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VOLATILITY IN THE MEXICAN OFFSHORING INDUSTRY

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Volatility in the Mexican Offshoring Industry

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Abstract

This paper studies how volatility in the Mexican maquiladora employment and wages are allocated between the number of plants operating each month (extensive margin) and the average employment per plant (intensive margin) among different groups of sectors, through a decomposition exercise. Then, the paper analyzes the impact of foreign affiliates located in Mexican regions on business cycle comovements based on the theory of the granular origins of aggregate fluctuations.

For the first objective, the main contribution of this paper is to extend the work done by Bergin, Feenstra, and Hanson (2009) in two directions: sector coverage and time-period. We find that for the most representative maquila sectors (apparel, chemicals, electronics, electrical equipment, furniture, and transportation equipment), adjustments in the number of plants are larger than for the least representative sectors (food processing, footwear, machinery, and toys), in particular during a period comprising a crisis. Thus, the least representative sectors are less volatile and less dependent on global production sharing.

Moreover, the current paper also presents a decomposition exercise for wages in the maquiladora industry, which was not previously analyzed. The purpose of this additional exercise is to show how volatility in wages is allocated between the number of plants (extensive margin) and the mean wages (intensive margin) for different groups of sectors. We find empirical evidence suggesting that for the most representative maquila sectors, adjustments in the number of plants are larger than for the least representative sectors. Once again, the least representative sectors are less volatile and less dependent on global production sharing.

For the second objective, the idea is to show how shocks experienced by a few large multinational enterprises have the potential to generate fluctuations on Mexican states' GDP. The analysis focuses on the largest 100 multinational enterprises engaged in offshoring activities with affiliates established in Mexican regions. We find empirical evidence supporting the claim that the presence of foreign affiliates in Mexican regions significantly increases the correlation between the fluctuations of the regions' GDP and the GDP of the source country.

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1 Introduction

The way we measure international trade is shifting from total gross exports to domestic value added, due to the increasingly importance of global value chains (GVCs) in the world economy. Nowadays, companies fragment their production processes and offshore some of these stages abroad. As a result, GVCs are the means through which developed, emerging, and developing countries engage in international trade.

Mexico has a strong participation in GVCs through its offshoring activities, also known as *maquiladoras*. The country is viewed as a natural site for offshoring activities, due to its preferential access to the American market through the North American Free Trade Agreement (NAFTA), low wages, and its geographical proximity to the United States. Mexico has an important offshoring activity across specific sectors, in particular among electronics, electrical material and transportation equipment, due to production fragmentation.

An important characteristic of the offshoring industry is its large volatility in host countries. Bergin, Feenstra, and Hanson (2009) show evidence on more pronounced swings in Mexican maquiladora activity than in their U.S. counterparts. During a recession, source countries tend to reduce levels of production abroad. The reduction of the number of plants abroad (extensive margin) acts as a powerful mechanism for the transmission of shocks, which have an impact on employment in the host country. This higher volatility is translated to a number of plants shutting down (extensive margin) and layoffs (intensive margin) affecting employment in Mexico.

This paper studies how volatility in the Mexican maquiladora employment is allocated between the number of plants operating each month (extensive margin) and the employment per plant (intensive margin) among different sectors, through a decomposition exercise. The main contribution of this paper is to extend the work done by Bergin, Feenstra, and Hanson (2009) in two directions: sector coverage and period.

In addition, this paper also presents a decomposition exercise for wages in the maquiladora industry, which was not previously analyzed. The purpose of this additional exercise is to show how volatility in wages is allocated between the number of plants (extensive margin) and the mean wages (intensive margin) for different groups of sectors.

As a second step, this paper analyzes the impact of foreign affiliates located in Mexican regions on business cycle comovements based on the theory of the granular origins of aggregate fluctuations (Gabaix, 2011). The analysis focuses on the largest 100 multinational enterprises (MNEs) engaged in offshoring activities with affiliates established in Mexico. The idea is to show how shocks experienced by a few large MNEs have the potential to generate fluctuations on the GDP of Mexican states.

The rest of the paper is structured as follows. Section 2 addresses the literature review. Section 3 gives a general overview of the maquiladora industry. Section 4 presents the data description. Section 5 explains the empirical methodology. Section 6 presents the

empirical evidence, and Section 7 concludes. An appendix provides broader insights on descriptive statistics and empirical evidence.

2 Literature Review

Global production sharing is responsible for a substantial portion of the world trade and it is the primary way by which many developing countries engage in international trade (Bergin, Feenstra, Hanson, 2009). In the case of Mexico, an important part of the trade relationship with the United States is based on offshoring. In fact, the share of maquiladoras on total Mexican exports towards the United States is 45.69% in 2006 (INEGI, 2006).

Offshoring can be defined as the arrangement whereby firms contract to carry out particular stages of production abroad (Bergin, Feenstra, and Hanson, 2011). Mexico is viewed as a natural spot to locate offshoring processes, as assembly, for the U.S. market. This is due to preferential access (NAFTA), low wages, and geographical proximity to the Northern neighbor country. As a result, most of the maquila plants are located in the border pair cities of San Diego-Tijuana, Imperial County-Mexicali, El Paso-Ciudad Juarez, Laredo-Nuevo Laredo, McAllen-Reynosa, and Brownsville-Matamoros (Hanson, 1997).

2.1 Volatility due to Offshoring

The expansion of export assembly activity in Mexico has lead to significant employment growth. In particular, cities along the U.S.-Mexican border have experienced different employment and wage growth patterns. Otero and Pagan (2002) show evidence suggesting that the variance could be owed to differences in union strength across border cities. For example, maquiladora employment growth has been slow in Matamoros (Tamaulipas), but wages have risen faster than in any other border city, due to the high presence and power of unions in this city. On the other hand, cities as Tijuana and Mexicali (Baja California), where unions have a weak power, there is higher employment volatility and wages tend to be lower.

Bergin, Feenstra, and Hanson (2011) provides an explanation for the volatility transmission by saying that increases and reductions in the number of plants abroad (extensive margin) acts as a powerful mechanism for the transmission of shocks to host countries. Furthermore, Alejandro Cuña and Marc Melitz (2007) present evidence suggesting that international differences in labor market regulations affect how firms adjust to idiosyncratic shocks. These institutional differences interact with sector-specific differences in the variance of the firm-specific shocks in a sector to generate a new source of comparative advantage. In addition, Burstein, Kurz, and Tesar (2008) explain that if production sharing tends to be concentrated in sectors that are more likely affected by cyclical fluctuations, as transportation equipment, the transmission mechanism will be amplified.

In the case of Mexico, the country performs offshoring activities in highly volatile industries such as electronics, transportation equipment, and electrical material. This

may suggest that source countries, as the United States, transmit a portion of its employment fluctuations to Mexico through the offshoring channel (Bergin, Feenstra, and Hanson, 2009). In addition, one might infer the transmission of shocks is even larger in Mexico, due its specialization in high-volatile maquila sectors.

2.2 Business Cycle Comovements

Countries engaged in production sharing are more likely to experience common shocks, due to a specialization in similar industrial sectors (Burstein, Kurz, and Tesar, 2008). Literature on business cycles establishes that there are important determinants for business cycles comovements such as: bilateral trade intensity (Frankel and Rose, 1998), intra-industry trade (Imbs, 2004), distance and border (Clark and van Wincoop, 2001).

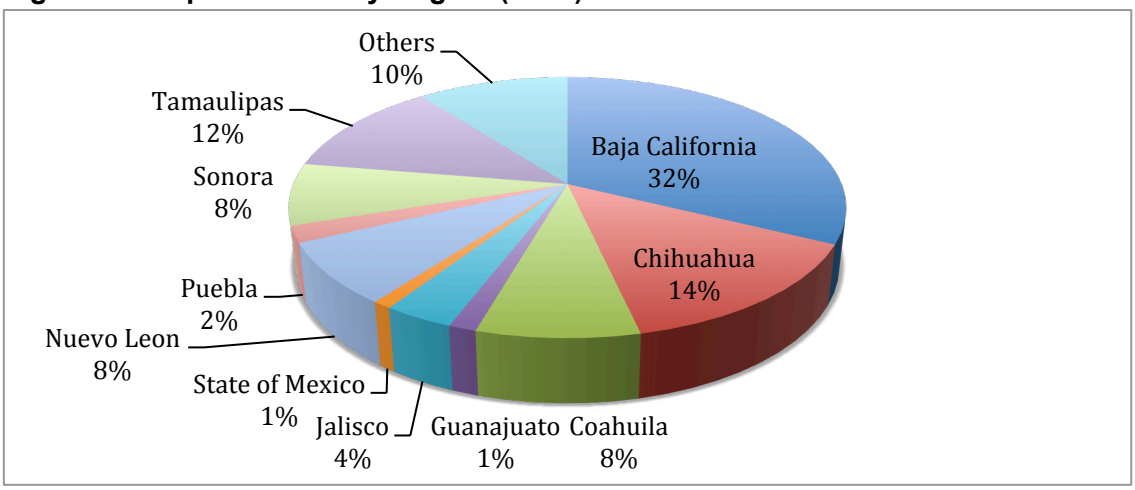
Xavier Gabaix (2011) argues that idiosyncratic shocks experienced by large firms can explain an important part of aggregate fluctuations. Evidence shows that these idiosyncratic shocks faced by MNEs constitute an important part of the origin of business cycle fluctuations. Furthermore, Kleinert, Martin and Toubal (2012) show empirical evidence suggesting that foreign affiliates established in a region significantly increases the correlation between the fluctuations of the region's GDP and the source country's GDP.

