

# Trade Shocks and Mexican Local Labor Markets in the Great Recession

Job Market Paper

Oscar Mendez

University of California, Davis

November 2014

## Abstract

This paper studies the spread of the U.S. credit crisis to Mexican local labor markets, explicitly identifying the role that trade played in the transmission of the negative shock across the two countries. To identify the trade channel empirically, I exploit the variation in dependence on the U.S. market displayed by Mexican local labor markets. Differences in manufacturing industry structure caused by Mexico's opening process have made a subset of Mexican municipalities especially vulnerable to economic events in the U.S. Mexican municipalities that exported relatively more to the U.S. experienced large and significant differential effects when compared to municipalities more focused on the domestic market. Mexican regions with significant ties to the U.S. market experienced, during the crisis, a significantly larger decrease in employment and wages, and greater within local labor market adjustments than their less open counterparts.

**Keywords:** U.S. credit crisis, trade shock, local labor markets, Mexican employment and wages

JEL: E24, F14, F16, J30, L60

## 1. Introduction

Trade has proven to be an important driver of business cycle synchronization across countries, especially when demand shocks are the dominant force in the economic relationship (Frankel and Rose, 1998). Under these circumstances, the strengthening of economic ties tends to increase the sharing of economic benefits between countries, since growth in the economically dominant country is normally accompanied by an increase in demand for the goods exported by the trade partner. However, this relationship is a two-edge sword. What happens when the dominated country becomes too dependent on the dominant country and a large negative shock affects the latter? That is the case of Mexico and the U.S.

Mexico's economic opening started in the mid-1980s, when it became a member of the GATT (*General Agreement on Trade and Tariffs*), and then was reinforced in 1994 when NAFTA (*North America Free Trade Agreement*) was enacted. The new openness created a strong link between the business cycles of Mexico and the United States (Robertson, 2000). Trade links function as a channel of transmission. Fluctuations in the U.S. industrial activity affect the demand for Mexican exports, which in turn influence the Mexican business cycle. This trade-driven phenomenon has had significant consequences for Mexico's economic geography (Hanson, 1996). In particular, closer ties with the U.S. appear to have contributed to a contraction of employment in the Mexico City manufacturing belt and a rapid expansion of manufacturing employment in northern Mexico, with the corresponding increase in wages relative to other Mexican regions. Thus, it appears that some Mexican regions have reaped the benefits of a stronger integration with the U.S. market at the expense of others. However, this has also made the trade-integrated regions more vulnerable to negative events in the U.S. What happens to these Mexican regions when the large negative demand shock arrives?

This study argues that closer ties between the economies of Mexico and the U.S. have made a number of Mexican municipalities overly dependent on the U.S. market, while others have gained less and now risk less. I exploit differences in the degree of outward orientation of the industry mix across Mexican municipalities to determine the level of U.S. dependence of each municipality. I then use this heterogeneity on U.S. dependence across Mexican

municipalities to identify the role that trade played in the transmission of a negative demand shock originated in the U.S. (namely, The Great Recession). My empirical approach relies on the identification assumption that municipalities more dependent on the U.S. market are not relatively more affected by other shocks. Thus, I control for other potentially confounding factors such as Mexican export supply shocks and omitted-variable bias. I discuss in length the particular case of Chinese exports into the U.S. market as a contemporaneous shock with potentially biasing results and the strategy that I follow in order to prevent it from affecting the main estimates<sup>1</sup>.

I find that trade played an important role in the transmission of the negative shock and, to answer the question above, Mexican municipalities depending heavily on the U.S. were more affected than municipalities more focused on the domestic market. I also analyze the period preceding the negative demand shock, characterized by a build-up of U.S. consumption financed by an increase in credit. I find that the increase in U.S. imports during this booming period was not enough to differentially benefit those Mexican municipalities more dependent on the U.S., implying that these municipalities are especially vulnerable to large negative shocks, but not particularly benefited by positive trade shocks.

This study touches on several streams of literature. One prominent stream has been opened by the “China Syndrome” article of Autor et al. (2013), which highlights how greater trade volumes can magnify the relationship between trade shocks and labor market outcomes. By estimating the extent to which domestic U.S. industries compete with imports coming from China, they find that the export growth displayed by China in the previous two decades had a significantly negative impact on employment and wages in those regions with similar industrial production patterns to those shown by Chinese exporting industries. For the empirical estimation, I derive a measure of U.S. dependence for each Mexican local labor market by focusing only on direct effects, similar to Autor et al. (2013). The strategy is to capture how vulnerable a given Mexican region is to events in the U.S. market and then to analyze the relationship between this measure and adjustments at the municipality level within Mexico.

---

<sup>1</sup> The second chapter of my dissertation, “The Effect of Chinese Import Competition on Mexican Local Labor Markets”, explores the direct effect of the increase in supply of Chinese exports into the Mexican market.

Second, this paper extends a related literature on trade and business cycle comovements. Since Frankel and Rose (1998) first studied the conditions under which trade integration leads to a higher degree of business cycle synchronization, several papers have tested the relationship between trade openness and output comovement. Most relevant for my study are Robertson (2000) and Chiquiar and Ramos-Francia (2005). The former article tests the hypothesis that the labor markets of U.S. and Mexico are integrated. The author finds that even though a large differential exists between them, the labor markets of the U.S. and Mexico are closely integrated, and trade, alongside of migration, is one of the main culprits. In the latter study, the authors find evidence that Mexico's trade integration with the U.S. has helped foster business cycle synchronization between the two countries. Trade functions as a channel of transmission through which U.S. industrial activity affects the demand for Mexican exports, which in turn influences the Mexican business cycle. My paper complements this literature both by estimating the role that trade plays in transmitting shocks from U.S. to Mexico and by analyzing how local labor markets adjust to this shock, a feat that could not be studied previously due to lack of appropriate data and the adequate empirical approach.

