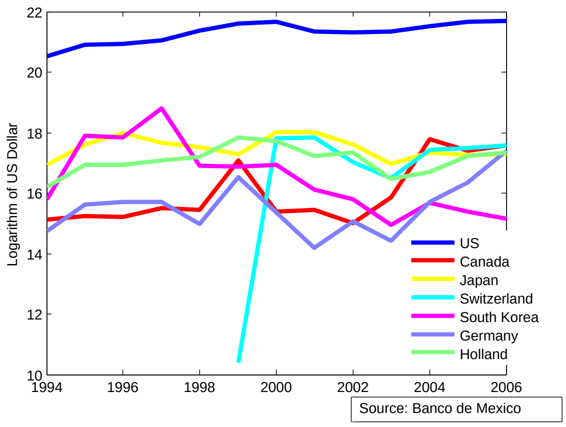
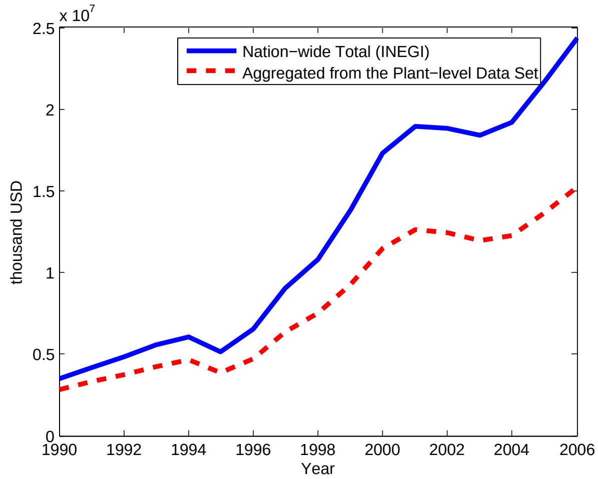
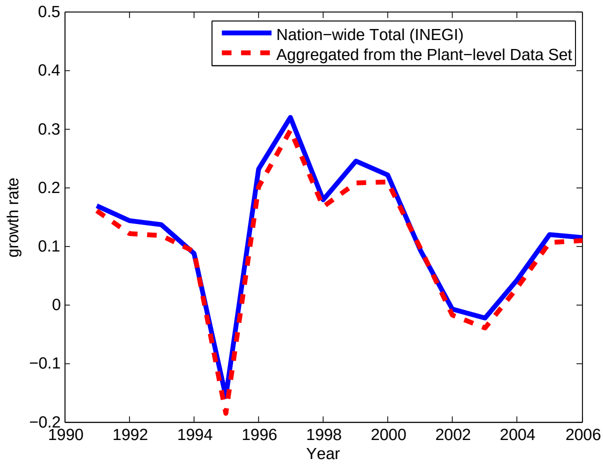


Figure A-1: Capital Equipment Investment in Maquiladora Industry By Country



(a) In Level



(b) Growth Rates

Figure A-2: Maquila Export Value Added (Source: INEGI)

Table A-1: Descriptive Statistics: Panel Information

Year	Number of Plants	Years in the Panel	Number of Plants
1990	1194	17	362
1991	1285	16	59
1992	1372	15	57
1993	1443	14	86
1994	1430	13	103
1995	1425	12	171
1996	1548	11	127
1997	1632	10	158
1998	1741	9	179
1999	1862	8	186
2000	1995	7	222
2001	2083	6	272
2002	1848	5	392
2003	1688	4	406
2004	1662	3	404
2005	1678	2	357
2006	1662	1	228

Note: The left hand side of the table shows the number of plants in a given year. The right hand side of the table shows the distribution of plants over their length of the stay in the panel.