3 The Maquiladora Industry

3.1 Maquiladoras in Mexican Regions

As identified by Hanson (1997), most of the offshoring industry in Mexico is located in the Northern region of the country in the states of Baja California, Sonora, Chihuahua, Coahuila, Nuevo Leon, and Tamaulipas (Figure A1). In fact, the Northern border region accounts for 86% of the total amount of 2,783 maquiladora plants located in the country in 2006 (Figure 1). As a matter of fact, the Mexico-U.S. border is perceived as a natural location for offshoring processes due to its proximity to the United States. However, maquila activity is not only located in the border region, but also in the central region of Mexico, which accounts for a lower share of plants. A plausible explanation is that these plants are meant to serve the domestic market.

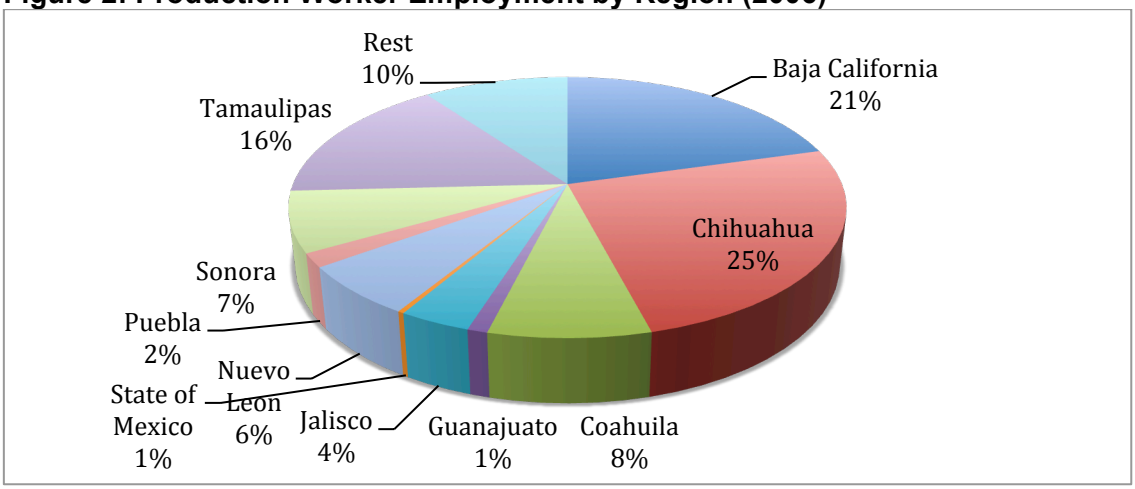
Figure 1: Maquila Plants by Region (2006)



Source: Mexican National Institute of Statistics.

Moreover, when we look at production worker employment in the maquiladora industry by region (Figure 2), we can notice that 58% of the 912,047 employees is concentrated among three states: Chihuahua (25%), Baja California (21%), and Tamaulipas (12%).

Figure 2: Production Worker Employment by Region (2006)

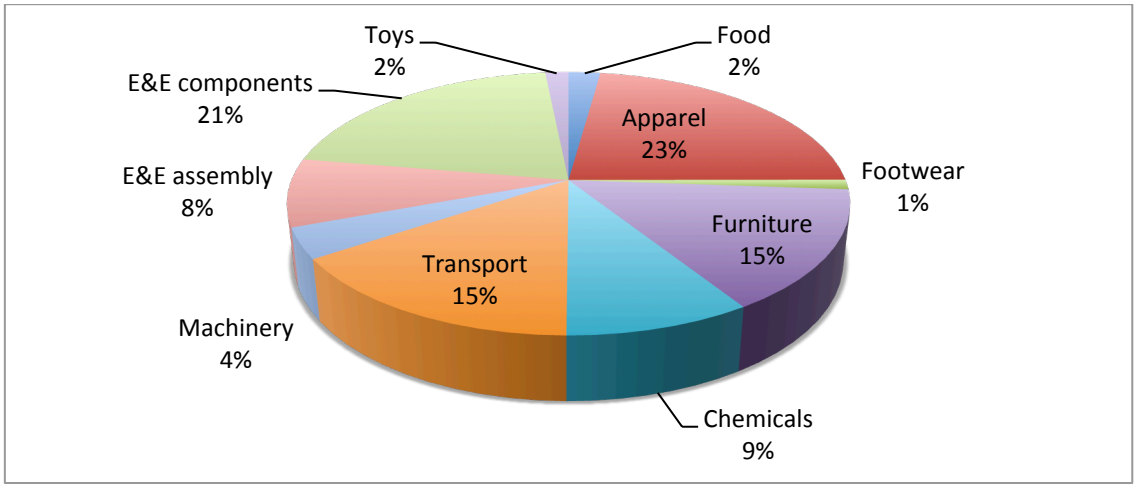


Source: Mexican National Institute of Statistics.

3.2 Maquiladora Sectors

Mexico strongly participates in offshoring processes with a total of 2,783 plants distributed among ten manufacturing maquila sectors (Figure 3), in particular in six sectors: apparel (23%), electronic and electrical components (21%), transportation equipment (15%), furniture (15%), chemicals (9%), and electronic and electrical assembly (8%).

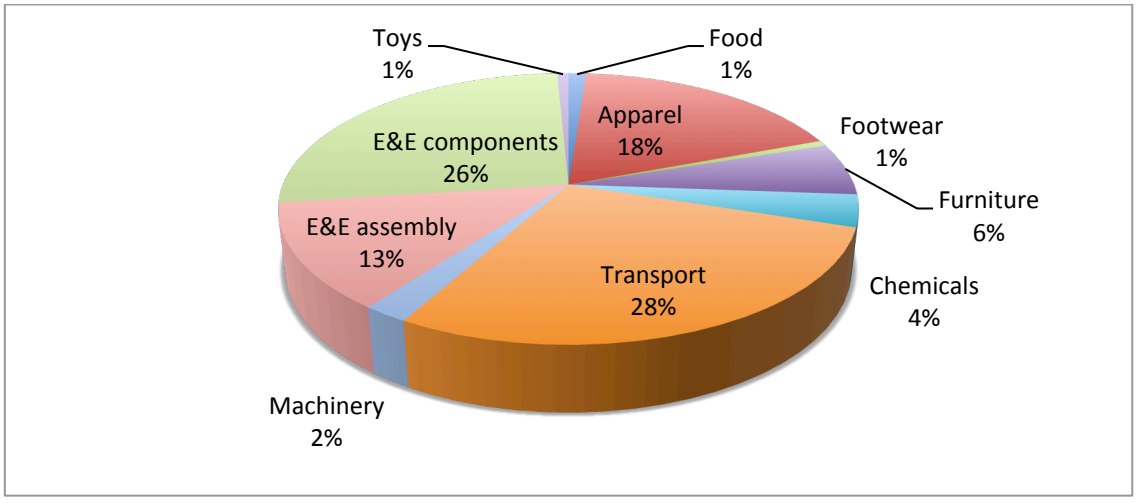
Figure 3: Maquila Plants by Sector (2006)



Source: Mexican National Institute of Statistics.

The distribution of the 912,047 production workers by sector is mainly concentrated among four sectors (Figure 4): transportation equipment (28%), electronic and electrical components (26%), apparel (18%), and electronic and electrical assembly (13%). It is worth mentioning that Bergin, Feenstra, and Hanson (2009) identified these four sectors as Mexico's largest offshoring sectors.

Figure 4: Production Worker Employment by Sector (2006)



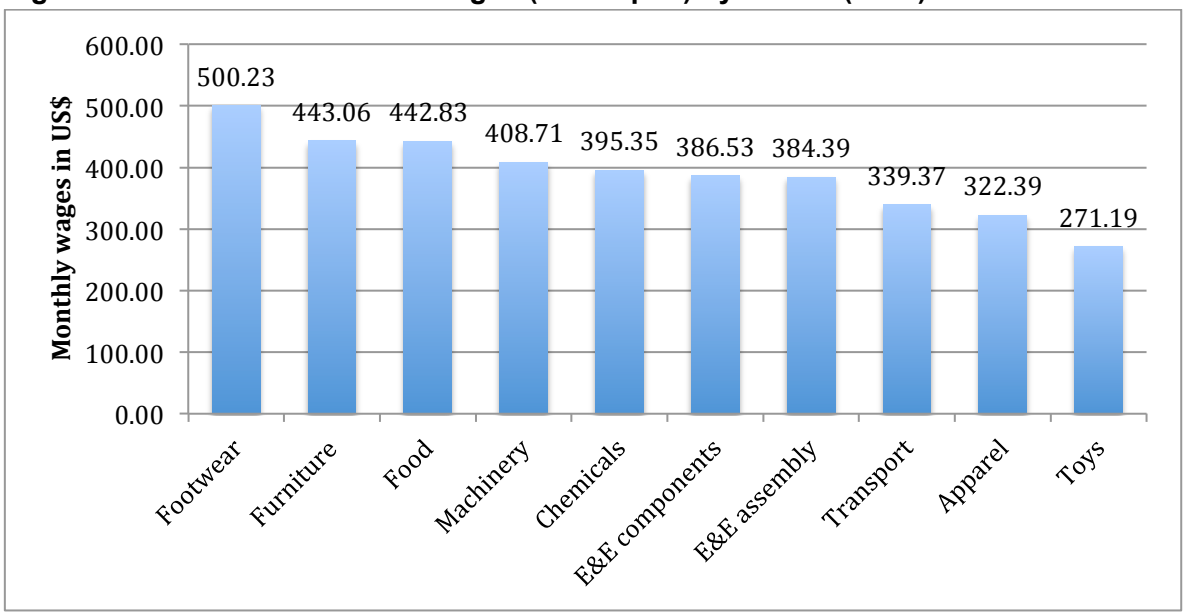
Source: Mexican National Institute of Statistics.

In addition, it is important to look at the average wage of production workers in each maquiladora sector (Figure 5). We can notice that per capita wages in this industry

ranges from 500.23 US$ to 271.19 US$ per month, depending on the sector of activity. More precisely, the highest wages are observed in the footwear, furniture, and food processing sectors. In contrast, the lowest wages are centered in the electronic and electrical components, electronic and electrical assembly, transportation equipment, apparel, and toys sectors.