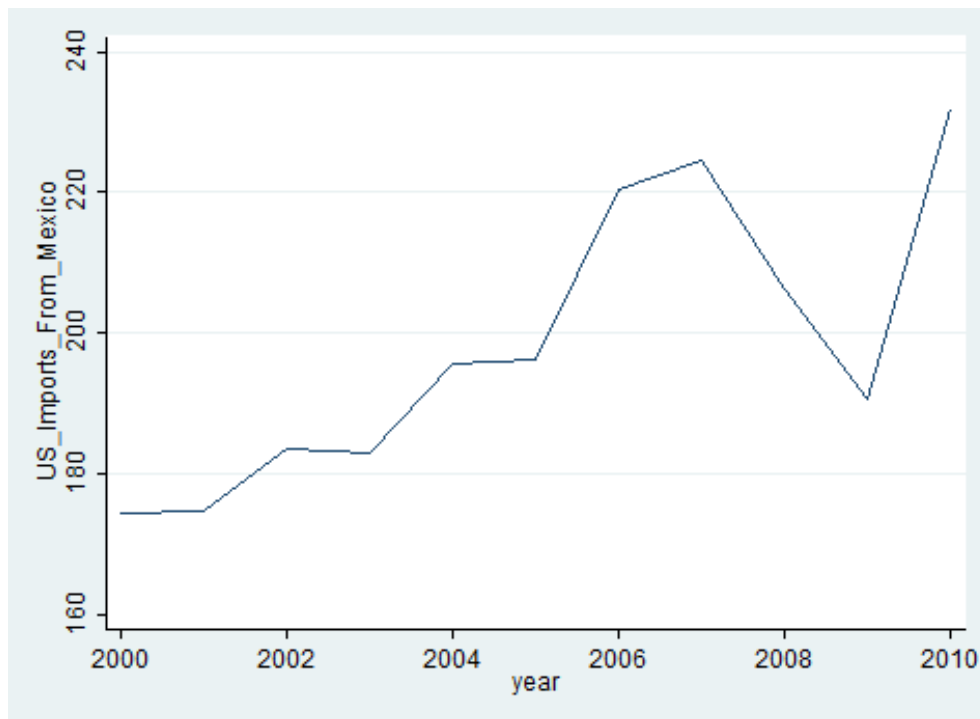
Finally, this article is related to the literature on crisis contagion. This line of research, best represented by the seminal work by Kaminsky and Reinhart (2000), has focused mostly on contagion across countries using aggregate data on trade linkages. In contrast, my approach focuses on the effect of cross-country trade on disaggregated geographic units, and uses local labor market heterogeneity in the degree of vulnerability to trade shocks to identify the trade channel.

While the transmission of economic shocks at the country level has been widely studied, data and identification challenges have complicated the study of these phenomena at more disaggregated geographic levels. Mexico's characteristics allow me to overcome some of these challenges, and to study how local markets adjust to demand shocks coming from abroad. Additionally, taking local labor markets as the unit of analysis allows me to observe economic adjustment in several dimensions: wages, labor-force participation, and the shares of manufacturing versus non-manufacturing sectors.

## 2. Empirical Strategy

My estimates are designed to relate changes in labor market outcomes across Mexican local labor markets (municipalities) to fluctuations in their ‘potential U.S. market share’, a variable that captures the size of the U.S. market that a given Mexican municipality has access to, and that depends on the Mexican municipality’s level of U.S. dependence and the volume of U.S. imports from Mexico. A dramatic example of such fluctuations has occurred during the U.S. economy’s boom and bust periods over the last decade (Figure 1). In order to exploit these developments, I focus my analysis on the periods with greater fluctuations, which comprise the two-year period before the crisis, 2005 to 2007, and the two-year period during which the crisis developed, 2007-2009.

Figure 1. U.S. imports from Mexico, 2000-2010 (in billions of 2010 dollars)



Following the growing strand of literature that studies the direct effects of trade shocks on labor markets by exploiting local labor market characteristics<sup>2</sup>, I focus my analysis on the direct effect of the crisis-generated trade shock and assume that the susceptibilities of Mexican local labor markets to events in the U.S. differ according to two factors: (i) their initial pattern of industry specialization; and (ii) the initial degree of outwards orientation of their industry structure. In principle, those municipalities with stronger trade links with the U.S. economy and with initial patterns of industry specialization more similar to the mix of U.S. imports more affected by the crisis will be more exposed to the trade shock. I would then expect to see a larger labor market adjustment in these municipalities than in regions less dependent on the U.S. market, or regions that, although dependent on the U.S. market, were specialized in exporting industries that did not suffer major drawbacks during the crisis.

The ‘potential U.S. market share’ of Mexican region  $i$  is captured by the following expression:

$$\Delta USmkt_{mit} = \sum_j \frac{L_{ijt}}{L_{it}} \times \frac{X_{ijut}}{X_{ijt}} \times \frac{\Delta M_{ujmt}}{E_{ujt}}, \quad (1)$$

where  $\Delta USmkt_{mit}$  represents the change in ‘potential U.S. market share’ for Mexican municipality  $i$  between year  $t$  and the end of the period. This expression is composed by three ratios that determine how relevant the U.S. market is for municipality  $i$ : (i)  $\frac{L_{ijt}}{L_{it}}$ , initial ratio of employment in industry  $j$  to total employment in municipality  $i$ ; (ii)  $\frac{X_{ijut}}{X_{ijt}}$ , initial share of output in industry  $j$  by region  $i$  that is exported to the U.S.; and (iii)  $\frac{\Delta M_{ujmt}}{E_{ujt}}$ , exogenous change in U.S. imports from Mexico in industry  $j$  as a share of total U.S. purchases in industry  $j$ .

Equation (1) allocates exogenous components in U.S. imports from Mexico ( $\frac{\Delta M_{ujmt}}{E_{ujt}}$ ) to municipality  $i$  according to two characteristics of industry  $j$ : (i) the ‘level of dependence’ of

---

<sup>2</sup> See, for example, Autor et al. (2013) and Stumpner (2014).

industry  $j$  in municipality  $i$  on the U.S. market, captured by the ratio  $\frac{X_{ijut}}{X_{ijt}}$ ; and (ii) the ‘level of importance’ of industry  $j$  on total employment in municipality  $i$ , represented by the ratio  $\frac{L_{ijt}}{L_{it}}$ .

The intuition behind equation (1) is straightforward: an exogenous change in the volume of U.S. imports from Mexico in industry  $j$  can affect a labor market outcome in Mexican municipality  $i$  only if (i) municipality  $i$  exports output from the same industry  $j$  to the U.S. (i.e.,  $\frac{X_{ijut}}{X_{ijt}}$ , the ‘level of dependence’ of industry  $j$  in municipality  $i$  on the U.S. market, is positive); and (ii) employment in industry  $j$  represents a positive share of total employment in region  $i$  (i.e.,  $\frac{L_{ijt}}{L_{it}}$ , the ‘level of importance’ of industry  $j$  on total employment in municipality  $i$ , is positive).

## 2.1 Regression Model

The base regression model to be used throughout the analysis is:

$$\Delta y_{it} = \beta_1 \Delta USmkt_{mit} + X'_{it} \beta_2 + e_{it}, \quad (2)$$

where  $i$ ,  $t$ , and  $m$  index municipality, period, and Mexico, respectively.  $\Delta y_{it}$  is a two-year change in municipality  $i$ 's employment or wages; the vector  $X'_{it}$  includes such variables as the proportion of manufacturing employment, proportion of working age population with college, the share who are female, and the share of the informal sector in total employment, all measured at the beginning of the period. The standard errors are clustered at the municipality level.

## 2.2 Identification Issues

This approach exploits the demand shock that Mexican exports to the U.S. experienced during the Great Recession. As has been documented, this crisis originated in the credit market of the G7 countries, especially the U.S. and the U.K (Baldwin, 2009). In particular, the looseness of

credit lending allowed housing prices to rise during most of the 2000s, creating a housing price bubble that burst on 2006. This housing price reversal had a negative effect on the U.S. economy, including large drops in internal and international trade. It is essential for my empirical strategy to ensure the exogeneity of this trade shock to the Mexican economy. In order to clear any major reason for concern in the identification, I take the following measures.