Table A-2: Descriptive Statistics: Average Skill-Intensity

Number of Employees	1990-2000	2001-2006
Overall	333.549	409.955
Entrants	83.438	87.827
$\frac{SkilledWorkers}{UnskilledWorkers}$	1990-2000	2001-2006
Overall	0.289	0.401
Entrants	0.339	0.609

Source: Plant-level Survey of Maquiladoras (INEGI). Authors' calculation. $\frac{SkilledWorkers}{UnskilledWorkers}$ is defined for plants employing more than 1 person.

Table A-3: Decomposition of Aggregate Productivity Growth over 1999-2006

	Total Growth	Within Plant	Between Plants (Within Industry)	Net Entry	Between Sectors
All	0.078	0.024	0.003	0.012	0.039

The decomposition exercise follows the analysis presented in section C.2.

Table A-4: Evolution of Technology among Maquilas I: Descriptive Statistics

Year	Number of Plants	Average Employment (Head Count)	Foreign Owned Capital (%)
1999	589	933.093	79.822
2001	675	1245.003	78.514
2005	791	800.510	82.729

Source: Encuesta Nacional De Empleo, Salarios, Tecnologìa Y Capacitaci`n (ENESTYC). Authors' calculation.

Table A-5: Evolution of Technology among Maquilas II: Research and Development

Year	Performed R&D (%)	Performed Product Development (%)
1997	38.879	20.713
1999	39.704	20.593
2004	45.891	32.111

Source: Encuesta Nacional De Empleo, Salarios, Tecnologìa Y Capacitaciòn (ENESTyC). Authors' calculation. In ENESTyC 1999, R&D questions refers to the year 1997. In ENESTyC 2001, R&D questions refers to the year 1999 and in ENESTyC 2005, R&D questions refers to the year 2004.

Table A-6: Evolution of Technology among Maquilas III: Capacity Utilization

	Percentage Capacity Utilization		
Year	Maquila Plants	Manufacturing Plants (Panel)	All Manufacturing Plants
1997			
Mean	81.3	76.0	72.3
Median	85	79	78
Standard Deviation	20.0	15.2	23.7
Observation	589	686	6806
1999			
Mean	82.6	76.2	75.7
Median	85	80	80
Standard Deviation	16.4	17.4	20.1
Observation	675	690	8178
2004			
Mean	85.7	76.9	76.9
Median	90	80	80
Standard Deviation	16.4	17.9	18.3
Observation	786	689	6364

Source: Encuesta Nacional De Empleo, Salarios, Tecnologìa Y Capacitaci`n (ENESTyC 1999, 2001, and 2005). Authors' calculation. The second column is among non-maquila manufacturing plants that are surveyed continuously by ENESTyC. The third column is from all manufacturing (non-maquila) plants that are surveyed.

Table A-7: Evolution of Technology among Maquilas IV: Management and Organization Techniques

Year	2000 (%)	2005 (%)
Just in Time	20.1	41.1
Statistical Process Control	41.6	61.6
Total Quality Management	31.3	60.2
Job Rotation	22.7	46.8
Rearrangement of Equipment	26.0	55.0
Process Re-engineering	19.6	45.5
Number of (Maquila) Plants	642	791

Source: Encuesta Nacional De Empleo, Salarios, Tecnologìa Y Capacitaciòn (ENESTYC) 2005. Authors' calculation. The information is derived from ENESTYC 2005, Section 12, question 6 which asks whether a specified technique has been implemented, and, if so, the starting year of the implementation. The survey also presents brief descriptions of each technique to prevent recording errors.