Surprisingly, the strongest sectors in maquila activity display the lowest wages, except for toys, which is a weak sector. A plausible explanation for this difference on wages might be that the strongest sectors are represented by a larger number of multinational enterprises that use scale economies.

Figure 5: Production Workers Wages (Per Capita) by Sector (2006)



Source: Mexican National Institute of Statistics.

3.3 The Role of Foreign Affiliates in Mexico

Multinational enterprises established in Mexico represent a small portion of the total number of firms in the country. However, according to the theory of granular origins of aggregate fluctuations by Xavier Gabaix (2011), this small portion of firms engaged in the maquiladora industry can contribute to a significant share of GDP and employment in Mexico.

Figure A3 in the appendix displays a regional breakdown of the maquila activity in the most representative regions in Mexico for the share of employment, imported inputs and value added. Firms engaged in maquila activity account for the vast majority of employment in the Northern states in Mexico: Baja California (92.30%), Chihuahua (92.90%), Tamaulipas (89.18%), Sonora (76.49%), and Coahuila (57.39%).

An exception to the rule is Nuevo Leon, where the share of maquila employment in the region accounts for only 28.10%. This might be explained by the fact that Nuevo Leon

is the most industrialized state in Mexico. It is important to highlight that the majority of the companies established in this state are domestic manufacturing firms.

Figures for imported inputs and domestic value added reflect that Mexico imports a large amount of intermediate goods that are embodied in exports. The regions that present the largest shares of imported inputs and value added are Coahuila, Baja California and Tamaulipas, in order of importance. The three states are located in the Northern region of Mexico, which is consistent with the argument explaining that the final market for the assembled products is the United States.

Figure A4 in the appendix shows a more detailed analysis on the 100 largest foreign MNEs engaged in maquila activity in Mexico. If we look at the number of maquila plants by state, offshoring activities are mainly performed in Chihuahua (103 plants), Nuevo Leon (66 plants), and Baja California (62 plants). However, if we look at the share of employment in these foreign affiliates (673,174 employees) by region, then we can see that Tamaulipas has the highest share of employment (28.26%), followed by Chihuahua (16.59%) and Mexico City (13.61%).

Figure A7 in the appendix displays a list of the 100 largest maquiladora firms in Mexico. The most representative sectors from this list are electronics (40%) and transportation equipment (26%). Furthermore, from the ten largest MNEs, half of them are affiliates with origins in Southeast Asia, four of them are affiliates from North America, and only one of them is a European affiliate.

3.4 Intra-Industry Trade with Foreign Affiliates

The structure of bilateral trade is one of the main determinants of business cycle comovements (Imbs, 2004). Therefore, a higher similarity between partner countries and Mexico could be translated into a greater synchronization of business cycles. Figure A5 in the appendix shows the index of Grubel and Lloyd regarding the structure of bilateral trade between partner countries and Mexico. The computation of the index is based on sector data at a 2-digit level of the HS nomenclature.

From the table we can see that Mexico is strongly engaged in intra-industry trade with the United States (67.38%), the Netherlands (87.34%), Germany (73.84%), Finland (60.93%), and Canada (46.13%). This evidence should be interpreted with caution as the analysis is based in a general sector distinction and trade flows vary from country to country. Nevertheless, the main conclusion from the table is that Mexico and these partner countries face the same supply and demand shocks, due to their strong engagement in global production.

3.5 Comovements across Mexican Regions and Partner Countries

Figure A6 in the appendix displays the maximum and minimum correlations of Mexican regions with the main partner countries engaged in offshoring activities. The analysis covers thirteen states in Mexico and eleven partner countries. For practical purposes in the interpretation of the results, partner countries were grouped in three geographical regions: North America, Europe, and Southeast Asia.

For North America, the United States displays the highest GDP correlations with two border states (Baja California and Chihuahua) and with Mexico City. Some of the United States affiliates located in Baja California are: Thomson (electronics), Honeywell (electronics), and Bose Corporation (electronics). In Chihuahua, we can find Lear Corporation (transportation equipment), Visteon Corporation (transportation equipment), and A.O. Smith Corporation (electrical equipment). Finally, in Mexico City we can find Ford (transportation equipment), Motorola (electronics), and Emerson Electric (electrical equipment).

In contrast, the United States presents the lowest GDP correlations with Coahuila, Guanajuato and Tamaulipas. This evidence is unexpected for Coahuila and Tamaulipas, which are border states that offer a strategic location for offshoring activities. In addition, Coahuila hosts large American affiliates as Daimler Trucks (transportation equipment), Sigmatron International (electronics), and VF Imagewear (apparel). As for Tamaulipas, we can find Motorola (electronics), TI Group Automotive System (transportation equipment), and Trico Technologies (transportation equipment). A possible explanation for this low correlation is that both states have high union presence and power, which is consistent with evidence shown by Otero and Pagan (2002).

For Europe, the largest affiliates established in Mexico are Sperian (France), Nokia (Finland), Elcoteq Network Corporation (Finland), Volkswagen AG (Germany), Siemens AG (Germany), Philips Electronics (Netherlands), and Autoliv Inc. (Sweden). Due to important trade predictors as distance and transportation costs, there are just a few European affiliates in Mexico engaged in offshoring. Moreover, these European affiliates perform assembly activities in Mexico to later export the final goods towards the United States.

Evidence shows that European affiliates have high GDP correlations with Northern states in Mexico, which is consistent with the argument on the final market destination. Nevertheless, it is worth mentioning that two important German affiliates are established in the central region of Mexico: Volkswagen (Puebla) and Siemens (Mexico City). A plausible explanation is that both companies serve the domestic market, so the center of the country offers a strategic location for them.

Southeast Asian affiliates have a similar story to European affiliates in the sense that distance and transport costs play a major role. Therefore, the main destination market for Southeast Asian affiliates located in Mexico is also the United States. These affiliates present the highest GDP correlations with two border states: Tamaulipas and Baja California. In Tamaulipas, we may find the Sony Corporation (Japan), Alpine Electronics (Japan), and LG Electronics (Japan). In Baja California, we can find Sanyo (Japan), Samsung (Korea), and the Hyundai Motor Company (Korea).

Surprisingly, there is no evidence of a high GDP correlation of Southeast Asian affiliates with Chihuahua and Nuevo Leon despite the fact that these two state host several large firms. For example, the state of Chihuahua hosts companies as: Sumitomo Wiring Electric Systems (Japan), Foxconn (Taiwan), Asustek Computer Inc.

(China), Tatung (Taiwan), and Pegatron Corporation (China). Moreover, the state of Nuevo Leon is also host for three large Japanese companies belonging to the transportation equipment sector (Yazaki and Takata) and to the electronics sector (Toshiba).

Furthermore, there are also a few Southeast Asian affiliates established in Mexico City as Nissan and Daewoo Industrial Corporation. Finally, it is important to highlight that there is an important increase in the number of Southeast Asian affiliates established in Mexico in the last decade.

4 Data description

For the subsection on the decomposition exercise, data on the number of plants, employment of production workers, and wages of production workers was taken from the Mexican Institute of Statistics, Geography and Information (INEGI). The data is collected in a monthly basis covering the period 1990-2006, and it is disaggregated among 10 maquila-manufacturing sectors[1]. In addition, Mexican peso/US dollar exchange rates were retrieved from the Mexican Central Bank for the same period.

For the subsection on foreign affiliates and comovements, a database was built on the largest 100 firms engaged in the maquiladora industry. This database contains information on the source country, manufacturing sector, number of employees, number of plants, and the location of the plants. The database is a merge of two datasets provided by the Mexican Ministry of Economy and the Maquila Portal.

The database contains a sample of 100 foreign affiliates with offshoring activity in Mexico. This number of observations is in line with the theory of granularity of Xavier Gabaix (2012), explaining a few firms are able to generate aggregate fluctuations in a given country. The database comprises region-country specific information on plants and employees for thirteen states in Mexico and eleven partner countries with affiliates located in Mexican regions.

Data on Mexican regional GDP was retrieved for the period 1993-2006 from the Mexican Institute of Statistics. Data on partner countries' GDP over the same time-period was retrieved from the World Bank Development Indicators. Moreover, data on employment, imported inputs and domestic value added was taken for 2006 from the Mexican Institute of Statistics.

Furthermore, data on bilateral exports and imports for 2006 was taken from the IMF Direction of Trade Statistics (DOTS). In addition, data on trade structure flows was collected at a 2-digit level of the HS nomenclature for 2006 from the BACI database (CEPII). Finally, data on latitude and longitude between capital cities and maquila locations in Mexico were taken from the GeoDist database (CEPII) and from World Gazetteer.

[1] The 10 Mexican maquila sectors included in the analysis are: apparel, chemicals, electronic and

5 Empirical Methodology

5.1 Employment Volatility

The econometric methodology used in this subsection is based along the lines of Paul R. Bergin, Robert C. Feenstra, and Gordon H. Hanson (2009). In their paper, the authors analyzed how volatility in the maquiladora employment is allocated between the extensive and intensive margins for the four most representative sectors of the maquiladora industry (apparel, electronics, electrical material, and transportation equipment) over the period 1996-2005.

In this paper, the analysis of Bergin, Feenstra, and Hanson (2009) is replicated. The main contribution of the current paper is to extend the analysis in two directions: industry coverage and period. Therefore, this analysis includes six sectors that were not previously analyzed: chemicals, food manufacturing, footwear, furniture, machinery, and toys. It also includes an extended period running from 1990 to 2006. The main reasons standing for these extensions are the robustness of results and to have a broader picture of the Mexican offshoring industry.

