Are Mexican and U.S. Workers Complements or Substitutes?

Raymond Robertson
The Bush School of Government and Public Service
Texas A&M University

Keywords: labor demand, Mexico, trade and labor markets

Abstract: Fears of NAFTA in the United States were largely based on the belief that Mexicans and U.S. workers were substitutes: lowering barriers would allow competing products into the United States and investment outflows that would cause U.S. workers to lose their jobs to Mexico. While this may have been true when NAFTA first went into effect, subsequent production specialization between Mexico and the United States may suggest that Mexican and U.S. workers are now complements. In particular, NAFTA may have induced production restructuring throughout North America to generate integrated value chains in which workers in the three NAFTA countries work together to produce final products. This paper formally tests this idea using matched high-frequency U.S. and Mexican data. The main results suggest that, during the NAFTA period, Mexican and U.S. production workers are complements, rather than substitutes, suggesting that both countries could benefit from viewing the economies as partners rather than competitors. Prior to NAFTA, U.S. and Mexican production workers were substitutes.

Acknowledgements: The author thanks without implicating the Mission Foods Texas-Mexico Center at Southern Methodist University for financial support and comments, Eugene Beaulieu, Daniel Lederman, Liliana Meza-Gonzalez, David Kaplan, and Anil Kumar for helpful comments and discussion. Laura Gould and Cael Warren provided outstanding research assistance.

Introduction

In 2018, the U.S, Canada, and Mexico renegotiated the North American Free Trade Agreement (NAFTA) and offered the U.S.-Mexico-Canada Agreement (USMCA) as its successor. Much of the renegotiation was predicated on the idea that U.S. and Mexican workers compete for jobs. Indeed, over the last 25 years, U.S. manufacturing employment has been falling. Figure 1a shows the evolution of U.S. manufacturing employment and output from the early 1980s to 2018. The 2000-2010 decline is especially dramatic, renewing concern over the loss of relatively-well-paying manufacturing jobs. One possible reason for the decline in manufacturing employment is competition from low wage countries (Bernard, Jensen, and Schott 2006) and specifically from Mexico. Hakobyan and McLaren (2016) find that NAFTA significantly contributed to falling wages in the U.S. within localized labor markets during the 1990-2000 period.

It is not clear, however, that Mexico has been gaining relative to the United States. Figure 1b shows that Mexican and U.S. manufacturing employment and output follow the same, not opposite, paths. In particular, both countries experienced rising manufacturing employment during the late 1990s, then falling during the 2000-2010 decade, and rising employment since 2011.

Common employment and output trends in the two countries are consistent with changes in global production technology—such as production fragmentation, outsourcing, and offshoring. Vertical specialization, outsourcing, and parts trade may increase domestic employment if the cost savings are great enough to affect output. In other words, if the output effect is large enough, domestic employment would increase (Chen and Ku 2003). The 1990-2000 period was the beginning of the NAFTA adjustment period for both countries because NAFTA went into effect in 1994. Since 2011, manufacturing employment in both countries has been rising.

Outsourcing and vertical integration received significant attention shortly after NAFTA went into effect (Feenstra and Hanson 1996, 1999, Hummels et al. 2001). Feenstra and Hanson modeled countries (such as Mexico and the United States) producing a single product, which raises the possibility that domestic and foreign workers are complements, rather than substitutes. One implication of rising production fragmentation is rising two-way trade in intermediate goods. Figure 2 shows that U.S. exports to Mexico and U.S. imports from Mexico move very closely together (correlation coefficient for the entire series is over 0.98) and increase their correlation over time and that the rate of increase in trade rises after 1994. Sotomayor (2016) shows that U.S.-Mexican trade is increasingly characterized by vertical specialization.

Most previous studies focus on the role of foreign investment (usually by multinationals).[1] Feenstra and Hanson (1997) focus on the role of foreign investment in Mexico's *maquiladora* sector[2] in its northern border region using the outsourcing model mentioned above. Vertical integration does not, however, necessarily require foreign direct investment. Foreign producers may independently design parts and products that can be used as inputs into production in other countries. This structure is known as global value chains (e.g. Gereffi 1999,2014). Falling trade barriers therefore potentially contribute to expanding trade in final, intermediate, and capital goods that facilitate vertical integration and global value chains.