B Additional Robustness Checks

Table B-1: Robustness Check: Results with Alternative Instruments I

Instrument $IMPCH_{j99} * \frac{CHIMP_t}{WIMP_t}$				
	(1)	(2)	(3)	(4)
Specification	IV	IV	IV	IVProbit
Dependent Variable	lnE	ΔlnE	Productivity	χ
$IMPCH_{jt}$	-3.586***	-1.762**	0.514***	1.962**
	(0.681)	(0.560)	(0.119)	(0.658)
AgeDummy 1	0.445***	-0.652***	-0.015	0.032
	(0.074)	(0.096)	(0.009)	(0.046)
AgeDummy 2	0.432***	-0.608***	-0.014*	0.162***
	(0.047)	(0.056)	(0.006)	(0.048)
Multi-plant Dummy	-0.103***	0.076***	0.013*	0.052
	(0.027)	(0.019)	(0.006)	(0.034)
Plant Fixed Effects	✓	✓	✓	No
Industry Fixed Effects	No	No	No	✓
Year by State Fixed Effects	✓	✓	✓	✓
Number of Observation	27548	23743	20742	25559
$IMPCH_{j99} * \frac{CHIMP_t}{WIMP_t}$	12.685***	14.295***	12.367***	15.099***
	(1.393)	(1.595)	(1.390)	(1.595)
R^2	0.526	0.569	0.487	
F-test of excluded instruments	82.93	80.29	40.76	

Note: The dependent variable in column (1) is the logarithm of employment. The dependent variable in column (2) is the annual employment growth among continuing plants. The dependent variable in column (3) is the plant TFP. The dependent variable in column (3) is the plant exit indicator. Robust standard errors are reported in parentheses and they are clustered by each industry and year. *, ** and *** indicate significance at the 10 %, 5% and 1% levels respectively. State by year fixed effects are partialled-out. A constant term is included but not reported.

Table B-2: Robustness Check: Results with Alternative Instruments II

Instrument $\frac{OAdvCHIMP_{jt}}{OAdvTOTIMP_{jt}}$

	(1)	(2)	(3)	(4)
Specification	IV	IV	IV	IVProbit
Dependent Variable	lnE	ΔlnE	Productivity	χ
$IMPCH_{jt}$	-4.659***	-2.661**	0.604**	2.351
	(1.043)	(0.937)	(0.225)	(1.279)
AgeDummy 1	0.444***	-0.653***	-0.015	0.025
	(0.074)	(0.096)	(0.009)	(0.046)
AgeDummy 2	0.436***	-0.608***	-0.014*	0.157**
	(0.047)	(0.057)	(0.006)	(0.048)
Multi-plant Dummy	-0.128***	0.074***	0.015*	0.044
	(0.026)	(0.020)	(0.006)	(0.034)
Plant Fixed Effects	✓	✓	✓	No
Industry Fixed Effects	No	No	No	✓
Year by State Fixed Effects	✓	✓	✓	✓
Number of Observation	26354	23743	19942	24458
$\frac{OAdvCHIMP_{jt}}{OAdvTOTIMP_{jt}}$	0.472***	0.485***	0.465***	0.485***
	(0.056)	(0.055)	(0.054)	(0.069)
R^2	0.292	0.326	0.303	
F-test of excluded instruments	72.07	77.61	74.76	

Note: The dependent variable in column (1) is the logarithm of employment. The dependent variable in column (2) is the annual employment growth among continuing plants. The dependent variable in column (3) is the plant TFP. The dependent variable in column (3) is the plant exit indicator. Robust standard errors are reported in parentheses and they are clustered by each industry and year. *, ** and *** indicate significance at the 10 %, 5% and 1% levels respectively. State by year fixed effects are partialled-out. A constant term is included but not reported.

Table B-3: Robustness: The Impact of Chinese Competition on Employment Growth (additional plant-level controls)

Panel A

	(1)	(2)	(3)	(4)	(5)
Specification	OLS	OLS	OLS	IV	IV
Dependent Variable	ΔlnE	ΔlnE	ΔlnE	ΔlnE	ΔlnE
$IMPCH_{jt}$	-1.344**	-2.111***	-1.862***	-4.714***	-2.718***
	(0.435)	(0.477)	(0.467)	(1.108)	(0.701)
IMP_{jt}		-1.569**	-1.233*		-1.446**
		(0.494)	(0.496)		(0.458)
$RelWage_{jt}$			0.120		
			(0.246)		
$lnUSPI_{jt}$			0.089*		
			(0.039)		
$lnTFP_{ijst}$	0.109**	0.109**	0.107**	0.123**	0.096*
	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)
Size Dummies	✓	✓	✓	✓	✓
Plant Level Controls	✓	✓	✓	✓	✓
Plant Fixed Effects	✓	✓	✓	✓	✓
Year by State Fixed Effects	✓	✓	✓	✓	✓
N	18222	18222	18222	18222	15675
R^2	0.228	0.230	0.230		