The objective is to study how the volatility in employment is allocated between the number of maquila plants operating each month (extensive margin) and the average employment per maquila plant (intensive margin) through a decomposition exercise. To do so, two regression equations were specified:

$$\ln N_{it} = \alpha_0 + \alpha_1 \ln \frac{E_{it}}{E_t} + \alpha_2 E_t + \varepsilon_{it} \quad (1)$$

where N_{it} denotes the number of maquila plants in sector *i* at time *t*, $\frac{E_{it}}{E_t}$ represents the maquila industry share of aggregate employment in time *t*, and E_t is the total Mexican manufacturing employment in time *t*. The coefficient of interest is α_1, which identifies how aggregate shocks affect the number of maquila plants (extensive margin).

The second equation regarding the intensive margin is defined as follows:

$$\ln \frac{E_{it}}{N_{it}} = \beta_0 + \beta_1 \ln \frac{E_{it}}{E_t} + \beta_2 E_t - \varepsilon_{it} \quad (2)$$

where $\frac{E_{it}}{N_{it}}$ stands for the average employment per maquila plant in sector *i* at time *t*, $\frac{E_{it}}{E_t}$ represents the maquila industry share of aggregate employment in time *t*, and E_t is the total Mexican manufacturing employment in time *t*. The coefficient of interest is β_1, which identifies how aggregate shocks affect the employment per plant (intensive margin).

The constraints on the coefficients are: $\alpha_0 + \beta_0 = 0$, $\alpha_1 + \beta_1 = 1$, and $\alpha_2 + \beta_2 = 1$. The empirical procedure for this decomposition exercise is to run OLS regressions for two different time periods: one concerning the benchmark specification over the period 1996-2005 (Table 1), and a second one corresponding to the extended period 1990-2006 (Table 2). Furthermore, a regression for the Mexican manufacturing industry is

also presented in the appendix (Table A1). Notice that all the variables are expressed in log terms and the data is seasonally adjusted and HP filtered.

In addition, maquila sectors were divided into four categories for the two time-periods. Group 1[2] contains the replication of the four sectors previously analyzed in Bergin, Feenstra, and Hanson (2009). Group 2[3] includes a sample with the six most representative maquila sectors in terms of the number of plants. Group 3[4] contains the four least representative maquila sectors in terms of the number of plants. Group 4[5] includes a sample with the full range of the ten maquila sectors.

5.2 Wage Volatility

This decomposition exercise can also be used to analyze how the wage volatility is allocated between the number of maquila plants operating each month (extensive margin) and the average wage per maquila plant (intensive margin). For this subsection, two regression equations were specified:

$$\ln N_{it} = \gamma_0 + \gamma_1 \ln \frac{W_{it}}{W_t} + \gamma_2 W_t + \varepsilon_{it} \quad (3)$$

where N_{it} denotes the number of maquila plants in sector *i* at time *t*, $\frac{W_{it}}{W_t}$ represents maquila industry share of aggregate mean wages in time *t*, and W_t stands for mean wages in aggregate Mexican manufacturing industry in time *t*. The coefficient of interest is γ_1, which identifies how aggregate shocks affect the number of maquila plants (extensive margin).

The second equation regarding the intensive margin is defined as follows:

$$\ln \frac{W_{it}}{N_{it}} = \delta_0 + \delta_1 \ln \frac{W_{it}}{W_t} + \delta_2 W_t - \varepsilon_{it} \quad (4)$$

where $\frac{W_{it}}{N_{it}}$ stands for the wages per maquila plant in sector *i* at time *t*, $\frac{W_{it}}{W_t}$ represents maquila industry share of aggregate mean wages in time *t*, and W_t denotes mean wages in the Mexican aggregate manufacturing industry in time *t*. The coefficient of interest is δ_1, which identifies how aggregate shocks affect the wages per plant (intensive margin).

The constraints on the coefficients are: $\gamma_0 + \delta_0 = 0$, $\gamma_1 + \delta_1 = 1$, and $\gamma_2 + \delta_2 = 1$. The empirical procedure used for this decomposition exercise is to run the OLS regressions for three different time-periods for the maquiladora industry: over the same time-period as for the extended employment analysis 1990-2006 (Table 3); during a period of crisis

[2] Group 1 includes four sectors: apparel, electronics, electrical equipment, and transportation equipment.
[3] Group 2 includes six sectors: apparel, chemicals, electronics, electrical equipment, furniture, and transportation equipment.
[4] Group 3 includes four sectors: food processing, footwear, machinery, and toys.
[5] Group 4 includes ten sectors: apparel, chemicals, electronics, electrical equipment, food processing, footwear, furniture, machinery, toys, and transportation equipment.

(Table A2); and during a rebound period (Table A3). In addition, a regression for the Mexican manufacturing industry during a rebound period is also presented (Table A4). Notice that all the variables are expressed in log terms and the data is seasonally adjusted and HP filtered.

Following the same methodology as in the previous subsection, four different categories of maquila sectors are taken into account for the three time-periods: Group 1 contains the same four maquila sectors as in Bergin, Feenstra, and Hanson (2009), Group 2 includes the six most representative maquila sectors in terms of the number of plants, Group 3 comprises the four least representative maquila sectors in terms of the number of plants, and Group 4 includes the 10 maquila sectors.

5.3 Foreign Affiliates and Comovements

This subsection focuses on the impact of foreign affiliates on the correlations of GDP growth rates between thirteen states in Mexico and eleven partner countries. This cross-section of correlations contains information on countries with affiliates in Mexico belonging to the largest 100 maquiladora firms according to the number of employees.

The empirical methodology used to examine the effect of foreign affiliates on business cycle comovements is based along the lines of Jörn Kleinert, Julien Martin, and Farid Toubal (2012). The analysis focuses on the correlation of GDP growth rates between thirteen states in Mexico and eleven countries over the period 1993-2006. The correlation between region *r* and country *c*, ρ_{cr}, is used as the main dependent variable:

$$\rho_{cr} = corr\left(\frac{GDP_{c,t} - GDP_{c,t-1}}{GDP_{c,t-1}}, \frac{GDP_{r,t} - GDP_{r,t-1}}{GDP_{r,t-1}}\right) \quad (5)$$

The cross-section equation contains covariates taken for 2006 and it is defined as follows:

$$\rho_{cr} = \alpha\, FME_{cr} + X_{cr}\beta + \varepsilon_{cr} \quad (6)$$

where FME_{cr} is an indicator of the importance of foreign affiliates from country *c* in region *r*, X_{cr} is a matrix of other covariates, and ε_{cr} is the error term.

To control for the importance of foreign affiliates established in Mexican regions, the variable of employment is used:

$$FME_{cr} = \frac{\Sigma_f\, Emp_{fcr}}{Emp_r} \quad (7)$$

where FME_{cr} stands for the share of employment by foreign affiliates of country *c* in region *r*, Emp_{fcr} represents the employment of maquila firms *f* with ownership from *c* in region *r*, and Emp_r is the total employment in region *r*.

Literature on business cycles comovements identifies important determinants including bilateral trade intensity (Frankel and Rose, 1998), bilateral trade structure (Imbs, 2004), and geographical proximity (Clark and van Wincoop, 2001), which are included in matrix X_{cr}.

The index of bilateral trade intensity is established as the ratio of exports and imports between country *c* and region *r* over the sum of the regional GDP and country GDP. A drawback of the analysis is that there is no available data on exports and imports for region-country pairs. Therefore, this variable is constructed with the exports and imports between country *c* and the aggregate data for Mexico *mex*:

$$BT_{c\,mex} = \frac{x_{c\,mex} + m_{c\,mex}}{GDP_c + GDP_{mex}} \tag{8}$$

where $x_{c\,mex}$ denotes the value of exports from Mexico *mex* to partner country *c*, and $m_{c\,mex}$ stands for the value of imports to Mexico *mex* from country *c*. GDP_c stands for the GDP of country c, and GDP_{mex} stands for Mexico's aggregate GDP.

In addition to this variable, another variable related to the index of bilateral trade intensity is included. This variable contains data at the regional-level for Mexico, but does not identify each partner country:

$$BT_{par\,r} = \frac{x_{par\,r} + m_{par\,r}}{GDP_c + GDP_r} \tag{9}$$

where $x_{par\,r}$ represents the value of exports from Mexican region *r* to the aggregate countries *par*, and $m_{par\,r}$ is the value of imports to Mexican region *r* from the aggregate countries *par*. GDP_c stands for the GDP of country c, and GDP_r stands for Mexican regional GDP.

Another important variable to consider is the structure of bilateral trade. The computation of an index of dissimilarity based on detailed sector data between countries and regions is desirable. However, there is no available data regarding exports and imports at sector- and regional-level for Mexico. Nevertheless, there is disaggregate data available at sector-level for national exports and imports of Mexico.

$$IIT_{c\,mex} = 1 - \frac{\Sigma_k \left| X^k_{c\,mex} - M^k_{c\,mex} \right|}{\Sigma_k X^k_{c\,mex} + M^k_{c\,mex}} \tag{10}$$

where $X^k_{c\,mex}$ and $M^k_{c\,mex}$ are the exports to and imports from country *c*, by Mexico *mex*, for sector *k*. In this analysis sector data is considered at a 2-digit level of the HS nomenclature. An index close to 1 means that country *c* and Mexico *mex* are engaged in intra-industry trade (Figure A5).

To capture geographical proximity, the variables distance and common border between region *r* and country *c* are used. $Border_{rc}$ is a dummy variable equal to 1 if country *c* and region *r* share a common border, and 0 otherwise.

The first step to compute the distance between country *c* and region *r* is to identify the latitude and longitude of each firm and each country's capital city in the sample. Then, the distance between each firm and each country is computed by using the great circle formula. The distance between region *r* and country *c* is the arithmetic average of the individual distance that separates firms in region *r* and the capital city of country *c*:

$$Dist_{cr} = \frac{\Sigma_{f \epsilon \{r\}} dist_{fc}}{N_f^r} \quad (11)$$

where $dist_{fc}$ denotes the distance between firm *f* from region *r* and the capital of country *c*, and N_f^r represents the number of firms in region *r*.