First, it is possible that U.S. imports from Mexico were also affected by Mexican supply shocks rather than just the negative demand shock to the U.S. economy due to the recession. To prevent idiosyncratic Mexican export-supply shocks from biasing my results, I instrument for  $\Delta M_{ujmt}$  with  $\Delta M_{ujot}$ . Instead of realized U.S. imports by industry from Mexico, the variable  $\Delta M_{ujot}$  uses realized U.S. imports from other high-income countries.<sup>3</sup> This instrument ensures that the variation in estimated U.S. imports from Mexico coming from the first stage regression ( $\Delta \widehat{M}_{ujmt}$ ) is clean from events affecting the supply side of the trade relationship. Since the U.S. is the destination of 80% of Mexican manufacturing exports (INEGI, 2012), the validity of the instrument is under small risk of being violated. To test for the weakness of the instrument, I present in the results section the F-statistic pertaining to the first stage of the IV (Instrumental Variable) regression.

Second, the anticipation of shocks to the U.S. economy might affect the behavior of Mexican manufacturers, causing a bias that would attenuate the effect of changes in ‘U.S. market share’ on Mexican local labor market outcomes. To mitigate this bias I use lagged levels of sales, output, and labor. Adding these two modifications gives me the following instrument:

$$\Delta USmkt_{oit} = \sum_j \frac{L_{ij,1998}}{L_{i,1998}} \times \frac{X_{iju,1998}}{X_{ij,1998}} \times \frac{\Delta M_{ujot}}{E_{uj,1998}}, \quad (3)$$

where the only differences between this expression and the expression in (1) are: (i)  $\Delta USmkt_{mit}$  and  $\Delta M_{ujmt}$  have been replaced by  $\Delta USmkt_{oit}$  and  $\Delta M_{ujc,t}$ , respectively, denoting the use of

---

<sup>3</sup> The countries included in the sample are Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain, and Switzerland according to their income levels presented in the World Bank report (2001).



U.S. imports from other developed countries rather than Mexico; and (ii) this expression uses levels of sales, output, and employment with 1998 as the base year, having thus a lag with a length dependent on the specific years under analysis.

### 2.3 China as a Trade Diversion Factor Between Mexico and the U.S.

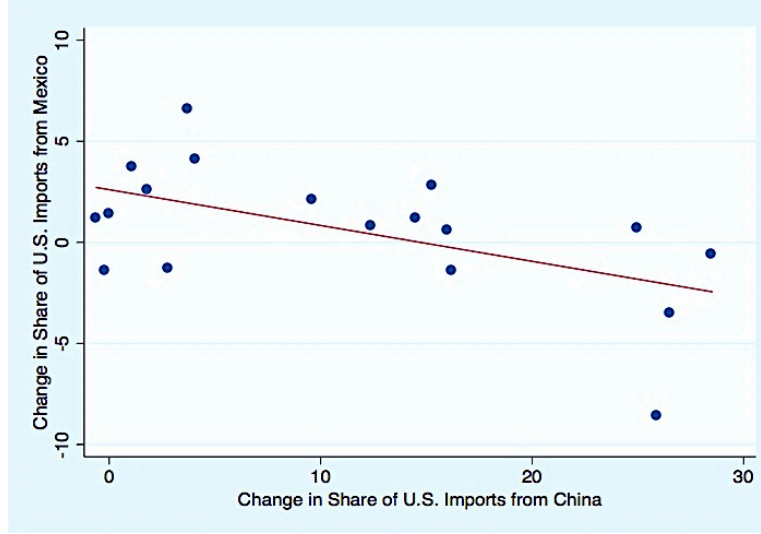
A third reason for concern when attempting to identify the effect of the trade shock caused by the Great Recession on Mexican local labor markets is potential omitted variable bias. In addition to a demand shock that is transmitted through trade, a particular region may be subject to other shocks that also affect economic outcomes. If these shocks are unaccounted for and correlated with the trade demand shock, the estimated coefficient will be inconsistent. In this section I discuss the role that the Chinese trade growth between 2000 and 2010 played in the evolution of, both, economic outcomes in Mexican municipalities and the variable  $\Delta USmkt_{mit}$ , and the need to control for it in order to obtain consistent estimates.

The 2001 accession of China into the World Trade Organization, paired with an impressive set of institutional changes that fostered its economic opening process, has turned the Chinese economy into a significant factor in the performance of all open economies in the world. In particular, these developments made of China the primary supplier of labor-intensive type of goods for the North American market. Between 2000 and 2010, China's share of U.S. imports went from 3.1% to 18.4%, and as early as 2006 it displaced Mexico as the second largest exporter to the U.S.

Figure 2 plots the change in the share of U.S. imports from Mexico and China for three-digit NAICS manufacturing industries between 2000 and 2010. As we can see in the figure, there was a significant negative relationship between Mexico and China's growth in manufacturing industries as a share of U.S. imports. It is even more impressive when we explore the values represented in the axes. While for China most industries showed an increment in the proportion of U.S. imports they represent, with more than half of them growing by more than 15 percentage points, for Mexico one-third of all industries decreased

their participation in U.S. imports, with the remainder two-thirds growing less than 5 percentage point, and only one industry reaching a growth of 7.5 percentage points.

Figure 2: Changes in Share of U.S. Imports from China and Mexico for Selected Industries, 2000-2010



I complement this preliminary evidence of displacement in the U.S. market with a formal analysis of the effect that China, through trade diversion, had on Mexican municipalities more exposed to the U.S. market. In order to do this, I use a variation of equation (3):

$$\Delta USmkt_{cit} = \sum_j \frac{L_{ij,1998}}{L_{i,1998}} \times \frac{X_{iju,1998}}{X_{ij,1998}} \times \frac{\Delta M_{ujct}}{E_{uj,1998}}, \quad (4)$$

In order to estimate equation (4) I use, in addition to all other variables analogously defined, U.S. imports from China in industry  $j$  ( $M_{ujc}$ ). The intuition behind equation (4) is analogous to that of equation (1): an increase in Chinese competition for U.S. market share represented by an exogenous increase in the volume of U.S. imports from China in industry  $j$  can affect a labor market outcome in Mexican municipality  $i$  only if (i) municipality  $i$  exports output from the same industry  $j$  to the U.S.; and (ii) employment in industry  $j$  represents a positive share of

total employment in region  $i$ . The only difference for Mexican municipality  $i$  is that, instead of facing a ‘U.S. market share’ reduction due to fluctuations in U.S. importing capabilities, it is now facing a reduction due to stronger competition from Chinese goods in U.S. territory.

I modify the base regression presented in equation (2) in the following way:

$$\Delta y_{it} = \beta_1 \Delta USmkt_{cit} + X'_{it} \beta_2 + e_{it}, \quad (5)$$

This expression now includes  $\Delta USmkt_{cit}$ , which estimates the change in ‘Chinese competition for U.S. market share’ for municipality  $i$  due to China’s exports into the U.S. and which uses lagged levels of all Mexican industry structure variables. Also,  $\Delta y_{it}$  is defined as a five-year change in employment or wages in Mexican municipality  $i$ , since I am analyzing the trade-diversion effect caused by China during the relevant period of 2005-2010.