Note: The dependent variable is the change in the logarithm of employment between two consecutive years among continuing plants. Robust standard errors are reported in parentheses, they are clustered for each industry in each year. *, ** and *** indicate significance at the 10 %, 5% and 1% levels respectively. Plant-level controls are age, size and multi-plant dummies. For IV regressions the instrument for $IMPCH$ in column (4) and (5) is the worldwide Chinese imports (exports from China) as a share in total world imports interacted with the 1999 shares of Chinese imports in other advanced/high income countries. In column (5), the instruments for IMP are the industry specific exchange rate for the US industry where the weights for each trading partner's currency are the lagged share of imports of that particular trading partner, and lagged values of import-penetration rates constructed without Mexican and Chinese imports. A constant term is included but not reported.

Table B-4: The Impact of Chinese Competition on Maquiladora Exits (additional plant-level controls)

Panel A

Specification Variables	(1) Probit χ	(2) Probit χ	(3) Probit χ	(4) IV χ	(5) IV χ
$IMPCH_{jt}$	2.103**	2.794***	2.113*	4.400***	3.119**
	(0.792)	(0.813)	(0.826)	(1.321)	(1.110)
IMP_{jt}		1.790**	1.037		1.538*
		(0.633)	(0.726)		(0.652)
$lnUSPI_{jt}$			-0.158*		
			(0.075)		
Relative Wage ($\frac{MXWage_{jt}}{USWage_{jt}}$)			0.390		
			(0.651)		
Size	-0.352***	-0.353***	-0.354***	-0.351***	-0.360***
	(0.019)	(0.019)	(0.019)	(0.019)	(0.013)
Productivity	-0.406***	-0.405***	-0.404***	-0.422***	-0.378***
	(0.106)	(0.106)	(0.106)	(0.107)	(0.089)
Productivity Square	0.394***	0.391***	0.392***	0.401***	0.366***
	(0.082)	(0.082)	(0.083)	(0.082)	(0.070)
Age Dummy 1	-0.296***	-0.302***	-0.302***	-0.289***	-0.311***
	(0.057)	(0.057)	(0.057)	(0.057)	(0.056)
Age Dummy 2	0.039	0.027	0.027	0.041	0.026
	(0.051)	(0.051)	(0.051)	(0.051)	(0.053)
Multi-plant Dummy	0.096*	0.093*	0.093*	0.099*	0.089*
	(0.042)	(0.042)	(0.042)	(0.042)	(0.044)
Year by State Fixed Effects	✓	✓	✓	✓	✓
Industry Fixed Effects	✓	✓	✓	✓	✓
N	18504	18504	18504	18504	17840
Pseudo R^2	0.227	0.228	0.229		

The dependent variable is the indicator variable that takes 1 if the plant does not participate the next period (t+1). Robust standard errors are reported in parentheses. They are clustered for each industry in each year. *, ** and *** indicate significance at the 10 %, 5% and 1% levels respectively. Size variable is measured by the logarithm of labor. The constant is included but not reported. For IV regressions the instrument for $IMPCH$ in columns (4) and (5) is the worldwide Chinese imports (exports from China) as a share in total world imports interacted with the 1999 shares of Chinese imports in other advanced/high income countries. In column (5), the instruments for IMP are the industry specific exchange rate for the US industry where the weights for each trading partner's currency are the lagged share of imports of that particular trading partner, and lagged values of import-penetration rates constructed without Mexican and Chinese imports.