6 Offshoring and the Decomposition Exercise

This section of the paper presents the empirical results of the decomposition exercise for employment and wages, as well as the results for the foreign affiliates and comovements.

6.1 Employment Volatility in the Maquiladora Industry

This subsection shows the decomposition exercise on employment volatility over two time-periods: the benchmark specification (1996-2005) and the extended period (1990-2006).

6.1.1 Employment Volatility in the Maquiladora Industry (1996-2005)

Table 1 reports the OLS results for this decomposition exercise on employment volatility over the period 1996-2005. Each series is in log values, seasonally adjusted, and HP filtered. The data is pooled across the four categories of maquila sectors and the estimation includes industry fixed effects. Each specification is run separately on the two regression equations standing for the extensive margin (number of plants) and intensive margin (employment per plant). Recalling the constraints on the coefficients, $\alpha_0 + \beta_0 = 0$, $\alpha_1 + \beta_1 = 1$, and $\alpha_2 + \beta_2 = 1$, the sum of the coefficients corresponding to the extensive and intensive margins is equal to 1. Therefore for practical purposes, the interpretation of the analysis is done only for the extensive margin.

Table 1: Employment Adjustment in the Maquiladora Industry: Extensive Margins

	Number of plants	Employ. per plant	Number of plants	Employ. per plant	Number of plants	Employ. per plant	Number of plants	Employ. per plant
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Maquila share of Agg. Employ.	0.218*	0.782***	0.187**	0.813***	0.0914	0.909***	0.114	0.886***
	(0.0920)	(0.0920)	(0.0603)	(0.0603)	(0.0885)	(0.0885)	(0.0695)	(0.0695)
Total Mexican Mfg. Employ.	0.246*	0.754***	0.215**	0.785***	0.182**	0.818***	0.169***	0.831***
	(0.0839)	(0.0839)	(0.0575)	(0.0575)	(0.0474)	(0.0474)	(0.0473)	(0.0473)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	480	480	720	720	480	480	1,200	1,200
R-squared	0.122	0.632	0.090	0.640	0.030	0.711	0.041	0.693

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: Columns (1) to (8) show regressions of either the number of plants or employment per plant on the maquiladora share of aggregate employment and on total Mexican manufacturing employment. Columns (1) and (2) contain a sample of the 4 most representative maquiladora sectors. Columns (3) and (4) report results for a sample containing the 6 most representative maquiladora sectors. Columns (5) and (6) contain a sample of the 4 least representative maquiladora sectors. Columns (7) and (8) contain the whole extended sample of the 10 maquiladora sectors. Each series is in log values, seasonally adjusted, and HP filtered. Data is presented at a monthly frequency from 1996:1 to 2005:12. Regressions include controls for industry fixed effects. Standard errors (clustered by industry) are in parentheses.

Columns (1) and (2) present the results of the decomposition exercise replicating the work done by Bergin, Feenstra, and Hanson (2009) for the four most representative sectors at the extensive and intensive margin, respectively. Columns (3) and (4) show the results of the estimation for a larger sample corresponding to the six most representative sectors out of ten maquila sectors. Columns (5) and (6) display the results of the estimation for a sample that was not previously analyzed corresponding to the four least representative sectors out of ten maquila sectors. Columns (7) and (8) represent the whole extended sample grouping the six most representative and the four least representative sectors. We accordingly end up with 1,200 observations, comprising 720 observations corresponding to the six most representative sectors and 480 observations corresponding to the four least representative sectors.

In column (1), the estimate for α_1 is 0.22 and for α_2 is 0.25, where both are weakly statistically significant. In response to an increase in the share of aggregate employment in an offshoring industry (holding aggregate employment constant), over one-fifth of adjustment in industry employment occurs at the extensive margin. Moreover, in response to an increase in aggregate employment (holding the industry employment share constant), one-quarter of adjustment in industry employment occurs at the extensive margin.

In column (3), the estimate for α_1 is 0.19 and for α_2 is 0.22, where both are statistically significant. Notice that once we add two more representative sectors to this category, the level of significance is higher, but the magnitude of the coefficient is lower compared to column (1). This suggests that the additional two sectors are not as volatile as the four previous sectors.

In column (5), the estimate for α_1 is 0.09 and for α_2 is 0.18, where only α_2 is statistically significant. There is no proof of significance for the industry share of aggregate employment at the extensive margin. This suggests that less representative maquila sectors (food processing, footwear, machinery, and toys) are not highly integrated in global production, which means that they are less volatile.

In column (7), the estimate for α_1 is 0.11 and for α_2 is 0.17, where only α_2 is highly statistically significant. There is no proof of significance for the industry share of aggregate employment at the extensive margin. Notice that the estimate on maquila industry employment losses its significance when we include the whole range of sectors, compared to the estimate in column (1). This suggests that it is important to make a distinction between different groups of sectors with different levels of volatility when analyzing the implications of production sharing on employment. In other words, different groups of sectors adjust in different ways at the extensive and intensive margins depending on their level of volatility.

6.1.2 Employment Volatility in the Maquiladora Industry (1990-2006)

Table 2 presents the OLS results for this decomposition exercise on employment volatility over the extended period 1990-2006. The methodology is the same as in the previous decomposition exercise, where each series is in log values, seasonally

adjusted, and HP filtered. The data is pooled across the four categories of maquila sectors and the estimation includes industry fixed effects. Each specification is run separately on the two regression equations standing for the extensive and intensive margins. The constraint on the coefficients is $\alpha_0 + \beta_0 = 0$, $\alpha_1 + \beta_1 = 1$, and $\alpha_2 + \beta_2 = 1$. Once again, the interpretation of the analysis is done only for the extensive margin for practical purposes.

Table 2: Employment Adjustment in the Maquiladora Industry: Extensive Margins

	Number of plants	Employ. per plant	Number of plants	Employ. per plant	Number of plants	Employ. per plant	Number of plants	Employ. per plant
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Maquila share of Agg. Employ.	0.388*	0.612**	0.410***	0.590***	0.0806	0.919***	0.175*	0.825***
	(0.145)	(0.145)	(0.0788)	(0.0788)	(0.0556)	(0.0556)	(0.0825)	(0.0825)
Total Mexican Mfg. Employ.	0.387*	0.613**	0.418***	0.582***	0.138**	0.862***	0.213**	0.787***
	(0.138)	(0.138)	(0.0795)	(0.0795)	(0.0427)	(0.0427)	(0.0747)	(0.0747)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	816	816	1,224	1,224	816	816	2,040	2,040
R-squared	0.358	0.581	0.384	0.562	0.034	0.791	0.110	0.723

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: Columns (1) to (8) show regressions of either the number of plants or employment per plant on the maquiladora share of aggregate employment and on total Mexican manufacturing employment. Columns (1) and (2) contain a sample of the 4 most representative maquiladora sectors. Columns (3) and (4) report results for a sample containing the 6 most representative maquiladora sectors. Columns (5) and (6) contain a sample of the 4 least representative maquiladora sectors. Columns (7) and (8) contain the whole extended sample of the 10 maquiladora sectors. Each series is in log values, seasonally adjusted, and HP filtered. Data is presented at a monthly frequency from 1990:1 to 2006:12. Regressions include controls for industry fixed effects. Standard errors (clustered by industry) are in parentheses.

Columns (1) and (2) present the results of the four most representative sectors in line with Bergin, Feenstra, and Hanson (2009) at the extensive and intensive margin, respectively, but within a wider time-period. Columns (3) and (4) show the results of the estimation for a larger sample corresponding to the six most representative sectors out of ten maquila sectors. Columns (5) and (6) display the results of the four least representative sectors out of ten maquila sectors. Columns (7) and (8) represent the whole extended sample grouping the six most representative and the four least representative sectors. We accordingly end up with 2,040 observations, comprising 1,224 observations corresponding to the six most representative sectors and 816 observations corresponding to the four least representative sectors.

In column (1), the estimate for α_1 is 0.39 and for α_2 is also 0.39, where both are weakly statistically significant. In response to an increase in the share of aggregate employment in an offshoring industry (holding aggregate employment constant), over one-third of adjustment in industry employment occurs at the extensive margin. Moreover, in response to an increase in aggregate employment (holding the industry

employment share constant), over one-third of adjustment in industry employment occurs at the extensive margin.

In column (3), the estimate for α_1 is 0.41 and for α_2 is 0.42, where both are highly statistically significant. In response to an increase in the share of aggregate employment in an offshoring industry (holding aggregate employment constant), nearly one-half of adjustment in industry employment occurs at the extensive margin. Moreover, in response to an increase in aggregate employment (holding the industry employment share constant), nearly one-half of adjustment in industry employment occurs at the extensive margin.

Notice that adding two more representative sectors to the previous category within the extended period results in a highly statistically significant coefficient with a higher magnitude and with a lower standard error, compared to column (1). This suggests that the additional two sectors are as volatile as the four most representative maquila sectors during this time-period. A plausible explanation is that the extended period includes a sever crisis that happened in Mexico in late 1994 (Figure A2). During this crisis, the Mexican peso suffered a large depreciation and as a consequence, capital fled away the country, which caused a large GDP drop in 1995. Therefore, the six most representative maquila sectors present larger adjustments at the extensive margin.

To this point, it is worth mentioning that closing plants (extensive margin) is worse than layoffs (intensive margin) for the host country. A possible explanation is that layoffs are not permanent. In other words, during a rebound period, firms can easily hire again workers who were previously fired, while it is more difficult to restart operations on a plant that was previously closed.

