Employment and Wage Responses to Trade Shocks:

Evidence from Mexico during the 2008-09 U.S. Recession

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Abstract: During the "Great Trade Collapse" of 2008, Mexico's trade with the U.S. fell nearly 45 percent. The severity and suddenness of this unfortunate external shock for Mexico provides a natural experiment to assess the effect of trade shocks on labor market outcomes in a developing economy. Our analysis of Mexico's social security records suggests that, contrary to many other studies, employment is more responsive to trade shocks than wages (at least in the short run). Formal employment in the trade-intensive northern states fell more than 9 percent from September 2008 to March 2009, while the average change in the log real wage of workers who stayed at the same firm between quarters was 0.030 and 0.018 in the first and second quarters of 2008 respectively and -0.001 and -0.012 in the third and fourth quarters respectively. The authors develop a new measure of industry relatedness to analyze how the shocks are spread through the economy, both across industries and over time, and find evidence suggesting that trade shocks spread through output linkages rather than through worker mobility.

Key words: trade shocks, labor market dynamics, adjustment costs

JEL codes: F16, J63, J31

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1. Introduction

The labor-market effects of globalization have inspired a large, growing, and controversial literature.[1] Controversy in the literature spans several debates, including whether prices or quantities are the relevant metric for globalization (Richardson 1995), the effects of vertical integration (Feenstra and Hanson 1997), the importance of firm-level heterogeneity (Melitz 2003), and the role of labor-market adjustment costs (dynamics) in trade theorems and empirics (Artuc et al. 2007 and 2010, Davidson et al. 2008, Dix-Carneiro 2010, Felbermayr et al. 2011, and Helpman 2010). Nearly all of these papers implicitly or explicitly define globalization as trade liberalization, such as falling tariffs or other trade barriers that might change relative prices, and therefore make predictions that might be most relevant for the long run.

Given that most developing-country liberalization occurred in the 1990s, however, popular concerns about globalization are shifting towards a heightened exposure to short-run international shocks, especially in developing countries (Bergin et al. 2009, Jansen and von Uexkull 2010). Verhoogen (2008), in particular, found that the 1994 Mexican peso crisis significantly affected wages and employment. The effects of international shocks on the labor market depend critically on how the shock is transmitted from trade flows to the rest of the economy. It is therefore surprising that few papers, if any, empirically analyze how these short-run shocks spread from trade-related industries to the rest of the economy in developing countries. Two reasons for this gap include the difficultly of identifying exogenous short-run (but large in magnitude) shocks and the availability of matched worker-firm data that are considered to be essential by the papers cited above.

[1] Surveys by Winters et al. (2004), Hoekman and Winters (2005), and Goldberg and Pavcnick (2007) highlight the importance and size of the literature.

Our paper contributes to this literature in three ways. First, we take advantage of the global financial crisis as an exogenous short-run shock (we support the claim of exogeneity in section 2) and examine the effects of this shock on the labor market in northern Mexico. Since the early 1970s, northern Mexico has hosted *maquiladora* plants that produce primarily for export, and these plants continue to characterize economic activity in the region. Therefore, our focus on northern Mexico provides a unique opportunity to examine the effects of trade shocks on workers in a vertically-intergrated "trade-in-tasks" environment (Baldwin and Robert-Nicoud 2010) that increasingly characterizes the globalization experience of developing countries (Robertson et al. 2009). Bergin et al. 2009, for example, highlight the value of focusing on this region as an example of the transmission of shocks across countries.

Our second contribution is that we use a unique matched worker-firm dataset that allows us to control for individual worker characteristics as they move between firms. In the presence of heterogeneous firms and assortative matching, matched worker-firm data are required to control for worker, firm, and match heterogeneity that has been shown to have significant effects on wages, employment, and inequality (Davidson et al. 2010, and Helpman et al. 2010). Our unique data set of quarterly observations is particularly well suited to capture these leads and lags in response to the sudden reduction in U.S. demand after September 2008. It also allows us to examine the changes in the employment composition (the mix of skilled and less skilled workers) that is featured in this literature.

Consistent with the spirit of these papers, we compare price (wages) and quantity (employment) responses to short-run trade shocks with a particular focus on within-industry adjustment. This distinction is very important for understanding not only how globalization affects workers, but for policy as well. If the short-run effects differ from expected long-run

effects, then the appropriate policy response may differ as well. Programs like unemployment insurance might be better suited to deal with short-term problems, whereas long-term effects such as a permanent increase in the demand for skill might be better addressed through education and training programs. In any case, studies attempting to empirically evaluate a given long-run framework might find less support for those models than they deserve if the variation in trade variables observed in the data is of a more transitory nature.

The data we use in this paper also allow us to examine the dynamic labor market responses of short-run international shocks. While imports and exports may not be appropriate proxies for the long-run price-based trade liberalization modeled in theory (Richardson 1995), short-run shocks are more likely to be accurately captured by exports and imports. We show that the financial crisis had more significant effects on quantities than prices. We then examine the effects of imports and exports with different lag structures. Vertical integration has implications for the timing of the effects of imports and exports that would be consistent with a "time to build" style model[2] in the sense that when imports are primarily intermediate inputs, they lead employment and wage changes. Likewise, when exports are primarily assembled from intermediate inputs, they lag employment and wage changes.

Our third contribution is the development and implementation of a new measure of "relatedness" that we use to analyze how a trade shock affecting a particular industry is spread to other industries. Firms are linked across industries through both output and input markets. The degree of worker mobility is at the heart of two other recent papers. Using U.S. data, Ebenstein et al. (2009) show that wage effects tend to be insignificant whilst employment effects appear easier to identify. They base their explanation on the assumption that inter-occupational labor

[2] Kydland and Prescott (1982) made this concept famous in their analysis of real business cycles. Other than the concept of the importance of production-induced lags and leads, our paper bears little resemblance to theirs.

mobility is lower than inter-industry labor mobility, suggesting that trade effects on wages are estimated with less attenuation within occupations than within industries. Galiani and Porto (2010) focus on industry-specific rigidities arising from variations in unionization across industries. They show that it is theoretically plausible that a given trade shock will have different wage effects across industries and across types of workers and therefore hiring and wage-setting frictions can affect the results. Comparing our Mexican results with other empirical papers that incorporate adjustment costs from developed countries stands to be informative, given that *de facto* labor market adjustment costs in Mexico are an order of magnitude smaller than in the United States (Robertson and Dutkowsky 2002).

The main findings of the paper can be summarized as follows. First, the labor market mainly responded to the negative trade shock by reducing employment levels, although we also find statistically significant effects on wages. Second, the results suggest that dynamics matter. Consistent with the "time to build" concept, imports lead employment and wage changes. Exports on the other hand, which are primarily assembled from intermediate inputs, lag employment and wage changes. Third, we find evidence suggesting that the employment changes favored skilled workers during the short-run, which is not consistent with the long-run complementarity of exporting and skill found in other papers, but is consistent with previous findings suggesting that skilled workers have higher short-run adjustment costs.

Finally, we find that trade shocks to related industries (those industries to which the workers are likely to move in the future) have effects that are similar in sign and in magnitude to own-industry shocks. These results are consistent with a transmission of shocks through output, rather than input (labor), markets and are robust to controls for general demand-side shocks.

The rest of the paper is organized as follows. Section 2 describes the trade shock and the general trends in wages and employment in Northern Mexico. Section 3 describes the labor market data. Section 4 discusses our two empirical strategies for identifying the effects of trade fluctuations on employment and wages, including a novel concept of inter-industry "relatedness" that we use to explore the effect of inter-sector labor mobility on the estimation of the employment and wage functions. Section 5 presents the econometric results, and Section 6 concludes by summarizing the main findings and lays out a future agenda on trade and labor that would consider both leads and lags in empirical models of labor-market outcomes as well as labor mobility across industries.

2. The Great Trade Collapse and U.S.-Mexican Trade

The Great Trade Collapse has received a great deal of attention both in the academic literature and popular press. The collection of essays published in Baldwin (2009) suggest the "Great Trade Collapse" between the third quarter of 2008 and the second quarter of 2009 was primarily a demand-side shock induced in large part by European Union and U.S. firms and consumers postponing purchases of consumer durables and investment goods. Eaton et al. (2009) estimate that changes in demand for manufactured goods accounted for about 70 percent of the global decline in the incidence of international trade over Gross Domestic Product (GDP). These authors cite the World Trade Organization's estimate that merchandise trade dropped by 23 percent in 2009 relative to the previous year—the largest drop in trade by a factor of four since World War II.

The impact of the trade collapse was especially acute in Mexico. The decline in Mexican trade was highly correlated with the decline in U.S. GDP (Robertson 2009). Our data show that

formal employment in the trade-intensive northern states fell more than 9 percent from September 2008 to March 2009. Real log wages of workers who did not lose their jobs (stayed with the same firm) fell on average by 0.001 log points from September 2008 to December 2008 and by 0.012 log points from December 2008 to March 2009. As exports and imports with the United States began to recover in the second quarter of 2009, employment and wages recovered as well. Since this shock originated outside of Mexico, and there have been few, if any, suggestions that factors within Mexico induced the crisis, we consider the shock to be reasonably exogenous from Mexico's point of view.

Figure 1 shows total Mexican imports and exports for the 2000-2010 period using data from Mexico's National Institute of Geography, Informatics, and Statistics (INEGI). The effect of the 2008 crisis on trade flows is clear. Between the local peak (around April 2008) and the trough (January 2009) Mexican trade fell about 43% in real terms. The drop erased nearly a decade of trade growth in a few months. Figure 1 also shows a relatively quick recovery.

Figure 1 also shows that the very close relationship between Mexican imports and exports is not a new phenomenon. The close relationship between imports and exports is characteristic of a vertically-integrated economy that is heavily engaged in processing activities.

Mexico's significant engagement in processing has traditionally been tied to Mexico's close economic relationship with the United States. Over the past ten years, however, Mexico's trade has been diversifying away from the United States. Figure 2, for example, shows a declining trend in the U.S. share of both Mexico's imports and exports. While over 80% of Mexico's non-petroleum exports continue to go to the United States, non-petroleum imports from the United States fall from over 70% at the beginning of the decade to less than 50%. The crisis, however, does not seem to have affected the share of Mexico's trade with the United States other

than to possibly stabilize the values. This is important for the analysis that follows because it suggests that trade with the United States is a reasonable proxy for total Mexican trade because there does not seem to be a great deal of inter-country substitution as a result of the crisis.

The *change* in trade flows varied significantly across industries during the crisis. Using Harmonized System 6-digit industries, Figure 3 shows the distribution of the change in imports and exports between April 2008 and January 2009. The average change (difference in log values) in Mexican exports to the United States was about 42%. The standard deviation was nearly 1.14. The mean change in Mexican imports from the United States was smaller—about a 17% drop—but the standard deviation was larger - just over 1.18. We take advantage of the differences in the changes in trade across industries to analyze how the trade shock begins as an industry-specific shock and then ripples through the labor market.

The shock also seemed to affect the quantities of traded goods more than prices. We calculated the coefficient of variation across both unit values and quantities for all available products across the 24 months in 2008 and 2009 traded between the United States and Mexico, combining changes along the extensive and intensive margins.[3] The median coefficient of variation for imports was 0.49 for quantities and 0.22 for unit values. The comparable values for exports were 0.59 and 0.26. Given that the shock to Mexico was primarily through demand, these numbers are consistent with a relatively elastic supply curve. In a small-country trade-in-tasks environment, it might not be surprising that U.S. firms would cut quantity first as a short-run response to the shock.

3. Data

[3] Product-month observations with zero trade values or missing data were not used to compute the variation coefficients.

The empirics require trade data and labor-market data, and we discuss each below.

3.a. Trade Data

The bilateral monthly trade data used for the econometric models originate from U.S. customs records. They were collected by the World Bank's Trade and Integration research unit from the United States International Trade Commission's data web interface. The monthly data were then summed over quarters. The industry classification system originating from the trade data (6-digit level of the Harmonized System (HS)) differs significantly from the industry classification system from the Mexican wage and employment data described below. We therefore constructed an industry classification concordance table to match the employment and wage data from the Mexican social security records with the U.S.-Mexico bilateral trade data. The resulting data set covers 105 tradable industries and one non-tradable industry, which covers all workers who were employed in industries that could not be matched to the trade data by HS industries. Examples of the 105 tradable industries include beer, sugar, prepared vegetables, plasters, cement, and industrial chemicals. An important feature of this level of aggregation is that it is probably not sufficient to exclude products that are used as inputs for the production of final goods within a given industry category. Consequently imports in each industry include imported inputs, which are likely to be complementary with labor.