Table B-5: Productivity: Balanced Sample

Panel A

Dependent Variable	(1) OLS lnTFP	(2) OLS lnTFP	(3) OLS lnTFP	(4) IV lnTFP	(5) IV lnTFP
IMPCH	0.770***	0.732***	0.728***	0.789**	1.227***
	(0.155)	(0.144)	(0.146)	(0.245)	(0.289)
IMP		-0.294*	-0.283*		-0.306*
		(0.124)	(0.141)		(0.141)
USIP			0.002		
			(0.007)		
Age Dummy 1	-0.046	-0.055	-0.054	-0.045	-0.018
	(0.028)	(0.029)	(0.030)	(0.027)	(0.026)
Age Dummy 2	-0.108**	-0.117***	-0.117***	-0.107**	-0.106**
	(0.034)	(0.034)	(0.034)	(0.033)	(0.033)
Multi-plant Dummy	0.004	0.005	0.005	0.004	0.006
	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)
R^2	0.158	0.159	0.159		
N	4755	4755	4755	4755	4504
Year by State Fixed Effects	✓	✓	✓	✓	✓
Plant Fixed Effects	✓	✓	✓	✓	✓

Note: The dependent variable is the logarithm of plant TFP. Calculation of TFP indices are explained in section C.1 in the appendix. Robust standard errors are reported in parentheses and they are clustered for each industry in each year. *, ** and *** indicate significance at the 10 %, 5% and 1 % levels respectively. A constant term is included but not reported. For IV regressions the instrument for $IMPCH$ in column (4) and (5) is the worldwide Chinese imports (exports from China) as a share in total world imports interacted with the 1999 shares of Chinese imports in other advanced/high income countries in the corresponding US NAICS for each Maquiladora sector. In column (5) the instruments for IMP are the lagged values of import-penetration rates constructed without Mexican and Chinese imports and the industry specific exchange rate for the US industry where the weights for each trading partner's currency are the lagged share of imports of that particular trading partner.

Table B-6: The Impact of Chinese Competition on Productivity : Alternative Productivity Measure

Panel A

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) IV
Dependent Variable	lnTFP-Fix	lnTFP-Fix	lnTFP-Fix	lnTFP-Fix	lnTFP-Fix
IMPCH	0.448**	0.370*	0.391*	0.600**	0.640**
	(0.136)	(0.169)	(0.171)	(0.223)	(0.221)
IMP			0.049		0.056
			(0.132)		(0.136)
Age Dummy 1	0.012	-0.004	-0.004	0.012	0.013
	(0.013)	(0.015)	(0.015)	(0.013)	(0.013)
Age Dummy 2	-0.004	-0.010	-0.010	-0.004	-0.003
	(0.009)	(0.010)	(0.010)	(0.009)	(0.009)
Multi-Plant Dummy	-0.013	-0.014	-0.014	-0.013	-0.012
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Entrant Dummy		0.001	0.001		
		(0.009)	(0.009)		
Entrant*IMPCH		-0.147	-0.144		
		(0.134)	(0.135)		
Exit Dummy		-0.076***	-0.076***		
		(0.016)	(0.016)		
Exit*IMPCH		0.378*	0.378*		
		(0.149)	(0.149)		
Plant Fixed Effects	✓	✓	✓	✓	✓
Year by State Fixed Effects	✓	✓	✓	✓	
Number of Observations	20742	18572	18572	20742	19942
R^2	0.053	0.052	0.052		

Note: The dependent variable is the logarithm of TFP, where TFP is calculated using fixed effects model. Robust standard errors are reported in parentheses. They are clustered for each industry in each year. *, ** and *** indicate significance at the 10 %, 5% and 1 % levels respectively. A constant term is included but not reported. The instrument for $IMPCH$ is the worldwide Chinese imports (exports from China) as a share in total world imports interacted with the 1999 shares of Chinese imports in other advanced countries. In column (5), the instruments for IMP are the industry specific exchange rate for the US industry where the weights for each trading partner's currency are the lagged share of imports of that particular trading partner, and lagged values of import-penetration rates constructed without Mexican and Chinese imports.