Table 1 presents the IV results. Column 1 shows the effects of the change in U.S. market size on five-year changes in the municipality’s total employment as a share of the working-age population, in manufacturing employment, and in the wage rate. I control for demographic characteristics of the municipality such as the proportion of working age population with college, the share of female workers, and the share of the informal sector in total employment, all measured in  $t = 2005$ . The employment impact is negative, as predicted, indicating that an increase in U.S. imports from China decreases Mexican employment, with the coefficient showing significance at the 13% level. However, when I use the five-year change in proportion of manufacturing employment as dependent variable, not only does the negative effect become significant at a level of less than 1%, but also its absolute size increases by more than four times with respect to the coefficient on total employment. The coefficient -0.853 implies that an increase of one standard deviation in estimated ‘Chinese competition for U.S. market share’ (0.0155) would decrease manufacturing employment in the average Mexican municipality by 1.32 percentage points. Chinese competition in the U.S. market also strongly lowers the municipality’s average wage. The coefficient -2.166, significant at a level of less than 1%, implies that an increase of one standard deviation in Chinese competition would decrease the

average local wage by 3.3 percentage points. In principle, if Mexico's labor markets were fully integrated and adjusted promptly to shocks, an exogenous increase in Chinese competition for U.S. imports could not have affected wage rates differentially. The wage result I obtained points at an important characteristic of Mexican labor markets: a sluggish rate of labor market adjustment (Robertson, 2000).

This shows that Mexican municipalities with a higher dependence on their sales abroad are more sensitive to Chinese import competition in the U.S. market. Thus, in order to obtain a consistent estimate of the role that trade played in the transmission of the U.S. crisis to Mexican municipalities, it is imperative to control for Chinese competition in the U.S. In order to do this, it must be the case that the correlation between my main explanatory variable  $\Delta USmkt_{mit}$  and  $\Delta USmkt_{cit}$  is only moderate. Otherwise, it would be impossible to empirically disentangle the effect of these two variables. The correlation coefficient of  $\Delta USmkt_{cit}$  and  $\Delta USmkt_{mit}$  is only 0.21, leaving thus room to disentangle the effects of Chinese competition from other determinants of exports to the United States.

The results from this section have shown that my empirical approach must take into account the economic presence of China in the U.S. market. To account for this factor, plus the previously mentioned identification concerns, equation (2), my base regression model, changes in the following way:

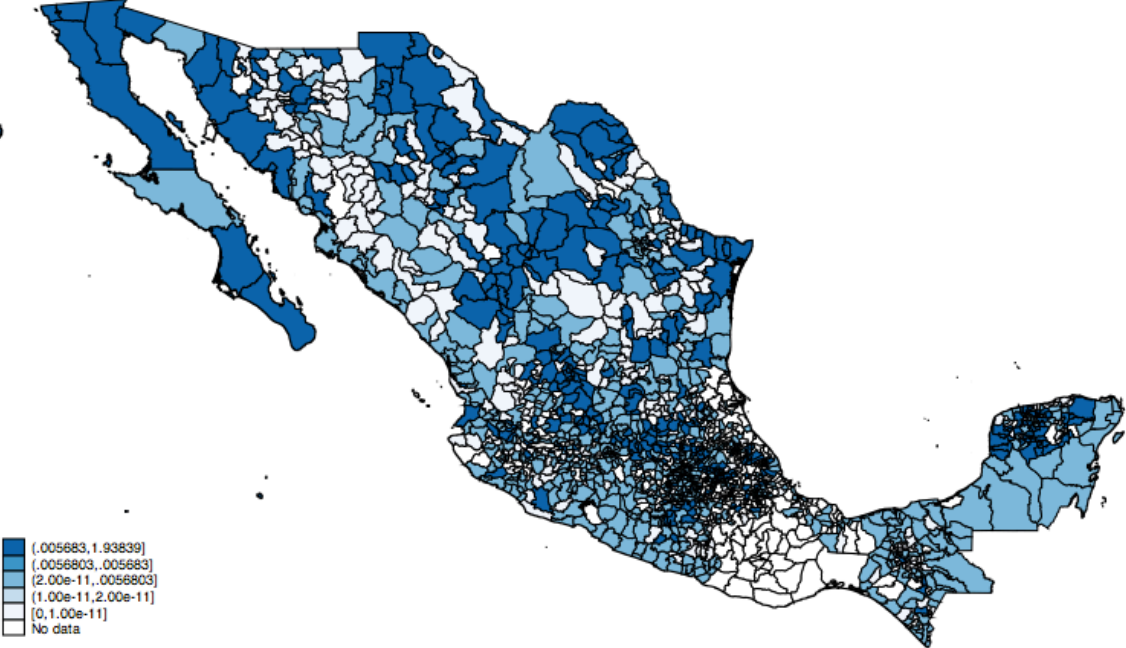
$$\Delta y_{it} = \beta_1 \Delta \widehat{USmkt}_{mit} + \beta_2 \Delta USmkt_{cit} + X'_{it} \beta_3 + e_{it}, \quad (6)$$

where  $\Delta \widehat{USmkt}_{mit}$  is the 2SLS estimate of  $\Delta USmkt_{mit}$ , and the rest of the indexes and variables are defined as in equations (2) and (5).

Figure 3 maps the variable  $\widehat{USmkt}_{mit}$ , by quintile, for all available Mexican municipalities based on U.S. import data from the year 2000; that is, it shows the level of U.S. dependence of each municipality measured as the 'U.S. market share' that each municipality possesses. An important determinant of U.S. dependence is distance to the U.S. market. This is represented in

the map by showing a high concentration of first-quintile municipalities in the north part of the country. However, the Mexico City manufacturing belt and the Yucatan peninsula (southeastern tail of the Mexican map) also display high dependence on the U.S. market. This heterogeneity, plus the evolution of U.S. trade during the Great Recession (2007-2009), allows me to identify the role that trade linkages played in the transmission of the crisis to Mexican local labor markets.

Figure 3. Mexican Municipalities' Level of U.S. Market Dependence, 2000



### 3. Data

All my data comes from three sources: the United Nations Comtrade database (UN Comtrade), the Mexican Economic Census, and the Mexican Occupation and Employment National Survey.

The UN Comtrade database contains bilateral trade data for most countries in the world at a level of disaggregation of five-digits in the SITC code. This level of disaggregation allows me to have the values of U.S. imports from Mexico and a set of both developed and developing countries for 180 manufacturing industries for the years 2005-2010.

I combine this trade data with information on Mexican local production, sales, and employment in detailed industries. Information on Mexican industry structure by municipality is obtained from the 1998 Mexican Economic Census, a survey run every five years, which covers all economic firm activity in Mexican territory.<sup>4</sup> This survey contains data on production, sales, and employment by Mexican municipality and by detailed industry (in NAICS code) for the year 1998.