3.b. Employment and Wage Data

The wage and employment information come from Mexico's confidential social security records maintained by the *Instituto Mexicano del Seguro Social* (IMSS) in Mexico City. The IMSS gathers data from all plants (establishments) on wages paid to each registered employee.

We use these data to calculate total employment by industry and we work with end-of-quarter data on employment and wages from 2007-2009. The frequency and end-of-period feature of the data have implications for interpretation and model specification, which are discussed further below. Overall, the data set covers between 3.6 and 4.2 million workers from the Mexican states that share a border with the United States.

In order to produce a data set that did not violate the confidentiality of the information, IMSS staff provided data on worker-firm pairs. That is, we received data on the employment and wage history of a person while he or she remained at the same firm. If a person moves to a new firm, the new worker-firm pair is coded with an entirely new identifier. We cannot, for example, follow a person over time when she changes firms. We also do not know if two people are working in the same firm. To compensate for our inability to follow workers when they leave their firms, IMSS also provided us with industry-level calculations of transition probabilities, which we use to calculate the degree to which industries are related to each other. These transition probabilities were calculated using the entire country, not just data from the states that border the United States, and therefore provide a more robust indicator of inter-industry mobility.

The resulting data can be used to illustrate the relationship between Mexico-U.S. trade and employment in Northern Mexico during 2007-2009, and the resulting trends provide strong motivations for the discussion of the empirical strategies. Figure 4 shows the quarterly data on total employment in tradable industries (i.e., those industries for which we found a match with the trade data under the HS classification) and Mexican exports to the United States. A positive correlation appears very strong during the period 2007q3-2009q1. Figure 5 plots the same export series together with total employment in non-tradable industries. Surprisingly, the correlation

between exports and employment in non-tradables appears to be even stronger, especially during non-crisis periods, although it is also strong during the crisis. We interpret this surprising finding as suggestive evidence that trade shocks affect employment decisions in industries that are not necessarily directly engaged in trade, which lends further credence to the idea that inter-industry labor mobility or other inter-industry linkages can play an important role in determining the empirical correlation between labor-market outcomes and trade.

During the crisis period, however, tradable-sector employment fell proportionately more than employment in non-tradable industries, as shown in Figure 6. Despite the important differences in magnitudes, changes in employment in tradable and non-tradable industries are also highly correlated. Figure 7a shows trends in real log wage changes for tradable and non-tradable industries for workers that remained with their employers for consecutive quarters (i.e., the changes in wages control for firm-worker fixed effects). These two series appear even more correlated than the employment series.

The correlation between traded and non-traded sectors (in both employment and wages) raises the possibility of two (not mutually exclusive) hypotheses: trade shocks can affect industries that are not directly exposed to trade (through input or output linkages) or the correlation is driven by common shocks (such as interest rate variations, remittances, or any other shocks that could have similar effects across all industries). We evaluate these hypotheses below by controlling for common shocks and differentiating between input and output linkages.

As a way of showing the importance of controlling for firm-worker fixed effects, Figure 7b presents the changes in the average log wage using all workers. The fact that figures 7a and 7b appear so different indicates that compositional changes are also taking place. That is, the trade shocks we are studying in this paper are not only affecting the employment levels, but also

the types of workers who are employed in these industries. For example, the fact that wages in tradable sectors fell in the fourth quarter of 2008 for stayers even though average log wages rose suggests that the tradable sectors laid off the lower-wage workers between the third and fourth quarters of 2008. We continue to examine these compositional changes below.

4. Empirics and Identification

The literature that focuses on the effects of globalization on labor markets has identified many estimation issues that are relevant for our analysis. First, Richardson (1995) argues that the relevant metric for globalization is prices, not quantities (such as imports and exports) because imports are subject to changes in domestic demand or domestic productivity shocks (endogeneity).

We use quantities in our analysis for several reasons. First, we are dealing with essentially a macroeconomic shock rather than a change in tariffs that would change relative prices. Second, in a small-country vertically-integrated environment such as ours, quantities may be the more relevant adjustment margin. The fact that quantities changed significantly more than prices supports this approach.

As argued above, we are also not worried about endogeneity because the sudden and the severe decline in bilateral trade between the United States and Mexico supports the view that the trade collapse was driven by demand conditions in the United States. Nevertheless, one of our empirical approaches provides some additional support for the idea that the observed fluctuations in bilateral trade between the last quarter of 2008 and the first quarter of 2009 had effects on formal-labor market outcomes in Northern Mexico relative to what would have been expected from industry-specific trends.

Third, imports are generally considered to have adverse effects on wages and employment. Again, this assumption may not hold in the "trade-in-tasks" environment where imports are significantly comprised of intermediate inputs. We therefore remain open to the possibility of positive effects of imports. Fourth, estimates can be sensitive to the lag structure specified in the model. We therefore incorporate a general lag structure in our estimation. Finally, labor mobility across industries may attenuate estimated wage effects (Ebenstein et al. 2009) and is costly (Artuc et al. 2007a and 2010, Felbermayr et al. 2011, Davidson et al. 2008, and Helpman 2010). Our new measure of relatedness specifically addresses labor mobility concerns, and is described in detail in 4.c. In section 4.d. we describe how we further disaggregate by examining changes in the composition of workers in response to shocks.

We proceed in stages. First, we focus on employment effects within industries. To some extent, this approach follows the existing literature on trade and labor by including industry fixed effects. However, we also experiment with lag structures that may identify time-to-build effects. Second, we estimate wage equations, which also follow standard specifications and also with time-to-build effects. We also estimate equations in which the dependent variable measures how the composition of workers changes in response to trade shocks. Third, we contribute to the existing literature by proposing a new metric of labor relatedness across industries. Finally, we evaluate robustness with what can be called "continuous treatment effects" estimations, which essentially allow us to derive conclusions about whether the trade collapse of 2008-09 can be interpreted as exogenous.

4.a. Employment effects within industries

The basic employment equation to be estimated can be formalized as follows:

(1) $E_{i,t} = \beta_m \cdot m_{i,t} + \beta_x \cdot x_{i,t} + \alpha_i + \gamma_t + \varepsilon_{i,t}$.

The subscripts represent industries and time periods. *E* is the log of employment in industry *i* at the end of quarter *t*, *m* is the log of that industry's imports from the United States, and *x* is the log of Mexican exports of that industry to the United States. The inclusion of industry fixed effects, α_i, makes this model a typical within-industry model. The time-period specific fixed effect, γ_t, acquires particular importance in our application, because common effects across industries are especially important for identifying the effects of trade shocks in the context of a broader macroeconomic shock. The parameters β_m and β_x are the elasticities of interest. If imports are complementary inputs to labor, that is, if both are needed to produce a unit of a final good, then $\beta_m > 0$ and $\beta_x > 0$. The error term $\varepsilon_{i,t}$ is assumed to be the standard regression error that is uncorrelated with the independent variables.[4]

The time-to-build specification of the model can be written as:

(2) $E_{i,t} = \beta_m \cdot m_{i,t} + \beta_x \cdot x_{i,t} + \beta_{m2} \cdot m_{i,t+1} + \beta_{x2} \cdot x_{i,t+1} + \alpha_i + \gamma_t + \varepsilon_{i,t}$,

where the inclusion of exports one period ahead captures the time lag in the realization of exports. The inclusion of one-period-ahead imports toughens the test of the time-to-build model, because evidence in favor of the model requires that $\beta_{x2} > 0$ with $\beta_{m2} = 0$.

In practice, both models are estimated in differences to take out the industry fixed effects. The final time-to-build specification is thus:

(3) $\Delta E_{i,t} = \beta_m \cdot \Delta m_{i,t} + \beta_x \cdot \Delta x_{i,t} + \beta_{m2} \cdot \Delta m_{i,t+1} + \beta_{x2} \cdot \Delta x_{i,t+1} + \gamma_t + \Delta \varepsilon_{i,t}$.

An augmented specification that includes "related-industry" effects are discussed further below.

4.b. Wages within industries

4 We do, however, calculate the standard errors of our coefficients allowing for the possibility that the errors within an industry are arbitrarily correlated with each other over time (serial correlation) using the "cluster" option in Stata.

The models used to estimate the wage effects of trade mimic the employment equations (1) - (3) presented above. As mentioned, however, it is important to control for firm-worker specific effects in the wage equation in order to be sure that the estimates are not affected by selectivity biases. Therefore the approach to estimating the wage effects follows two stages. The first strips out the match fixed effect using an underlying first-stage wage model:

(4) $w_{f,w,i,t} = \gamma_{i,t} + \theta_{w,f} + \varepsilon_{f,w,i,t}$.

The dependent variable was the log of wages of a worker *w*, in firm *f*, industry *i*, at time *t*. The first term on the right-hand side is the industry-time effect that we are interested in studying in the second stage. The second term is the worker-firm specific effect. By estimating (4) in differences, this second term disappeared and the resulting model was:

(5) $\Delta w_{f,w,i,t} = \gamma_{i,t} + \Delta\varepsilon_{f,w,i,t}$.

In this case, $\gamma_{i,t}$ is the estimated average change in log wages for all workers that did not lose their jobs in industry *i* between *t* and *t-1*.

Therefore the second stage estimation of the trade effects on wages within industries is:

(6) $\gamma_{i,t} = \beta_m \cdot \Delta m_{i,t} + \beta_x \cdot \Delta x_{i,t} + \beta_{m2} \cdot \Delta m_{i,t+1} + \beta_{x2} \cdot \Delta x_{i,t+1} + \gamma_t + \Delta\varepsilon_{i,t}$.

One concern about this model is that the dependent variable is an estimate, not a precise statistic. Consequently, we estimated (6) with Weighted Least Squares, with the weights for each observation being the initial levels of employment. In addition, we used the inverse of the first-stage standard error of $\gamma_{i,t}$ as weights, and the results were virtually identical, because the standard errors of $\gamma_{i,t}$ are negatively correlated with the size of the industry. For the sake of brevity, the results reported below are limited to the WLS estimates with initial employment as weights, but the results with the standard errors as weights are available upon request.