Table B-7: Late Sample: 1999-2006 First Order Effects

	(1)	(2)	(3)	(4)	(5)	(6)
Specification	OLS	IV	OLS	IV	OLS	IV
Dependent Variable	$lnSales$	$lnSales$	$lnXVad$	$lnXVad$	lnE	lnE
IMPCH	-1.962*	-3.352**	-2.038**	-2.738**	-3.264***	-4.008***
	(0.858)	(1.172)	(0.705)	(1.042)	(0.734)	(1.203)
R^2	0.045		0.046		0.050	
Number of Observations	14478	14478	14478	14478	14478	14478
Plant-level controls	✓	✓	✓	✓	✓	✓
Plant Fixed Effects	✓	✓	✓	✓	✓	✓
Year by State Fixed Effects	✓	✓	✓	✓	✓	✓

The sample period is 1999-2006. Plant-level controls are age dummies and multi-plant dummy. Robust standard errors are reported in parentheses. They are clustered for each industry in each year. The instrument for $IMPCH$ is the worldwide Chinese imports as a share in total world imports interacted with the 1999 shares of Chinese imports in other advanced/high income countries.

Table B-8: Late Sample: 1999-2006 Dynamic Effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Specification	OLS	IV	OLS	IV	OLS	IV	OLS	IV	Probit	IVProbit
Dependent Variable	ΔlnE	ΔlnE	TFP	TFP	Skill Intensity	Skill Intensity	Relative Skilled Wages	Relative Skilled Wages	χ	χ
IMPCH	-1.669	-4.321*	0.437***	0.728***	0.944***	1.670***	0.523**	0.239	2.340**	3.621**
	(0.901)	(1.745)	(0.118)	(0.214)	(0.241)	(0.273)	(0.181)	(0.468)	(0.887)	(1.295)
R^2	0.127		0.048		0.022		0.042			
Number of Observations	13188	13188	11403	11403	13895	13895	13125	13125	12816	12816
Plant-level controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Plant Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓	No	No
Industry Fixed Effects									✓	✓
Year by State Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

The sample period is 1999-2006 except for exit, which is 1999-2005, since exit dummy, χ, is not defined in 2006. Plant-level controls are age dummies and multi-plant dummy. Robust standard errors are reported in parentheses. They are clustered for each industry in each year. The instrument for $IMPCH$ is the worldwide Chinese imports as a share in total world imports interacted with the 1999 shares of Chinese imports in other advanced/high income countries.

C Sources and Construction of the Data

C.1 Calculation of Plant TFPs

We use a KLEM approach and calculate a multi-factor productivity index using gross-output measures. In order to calculate an index that is comparable across firms and years, we follow Aw, et al. (2001) and use the extension of the total factor productivity index proposed by Good, et al. (1997) that incorporates both the chaining approach and the hypothetical firm approach of Caves, et al. (1982) which is suitable for a panel data-setting. Assuming an underlying production technology represented by an unrestricted constant returns to scale translog function, Caves et al. (1982), derive a superlative TFP index which is expressed relative to a hypothetical firm, allowing the index to be transitive across firms. Good et al. (1997) extend this index using the chaining approach to make it sample independent, so that it can be used for both cross-section and across time comparisons. The TFP index is calculated separately for each industry. To do that, for each industry we construct a hypothetical firm whose subcomponent expenditure shares are the arithmetic mean expenditure shares and whose subcomponent quantities (as measured by deflated sales) are the geometric means of the subcomponent quantities for each cross section. We then chain the hypothetical firms together over time. So the TFP index is calculated as follows:

$$\begin{aligned} lnTFP_{it} = (q_{it} - \overline{q_t}) + \sum_{s=2}^{t}(\overline{q_s} - \overline{q}_{s-1}) - [\sum_{j=k,sl,ul,e,m} 0.5 * (\alpha_{it}^j + \overline{\alpha_t^j})(x_{it}^j - \overline{x_{it}^j}) + \\ \sum_{s=2}^{t} \sum_{j=k,sl,ul,e,m} 0.5 * (\overline{\alpha_s^j} + \overline{\alpha_{s-1}^j})(\overline{x_s^j} - \overline{x_{s-1}^j})] \end{aligned} \quad \text{(C-1)}$$

where q_{it} is the logarithm of deflated sales of plant i, and x_{it}^j is the logarithm of the input j used by plant i at period t, where the type of input is indicated with superscript $j = sl, ul, k, e, m$. sl denotes skilled labor measured by the total number of administrative and technical personnel, ul denotes unskilled labor as measured by the total number of workers, k denotes capital measured by the deflated rental expenditures on buildings, machinery and equipment, e denotes energy measured by deflated expenditures on fuel and electricity and m denotes materials measured by deflated expenditures on domestic and imported materials. Input weights, α^j's, are calculated using the share of expenditure of input j in the total expenditures of firms, and so constant returns to scale are implicitly assumed. The bar indicates an average over the relevant variable (e.g. $\overline{q_t}$ indicates the natural logarithm of the geometric average for output across all plants within an industry at period t). In equation C-1 both output and input are expressed in two parts. The first parts express output and input in relation to the hypothetical or representative firm of the current period, and the second parts express the change in the representative firm across time.

C.2 Productivity Decomposition

Following Griliches and Regev (1995) and Foster et al. (1999), we decompose the aggregate productivity growth into within-plant, reallocation within sector, turnover and reallocation between sectors components as follows:

$$\Delta P_t = \sum_j \overline{s_t^j}[\sum_{i \in C_j} \overline{s_t^j} \Delta P_{it}^j] + \sum_j \overline{s_t^j}[\sum_{i \in C_j} (\overline{p_i^j} - \overline{P^j}) \Delta s_{it}^j] + \sum_j \overline{P_t^j} \Delta s_t^j + \sum_j \overline{s_t^j}[\sum_{i \in N_j} (s_{it}^j (p_{it}^j - \overline{P^j})) - \sum_{i \in X_j} (s_{it-1}^j (p_{it-1}^j - \overline{P^j}))] \quad \text{(C-2)}$$

Here a bar over a variable indicates the average of the variable over the base (t-1) and end year (t), i denotes plant, j denotes industry. Market shares are measured using export value-added. P_t denotes the aggregate industry productivity, $P_t = \sum_j s_t^j P_t^j$ where s_t^j is industry j's share of total export value-added. C_j refers to a set of continuing plants in sector j, N_j refers to a set of entering plants in sector j, and X_j refers to a set of exiting plants in sector j. The first term, $\sum_j \overline{s_t^j}[\sum_{i \in C_j} \overline{s_t^j} \Delta P_{it}^j]$ denotes the within-plant component, the second term is the within-industry reallocation term, the third term is reallocation between sectors followed by the net entry component.

C.3 Matching NAICS with Maquiladoras

INEGI has conducted an annual survey of the universe of plants registered under the maquiladora program and constructed one service and eleven manufacturing sectors, called 'economic groups'. In this paper, the 11 maquiladora industries were matched with the US NAICS. To do so, we use survey results conducted by INEGI, Dirección De Estadísticas De Comercio Exterior, Registros Administrativos Y Precios. Maquiladora sectors are tied to the US industries vertically within generally 4-digit industries (plants import from and export to the same 4-digit industries). In Table C-1, we provide the names of the eleven maquiladora sectors and the corresponding US NAICS. This matching is further confirmed by converting export trade data in 2-digit HS codes as reported by Banco de México to 3-digit NAICS.