### 3.1 Classifying Industrial Sectors

Trade and Mexican industry structure data are coded differently. While the UN Comtrade database contains the volume of trade by SITC industry code, the Mexican Economic Census uses NAICS code. In order to match trade and Mexican industry structure data I use the NBER concordance tables constructed with U.S import and export data from 1989, truncating the NAICS code to five digits (my concordance tables are available under request). In an attempt to minimize the number of Mexican municipalities that, due to strong economic and social ties among them, could dissipate the effect of changes in the ‘U.S. market’ variable, I then proceed to aggregate the data for those municipalities that, according to the 2005 INEGI Metropolitan Zones delimitation, have a high degree of socioeconomic integration. The remaining municipalities are also included in the sample. In total, I count 678 local labor markets, divided in 65 metropolitan areas and 613 isolated municipalities.

The main dependent variables are constructed using the Mexican Occupation and Employment National Survey between the years of 2005 and 2010.

---

<sup>4</sup> The Mexican Economic Census excludes agriculture, stockbreeding, forestry, hunting, passenger transportation in collective automobiles of fixed route, taxis and limousines services, political associations, political organizations, international organisms, and organisms outside of Mexican territory

### 3.2 Maquiladora Sales as a Measure of Local Export Orientation

A variable that is key in the estimation of the Mexican municipality's 'U.S. market size' index ( $\Delta USmkt_{mit}$ ), is  $X_{ijut}$ , exports to the U.S. in industry  $j$  by municipality  $i$ . However, I am restricted by the lack of data on total exports by municipality by industry. In order to estimate  $\Delta USmkt_{mit}$ , I proxy for  $X_{ijut}$  with 'total maquiladora sales' per municipality, per industry.

Maquiladoras are assembly plants located in Mexico operating under a special customs regime, which allows them to import, duty-free, all the machinery, tools, equipment, and raw materials necessary to assemble and manufacture products for export. Between 2001 and 2006, maquiladoras exported, on average, 98% of their products to the U.S. Additionally, in the same period, the maquila sector generated 48% of Mexico's total exports and 70% of manufacturing exports.

My results must be interpreted with caution since, by using a proxy rather than the real volume of exports by municipality by industry, I am assuming that non-maquila manufacturing exports do not significantly affect the estimated 'U.S. market size' of municipality  $i$  or, if it did, both variables are strongly correlated. If the real data did not support this assumption, then any effect found would be attenuated by municipalities that, although without a strong maquila presence, are still significantly affected by events in the U.S. market.

## 4. Results

### 4.1 Summary Statistics

I start the results section with a look at how Mexican municipalities performed, unconditionally and on average, before and during the Great Recession.

Table 2 presents summary statistics for municipalities below the 25<sup>th</sup> percentile and above the 75<sup>th</sup> percentile in the change of the 'U.S. market size' variable (all tables can be found at the

end of the paper). The ‘before crisis’ period refers to the two years previous to the crisis (2005-2007), and during which U.S. imports were still on a positive trend. The ‘during the crisis’ period refers to the span of time ranging from 2007 to 2009, year in which U.S. imports reached their minimum level. One feature that stands out is that Mexican employment, both in general and in manufacturing, was not performing well neither before nor during the crisis. The negative trend, however, exacerbates significantly during the crisis period.

Another important fact to take into account is that, by construction, there is a compositional shift between groups when going from the ‘before’ to the ‘during’ period: 11% of municipalities above the 75<sup>th</sup> percentile in the ‘before’ period moved to below the 25<sup>th</sup> percentile in the ‘crisis’ period. This is the group of municipalities with strongest ties to the U.S. market and, therefore, most susceptible to events in that country. Before the crisis, strong house price growth and increase in credits had a positive effect on U.S. overall consumption, including imports, resulting in an increase in the ‘potential U.S. market’ of Mexican municipalities ( $\Delta\widehat{USmkt}_{mit}>0$ ), especially for the group of municipalities most dependent on the U.S. In fact, these municipalities captured 94% of the growth in ‘U.S. market size’ during the ‘before crisis’ period. However, during the crisis, all these effects were reverted. There was a large drop in total U.S. imports, significantly decreasing the ‘potential U.S. market’ of Mexican municipalities ( $\Delta\widehat{USmkt}_{mit}<0$ ), with the group of municipalities most dependent on the U.S. market suffering the largest setback (absorbing 48% of the reduction in ‘U.S. market size’), thus resulting in a significant compositional change in the percentile groups.

First, I compare percentile groups within their own timeframe. In the period before the crisis we do not see large differences in most industries. Although total employment fell by less for municipalities above the 75<sup>th</sup> percentile and manufacturing employment fell by more, this difference is indistinguishable from zero. The variable with the most outstanding difference is wage. In this instance, wages for the group of municipalities above the 75<sup>th</sup> percentile grew by 6.4 percentage points, while for the group below the 25<sup>th</sup> percentile it only increased by 0.7. This is consistent with the presumption that municipalities more dependent on the U.S. were benefited by the increase in U.S. consumption due to the housing bubble. Again, all these



unconditional differences are tainted by the potential effect of omitted variables, which, as we have seen, could be large and significant.

Second, I compare groups across timeframes. Both percentile groups experienced a significant worsening in overall employment during the crisis period as compared to the pre-crisis period. However, we can see that this deterioration was larger for regions more dependent on the U.S. market. While, during the crisis, municipalities below the 25<sup>th</sup> percentile experienced a 1.9 percentage point larger decline in overall employment than in the previous period, for municipalities above the 75<sup>th</sup> percentile the decline was only 1.2 percentage points larger. This difference is even most striking on manufacturing employment, where the below 25<sup>th</sup> percentile group had a decline 2.1 percentage points larger than in the previous period, while the 75<sup>th</sup> percentile had an increase of 0.3 percentage points. Within municipality adjustment seemed to have the agricultural industry as the main escape valve for all manufacturing employment lost during the crisis period, as it went from no change before the crisis to an increase of 1.3 percentage points in U.S. dependent municipalities.

Finally, the evolution of wage through time is also consistent with the hypothesis that municipalities with stronger ties to the U.S. economy experienced larger labor market adjustments. Both groups experienced a worsening in wages. However, while for the least dependent municipalities wage went from growing 0.7 percentage points to declining 2.7 percentage points, for the group below the 25<sup>th</sup> percentile wage went from growing 6.4 percentage points to declining by 11.2 percentage points. Although in no way conclusive, this preliminary evidence gives us some insight into the differential ways in which the U.S. crisis affected municipalities on different ends of the U.S. dependence spectrum.