4.c. Inter-industry "Related" Employment

The empirical models of employment and wages can be augmented to address concerns about labor mobility. The additional explanatory variables need to satisfy two conditions. First, they need to capture the trade shocks affecting industries that employ similar workers, and second, they need to weigh these trade shocks in other industries by the extent to which workers move between industries. We propose the following "relatedness" indices for imports and exports that satisfy both conditions:

(7) $I_{i,t}^{m} \equiv \frac{\sum l_{j \neq i} \cdot m_{j,t}}{L_i}$, and

(8) $I_{i,t}^{x} \equiv \frac{\sum l_{j \neq i} \cdot j}{L_i}$,

where superscripts *m* and *x* denote the indices for imports and exports respectively. Denote *l* as the number of workers (in all of Mexico) employed in industry *i* at time *t*, but that were also employed in any other industry *j* during 2008-09. Intuitively, these indices are equal to the weighted average of "related" imports and exports in each time period, and the weights are the share of workers employed in industry *i* but who also were employed in any other industry *j* during 2008 and 2009.[5]

Since we cannot track workers over time when they change firms (due to confidentiality concerns), these industry-level "transition probabilities" were calculated separately by IMSS staff. It is also noteworthy that industries j can include non-tradable industries, in which case the value of imports and exports would be equal to zero (we set the log of exports or imports equal to zero in these cases). Hence the variance of these indices is lower than the variance of industry-specific trade flows. The variance of these indices is also lower because they are averages across

[5] Econometric results using employment data from 1997-9 were strikingly similar to those reported below, thus suggesting that endogeneity in labor mobility across industries during the period under examination is not a serious problem.

numerous sectors. This feature of the indices is important for interpreting the economic magnitude of the coefficients. The augmented employment and wage equations in differences (within industries) in the time-to-build specification that take into account the indirect effect of trade shocks on workers via their effects through related industries are:

$$\Delta E_{i,t} = \beta_m \cdot \Delta m_{i,t} + \beta_x \cdot \Delta x_{i,t} + \beta_{m2} \cdot \Delta m_{i,t+1} + \beta_{x2} \cdot \Delta x_{i,t+1} + \beta_{Im} \cdot \Delta I^m_{i,t} + \beta_{Ix} \cdot \Delta I^x_{i,t} + \beta_{Im2} \cdot \Delta I^m_{i,t+1} + \beta_{Ix2} \cdot \Delta I^x_{i,t+1} + \gamma_t + \Delta\varepsilon_{i,t}, \quad (9)$$

and

$$\Delta w_{i,t} = \beta_m \cdot \Delta m_{i,t} + \beta_x \cdot \Delta x_{i,t} + \beta_{m2} \cdot \Delta m_{i,t+1} + \beta_{x2} \cdot \Delta x_{i,t+1} + \beta_{Im} \cdot \Delta I^m_{i,t} + \beta_{Ix} \cdot \Delta I^x_{i,t} + \beta_{Im2} \cdot \Delta I^m_{i,t+1} + \beta_{Ix2} \cdot \Delta I^x_{i,t+1} + \gamma_t + \Delta\varepsilon_{i,t}. \quad (10)$$

The coefficients on the "related" trade flows can theoretically have positive or negative signs, depending on the economic nature of the mobility of labor across industries. On the one hand, related employment across industries can be due to worker characteristics, such as occupations, that are employed in different industries. If workers move between such horizontally-related industries, then positive shocks to related industries could be associated with declines in employment and increases in wages in a given industry, i.e., $\beta_{Ix} < 0$ or $\beta_{Im} < 0$ (when imports complement employment) in equation (9) and $\beta_{Ix} > 0$ or $\beta_{Im} > 0$ in the wage equation (10).

On the other hand, inter-industry relatedness may be driven by local supply chains. If workers are more likely to move between vertically-related industries (i.e., industries characterized by input-output relationships) then the expected coefficients in the employment equation could be different from those discussed above, because positive shocks to related industries would imply positive shocks for the supply chain. Specifically, the expectation would be that $\beta_{Ix} > 0$ or $\beta_{Im} > 0$ (again, when imports are complements of labor) in equation (9) and $\beta_{Ix} > 0$ or $\beta_{Im} > 0$ in the wage equation (10).

This estimation strategy errs on the side of caution. The inclusion of import and export variables both preceding the employment and wage observations (which correspond to the end of each period) and one period ahead as well as the inclusion of the related trade variables with the same leads and lags structure is a rather general specification of the model, and collinearity can mask the significance of the estimated coefficients. Therefore we present results from the models without leads, with leads, with "related" trade variables, and a final specification with only the explanatory variables that appear to be significant in the most general specification. Furthermore, we also discuss one model that tests for crisis-specific (during the two quarters of 2008q4 and 2009q1) coefficients of the latter model.

4.d. Changes in the composition of workers

At least since Reder (1955), the labor literature has emphasized compositional changes in employment during business cycles. Reder (1955) argued that upturns (when labor is scarce) are associated with downgrading of the skill composition of workers and downturns (when employers have a larger pool to choose from) are associated with upgrading.[6] Gautier et al. (2002) found evidence in favor of these predictions in matched employer-employee data from the Netherlands. Since skilled workers in Mexico have been found to have higher adjustment costs (Robertson and Dutkowsky 2002), it seems possible that the financial crisis led to changes in the firm-level mix of skilled and less skilled workers.

Although the empirical models of wage determination focus on the wage changes for stayers, it will also be useful to use a measure that gives us insight on the changing composition of workers as a result of trade shocks. More formally, we denote

[6] On the labor force upgrading and business cycles, see also Hamermesh (1993).

$$diff_{i,t} = \frac{\sum_{w \in stayers}^{N_{stayers}} ln(w_{w,i,t}) - ln(w_{w,i,t-1})}{N_{i,stayers}} - \left(\frac{\sum_{w}^{N_t} ln(w_{w,i,t})}{N_{i,t}} - \frac{\sum_{w}^{N_{t-1}} ln(w_{w,i,t})}{N_{i,t-1}} \right)$$

as the difference between the change in average log wages for stayers and the change in average log wages for all workers in industry *i* in time *t*. What might this measure capture? To see the idea behind this measure, consider the following model of wage determination,

$$ln(w_{w,s,t}) = \alpha_w + \gamma_{i,t} + \varepsilon_{w,f,t},$$

where α_w is a fixed effect for each worker and $\gamma_{i,t}$ is a time varying industry or sector effect.

Under this model of wage determination, the first term of the differential measure expressed above (the part corresponding to the wage changes of stayers) reduces to $(\gamma_{i,t} - \gamma_{i,t-1})$ since the person fixed effects are differenced away. The second term would reduce to

$$(\gamma_{i,t} - \gamma_{i,t-1}) + (\bar{\alpha}_{i,t} - \bar{\alpha}_{i,t-1}),$$

where $\bar{\alpha}_{i,t}$ is the average person effect in industry *i* in time *t*. This formulation implies that the difference between the change in average log wages of stayers and the change in average log wages of all workers in industry *i* in time *t* could be expressed as

$$diff_{i,t} = (\bar{\alpha}_{i,t-1} - \bar{\alpha}_{i,}).$$

A positive value for $diff_{i,t}$ could therefore be interpreted as a downgrading of average skill or human capital in the industry while a negative value would be interpreted as an upgrading of skill or human capital in the industry. The econometric exercises, therefore, can ascertain whether employers tend to upgrade the quality of their workforce during downturns driven by trade shocks.

Figure 8 presents the difference between the change in average log wages for stayers and the change in average log wages for all workers separately for tradable and non-tradable sectors. The figure shows that the variation of this measure was much larger in the tradable sector than in

the non-tradable sector. In particular, figure 8 suggests that the tradable sector shed low-skilled workers in the fourth quarter of 2008 and hired them back in the third quarter of 2009.

5. Results

We estimated these models with various definitions of the crisis period, including October-November 2008, October-December 2008, October 2008-January 2009, and October 2008-Feberuary 2009. The results were very similar across these definitions and for the sake of brevity the corresponding results section presents graphs based on the decline from October-November 2008.

Before proceeding to the main results, we present some basic statistics for both the trade and labor market variables in table 1. It is interesting to note that, on average, the quarterly changes in exports and imports were close to zero during this period. These figures, however, mask considerable heterogeneity across industries over time. Also, imports and exports are much more volatile than their associated relatedness indices, which will be important later when we interpret the coefficients from regressions using these variables.

The estimation results are discussed sequentially with the employment equations followed by the wage equations. We include the results for relatedness within the employment and wage sections. We then discuss change in composition and conclude with the continuous-treatment models of employment and wages that allow us to examine the robustness of our results.

5.a. Employment

Table 2 presents the results from the WLS estimations in which initial employment in 2007 in each industry is the weight.[7] The first column contains the basic results, and only imports from the United States appear significant and positive. The second specification is the time-to-build model that includes the one-period-ahead trade variables. Both export variables appear significant and positive. Model 3 is the time-to-build model augmented with the related trade variables. The results are similar to those of the previous model, but related imports (preceding the employment observed at the end of the period) appear significant as well. The fourth specification excludes the explanatory variables that were insignificant in model 3, and it confirms that the related trade variables are significant. The final specification tests for crisis-specific coefficients and the results imply that the positive partial correlation between exports to the United States and employment was magnified during the crisis period.

These results on employment suggest that the time-to-build model is probably the correct specification; employment decisions tend to take place prior and ahead of exports. Moreover, both own-industry and related-industry imports appear with positive coefficients, thus suggesting that they complement labor. This finding is consistent with the view that Northern Mexico's industries are largely vertically-integrated maquila operations that rely on imported inputs. Given the level of aggregation of our industrial classification, which is similar to the aggregations used elsewhere in the literature, it is possible that numerous studies of the relationship between imports and labor (or even imports and firm productivity) tend to confound import-competing and imported-input effects. In Northern Mexico, the latter effect appears to dominate.

Regarding the economic magnitude of the related-trade effects versus those of the own-industry effects, the elasticity of employment with respect to related-exports is substantially

[7] Similar results were obtained when using the inverse of the standard errors from the first-stage wage equation. These are available upon request.

larger than that of own-industry exports. However, as mentioned in section 4, the variance of the related-trade variables is much lower than that of own-industry trade. In particular, the standard deviation (weighted by initial employment) of the change in log exports is 0.25, while the corresponding standard deviation for the related exports variable is only 0.04. Multiplying the coefficient on direct exports from column 4 of table 2 by its standard deviation yields a "standardized" coefficient of 0.008, implying that a one standard deviation increase in the change of log exports yields a 0.8% increase in employment. Undertaking the same exercise for the related export coefficient yields a "standardized" coefficient of 0.007, implying that a one standard deviation increase in the change of related log exports yields a 0.7% increase in employment.

The analogous "standardization" exercise for the import coefficients yields economic magnitudes that are somewhat lower than those for the export coefficients. Multiplying the coefficient on direct imports from column 4 of table 2 by its standard deviation (0.23) yields a "standardized" coefficient of 0.004, while multiplying the coefficient on related imports by its standard deviation (0.04) yields a "standardized" coefficient of 0.005.

5.b. Wages

Table 3 contains the results for the wage equations, following the same sequence as the employment models. In column one, both trade variables appear significant and with positive coefficients. As we move across the table few other explanatory variables are significant, not even the interaction of the crisis dummy with own-industry exports. It is also worth noting that the elasticities of wages with respect to exports are much smaller than the elasticities in the employment regressions discussed above. Hence we interpret these results as evidence that most

of the inter-quarterly adjustment of labor markets in Northern Mexico occurred through employment quantities rather than wages. One possible interpretation of these results is that firms are small relative to the labor market and therefore take wages as given in the short run. These results are also consistent with an economy characterized by relatively low employment adjustment costs.

5.c. Employment Composition

In spite of the weak results concerning the wages of workers that stayed with a given employer, it is possible that employers changed the composition of their labor force. Table 4 presents the results related to the determinants of the relative wages of stayers relative to the average wage of all workers, which, as mentioned, can be interpreted as reflecting compositional changes in the employed labor force.

Several results appear robust. Under column 1, both contemporaneous exports to and imports from the U.S. have positive and significant coefficients, which suggest that increases in exports and imports lead to the disproportional hiring of lower-skilled workers. Conversely, a trade collapse would lead to lower-skilled workers to disproportionately lose their jobs.

The time-to-build model estimates under column 2 indicate that one-period-ahead exports are also positive and significant. These three variables remain positive and significant with only minor changes in the point estimates. Under the third column, the results suggest that related trade shocks are also significant with positive coefficients on both related imports and exports. Overall, a clear picture emerges that lower-skilled workers are the primary beneficiaries of positive trade shocks and suffer the most from negative trade shocks.

The fourth model's results suggest that some coefficients were different during the crisis quarters. In particular, the coefficient of contemporaneous exports was significantly smaller, implying that the effect of exports on the composition of workers was essentially zero during the crisis period while it was about 0.03 otherwise. In contrast, the coefficients on one-period-ahead exports and related exports were both larger in magnitude during the crisis than during other quarters.

Finally, it is noteworthy that the coefficients reported in Table 4 tend to be much larger than the coefficients reported in Table 3, which focused on the effects of trade shocks on the wages of workers that stayed with their employers. For example, comparing the coefficient on the only significant variable in Table 3, namely exports to the U.S., under columns 3 in both tables, the magnitude is more than three times larger in Table 4 than in Table 3 (e.g., 0.024 versus 0.007). Consequently, the negative effects that exports have on average log wages that are associated with skill downgrading dominate the positive effects of exports on average wages associated with wage increases for stayers.