The restructuring that took place following Mexico's liberalization in the 1980s (Hanson 1996) went beyond the foreign direct investment that characterized Mexico's maquiladora sector. Therefore, this paper asks whether Mexican manufacturing workers generally are complements

[1] For example, see Brainard and Riker (1997a,b)

[2] Mexico's maquiladora sector (sometimes referred to as the *in-bond* program) included assembly plants along Mexico's northern border that were allowed to effectively import parts duty-free for assembly in Mexico and then re-export to the United States. Mexico then paid tariffs only on value added within Mexico. NAFTA effectively extended the maquiladora program to the rest of the country, creating the potential for a national restructuring of production into the North American value chain.

or substitutes for U.S. workers. As such, this paper differs from past work because it abstracts from the direct role of outsourcing *per se* and focuses on manufacturing more generally. The main idea is that outsourcing plays an important, but not unique, role in labor market complementarities.

Estimating whether U.S. and Mexican workers are complements or substitutes is important for several reasons. The U.S. renegotiation and current consideration of the USMCA highlight the debate as to whether the U.S. and Mexico are competitors or partners. The education distribution of each country in 1994, shown in Figure 3, suggests that, at least in terms of skills, the United States and Mexico are natural complements. The differences in skills motivates trade in neoclassical trade models (e.g. the Heckscher-Ohlin theorem) and models of vertical investment. Feenstra and Hanson (1997) illustrate foreign direct investment's role in linking the U.S. and Mexico's northern border region and Robertson (2000) shows that the labor markets of the U.S. and Mexico are closely integrated. Nevertheless, several papers find that immigrants to the United States and U.S. workers are substitutes (Borjas 1987, 2003)[3] and popular antipathy towards NAFTA often centered on job loss to Mexico.

The remainder of the paper unfolds in three additional sections. The next section contains the estimation approach and results. Section three describes the data and section four presents the results. In this section, we also examine the robustness of the results by considering alternative measures of wages, specifications, and analyzing the relationship of U.S. production workers and Mexican maquiladora workers. The final section concludes.

[3] Although other studies, notably in other countries, find that migrants and natives are complements. See Dolado et al. (1996), Dorantes and Huang (1997), Gavosto et al. (1999), Greenwood and Hunt (1995) and Kim (2006).

Theoretic Foundation and Empirical Approach

While the Heckscher-Ohlin model suggests that production in two trading countries is separate and countries trade final goods, international production fragmentation implies that North America can be thought of as a single production unit. Papers that focus on production fragmentation, such as Feenstra and Hanson (1996,1997, 1999) often model production with a single international production function. The model here differs from their work because we model different worker types explicitly in a labor demand framework that is more general than their Ricardian-task model.

Begin by considering an industry i at time t with a simple production function that uses three kinds of labor: U.S. production workers (U^{us}), Mexican nonproduction workers (S^{mx}), and Mexican production workers (U^{mx}).[4] Mexican and U.S. workers enter into a single production function. Representing output as Y,

$$Y_{it} = F\left(U_{it}^{us}, S_{it}^{mx}, U_{it}^{mx}\right). \quad (1)$$

For the purposes of focusing on labor demand, it is convenient to focus on the cost function. The cost function approach requires a decision about exogeneity. We can either assume that quantities or wages are taken to be exogenous for the unit of observation. When dealing with relatively small industrial units (disaggregated industries), the general consensus (Hamermesh 1993) is that the appropriate assumption is that wages are considered exogenous. Therefore, the corresponding cost function can be represented as

$$C_{it} = G(w_{it}^{us,u}, w_{it}^{mx,s}, w_{it}^{mx,u}, Y). \quad (2)$$

[4] Here we use U for production workers and S for nonproduction workers in reference to early studies that used these categories to represent unskilled workers and skilled workers.