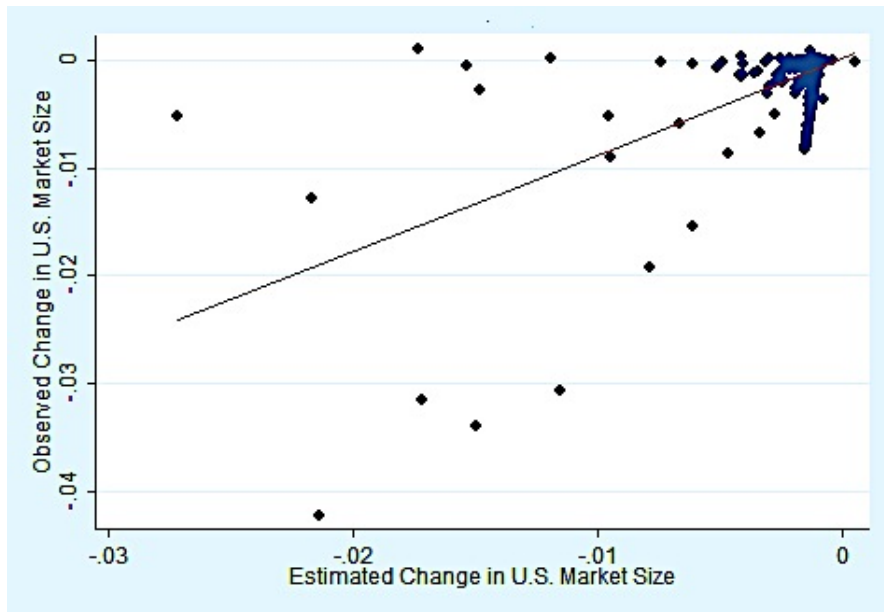
## 4.2 The Crisis Effect on Employment and Wages

This section presents the results of estimating equation (6) while using a two-year change (2007-2009) in total employment, employment share by industry, and the average wage as left hand side variables. I estimate equation (6) by two-stage least squares using  $\Delta USmkt_{0it}$  as an instrument for  $\Delta USmkt_{mit}$ . Figure 4 sketches the first-stage regression between the change in

estimated U.S. imports,  $\Delta \widehat{USmkt}_{mit}$ , and the change in observed U.S. imports,  $\Delta USmkt_{mit}$ , between 2007 and 2009.

The first-stage regression shows that there exists a strong and significant relationship between observed and estimated U.S. imports from Mexico, with an F-statistic of 22. Thus, having a weak instrument is not a concern.

Figure 4. First-Stage Regression



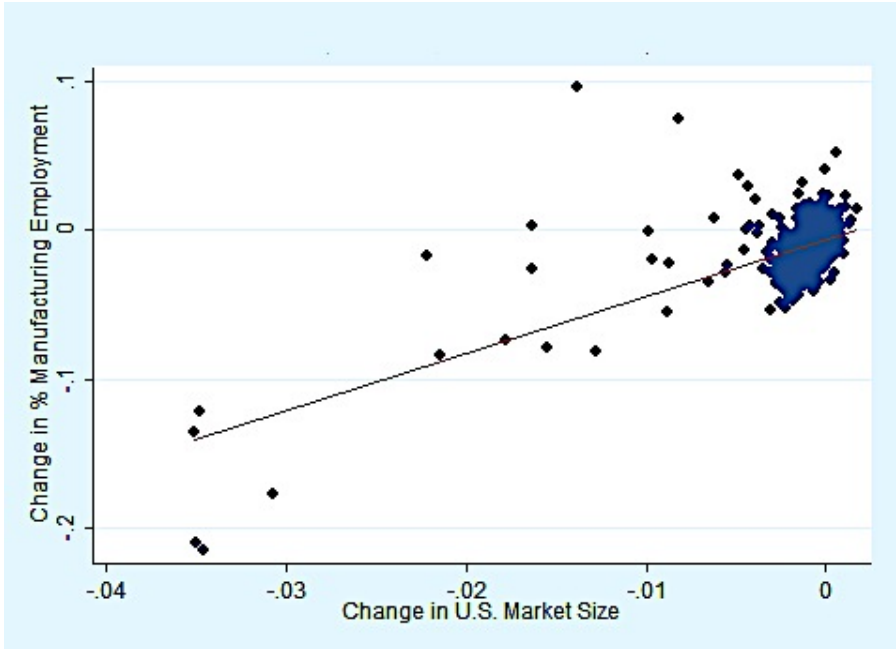
I first focus on the change in manufacturing employment during the Great Recession. A large share of the ties that have been built between the economies of Mexico and the U.S. are due to the growth of manufacturing trade volume, especially in the maquiladora sector. It is thus likely that, if Mexican municipalities with closer ties to the U.S. market were differentially affected during the crisis, this industry would experience a large and significant within-municipality adjustment. In order to test this I run equation (6) with  $\Delta y_{it}$  defined as the 2007-to-2009 change in the proportion of manufacturing employment in municipality  $i$ ;  $\Delta \widehat{USmkt}_{mit}$ , the main explanatory variable, and  $\Delta USmkt_{cit}$ , the estimated Chinese trade shock, are both also measured as 2007-to-2009 changes.

The coefficient of interest is  $\beta_1$ , which captures the effect that a 1-percentage-point change in the estimated ‘U.S. market share’ covered by Mexican municipality  $i$  would have on the proportion of manufacturing employment in that municipality. If the trade channel is relevant for transmitting shocks, then we would expect  $\beta_1 > 0$ , that is, U.S. imports from Mexico and the Mexican manufacturing sector move in the same direction. Also relevant is  $\beta_2$ , which captures the effect that a China-caused 1-percentage-point change in the estimated ‘U.S. market share’ of Mexican municipality  $i$  would have on that municipality’s manufacturing sector. If China has caused a diversion of trade between Mexico and the U.S. large enough to affect Mexican labor markets, then we would expect  $\beta_2 < 0$ , that is, U.S. import from China and the Mexican manufacturing sector move in opposite directions.

Table 3 presents two-stage least square and ordinary least square (OLS) estimates for the change in manufacturing employment in Mexican municipalities due to the change in the ‘U.S. market share’ variable. Columns 1 through 3 show the instrumental variable (IV) estimate with different control variables. In column 1 I estimate the effect by IV without any controls, and I obtain a  $\beta_1 = 1.56$  significant at a 1% level. Given that the within sample standard deviation of  $\Delta \widehat{USmkt}_{mit}$  is 0.008, this implies that a standard deviation decrease in the estimated ‘U.S. market share’ for Mexican municipality  $i$  would result in a decrease of 1.24 percentage points in manufacturing employment. In column 2, as I include the beginning of the period demographic and employment control variables, but without including the change in ‘U.S. market size’ due to China, the coefficient drops and loses all significance. However, under my preferred specification (column 3), the coefficient recovers significance at a 1% level and acquires a magnitude similar to the coefficient found under column 1. As comparison, column 4 shows the OLS estimate. The OLS coefficient is 32% smaller than the IV one, hinting at an attenuation bias. Figure 5 below sketches the specification under column 3, which includes initial period (2007) proportion of manufacturing employment, proportion of workers employed in the informal sector, proportion of female workers, and proportion of workers with a college degree.

Column 3 also shows a significantly negative  $\beta_2$ , confirming that during the crisis period Mexican manufacturing employment and U.S. imports from China moved in opposite directions. The interesting fact here is that, similarly to U.S. imports from Mexico, U.S. imports from China were also falling. Thus, it seems that during this difficult time for Mexican municipalities dependent on the U.S., the reduction in the presence of China in the U.S. market generated some form of relief, decreasing the differential negative effect with respect to less U.S. dependent municipalities.