To the extent that the previous literature has not adequately differentiated between short-run and long-run effects, our results could shed light on the reasons why the literature has had trouble finding the effects of trade on wages and has found mixed results for employment. Our results from table 3 suggest that an increase in exports is associated with a small increase in wages for workers who remain with the same firm. Our results from table 4, however, suggest that an increase in exports is associated with skill-downgrading, which has the effect of making industry wages appear to be *negatively* correlated with exports. Our results therefore highlight the importance of distinguishing between short-run and long-run when examining the within-industry compositional effects of trade shocks found to be so important in recent papers.

5.d. Robustness: Continuous treatment effects and exogeneity of trade shocks

One potential concern with our analysis is that the changes over time of exports and imports might not be truly exogenous. A related concern is that those industries that were most affected by the Great Trade Collapse were already experiencing different time trends prior to the collapse. In order to address these concerns, we adopt an empirical strategy that compares the labor markets of industries that suffered comparatively large trade collapses with those that experienced comparatively mild collapses prior to the collapse, during the collapse, and after the collapse.

In order to motivate models that focus on the large and negative export shock that occurred at the end of 2008, we present graphs on the effects of this shock on our three outcomes variables. We divide industries into three groups of approximately equal size in terms of their employment in the first quarter of 2007 that are grouped by the percent decline in exports between October 2008 and November 2008. We also divide industries into three groups using the same procedure for the shock to related exports.[8]

Figure 9a shows the results on employment dividing industries into groups based on the magnitude of the shock to direct exports. The first thing to notice from figure 9a is that the employment trends of the three groups of industries quite similar prior to the trade shock at the end of 2008. As we mentioned earlier, the similarity of the pre-shock trends provides empirical support for our assertion that the differences across industries in the size of the shock were exogenous.

[8] Industries were categorized as having large export shocks if the decrease in log exports from October to November 2008 was greater than 0.23 log points. Industries were categorized as having medium export shocks if the decrease was greater than 0.18 log points but less than 0.23 log points. Industries were categorized as having small export shocks if the decrease was less than 0.18 log points. The analogous cutoff points for the groups defined by the shocks to related exports were 0.094 and 0.0654.

Figure 9a also provides interesting information on the manner in which these exogenous trade shocks rippled through the labor market over time. Compared to industries that experienced only mild shocks, industries in the other two categories had larger reductions in employment in the fourth quarter of 2002 and the first quarter of 2003. There is some evidence that employment recovered towards the end of 2009. Figure 9b shows the analogous results for industries grouped by the magnitude of the shock to related exports and also reveals no evidence of differential trends prior to the shock. Compared to industries that experienced relatively mild related export shocks, industries in the other two categories experienced larger drops in log employment at the end of 2008 and beginning of 2009, with clear evidence of an employment recovery towards the end of 2009.[9]

This clear evidence of recovery is likely due to the fact that those industries experienced comparatively larger negative shocks towards the end of 2008 also caught up (that is, experienced comparatively larger positive shocks) in 2009. These results are entirely consistent with the results presented in table 2 (that is, with a positive correlation between trade flows and employment). An additional attractive feature about the evidence presented in figure 9b is that one can see how trade shocks of different magnitudes across industries, along with the associated recoveries of different magnitudes across industries, were mirrored by similar employment effects over time.

Figure 10a shows the results on wage changes for stayers dividing industries into groups based on the magnitude of the shock to direct exports. Once again, we see no evidence that the trends were different across these groups of industries prior to the trade collapse at the end of 2008. Compared to industries that experienced only mild shocks, industries in the other two

[9] Although cross-industry correlation between the shock to direct exports and the shock to exports in related industries are weakly correlated (p-value of 0.53), subsequent tables confirm the results of these simple graphs in models that control for both variables at the same time.

categories had poorer wage performance in the beginning of 2009, with a recovery of wages occurring at the end of 2009. Figure 10b shows similar results for wage changes for stayers when grouping industries by the magnitude of the shock to related exports.

Figure 11a shows the results on our measure of workforce composition (the difference between the change in average log wages for stayers and the change in average log wages for all workers), again dividing industries into groups based on the magnitude of the shock to direct exports. Again the pre-shock trends across industry groups appear quite similar. Compared to industries that experienced only mild shocks, industries in the other two categories shed low-skilled workers at the end of 2008 and beginning of 2009, but reversed this trend at the end of 2009. Figure 11b shows similar results when grouping industries by the magnitude of the shock to related exports.

We now proceed to the econometric models that implement the continuous treatment design. Specifically, we estimated the following continuous-treatment effects models of the export and related-exports shocks on employment and wages:

(11) $\Delta E_{i,t} = \beta_{x,t} \cdot \gamma_t \cdot \Delta x_{i,t \in crisis} + \beta_{Ix,t} \cdot \gamma_t \cdot \Delta I^{x}_{i,t \in crisis} + \Delta \varepsilon_{i,t}$,

(12) $w_{i,t} = \beta_{x,t} \cdot \gamma_t \cdot \Delta x_{i,t \in crisis} + \beta_{Ix,t} \cdot \gamma_t \cdot \Delta I^{x}_{i,t \in crisis} + \Delta \varepsilon_{i,t}$, and

(13) $diff_{i,t} = \beta_{x,t} \cdot \gamma_t \cdot \Delta x_{i,t \in crisis} + \beta_{Ix,t} \cdot \gamma_t \cdot \Delta I^{x}_{i,t \in crisis} + \Delta \varepsilon_{i,t}$.

Equations 11-13 are estimated using the 99 industries for which both the trade and the labor market data exist for every observation in the sample, for a total of 1,089 observations.

In a nutshell, these models provide estimates of crisis-specific deviations from common period-specific shocks across industries. The parameters of interest vary over time. If the export shocks observed during the crisis period did not affect ongoing trends across all industries then $\beta_{x,t} = 0$ and $\beta_{Ix,t} = 0$ across the whole sample period. However, if the crisis trade collapse

induced inter-industry dispersion in employment and wages that deviated from common trends, then $\beta_{x,t} > 0$ or $\beta_{Ix,t} > 0$ during $t \in crisis$. In other words, we should observe positive and significant coefficients in (11), (12), or (13) for the quarters of the crisis. If the crisis-induced drop in exports caused a shedding of low-skilled workers we would expect positive coefficients at the end of 2008 and negative coefficients later in 2009 as exports recovered.

The results from the estimations of models (11), (12), and (13) are summarized in figures 12, 13, and 14 respectively for the specifications that define the crisis shock as being from October 2008 to November 2008. We also present the underlying regression results in Table 5.[10]

In figure 12, industries less severely affected by export shocks from October 2008 to November 2008 (higher values for $\Delta x_{i,t \in crisis}$) experienced better employment in the fourth quarter of 2008 (this result is significant at the 0.05 level). The fact that the coefficients for the direct export shock move around substantially both before and after the shock makes this coefficient, however, somewhat suspect. The results on the shock to related industries, in contrast, are much more convincing. There is strong evidence that when related industries received less severe export shocks, employment growth was much stronger in the first quarter of 2009 (significant at the 0.01 level). More severe shocks from October 2008 to November 2008 to related industries were associated with stronger recoveries in the fourth quarter of 2009 (significant at the 0.05 level). No other coefficients for the shock to related industries are significant at conventional levels.

Turning now to the results for wages in figure 13, we observe patterns similar to those we observed for employment. Industries with less severe export shocks from October 2008 to November 2008 (higher values of $\Delta x_{i,t \in crisis}$) experienced higher wage growth in the first

[10] The analogous results using imports are similar to those using exports but with weaker statistical significance.

quarter of 2009 (this result is significant at the 0.05 level), but their wages declined in the third quarter of 2009 (significant at the 0.01 level). Likewise, wages in industries that faced less severe shocks to related industries grew faster in the first quarter of 2009 (significant at the 0.01 level), but, again, these wage gains were reversed in the third and fourth quarters of 2009 (both significant at the 0.10 level).

It is also worth noting that all of the coefficients from the wage regressions from the continuous treatment models are substantially smaller in magnitude than in the corresponding employment regressions. These results provide further evidence in favor of our earlier claim that labor markets reacted to the trade shock mainly by reducing employment, although wages also fell. These results are consistent with either relatively low employment adjustment costs or a relatively elastic labor supply curve faced by "small" (wage -taking) firms in the short run.

Finally, turning to the results on the difference between the change in average log wages for stayers and the change in average log wages for all workers, Figure 14 presents the results using $diff_{i,t}$ as the dependent variable. Sectors that were particularly hard hit by the *direct* export shock disproportionately shed low-skilled workers in the fourth quarter of 2008, that is, very quickly after the shock occurred. Industries that were particularly hard hit by shocks to *related* exports disproportionately shed low-skilled workers in the fourth quarter of 2008 and the first quarter of 2009, then brought them back at the end of 2009.

6. Conclusions

As developing countries become increasingly integrated into the world economy, understanding how international short-run shocks spread through domestic labor markets becomes increasingly important—especially in the context of vertical integration, labor market

adjustment costs, and dynamic adjustment. This paper exploits the exogenous variation in Mexico's trade with the United States to study the employment and wage effects of trade shocks with unique data on formal labor markets from Northern Mexico. The data from social security records allow tracking individual workers across industries, which is critical for estimating the effects of trade on employment and wages whilst allowing for such effects to operate through labor mobility across industries. In addition, the data from IMSS allowed for a careful matching of the data on labor by industries to bilateral trade data from U.S. customs records. This combination of trade and employment data resulted in a dataset of employment and wages with relatively high frequency (quarterly), which in turn permitted the estimation of labor-market models with leads and lags around the time of the Great Trade Collapse.

The econometric results revealed some interesting and novel patterns in the data that have not been reported in the trade and labor literature. First, imports appear to be complements to labor in Northern Mexico, which is intuitively consistent with outsourcing patterns whereby Northern Mexico is a fundamental stage in North American supply chains. We wonder whether the bulk of the empirical literature on trade and labor (and even the literature on trade and productivity) to some extent has confounded the import-competing and imported-inputs effects in models that utilize industrial classifications at medium levels of aggregation, which could partially explain the largely small estimated effects of trade that have been reported in the literature.

Second, a significant portion of hiring decisions tends to occur prior to the realization of exports. Hiring and firing decisions seem to be more important than wage setting because most of the adjustment to trade shocks in Northern Mexico, including during the trade collapse at the end of 2008 and early 2009, seems to have taken place through adjustments in employment,

much more so than through wages. Wages were probably affected, especially during the crisis period, but the estimated elasticities were significantly smaller than those of employment.

We also examined the employment-composition effects of the crisis. We find robust evidence suggesting that short-run positive shocks are associated with skill downgrading of the employed labor force, while downturns were associated with skill upgrading. Hence, while the wages of workers who did not lose their jobs during the crisis tended to be relatively (compared to employment) insensitive to the trade shock, the composition of the employed labor force changed significantly and to a larger extent than the wages of stayers. This result, which is consistent with a longstanding labor literature, suggests that short-run shocks can have significant effects not only on the level of employment within industries, but also on the composition of the employed labor force that differ sharply from long-run models of trade liberalization. This result therefore highlights the importance of considering timeframe in new dynamic trade models with search or labor-market adjustment costs.

Third, our new measure of industry "relatedness" suggests that related-industry trade shocks appear to be significant determinants of employment, with the economic magnitude of these shocks being just as large as those from own-industry trade shocks. These results are consistent with the idea that Mexican industries are related through output, rather than input (labor) markets. We find that, controlling for general shocks, relatedness does matter and that the trade shocks spread to other industries proportional to the probability that workers move between industry pairs. The most likely explanation for this is that industries with supply relationships hire similar workers, and contrasts with the idea that workers released from a given industry create hiring opportunities for industries that hire similar workers.