C.4 Import Penetration Rates and other Aggregate Variables

To calculate import penetration in the U.S., data from the Center for International Data at U.C. Davis on exports and imports by industry and country were used. The information is provided in 6-digit NAICS classification. Output information is provided by the Bureau of Economic Analysis (BEA). The matching is based on the combination of 4-digits NAICS as described in Table C-1.

Table C-1: Industry Descriptions

Ecogroup No	Description	NAICS Code
1	Selection, preparation, packing and canning of food	3114
2	Apparel and textile knitting and sewing	3151, 3152, 3159, 3169
3	Footwear manufacturing and leather and hide tanning	3161, 3162
4	Furniture and other wood and metal products assembly	3323, 3371,3379
5	Chemical products	3251, 3252, 3253, 3254, 3255, 3256, 3259
6	Transportation equipment (and accessories) assembly	3362, 3363, 3369
7	Assembly and repair of tools, equipment and parts, except electrical	3331, 3332, 3334, 3339
8	Electronic (and electrical) devices, machinery, accessories	3341, 3342, 3343, 3344, 3345, 3346, 3352
9	Electrical machinery, equipment and accessories	3351, 3353, 3359
10	Sporting goods and toy assembly	339920, 339931, 339932
11	Other manufacturing industries	334510, 3391, 3399, 339992 (excluding 339920-339931-339932)

Source: DEPARTMENT OF EXTERIOR COMMERCIAL STATISTICS, ADMINISTRATIVE AND PRICING REGISTRY, INEGI

The U.N. comtrade database is used to estimate import shares of the advanced countries. The U.N. comtrade information is provided in six-digit Harmonized System (HS) codes. The concordances developed by Pierce and Schott (2009) that link each ten-digit import and export HS code to a single six-digit NAICS (NAICS) industry are utilized. These concordances provide a mapping of HS to NAICS industries from 1989 to 2006. The advanced countries used in constructing the 1999 shares of Chinese imports in other advanced/high income countries, $\frac{OAdvCHIMP_{j99}}{OAdvTOTIMP_{j99}}$, are Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain and Switzerland; these countries are chosen to match the countries in Autor et al. (2012). In constructing the Chinese import shares in other high-income countries, $\frac{OAdvCHIMP_{jt}}{OAdvTOTIMP_{jt}}$, only seven of the advanced countries are used due to missing data in certain maquila matched industries in year 1997 for Denmark. Since Germany does not have data for the year 1990 (due to the unification), the sample for $\frac{OAdvCHIMP_{jt}}{OAdvOTIMP_{jt}}$ starts in 1991.

The source for the world-wide Chinese imports as well as world-wide total imports is the World Bank. Data on industry specific U.S. hourly wages is from the Bureau of Labor Statistics(BLS). To estimate maquiladora hourly wages, total worker wages reported in the plant-level data set were aggregated at the industry level and converted to the US dollar term using the nominal exchange rate between Mexican peso and the US dollar. The source for the nominal exchange rate between US dollar and Mexican peso is Banco de México. The relative wage variable, $RelWage$, which is used as an aggregate industry level control, is then constructed by dividing industry specific maquiladora hourly wages by their U.S. industry counterpart. Both US and maquiladora wages do not include benefits to workers. US wages are based on 3-digit NAICS matching. The source for the U.S. industrial production index, $USPI$, is the Federal Reserve Board of Governors. With the exception of ECOGROUP 1, which only corresponds to a single 4-digit NAICS, matching of the US production index is based on 3-digit NAICS. The source of industry-specific exchange rate measures for the US manufacturing industries, MER and $MERlag$, is Goldberg (2004). The data can be downloaded from `http://www.newyorkfed.org/research/global_economy/industry_specific_exrates.html` These measures are constructed by using the time histories of the weights of U.S. trading partners in the imports of each U.S. industry.