Figure 5. Change in Manufacturing Employment, 2007-2009



Having established the effect that the demand shock to U.S. imports had on manufacturing employment in the average Mexican municipality, I now turn my attention to employment, both as proportion of working age population and as proportion of the total by selected non-manufacturing industry, and wages. If a country’s labor markets are not geographically integrated, fully competitive, and in continuous equilibrium, then shocks to local manufacturing employment may also differentially affect employment and wages in surrounding industries within the locality (Autor et al., 2013). The wage results from section 2.3 provided some

evidence of the slow rate at which Mexican labor markets converge to a new equilibrium after a shock. Thus, it would not be surprising to see some significant within-labor market adjustments following the shock to manufacturing industries. The rest of the analysis is done using the preferred specification from Table 3 (Column 3).

In Table 4 I present results obtained by estimating equation (6) with  $\Delta y_{it}$  defined as the 2007-to-2009 change in employment as proportion of working age population, employment by aggregated industry as proportion of the total, and average municipality wage. The purpose of analyzing these variables is two-fold. First, it allows us to estimate what the effect of the U.S. crisis was on key aggregated labor market outcomes by municipality, as are total employment and wages; and second, we can catch a glimpse of how municipalities adjusted to an unbalanced shock to their employment structure.

Column 1 in Table 4 presents the estimated effect of  $\Delta \widehat{USmkt}_{mit}$  on employment as share of working age population. The coefficient 0.496 is significant at the 5% level and implies that, on average, a decrease of one standard deviation in estimated ‘U.S. market size’ for municipality  $i$  would result in a 0.4 percentage-point decrease in the proportion of working age population who are employed. This represents 23% of the decrease observed by the average municipality.

In columns 2 through 7 I present the effect of the change in the estimated ‘U.S. market size’ on employment in a representative set of industries. The main take-out from these results is that, although the industry most directly affected by the demand shock was manufacturing, the two-year period between 2007 and 2009 was enough time for the employment structure within the municipality to readjust and display differential shifts with respect to less U.S. dependent Mexican municipalities. The significant reduction in manufacturing employment was corresponded with an increase in the employment share of the service industry and an even larger increase in the employment share of agriculture. It seems that a part of the drop in wages, presented in column 8, could be explained by this redistribution of employment from the manufacturing industry, which in heavily exporting regions tends to pay higher wages, to lower paying industries such as services and, especially, agriculture. I do not find a differential effect

of the shock on informal employment or any other industry outside of manufacturing, services, and agriculture.

Finally, column 8 presents the effect of the change in ‘U.S. market size’ on average municipality wage. The dependent variable is measured as the two-year change in the logarithm of weekly wage in the municipality. The coefficient 2.754, significant at the 10% level, implies that a decrease of one standard deviation in ‘U.S. market size’ would decrease weekly wages by 2.3 percentage points.

### 4.3 Before the Crisis

In order to verify the consistency of the results I use the preferred specification from column 3 in Table 5 to estimate the effect of the change in ‘U.S. market size’ on Mexican municipalities during the pre-crisis period. Table 5 presents results on employment and wages for the period between 2005 and 2007.

The defining characteristic of the results is that, across the board, I find only statistically insignificant estimates. It appears that in the two years before the crisis (2005-2007) economic events in the U.S. do not have a differential effect on Mexican municipalities more dependent on the U.S. market over municipalities more focused on the domestic market. Judging by the IV regression coefficients, the increase in U.S. imports from Mexico between 2005 and 2007 was not large enough to have spillovers on Mexican local economies more dependent on the U.S. market, which remarks the magnitude of the Great Recession, which created large and significant differential effect on Mexican municipalities with different levels of dependence on the U.S. market. The lack of significant results before the crisis could also be due to the scale and velocity of the increase in U.S. imports. While between 2000 and 2007 U.S. imports from Mexico increased by approximately \$50 billion, it took only two years for them to drop \$40 billion. Thus, it is not surprising that the latter drop had a much stronger effect on the Mexican economy.

Another plausible reason the ‘before crisis’ increase in U.S. imports did not have a positive effect on Mexican municipalities more dependent on the U.S. market is the level of concentration in the increase of ‘U.S. market size’ in Mexican municipalities. As mentioned in the ‘Summary Statistics’ section, 11% of all municipalities above the 75<sup>th</sup> percentile (approximately 12 municipalities) captured 94% of the increase in ‘U.S. market size’, as compared to, those same municipalities, only capturing 48% of the decrease in ‘U.S. market size’ during the crisis.

## 5. Conclusion

In this paper I study the spread of the U.S. credit crisis to Mexican local labor markets, explicitly identifying the role that trade played in the transmission of the negative shock across the two countries. To identify the trade channel empirically, I exploit the variation in dependence on the U.S. market displayed by Mexican local labor markets. The economic opening process Mexico started in the mid-1980s when it became a member of the GATT, and then reinforced in 1994 when NAFTA was enacted, has created a strong link between the business cycles of Mexico and the United States. This trade-driven phenomenon has had significant consequences for Mexico’s economic geography. In particular, easier access to the U.S. market increased the level of dependence on exports to the U.S. for some Mexican municipalities. This increase in dependence was not homogenous throughout the country, mostly due to differences by municipality in transportation costs and industry specialization. This heterogeneity, plus the evolution of U.S. trade during the Great Recession (2007-2009), which involved a \$40 billion drop in U.S. imports from Mexico, allows me to identify the role that these trade linkages played in the transmission of the crisis to Mexican local labor markets. I show that differences in manufacturing industry structure caused by Mexico's opening process have made a subset of Mexican municipalities especially vulnerable to economic events in the U.S. I find that Mexican municipalities that exported relatively more to the U.S. experienced large and significant differential effects when compared to municipalities more focused on the domestic market. Mexican regions with significant ties to the U.S. market experienced, during the crisis, a significantly larger decrease in employment and wages, and greater within local

labor market adjustments than their less open counterparts, mainly characterized by a large drop in manufacturing employment and increase in the proportion of workers employed in services and agriculture.



## References

Autor, David, David Dorn, and Gordon Hanson, “The China Syndrome: Local Labor Market Effects of Import Competition in the United States.” *The American Economic Review*, American Economic Association, vol. 103(6), pages 2121-68, October 2013.

Baldwin, Richard (editor). “The Great Trade Collapse: Causes, Consequences and Prospects.” *The Graduate Institute, Geneva*. A VoxEU.org Publication. 2009.

Bergin, Paul, Robert Feenstra, Gordon Hanson. “Offshoring and Volatility: Evidence from Mexico’s Maquiladora Industry.” *The American Economic Review*, 99: 1664-1671, 2009.

Burfisher, Mary, Sherman Robinson, Karen Thierfelder. “The Impact of NAFTA on the United States.” *The Journal of Economic Perspectives*, 15: 125-144, 2001.

Chiquiar, Daniel, Manuel Ramos-Francia. “Trade and Business-Cycle Synchronization: Evidence From Mexican and U.S. Manufacturing Industries.” *North American Journal of Economics and Finance*, 16: 187-216, 2005.

Cuevas, Alfredo, Miguel Messmacher, Alejandro Werner. “Macroeconomic Synchronization Between Mexico and Its NAFTA Partners.” *Bank of Mexico Working Paper*, 2002.

Esquivel, Gerardo, Jos Antonio Rodríguez-López. “Technology, Trade, and Wage Inequality in Mexico Before and After NAFTA.” *Journal of Development Economics*, 72: 543-565, 2003.