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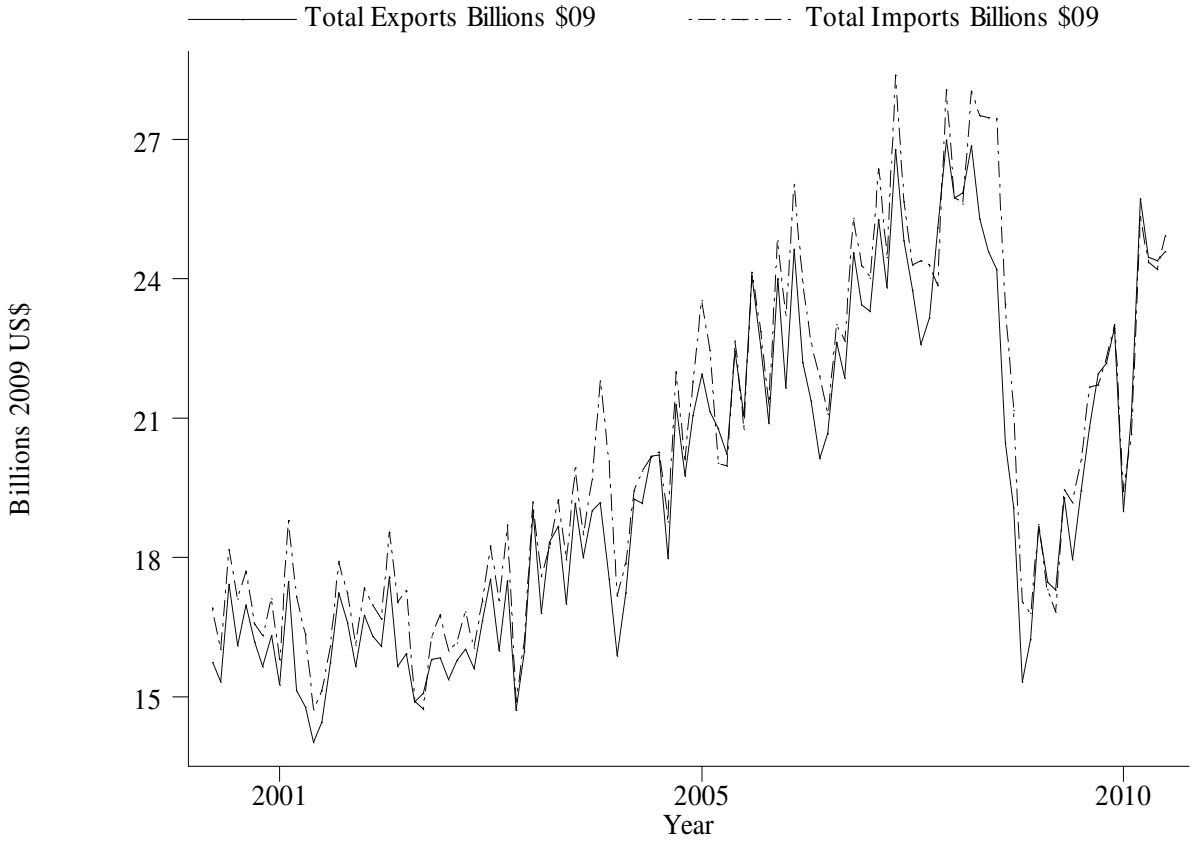
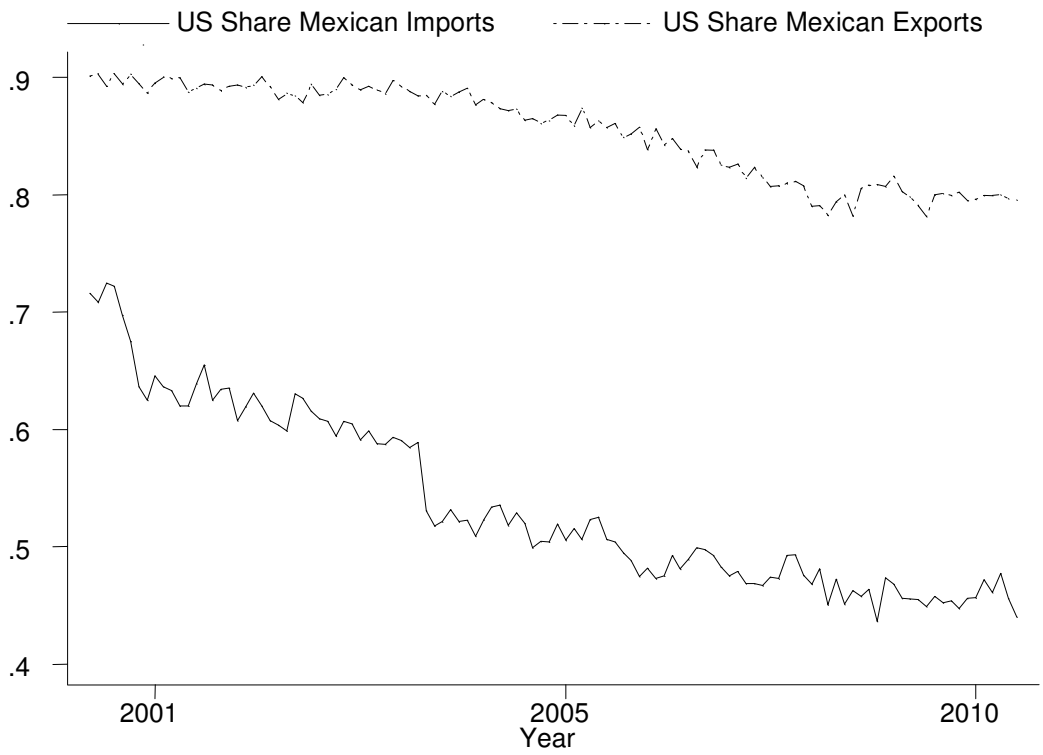
Figure 1. Total Mexican Exports and Imports
Billions 2009 U.S. Dollars



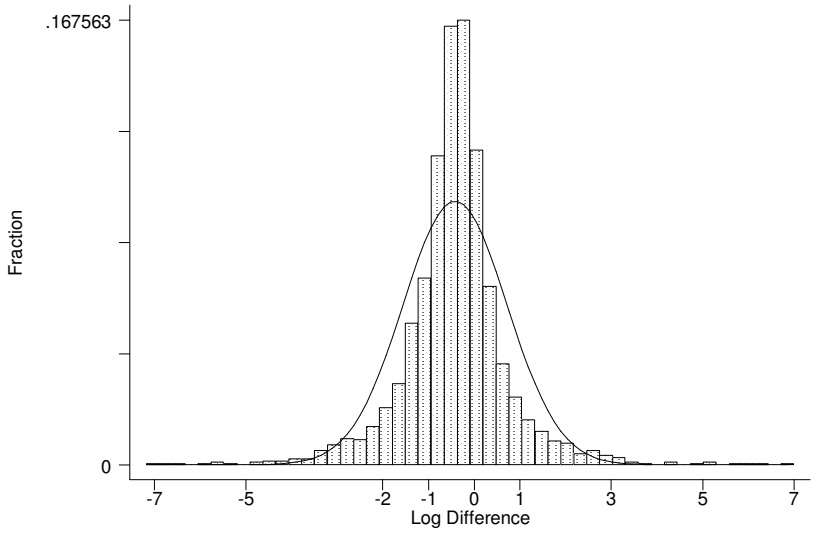
Notes: Exports and Imports are in billions of U.S. dollars deflated by the U.S. Consumer Price Index for all urban consumers (series CUUR0000AA0) in which 2009=100. Totals include petroleum trade. Data are from http://dgcnesyp.inegi.gob.mx/cgi-win/bdieintsi.exe/Consultar#.

Figure 2. United States Share of Mexican Non-petroleum Exports and Imports



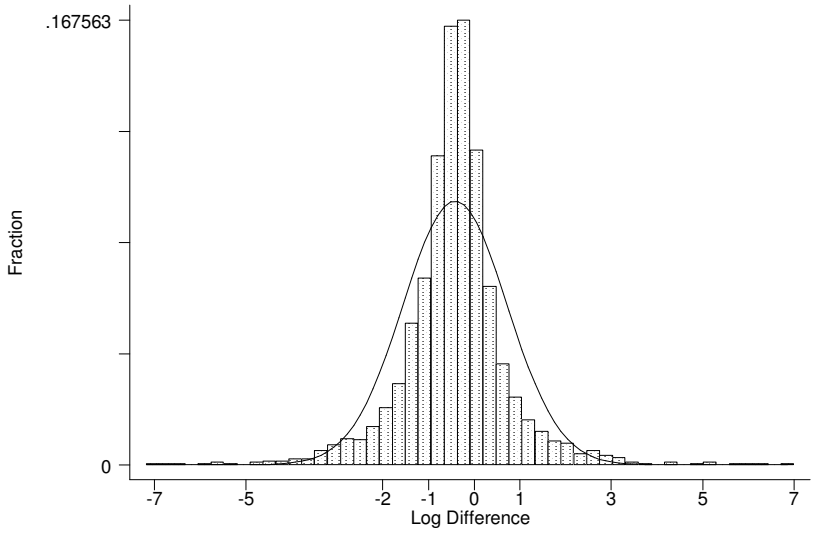
Notes: Series calculated by authors using data from http://dgcnesyp.inegi.gob.mx/cgi-win/bdieintsi.exe/Consultar#.

Figure 3a. Change in Mexican Exports to the U.S. by 6-digit HS Industry



Notes: Mean (standard deviation) log difference is -0.419 (1.138). Difference is calculated as the difference in the log of U.S. imports from Mexico between April 2008 (peak) and January 2009 (trough). Difference shown only represents the intensive margin (HS6 categories that had positive trade values in both periods). Normal distribution is superimposed over the histogram.

Figure 3b. Change in Mexican Imports from the U.S. by 6-digit HS Industry



Notes: Mean (standard deviation) log difference is -0.166 (1.182). Difference is calculated as the difference in the log of U.S. exports to Mexico between April 2008 (peak) and January 2009 (trough). Difference shown only represents the intensive margin (HS6 categories that had positive trade values in both periods). Normal distribution is superimposed over the histogram.

Figure 4. Employment in Tradables and Exports to the United States, 2007-2009

Figure 5. Employment in Non-Tradables and Exports to the United States, 2007-2009

Figure 6. Net Percent Change in Employment in Tradables and Non-Tradables, 2007-2009

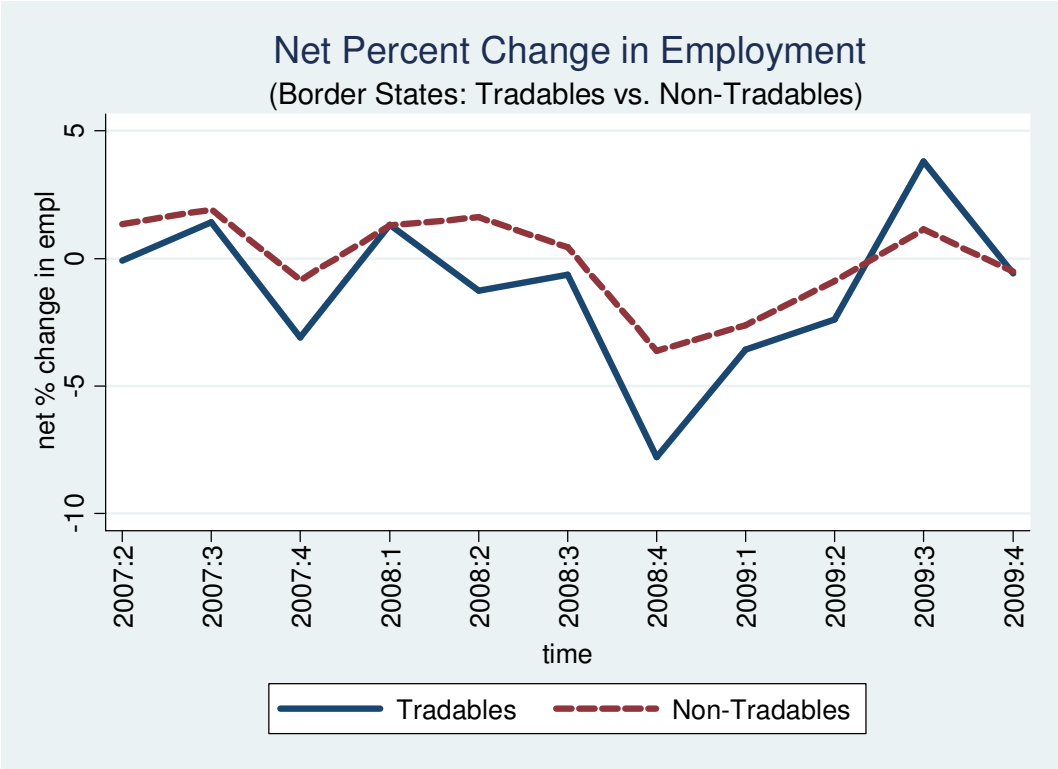


Figure 7a. Average Change in Log Real Wages for Stayers in Tradeables and Non-Tradables, 2007-2009