In column (5), the estimate for α_1 is 0.08 and for α_2 is 0.14, where only α_2 is statistically significant. There is no proof of significance for the industry share of aggregate employment at the extensive margin. This suggests that less representative maquila sectors (food processing, footwear, machinery, and toys) are not highly integrated in global production, which means that they are less volatile even during a time-period comprising a crisis.

In column (7), the estimate for α_1 is 0.18 and for α_2 is 0.21, where both are statistically significant. Notice that the estimate on maquila industry employment containing the full range of sectors gains significance compared to column (7) in Table 1. A plausible explanation is that the results for the extended period are more robust, due to the increase of observations, which were almost folded. Nevertheless, it is important to make a distinction between the different groups of sectors according to their level of volatility, when analyzing the implications of global production sharing on employment.

6.1.3 Result Comparison between Periods

As a general conclusion drawn from Tables 1 and 2, we find evidence suggesting that the most representative maquila sectors have higher adjustments occurring at the extensive margin, in particular during a period comprising a crisis. On the other hand, the least representative maquila sectors present no proof of significance at the

extensive margin. This suggests that the later sectors are not highly engaged in global production, which means that they are less volatile.

Furthermore, notice Table 2 (extended period) presents more robust results in terms of better position of estimates (r-squares), a nearly folded number of observations, lower standard errors, and gains in statistical significance for some coefficients. It is worth noting that the magnitude of the coefficients at the extensive margin significantly increases for the two specifications concerning the most representative sectors in Table 2.

6.2 Wage Volatility in the Maquiladora Industry (1990-2006)

Table 3 shows the OLS results for this decomposition exercise on wage volatility over the period 1990-2006. Each series is in log values, seasonally adjusted, and HP filtered. The data is pooled across the four categories of maquila sectors and the estimation includes industry fixed effects. Each specification is run separately on the two regression equations standing for the extensive margin (number of plants) and intensive margin (mean wage). Recalling the logic of least squares, $\gamma_0 + \delta_0 = 0$, $\gamma_1 + \delta_1 = 1$, and $\gamma_2 + \delta_2 = 1$, the sum of the coefficients corresponding to the extensive and intensive margins is equal to 1. Therefore for practical purposes, the interpretation of the analysis is done only for the extensive margin.

Table 3: Wage Adjustment in the Maquiladora Industry: Extensive Margins

	Number of plants	Mean Wage	Number of plants	Mean Wage	Number of plants	Mean Wage	Number of plants	Mean Wage
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Maquila share of Wages	0.239*	0.761***	0.260***	0.740***	0.0373	0.963***	0.126*	0.874***
	(0.0811)	(0.0811)	(0.0456)	(0.0456)	(0.0556)	(0.0556)	(0.0637)	(0.0637)
Total Mexican Mfg. Wages	0.0325	0.968***	0.0294*	0.971***	-0.109	1.109***	-0.0589	1.059***
	(0.0180)	(0.0180)	(0.0139)	(0.0139)	(0.0490)	(0.0490)	(0.0449)	(0.0449)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	816	816	1,224	1,224	816	816	2,040	2,040
R-squared	0.415	0.897	0.459	0.894	0.056	0.885	0.162	0.877

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: Columns (1) to (8) show regressions of either the number of plants or mean wages on the maquiladora share of aggregate wages and on Mexican manufacturing wages. Columns (1) and (2) contain a sample of the 4 most representative maquiladora sectors. Columns (3) and (4) report results for a sample containing the 6 most representative maquiladora sectors. Columns (5) and (6) contain a sample of the 4 least representative maquiladora sectors. Columns (7) and (8) contain the whole extended sample of the 10 maquiladora sectors. Each series is in log values, seasonally adjusted, and HP filtered. Data is presented at a monthly frequency from 1990:1 to 2006:12. Regressions include controls for industry fixed effects. Standard errors (clustered by industry) are in parentheses.

Columns (1) and (2) present the results of the decomposition exercise in line with the work done by Bergin, Feenstra, and Hanson (2009) for the four most representative sectors at the extensive and intensive margin, respectively. Columns (3) and (4) show the results of the estimation for a larger sample corresponding to the six most representative sectors out of ten maquila sectors. Columns (5) and (6) display the results of the estimation for the four least representative sectors out of ten maquila sectors. Columns (7) and (8) represent the whole extended sample grouping the six most representative and the four least representative sectors. We accordingly end up with 2,040 observations, comprising 1,224 observations corresponding to the six most representative sectors and 816 observations corresponding to the four least representative sectors.

In column (1), the estimate for γ_1 is 0.24 and for γ_2 is 0.03, where only γ_1 is weakly statistically significant. There is no proof of significance for the aggregate wages at the extensive margin. In response to an increase in the share of wages in an offshoring industry (holding aggregate wages constant), nearly one-quarter of adjustment in industry wages occurs at the extensive margin.

In column (3), the estimate for γ_1 is 0.26 and is highly statistically significant, while the estimate for γ_2 is 0.03 and is weakly statistically significant. Notice that when we include two additional representative sectors, the coefficient on the maquiladora industry is estimated with a higher degree of precision, compared to column (1). This suggests that the additional two sectors are as volatile as the four most representative maquila sectors.

It is important to recall that closing plants (extensive margin) is worse than reducing the salaries of employees (intensive margin) for the host country. A possible explanation is that salaries will go back to their original level once there is an economic recovery. On the contrary, it is more difficult for firms to restart operations on a plant that was previously closed.

In column (5), the estimate for γ_1 is 0.04 and for γ_2 is -0.11, where there is no proof of significance for the coefficients at the extensive margin. This suggests that these less representative maquila sectors (food processing, footwear, machinery, and toys) are not highly integrated in global production, which means that they are less volatile. In addition, the domestic counterpart industries also appear to be less volatile to shocks.

In column (7), the estimate for γ_1 is 0.13 and for γ_2 is -0.06, where only γ_1 is weakly statistically significant. This suggests that it is important to make a distinction between different groups of sectors with different levels of volatility when analyzing the implications of production sharing on wages. In other words, different groups of sectors adjust in a different manner depending on their level of volatility.

6.3 Foreign Affiliates and Comovements

This subsection analyzes the impact of the share of employment of foreign affiliates on business cycles comovements. The variables of interest are the employment share of

foreign affiliates and the trade variables. The regression explains about 63% of the variation of the business cycle correlations.

To illustrate the impact of the share of employment of foreign affiliates on business cycles comovements, lets take Japan as an example. Japan displays the highest GDP correlation with the state of Tamaulipas. This might be explained by the presence of several Japanese affiliates located in this state, in particular of the Sony Corporation, which is the largest maquila employer in Mexico with 158,500 employees in 2006.

Table 4 reports the regression results for equation (6). Looking across each specification, we can see evidence supporting the share of employment by foreign affiliates increases the correlation between their country of ownership and the region of location. In addition, to the share of employment, there is also evidence that bilateral trade and intra-industry trade have effects on the synchronization of business cycles.

Table 4: Foreign Affiliates and Business Cycle Correlations

	Dependent variable: ρ_{cr} = Correlation of GDP growth rates				
	(1)	(2)	(3)	(4)	(5)
FME_{cr}	0.441*	0.272	0.420**	0.346*	0.384*
	(0.256)	(0.233)	(0.199)	(0.185)	(0.188)
BT_{cmex}		10.39***	15.25***	18.98***	15.92***
		(3.289)	(3.033)	(3.138)	(4.820)
BT_{parr}			84.02***	91.05***	94.09***
			(21.95)	(20.36)	(20.60)
IIT_{cmex}				-0.267**	-0.319***
				(0.103)	(0.112)
$Distance_{cr}$					-1.50e-05
					(1.17e-05)
$Border_{cr}$					-0.0301
					(0.0880)
Constant	0.0320	-0.0604	-0.193***	-0.105*	0.0611
	(0.0431)	(0.0481)	(0.0532)	(0.0596)	(0.147)
Observations	35	35	35	35	35
R-squared	0.083	0.301	0.525	0.612	0.634

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: This table presents the determinants of the bilateral comovements of business cycles between Mexican regions and foreign GDPs. Comovements are measured by the correlation of the yearly growth of region *r* and country *c* GDPs over the period 1993-2006. The explanatory variables are the share of employment by foreign affiliates from country *c* in region *r* (FME_{cr}), the bilateral trade between Mexico *mex* and country *c* (BT_{cmex}), the bilateral trade between region *r* and the aggregate of partner countries *par* (BT_{parr}), the share of intra-industry trade between Mexico *mex* and country *c* (IIT_{cmex}), the bilateral distance, and a dummy variable equal to one for a common border between region *r* and country *c*.

Notice that in column (2), the share of employment losses its significance when we control for the bilateral trade variable between Mexico and partner countries ($BT_{c\,mex}$).

Nevertheless, compared to column (2), the share of employment variable is estimated with a higher degree of precision once we include both trade variables ($BT_{c\,mex}$ and $BT_{par\,r}$) in column (3). We observe that both bilateral trade variables are highly statistically significant, which shows that they have a positive effect on business cycles synchronization.

In column (4), the intra-industry trade variable is included in the regression. This variable displays a negative and statistically significant coefficient, which is not consistent with findings by Kleinert, Martin, and Toubal (2012). A plausible explanation for this negative sign is the dissimilarity of the bilateral trade structure between Mexico and partner countries. In other words, partner countries view Mexico as a strategic export-platform to reach the American market, due to its geographical proximity and its relatively abundant supply of low-wage labor. Therefore, Mexico imports intermediate goods from partner countries, which will be embodied in exports towards the U.S. market, while it exports agricultural goods to these partner countries.

In column (5), we include two exogenous components of business cycles: bilateral distance and borders. Notice that these two variables do not significantly influence the coefficients of employment share of foreign affiliates, bilateral trade variables, and intra-industry trade.