Feenstra, Robert, Gordon Hanson. “Foreign Direct Investment and Relative Wages: Evidence from Mexico’s Maquiladoras.” *Journal of International Economics*, 42: 371-393, May 1997.

Frankel, J. A. and Rose, A. K. “The Endogeneity of the Optimum Currency Area Criteria.” *The Economic Journal*, 108(449):1009-1025. 1998.

Hanson, Gordon. "Economic Integration, Intraindustry Trade, and Frontier Regions." *European Economic Review*, 40: 941-949, 1996.

Hanson, Gordon. "Increasing Returns, Trade, and the Regional Structure of Wages." *The Economic Journal*, 107: 113-133, 2011.

Hanson, Gordon. "U.S.-Mexico Integration and Regional Economies: Evidence From Border-City Pairs." *Journal of Urban Economics*, 50: 259-287, 2001.

Hanson, Gordon. "Labor-Market Adjustment in Open Economies: Evidence From U.S. States." *Journal of International Economics*, 57: 3-29, 2002

Instituto Nacional de Estadística, Geografía e Informática, "Delimitación de las Zonas Metropolitanas de México 2005." 2008.

Instituto Nacional de Estadística, Geografía e Informática. "Estadísticas del Comercio Exterior de México, 2012." *Estudios del INEGI*, 2012.

Kaminsky, G. L. and Reinhart, C. M. "On crisis, contagion, and confusion." *Journal of International Economics*. 51:145-168. 2000.

Robertson, Raymond. "Wage Shocks and North American Labor-Market Integration." *The American Economic Review*, 90: 742-764, 2000.

Robertson, Raymond, Donald Dutkowsky. "Labor Adjustment Costs in a Destination Country: The Case of Mexico." *Journal of Development Economics*, 67: 29-54, 2002.

Robertson, Raymond. "Trade and Wages: Two Puzzles from Mexico." *The World Economy*, 2003.

Stumpner, Sebastian. "Trade and the Geographic Spread of the Great Recession." *Working Paper*. 2014.

Torres, Alberto, Oscar Vela. "Trade Integration and Synchronization Between the Business Cycle of Mexico and the United States." *The North American Journal of Economics and Finance*, 14: 319-342, 2003.

## 6. Tables

	IV(1). Employment	IV(2). Manufacturing Emp	IV(3). Log Wage
$\Delta$ USmkt (US-China)	-0.1785 (0.1202)	-0.8527** (0.2706)	-2.1660** (0.7537)
$R^2$	0.0077	0.0385	0.0862
$N$	635	635	635

All regressions include a constant. SE are clustered on municipality. Models are unweighted and include, as controls, 2005 proportion of workers with college, share of female workers, and informal employment as proportion of the total. +  $p < 0.1$ ; \*  $p < 0.05$ ; \*\*  $p < 0.01$

	Before Crisis: 2005-2007		During Crisis: 2007-2009	
	< 25th	> 75th	< 25th	> 75th
$\Delta$ USmkt percentile				
$\Delta$ Employment	-0.006	-0.002	-0.021	-0.018
$\Delta$ Manufactures	-0.001	-0.008	-0.029	0.003
$\Delta$ Services	0.003	0.018	0.017	-0.002
$\Delta$ Agriculture	-0.02	-0.001	0.013	-0.002
$\Delta$ Construction	0.012	0.005	-0.005	0.001
$\Delta$ Log. Wage	0.007	0.064	-0.112	-0.027
$N$	173	173	170	170

Unweighted average changes.

Table 3. Change in Potential US market size and Manufacturing Employment in Municipalities, 2007-2009

	IV(1)	IV(2)	IV(3)	OLS
$\Delta$ USmkt (US-Mex)	1.558 (0.482)**	0.428 -0.522	1.552 (0.523)**	1.065 (0.329)**
L. % Emp Manuf		-0.317 (0.037)**	-0.303 (0.036)**	-0.31 (0.036)**
L. % Informal		0.04 (0.03)	0.037 (0.03)	0.041 (0.03)
L. % Female		-0.018 (0.054)	-0.012 (0.054)	-0.011 (0.054)
L. % College		0.037 (0.029)	0.039 (0.029)	0.04 (0.029)
$\Delta$ USmkt (US-China)			-2.046 (0.710)**	-1.923 (0.652)**
$R^2$	0.03	0.21	0.23	0.23
$N$	678	678	678	678

All regressions include a constant. SE are clustered on municipality. Models are unweighted. Proportion of manufacturing employment, share of workers with college, share of female workers, and informal employment as proportion of the total are all measured in 2007. +  $p < 0.1$ ; \*  $p < 0.05$ ; \*\*  $p < 0.01$

Table 4. Effect of Change in U.S. Market Size on Employment, Employment by Industry and Avg. Wages in Municipalities, 2007-2009

	Dependent Variable: Share Change							
	Employment (I)	Service Emp (II)	Agricultura l Emp (III)	Constructio n Emp (IV)	Informal Emp (V)	Commerce Emp (VI)	NILF (VII)	Log Wage (VIII)
$\Delta$ USmkt (US-Mex)	0.496 (0.253)*	-0.996 (0.580)+	-2.068 (0.904)*	1.209 (1.363)	1.982 (1.616)	-0.361 (0.365)	1.547 (1.749)	2.754 (1.515)+
$R^2$	0.17	0.07	0.03	0.08	0.17	0.01	0.04	0.05
$N$	678	678	678	678	678	678	678	678

All regressions include a constant. SE are clustered on municipality. Models are unweighted and include, as controls, 2007 proportion of manufacturing employment, share of workers with college, share of female workers, and informal employment as proportion of the total. +  $p < 0.1$ ; \*  $p < 0.05$ ; \*\*  $p < 0.01$

Table 5. Effect of Change in U.S. Market Size on Employment, Employment by Industry and Avg. Wages in Municipalities, 2005-2007

	Dependent Variable: Share Change							
	Emp (I)	Manufacturing Emp (II)	Service Emp (III)	Agricultural Emp (IV)	Construction Emp (V)	Commerce Emp (VI)	Informal Emp (VII)	Log Wage (VIII)
$\Delta$ USmkt (US-Mex)	-0.0336	-2.9163	3.3576	0.1777	2.0369	-1.6001	2.757	1.6984
	(0.83)	(3.5632)	(2.8704)	(1.161)	(1.9777)	(2.2068)	(3.6311)	(2.0172)
$\Delta$ USmkt (US-China)	-0.2135	-0.2085	0.3447	0.8637+	0.6338	-0.3844	0.7426	-3.4493+
	(0.2818)	(1.1627)	(1.0326)	(0.5006)	(0.6985)	(0.7263)	(1.2029)	(1.9644)
$R^2$	0.3303	0.2152	0.0171	0.0765	0.0091	0.0147	0.1949	0.0793
$N$	693	693	693	693	693	693	693	693

All regressions include a constant. SE are clustered on municipality. Models are unweighted and include, as control, 2005 proportion of manufacturing employment, share of workers with college, share of female workers, and informal employment as proportion of the total. +  $p < 0.1$ ; \*  $p < 0.05$ ; \*\*  $p < 0.01$