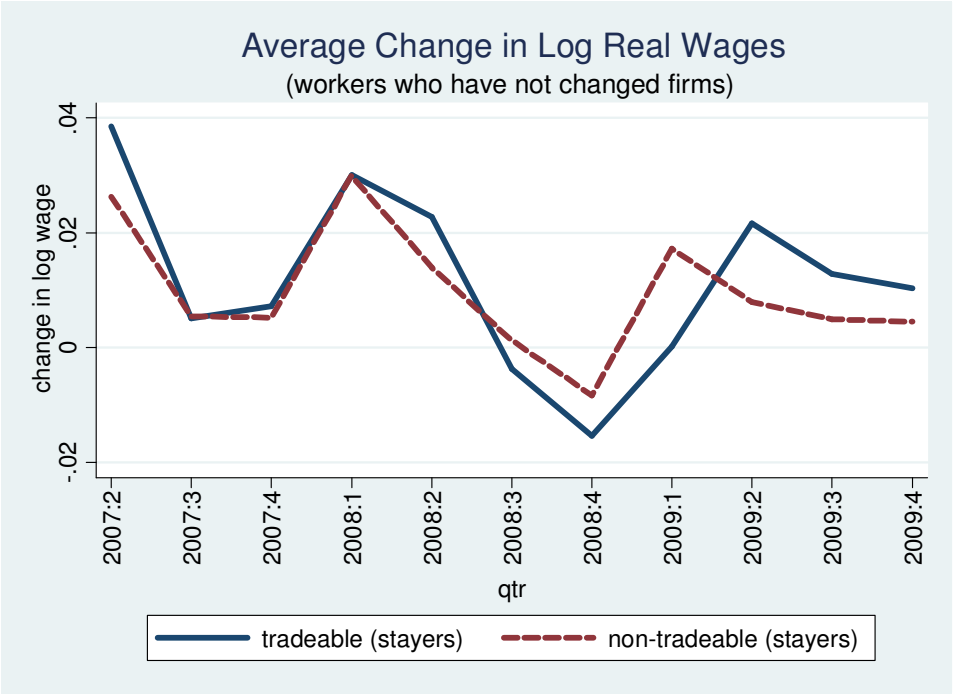


Figure 7b. Average Change in Log Real Wages for in Tradeables and Non-Tradables, 2007-2009

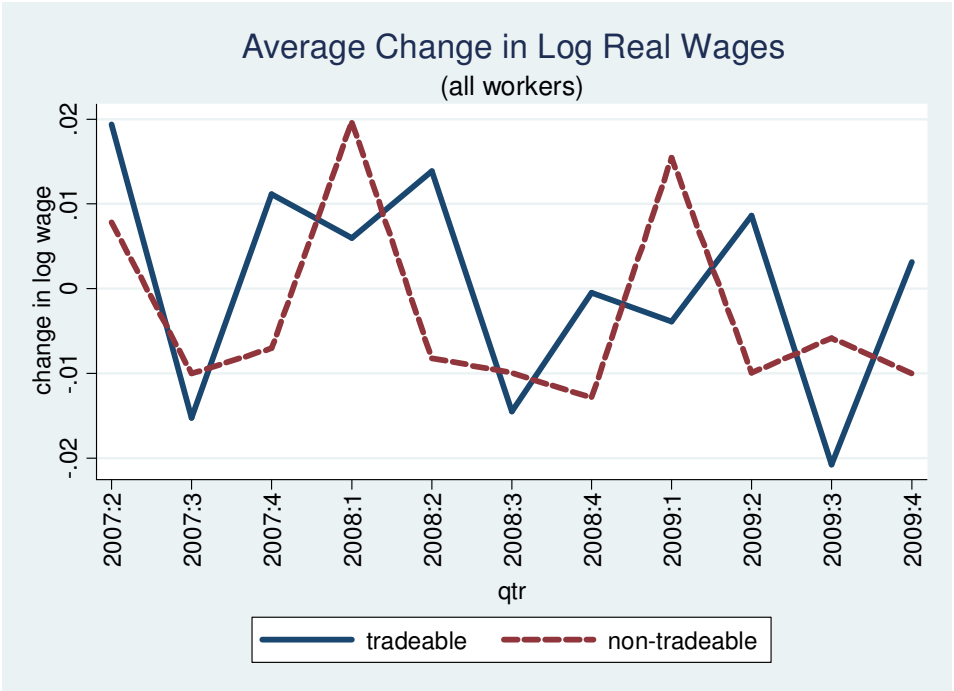


Figure 8. Change in Average Log Wage for Stayers Minus the Change in Average Log Wage for All Workers, 2007-2009

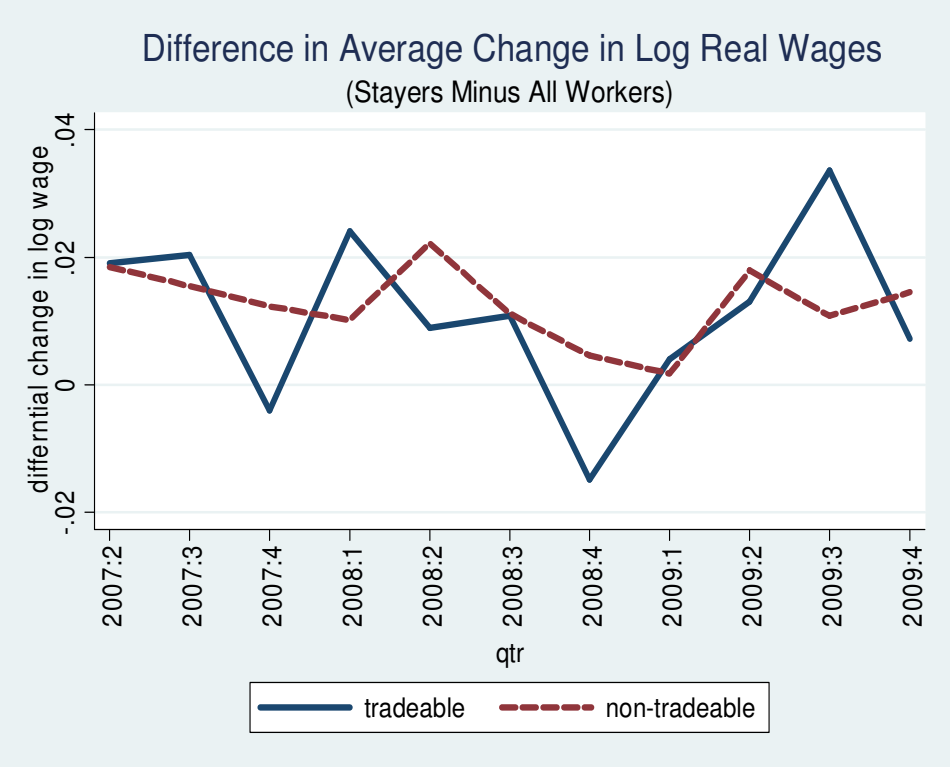


Figure 9a. Changes in Log Employment for Tradable Industries Grouped by the Magnitude of the Direct Export Shock, 2007-2009

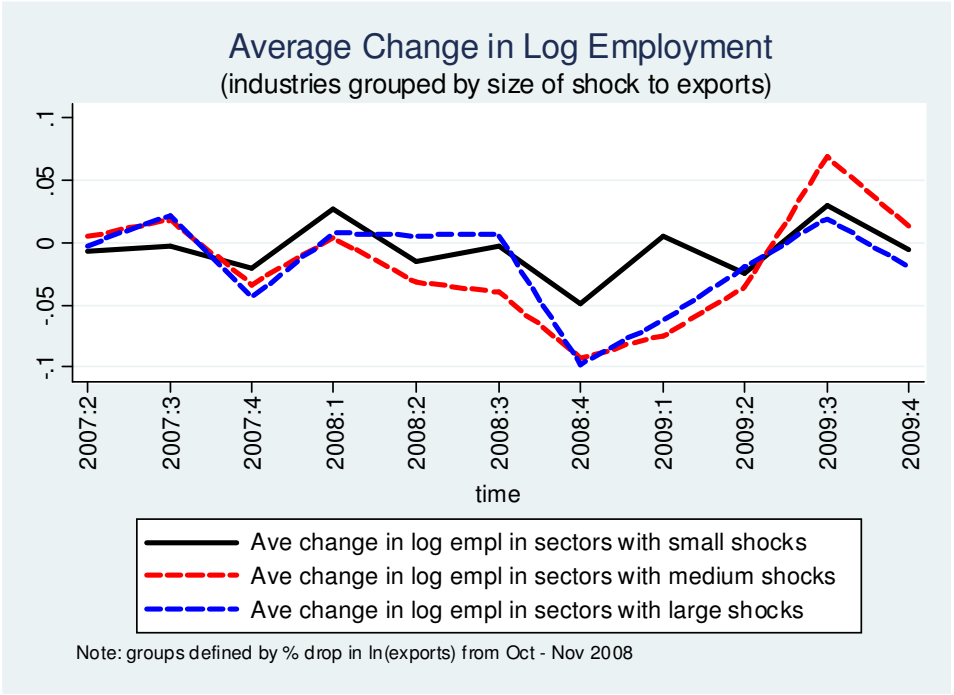


Figure 9b. Changes in Log Employment for Tradable Industries Grouped by the Magnitude of the Related Export Shock, 2007-2009

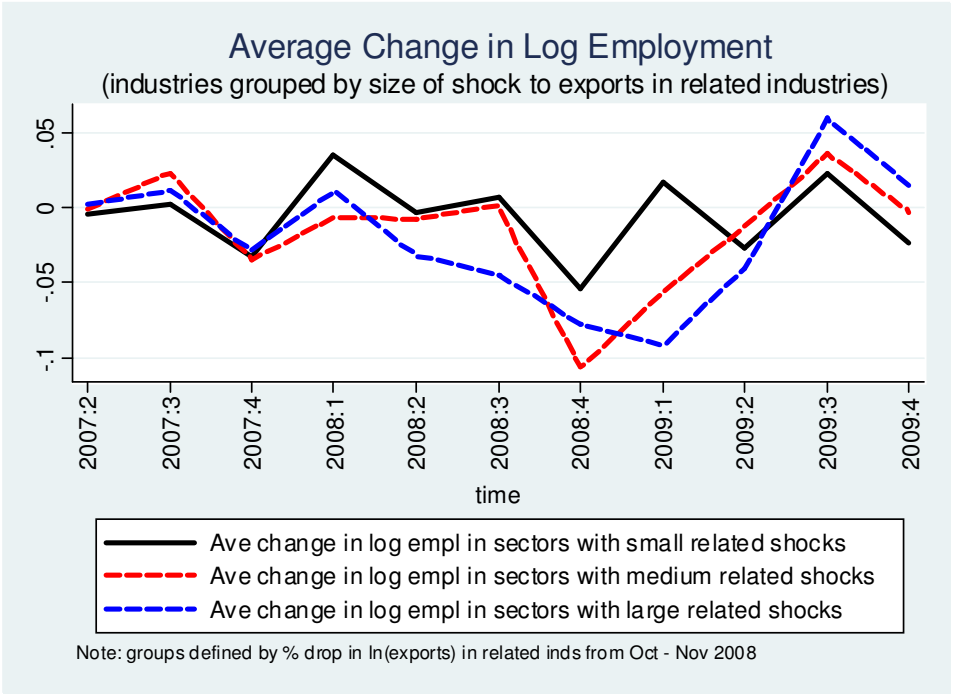


Figure 10a. Changes in Log Wages for Stayers in Tradable Industries Grouped by the Magnitude of the Direct Export Shock, 2007-2009