In conclusion, there is evidence showing a positive correlation between the share of employment by foreign affiliates and the business cycles comovements between Mexican regions and partner countries. Moreover, there is also evidence that bilateral trade has a positive effect on the synchronization of business cycles, while intra-industry trade has a negative effect on this synchronization. A drawback of this analysis is that the magnitude of the coefficients for bilateral trade variables and for the intra-industry trade variable is not accurate, due to a lack of specific data on a region-country pair basis. Aggregate trade data at the national-level was used instead of region-level data for Mexico. Therefore, these results should be interpreted with caution.

7 Conclusions

Global value chains are a current phenomenon shaping the world economy by engaging developed, emerging, and developing countries in global production. Mexico is integrated in GVCs through its participation in offshoring processes, due to low wages and preferential access to the U.S. market. In fact, the country has experienced employment growth and a significant expansion of its export assembly activities. However, it is important to identify the implications of GVCs, such as high levels of volatility of the economic activity in the host country.

Findings support the argument explaining that the number of plants in host countries acts as a powerful mechanism for the transmission of shocks from the source to the host country. To illustrate this, the Sony Corporation used to have a plant producing LCD televisions in Baja California. This plant had to shutdown operations in 2009 due to the economic crisis, resulting in a layoff of 600 employees. It is important to highlight that closing plants is worse than layoffs for the host country. A possible explanation is that layoffs are not permanent. During a rebound period, firms can easily hire again workers who were previously fired, while it is more difficult for firms to restart operations on a plant that has been previously closed.

This paper shows evidence suggesting that for the most representative maquila sectors, adjustments in the number of plants operating each month (extensive margin) account for nearly one-half of the employment volatility. This group of sectors includes: apparel, chemicals, electronics, electrical equipment, furniture, and transportation equipment. On the other hand, the least representative maquila sectors (food processing, footwear, machinery, and toys) present no poof of significance at the extensive margin. This suggests that these sectors are less volatile and not highly engaged in global production sharing. Moreover, there is empirical evidence suggesting that there is no significant difference in adjustments at the extensive margin between maquila sectors and the domestic counterpart industries. This suggests that the identified mechanism is not exclusive for maquiladoras, but for industries in Mexico.

Findings on wage volatility also show that for the most representative maquila sectors, adjustments in the number of plants operating each month (extensive margin) account for over one-quarter of wage volatility. On the other hand, results on the least representative maquila sectors show no proof of significance at the extensive margin. This provides additional evidence on the argument that these sectors are less volatile and less dependent on global production sharing. Once again, it is important to recall that closing plants is worse than reducing the salaries of employees for the host country. A possible explanation is that salaries will go back to their original level once there is an economic recovery. On the contrary, it is more difficult for firms to restart operations on a plant that was previously closed.

Finally, this paper shows empirical evidence supporting the argument that the presence of foreign affiliates in Mexico, measured by the share of employment, significantly increases the correlation between the fluctuations of the regions' GDP and the GDP of the source country. This conclusion is drawn by analyzing the largest 100 firms with maquila activity in Mexico. The findings are consistent with the theory of

granularity, showing that a few large firms engaged in global production activities can contribute to aggregate volatility in Mexico.

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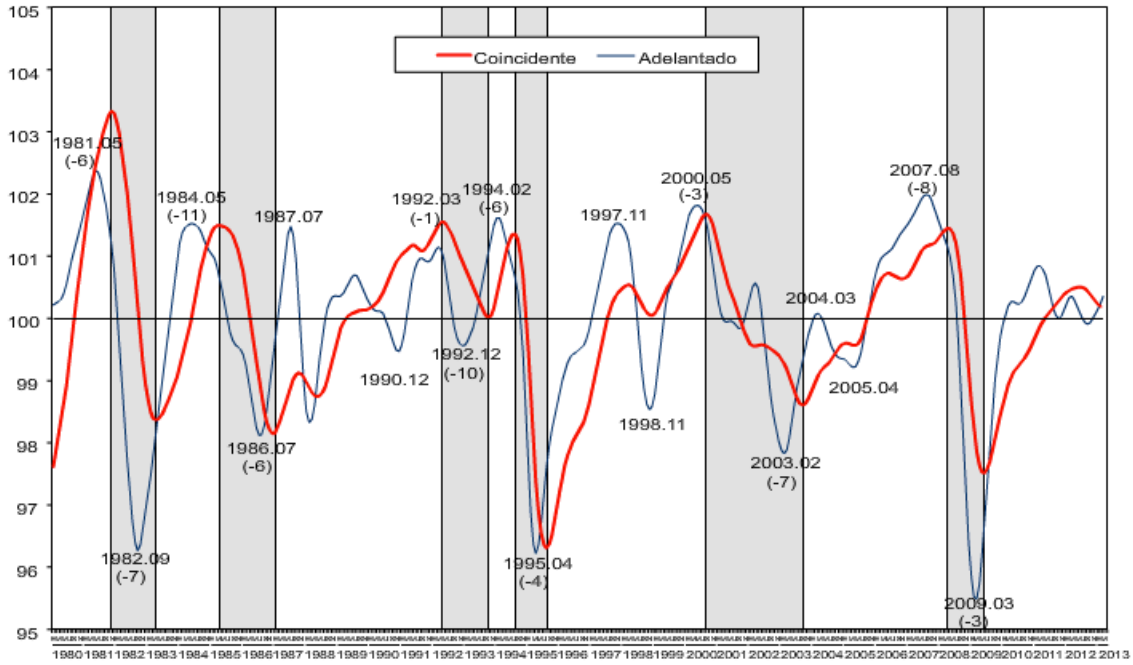
Appendix

Figure A1: Mexican Regions with the Highest Maquiladora Activity



Source: The map is marked according to the number of Maquila establishments at regional level in 2006.

Figure A2: Mexican Business Cycles (1980-2013)



Notes: The graph above displays the monthly economic activity in Mexico from 1980:1 to 2013:2. The blue line shows the forecast for the economic activity, while the red line represents the real economic activity. The graph was retrieved from the Mexican National Institute of Statistics.

Figure A3: Mexican Offshoring Industry by Region (2006)

Mexican Regions	Regional Employ.	Employ. in Maquilas	Share of Maquila Employ.	Imported Inputs	Value Added
Aguascalientes	50143	14957	0.2983	34,081,175	18,349,127
Baja California	269682	248924	0.9230	1,597,191,001	315,075,849
Chihuahua	332264	308661	0.9290	360,141,046	121,900,551
Coahuila	170061	97601	0.5739	1,704,559,871	425,885,583
Distrito Federal	215721	843	0.0039	7,070,431	5,336,914
Guanajuato	122842	11025	0.0897	35,938,567	35,796,602
Jalisco	181704	48675	0.2679	488,509,366	146,724,426
Mexico, State of	288127	2987	0.0104	6,713,682	5,373,921
Nuevo Leon	257944	72472	0.2810	419,968,503	155,632,782
Puebla	99617	20801	0.2088	17,810,192	25,988,980
San Luis Potosi	63312	13910	0.2197	56,475,206	34,303,489
Sonora	113476	86793	0.7649	423,136,271	94,765,840
Tamaulipas	210477	187704	0.8918	1,341,717,172	241,081,267

Notes: This table displays data for the Maquiladora industry by Mexican region in 2006. Figures by region are averages of monthly data. The variables concerning imported inputs and value added are expressed in US dollars. The data was retrieved from the Mexican National Institute of Statistics.

Figure A4: Regional Breakdown of Foreign Affiliates

Mexican Regions	Plants	Employ.	Share of Employ.	Sectors
Baja California	62	57098	0.0848	Electronics, Electrical, Transport, Medical, Apparel
Chihuahua	103	111706	0.1659	Electronics, Electrical, Transport
Coahuila	20	10515	0.0156	Electrical, Transport, Apparel
Distrito Federal	45	91608	0.1361	Transport, Medical, Electronics, Electrical, Apparel, Toys
Jalisco	59	55248	0.0821	Electronics, Electrical, Medical
Mexico, State of	44	31919	0.0474	Electronics, Transport, Food
Nuevo Leon	66	67987	0.1010	Transport, Electronics
Puebla	2	14487	0.0215	Transport
San Luis Potosi	33	13200	0.0196	Electronics, Transport
Sonora	14	29193	0.0434	Electronics, Transport, Medical
Tamaulipas	39	190213	0.2826	Electronics, Electrical, Transport

Notes: This table presents the contribution of the 100 largest foreign multinational firms with maquila activity established in Mexican regions. The data was retrieved from the Maquila Portal.

Figure A5: Intra-Industry Trade

Year	Mexico	Partner Countries	Index of Grubel and Lloyd
2006	Mexico	Canada	0.4613
2006	Mexico	China	0.1163
2006	Mexico	Finland	0.6093
2006	Mexico	France	0.4187
2006	Mexico	Germany	0.7384
2006	Mexico	Japan	0.1728
2006	Mexico	Korea, Rep.	0.0791
2006	Mexico	Netherlands	0.8734
2006	Mexico	Singapore	0.4446
2006	Mexico	Sweden	0.0853
2006	Mexico	United States	0.6738

Notes: A higher similarity between partner countries and Mexico, in terms of the structure of bilateral trade at a 2-digit level of the HS nomenclature, should lead to a greater synchronization of business cycles. An index close to one means that partner countries and Mexico trade similar type of products and therefore, they are engaged in intra-industry trade.