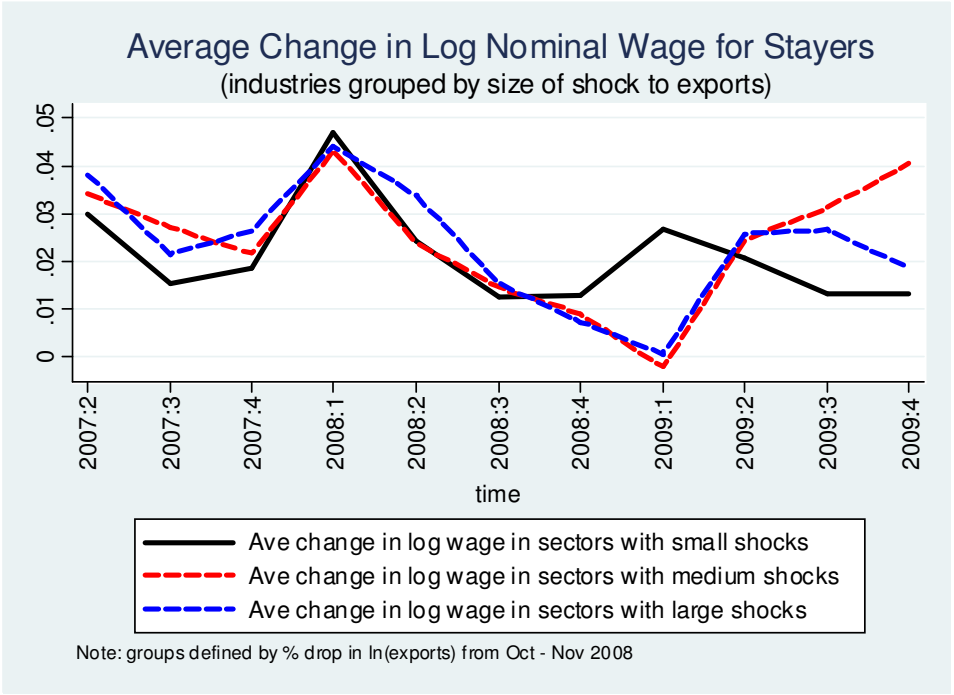


Figure 10b. Changes in Log Wages for Stayers in Tradable Industries Grouped by the Magnitude of the Related Export Shock, 2007-2009

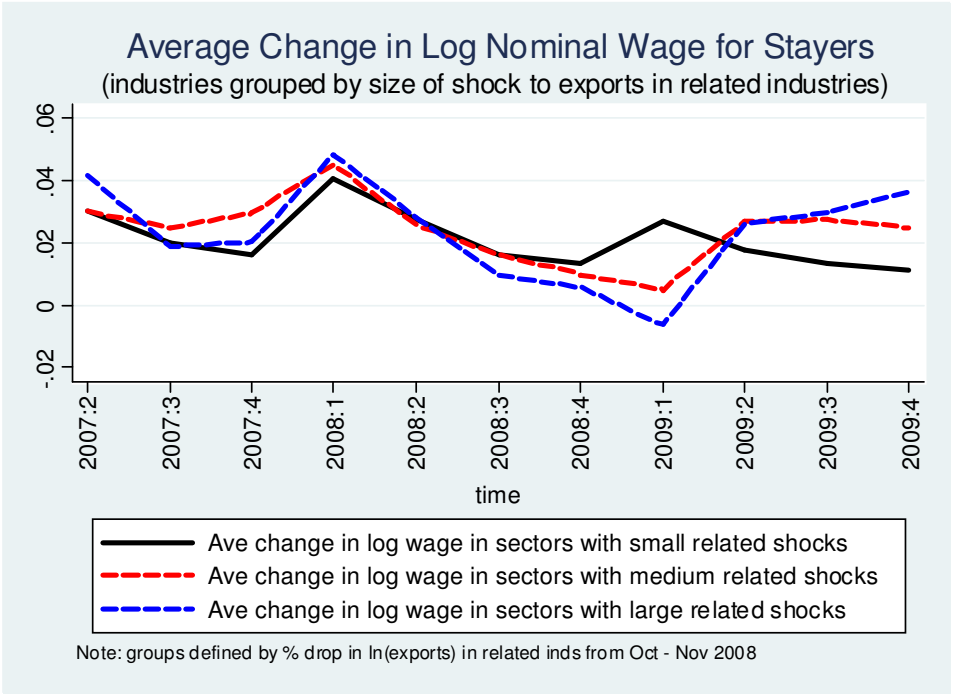


Figure 11a. Differences between the Change in Average Log Wages for Stayers and the Change in Average Log Wages for All Workers in Tradable Industries Grouped by the Magnitude of the Direct Export Shock, 2007-2009

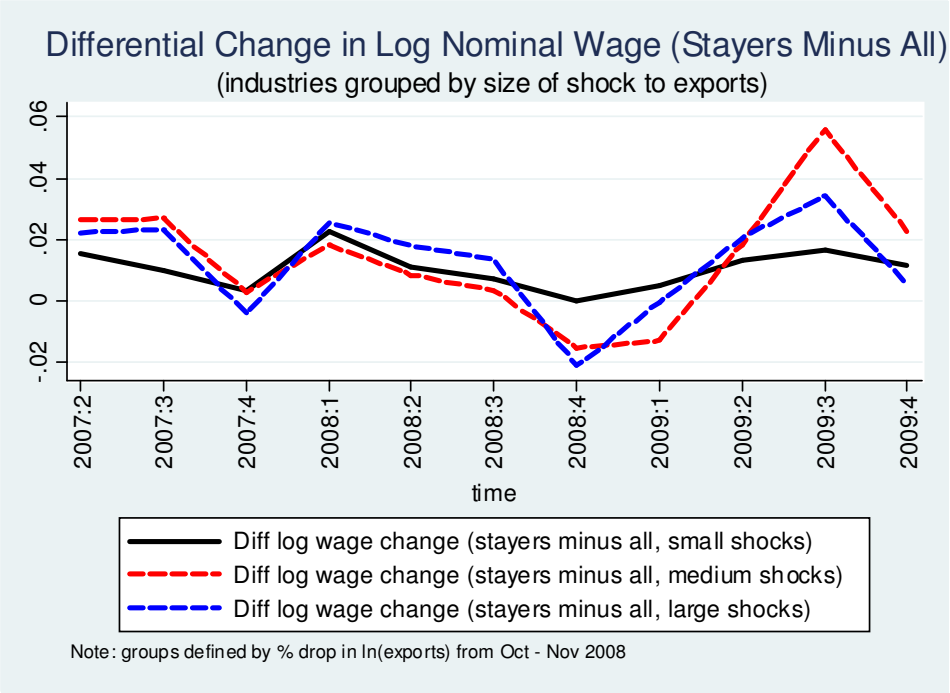


Figure 11b. Differences between the Change in Average Log Wages for Stayers and the Change in Average Log Wages for All Workers in Tradable Industries Grouped by the Magnitude of the Related Export Shock, q12007-q42009

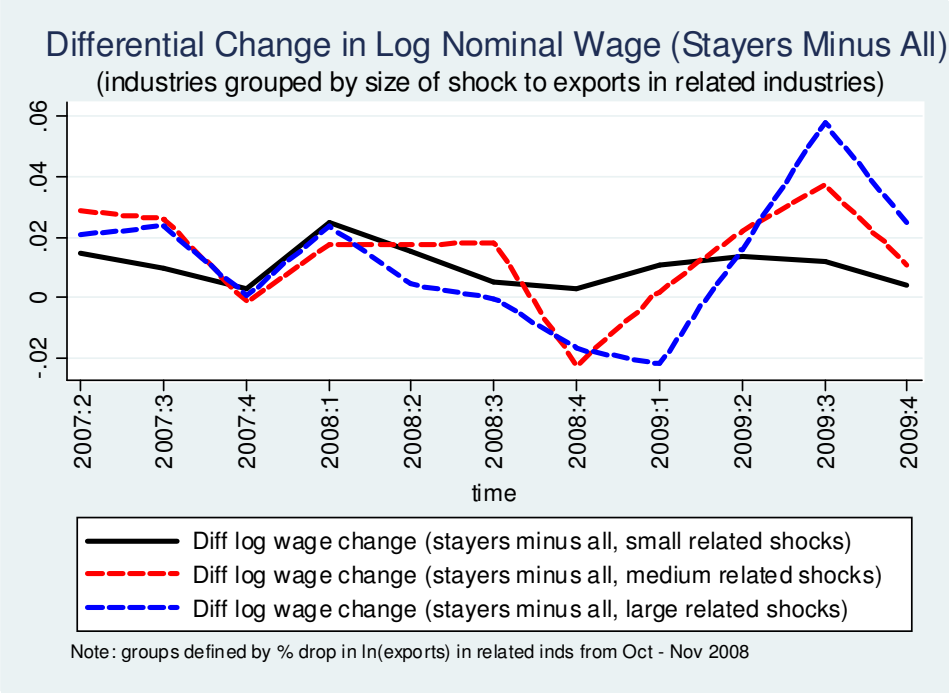


Figure 12. Continuous Treatment Effects of Exports and Related Exports on Employment

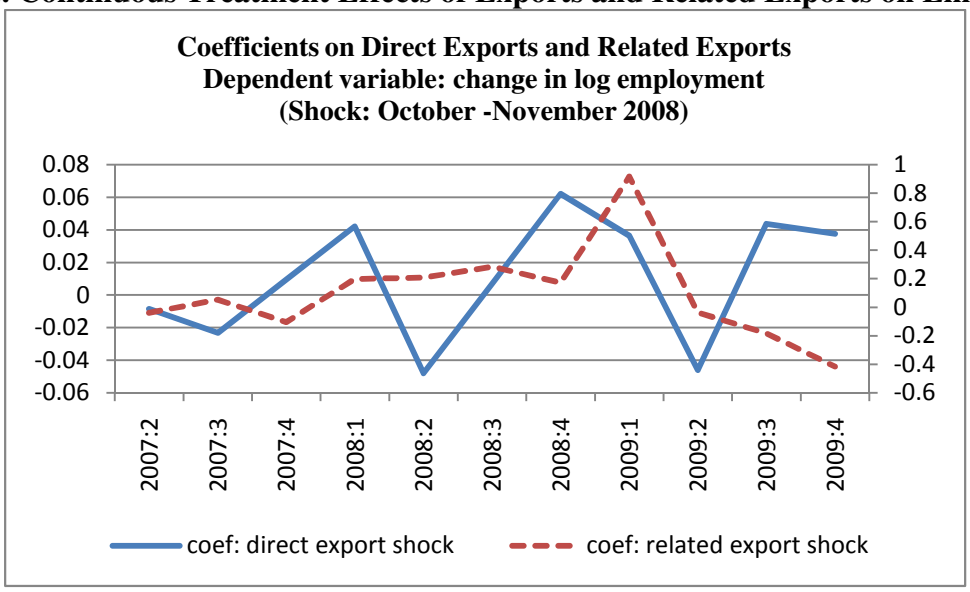


Figure 13. Continuous Treatment Effects of Exports and Related Exports on Wages of Stayers

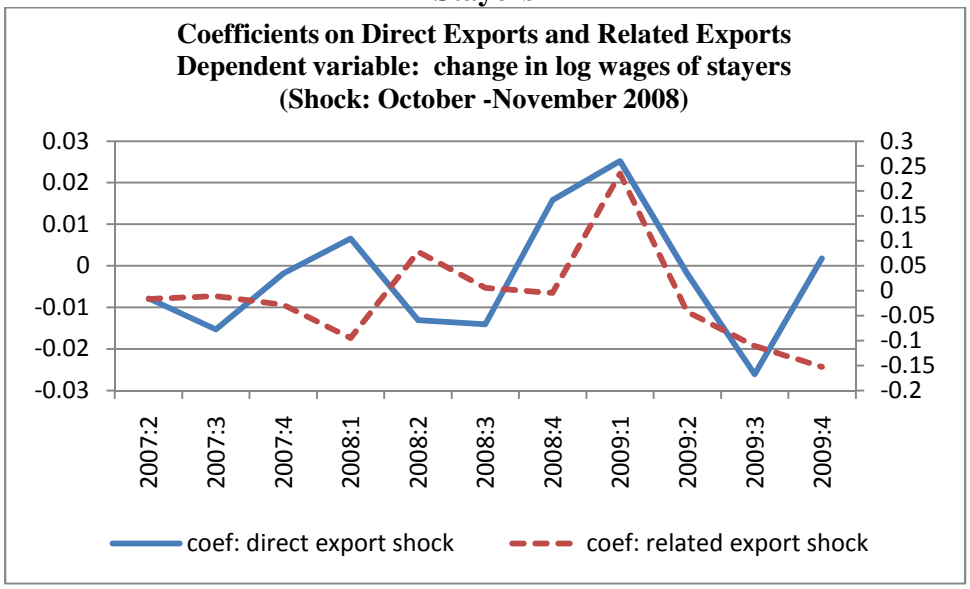


Figure 14. Continuous Treatment Effects of Exports and Related Exports on the Difference between the Change in Average Log Wage of Stayers and the Change in Average Log Wage of all workers

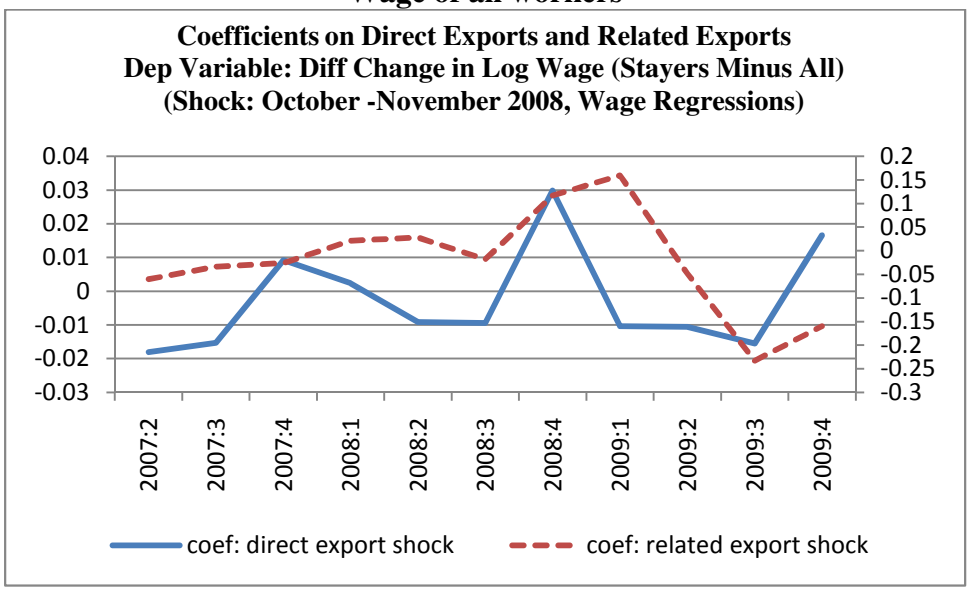


Table 1: Descriptive Statistics

	Obs.	Mean	Std. Dev.	Min.	Max.
Change in log exports	1,140	-0.007	0.250	-3.969	2.662
Change in log imports	1,144	0.003	0.227	-3.248	3.356
Relatedness index for imports	1,144	-0.001	0.042	-0.527	0.435
Relatedness index for exports	1,144	0.001	0.043	-0.545	0.349
Average change in log nominal wage	1,148	0.023	0.025	-0.349	0.433
Change in log employment	1,147	-0.013	0.066	-1.114	0.630

Note: All statistics are calculated using the industries of employment in the first quarter of 2007 as its weight.

Table 2. WLS Estimates of the Employment Equation
(weight= employment by industry in 2007)

	(1)	(2)	(3)	(4)	(5)
	Change in log employment				
Imports from the U.S.	0.020*	0.014	0.014	0.017*	0.019*
	(0.011)	(0.009)	(0.009)	(0.009)	(0.010)
Exports to the U.S.	0.021	0.034**	0.030*		
	(0.015)	(0.016)	(0.017)		
One-period ahead: Imports from the U.S.		-0.020*	-0.020*		
		(0.011)	(0.011)		
One-period ahead: Exports to the U.S.		0.039***	0.035**	0.032**	0.027*
		(0.015)	(0.014)	(0.014)	(0.014)
Related imports from the U.S.			0.138**	0.126*	0.039
			(0.070)	(0.070)	(0.044)
Related exports to the U.S.			0.151	0.177*	0.015
			(0.119)	(0.103)	(0.107)
One-period ahead: Related imports from the U.S.			-0.144		
			(0.109)		
One-period ahead: Related exports to the U.S.			0.180		
			(0.153)		
Crisis dummy * Imports from the U.S.					-0.021
					(0.036)
One-period ahead: Crisis dummy * Exports to the U.S.					0.001
					(0.016)
Crisis dummy * Related imports from the U.S.					0.417
					(0.413)
Crisis dummy * Related exports to the U.S.					0.451***
					(0.159)
Observations	1,132	1,027	1,025	1,027	1,027
R-squared	0.257	0.294	0.309	0.288	0.303

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Time effects are included but not reported. Crisis dummy equals one during 2008q4 and 2009q1.

Table 3. WLS Estimates of the Wage Equation
(weight= employment by industry in 2007)

	(1)	(2)	(3)	(4)
	Change in log wages of stayers			
Imports from the U.S.	0.008*	0.006	0.006	
	(0.004)	(0.004)	(0.004)	
Exports to the U.S.	0.010**	0.011***	0.007*	0.007**
	(0.004)	(0.004)	(0.004)	(0.003)
One-period ahead: Imports from the U.S.		-0.002	-0.003	
		(0.004)	(0.003)	
One-period ahead: Exports to the U.S.		0.003	0.004	
		(0.003)	(0.004)	
Related imports from the U.S.			0.001	
			(0.030)	
Related exports to the U.S.			0.140	
			(0.091)	
One-period ahead: Related imports from the U.S.			0.049*	
			(0.027)	
One-period ahead: Related exports to the U.S.			-0.002	
			(0.036)	
Crisis * Exports to the U.S.				0.012
				(0.009)
Observations	1,133	1,028	1,025	1,133
R-squared	0.553	0.554	0.571	0.552

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Time effects are included but not reported.

Table 4. WLS Estimates of Relative Wage Growth of Stayers (weight=employment by industry in 2007)

	(1)	(2)	(3)	(4)
	Change in log wages of stayers minus change of the average			
Imports from the U.S.	0.008**	0.006*	0.006*	0.008**
	(0.004)	(0.003)	(0.003)	(0.004)
Exports to the U.S.	0.021***	0.028***	0.024***	0.033***
	(0.007)	(0.007)	(0.007)	(0.007)
One-period ahead: Imports from the U.S.		0.000	0.000	
		(0.004)	(0.004)	
One-period ahead: Exports to the U.S.		0.016***	0.015***	0.015***
		(0.004)	(0.004)	(0.004)
Related imports from the U.S.			0.065**	0.045*
			(0.033)	(0.026)
Related exports to the U.S.			0.110***	0.075*
			(0.040)	(0.040)
One-period ahead: Related imports from the U.S.			-0.037	
			(0.041)	
One-period ahead: Related exports to the U.S.			0.041	
			(0.059)	
Crisis * Exports to the U.S.				-0.030***
				(0.009)
Crisis * Imports from the U.S.				-0.004
				(0.011)
One-period ahead: Crisis * Exports to the U.S.				0.011**
				(0.005)
Crisis * Related imports from the U.S.				0.058
				(0.104)
Crisis * Related exports to the U.S.				0.118*
				(0.071)
Observations	1,132	1,027	1,025	1,025
R-squared	0.388	0.426	0.444	0.455

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Time effects are included but not reported.

Table 5: WLS Estimates of Continuous Treatment Effects of Exports and Related Exports on Employment and Wages

	Change in log employment			Change in log wage for stayers			Differential wage change		
Export shock * 2007:2	-0.01		-0.01	-0.01		-0.01	-0.02**		-0.02*
	(0.016)		(0.016)	(0.006)		(0.007)	(0.010)		(0.010)
Export shock * 2007:3	-0.02		-0.02	-0.02**		-0.02*	-0.02*		-0.02
	(0.017)		(0.020)	(0.008)		(0.008)	(0.010)		(0.011)
Export shock * 2007:4	0.00		0.01	-0.00		-0.00	0.01		0.01
	(0.020)		(0.028)	(0.009)		(0.010)	(0.006)		(0.008)
Export shock * 2008:1	0.06		0.04	-0.00		0.01	0.00		0.00
	(0.041)		(0.038)	(0.007)		(0.007)	(0.012)		(0.012)
Export shock * 2008:2	-0.03		-0.05*	-0.01		-0.01*	-0.01		-0.01
	(0.029)		(0.029)	(0.005)		(0.007)	(0.013)		(0.013)
Export shock * 2008:3	0.03		0.01	-0.01		-0.01	-0.01		-0.01
	(0.035)		(0.029)	(0.011)		(0.011)	(0.008)		(0.008)
Export shock * 2008:4	0.08***		0.06**	0.02		0.02	0.04***		0.03***
	(0.021)		(0.025)	(0.014)		(0.014)	(0.010)		(0.011)
Export shock * 2009:1	0.10		0.04	0.04***		0.03**	0.00		-0.01
	(0.067)		(0.057)	(0.010)		(0.012)	(0.006)		(0.010)
Export shock * 2008:2	-0.05		-0.05	-0.01		-0.00	-0.01**		-0.01
	(0.045)		(0.039)	(0.005)		(0.006)	(0.005)		(0.007)
Export shock * 2009:3	0.03		0.04*	-0.03***		-0.03***	-0.03		-0.02
	(0.026)		(0.026)	(0.008)		(0.009)	(0.022)		(0.019)
Export shock * 2009:4	0.01		0.04	-0.01		0.00	0.00		0.02*
	(0.024)		(0.025)	(0.007)		(0.007)	(0.008)		(0.009)
Rel.exp. shock * 2007:2		-0.06	-0.04		-0.03	-0.02		-0.10*	-0.06
		(0.082)	(0.082)		(0.045)	(0.048)		(0.060)	(0.048)
Rel.exp. shock * 2007:3		0.00	0.05		-0.05	-0.01		-0.07	-0.03
		(0.074)	(0.080)		(0.052)	(0.054)		(0.059)	(0.054)
Rel.exp. shock * 2007:4		-0.08	-0.10		-0.03	-0.03		-0.01	-0.03
		(0.091)	(0.133)		(0.038)	(0.039)		(0.033)	(0.041)
Rel.exp. shock * 2008:1		0.29	0.20		-0.08**	-0.09**		0.03	0.02
		(0.203)	(0.162)		(0.037)	(0.036)		(0.058)	(0.052)
Rel.exp. shock * 2008:2		0.10	0.21		0.05	0.08*		0.01	0.03
		(0.175)	(0.172)		(0.047)	(0.044)		(0.063)	(0.055)
Rel.exp. shock * 2008:3		0.30	0.28		-0.03	0.01		-0.04	-0.02
		(0.218)	(0.212)		(0.066)	(0.072)		(0.049)	(0.048)
Rel.exp. shock * 2008:4		0.31*	0.17		0.03	-0.00		0.18**	0.12
		(0.180)	(0.177)		(0.033)	(0.030)		(0.081)	(0.070)
Rel.exp. shock * 2009:1		1.00***	0.92***		0.29***	0.24***		0.14	0.16
		(0.368)	(0.337)		(0.082)	(0.078)		(0.086)	(0.106)
Rel.exp. shock * 2008:2		-0.14	-0.04		-0.05	-0.04		-0.07**	-0.05
		(0.232)	(0.179)		(0.038)	(0.043)		(0.035)	(0.039)
Rel.exp. shock * 2009:3		-0.08	-0.18		-0.17**	-0.11*		-0.27*	-0.23
		(0.167)	(0.172)		(0.066)	(0.066)		(0.146)	(0.144)
Rel.exp. shock * 2009:4		-0.33**	-0.42**		-0.15**	-0.15*		-0.12*	-0.16**
		(0.136)	(0.160)		(0.070)	(0.082)		(0.064)	(0.080)

Robust standard errors in parentheses with 1,089 observations. *** p<0.001, ** p<0.01, * p<0.05.
Trade shock calculated from October 2008 to November 2008.