Figure A6: Comovements between Mexican regions and main partner countries

North America

Canada					
Highest correlations			**Lowest correlations**		
San Luis Potosi	SLP	0.1966	Distrito Federal	DIF	-0.4530
Guanajuato	GUA	0.0927	Aguascalientes	AGU	-0.3490
Tamaulipas	TAM	0.0506	Chihuahua	CHH	-0.3064

United States					
Highest correlations			**Lowest correlations**		
Baja California	BCN	0.4093	Coahuila	COA	-0.0544
Chihuahua	CHH	0.3606	Guanajuato	GUA	-0.0418
Distrito Federal	DIF	0.3293	Tamaulipas	TAM	0.1020

Europe

Finland					
Highest correlations			**Lowest correlations**		
Coahuila	COA	0.3897	Distrito Federal	DIF	-0.3098
Tamaulipas	TAM	0.2971	State of Mexico	MEX	-0.1185
Sonora	SON	0.2414	Chihuahua	CHH	-0.1109

France					
Highest correlations			**Lowest correlations**		
Coahuila	COA	0.2474	Distrito Federal	DIF	-0.4920
Tamaulipas	TAM	0.2444	Chihuahua	CHH	-0.3503
Guanajuato	GUA	0.2416	Aguascalientes	AGU	-0.3438

Germany					
Highest correlations			**Lowest correlations**		
Coahuila	COA	0.2685	Distrito Federal	DIF	-0.4681
Tamaulipas	TAM	0.2253	Chihuahua	CHH	-0.3056
Guanajuato	GUA	0.1941	Aguascalientes	AGU	-0.2941

Netherlands					
Highest correlations			**Lowest correlations**		
Coahuila	COA	0.2796	Distrito Federal	DIF	-0.4843
Tamaulipas	TAM	0.2523	Chihuahua	CHH	-0.3093
Guanajuato	GUA	0.2183	Aguascalientes	AGU	-0.2992

Sweden					
Highest correlations			**Lowest correlations**		
Guanajuato	GUA	0.4718	Distrito Federal	DIF	-0.2347
San Luis Potosi	SLP	0.4683	Chihuahua	CHH	-0.1221
Tamaulipas	TAM	0.4632	Aguascalientes	AGU	-0.0927

Southeast Asia

China					
Highest correlations			**Lowest correlations**		
Sonora	SON	0.4712	Jalisco	JAL	-0.0267
Coahuila	COA	0.3715	Distrito Federal	DIF	0.0404
Baja California	BCN	0.2858	Puebla	PUE	0.0819

Japan					
Highest correlations			**Lowest correlations**		
Tamaulipas	TAM	0.2534	State of Mexico	MEX	-0.1321
San Luis Potosi	SLP	0.1697	Puebla	PUE	-0.0901
Baja California	BCN	0.1385	Jalisco	JAL	-0.0708

Korea					
Highest correlations			**Lowest correlations**		
Sonora	SON	0.0218	Jalisco	JAL	-0.1832
Tamaulipas	TAM	0.0116	Puebla	PUE	-0.1528
Baja California	BCN	0.0106	Distrito Federal	DIF	-0.1449

Singapore					
Highest correlations			**Lowest correlations**		
Sonora	SON	0.4393	Jalisco	JAL	0.0652
Baja California	BCN	0.3258	Puebla	PUE	0.0971
Aguascalientes	AGU	0.3244	Tamaulipas	TAM	0.1224

Notes: The tables display the three highest and the three lowest levels of correlation of business cycles between Mexican regions and eleven partner countries. The business cycles correlations are computed as the correlation of GDP growth of Mexican regions and partner countries. Data on regional GDP comes from the Mexican National Institute of Statistics and was converted to US dollars. Data on countries' GDP is expressed in US dollars and comes from the World Bank Development Indicators.

Figure A7: List of the 100 Largest Maquiladora Firms in Mexico

Rank	Firm	Source Country	Employees	Plants	Sector
1	Sony Corporation of America	Japan	158500	5	Electronics
2	Mazda	Korea	42000	1	Automotive
3	Lear Corporation	United States	34000	8	Automotive
4	Yazaki North America	Japan	26352	32	Automotive
5	Jabil Circuit Inc.	United States	21000	4	Manufacture
6	Magna International Inc	Canada	18000	28	Automotive
7	Takata	Japan	17000	12	Automotive
8	The Offshore Group	United States	14498	3	Shelter
9	Volkswagen de Mexico	Germany	14000	1	Automotive
10	Foxconn Mexico Precision Industry Co.	China	13500	5	Electronics
11	Sumitomo Wiring Electric Systems	Japan	13000	9	Electrical
12	TRW Incorporation	United States	11000	10	Automotive
13	Thomson Inc.	United States	10874	6	Electronics
14	Kemet Corporation	United States	10620	5	Electronics
15	General Electric Company	United States	10600	30	Electronics
16	Sanmina-SCI	United States	10500	8	Electronics
17	Honeywell, Inc.	United States	9626	3	Electronics
18	Ford de Mexico	United States	9150	3	Automotive
19	American Industries	United States	8200	31	Shelter
20	Nissan Mexicana	Japan	8000	4	Automotive
21	Siemens AG	Germany	7655	15	Electronics
22	Visteon Corporation	United States	7641	13	Automotive
23	Mallinckrodt Inc.	United States	7521	8	Medical
24	Whirlpool	United States	7500	5	Electronics
25	A.O. Smith Corporation	United States	7400	17	Electrical
26	Cardinal Health	United States	7124	6	Medical
27	Tyco International Ltd.	United States	6785	4	Electronics
28	Flextronics Corporation	Singapore	6200	2	Electronics
29	Samsung	Korea	5850	3	Electronics
30	Motorola Inc.	United States	5691	2	Electronics
31	Elcoteq Network Corporation	Finland	5500	1	Electronics
32	Daewoo Industrial Co.	Korea	4856	5	Electronics
33	Tenaris Tamsa	Mexico	4500	2	Industrial
34	Autoliv Inc.	Sweden	4455	5	Automotive
35	Key Safety Systems Inc.	United States	4390	4	Automotive
36	Bosch Group	Germany	4320	7	Automotive
37	Mattel Inc.	United States	4200	2	Toys
38	Wistron	Taiwan	4100	1	EMS
39	The Chamberlain MFG	United States	4000	1	Electronics
40	ITT Industries	United States	3845	4	Automotive

Rank	Firm	Source Country	Employees	Plants	Sector
41	LG Electronics	Korea	3700	3	Electronics
42	Becton Dickinson	United States	3500	4	Medical
43	Philips Electronics	Netherlands	3500	4	Electronics
44	Hyundai Motor Company	Korea	3450	1	Automotive
45	The Tecma Group	United States	3206	18	Industrial
46	Molex	United States	3200	2	Electronics
47	Avery Dennison	United States	3200	4	Office products
48	Kimberly-Clark	United States	3196	4	Miscellaneous
49	TI Group Automotive Systems	United States	3106	7	Automotive
50	Intermex Manufactura	Mexico	3100	14	Shelter
51	Scientific Atlanta Incorporation	United States	2996	1	Electronics
52	Bose Corporation	United States	2900	2	Electronics
53	AM-MEX Products Co.	United States	2789	6	Shelter
54	Plantronics Inc.	United States	2700	1	Electronics
55	Smiths Healthcare Manufacturing	United States	2700	4	Medical
56	Trico Technologies Inc.	United States	2700	1	Automotive
57	Leviton Manufacturing Company	United States	2680	6	Electrical
58	Avail Medical Products	United States	2548	8	Medical
59	Key Tronic Corporation	United States	2500	4	Electronics
60	Nova Link	Mexico	2500	3	Shelter
61	Schlage de Mexico	United States	2227	3	Security
62	Industrial Vallera de Mexicali	Mexico	2200	14	Shelter
63	Yale de Mexico	United States	2169	1	Apparel
64	Eaton Corporation	United States	2113	2	Automotive
65	VF Imagewear	United States	2100	2	Apparel
66	Daimler Trucks North America	United States	2034	2	Automotive
67	Skywork Solutions	United States	2000	1	Semiconductors
68	Celestica Inc.	Canada	2000	3	Electronics
69	EPIC Technologies LLC.	United States	2000	2	EMS
70	Ensambles Hyson	United States	2000	2	Irrigation
71	Superior Industries International Inc.	United States	1998	3	Automotive
72	Arvin Meritor	United States	1950	4	Automotive
73	EDS Manufacturing Inc.	United States	1900	1	Electronics
74	Benchmark Electronics Inc.	United States	1900	1	Electronics
75	Sanyo North America Group	Japan	1900	1	Electronics
76	Accuride International	United States	1869	2	Steel products
77	Toshiba	Japan	1780	1	Electronics
78	Asustek Computer Inc.	Taiwan	1700	1	EMS
79	Strattec Security Corporation	United States	1584	3	Automotive
80	Cooper-Standard Automotive	United States	1520	3	Automotive
81	Alpine Electronics of America Inc.	Japan	1502	1	Automotive
82	Sperian	France	1500	2	Medical
83	Tatung	Taiwan	1500	1	Electronics
84	General Mills Inc.	United States	1450	1	Food processing
85	Invensys	United States	1420	6	Electronics

Rank	Firm	Source Country	Employees	Plants	Sector
86	Plexus	United States	1350	1	Electronics
87	Automotive Safety Components Int.	United States	1325	2	Automotive
88	Nokia	Finland	1250	1	Electronics
89	Pegatron Corporation	Taiwan	1200	1	Electronics
90	RSI Home Products	United States	1200	2	Home appl.
91	Emerson Electric Co.	United States	1200	2	Electrical
92	Sigmatron International	United States	1160	2	EMS
93	Saturn Electronics and Engineering Inc.	United States	1150	2	Electronics
94	USI Manufacturing Services Inc.	United States	1100	1	EMS
95	Diaco International	United States	1100	1	Apparel
96	Alcoa Fujikura	Japan	992	4	Industrial
97	SSI Tecnologias de Mexico	United States	940	1	Automotive
98	Kimball International Inc.	United States	860	1	EMS
99	Hamilton Proctor-Silex Inc.	United States	850	1	Appliances
100	Coilcraft Inc.	United States	850	3	Electronics

Source: Maquila Portal.