Hamermesh (1993) describes three ways to estimate labor demand equations. We opt for the second: estimating the derivatives of the cost function directly. Applying Shepard's lemma to (2) generates a system of three equations (one for each of the relevant factors) in which L represents employment.

$$\begin{aligned} L_{it}^{us\_u} &= \alpha_0 + \alpha_1 w_{it}^{us\_u} + \alpha_2 w_{it}^{mx\_s} + \alpha_3 w_{it}^{mx\_u} + \alpha_4 y_{it}^{mx} + \varepsilon_{it} \\ L_{it}^{mx\_s} &= \beta_0 + \beta_1 w_{it}^{us\_u} + \beta_2 w_{it}^{mx\_s} + \beta_3 w_{it}^{mx\_u} + \beta_4 y_{it}^{mx} + \lambda_{it} \\ L_{it}^{mx\_u} &= \gamma_0 + \gamma_1 w_{it}^{us\_u} + \gamma_2 w_{it}^{mx\_s} + \gamma_3 w_{it}^{mx\_u} + \gamma_4 y_{it}^{mx} + \varsigma_{it} \end{aligned} \quad (3)$$

In this structure, we expect that the own-price effect is negative ($\alpha_1 < 0, \beta_2 < 0, \gamma_3 < 0$). That is, we expect that the labor demand curves are downward sloping. The magnitude of these coefficients reveal how sensitive labor demand of each factor is to changes in its own wage.

The remaining estimated coefficients are the cross-price elasticities. The question presented by this paper – whether U.S. and Mexican workers are complements or substitutes – is answered by the signs of the $\alpha_2, \alpha_3, \beta_1, \beta_3, \gamma_1,$ and γ_2 coefficients. The signs of these estimates indicate whether or not factors are *p-complements* or *p-substitutes*. Positive (negative) coefficients suggest that increasing the wage of a factor on the right-hand side increases (reduces) the demand of the dependent factor on the left-hand side, which means that the factors are p-substitutes (complements). For example, a positive α_3 coefficient implies that U.S. and Mexican production workers are substitutes, while a negative α_3 coefficient implies that U.S. and Mexican production workers are complements.

The system in equation (3) includes Mexican industrial output.[5] The resulting coefficients are therefore interpreted as the constant-output substitution elasticities. Intuitively, these estimates tell us something about the curvature of the isoquant, and therefore we generally

[5] The value of production in real (1990) pesos.

expect that the factors are more likely to be substitutes. In practice, however, the output effect may be significant. That is, a fall in the price of one factor lowers the firm's total cost, and therefore may induce an expansion in output that increases the employment of any or all of the factors. Therefore, Hamermesh (1993) suggests that the *total* effect of factor price changes may be estimated by simply dropping the output terms from the system in (3), so that, alternatively, we may estimate

$$\begin{aligned} L_{it}^{us\_u} &= \alpha_0 + \alpha_1 w_{it}^{us\_u} + \alpha_2 w_{it}^{mx\_s} + \alpha_3 w_{it}^{mx\_u} + \varepsilon_{it} \\ L_{it}^{mx\_s} &= \beta_0 + \beta_1 w_{it}^{us\_u} + \beta_2 w_{it}^{mx\_s} + \beta_3 w_{it}^{mx\_u} + \lambda_{it} \,. \\ L_{it}^{mx\_u} &= \gamma_0 + \gamma_1 w_{it}^{us\_u} + \gamma_2 w_{it}^{mx\_s} + \gamma_3 w_{it}^{mx\_u} + \varsigma_{it} \end{aligned} \tag{4}$$

In the next section, we describe the data used to estimate (3) and (4).

Data

The data combine Mexico's Monthly Industrial Survey (*Encuesta Industrial Mensual,* or *EIM*) with U.S. Current Employment Statistics surveys. The Mexican National Institute for Statistics, Geography, and Informatics (*Instituto Nactional de Estadística, Geografia, e Informatica,* or *INEGI*) conducts the survey. Aggregated data for 205 industries are available on the internet[6] and cover the 2007-2017 period. The survey is designed to cover 80% of Mexican manufacturing production. The survey design is based in the Mexican Industrial Census, which is taken every five years. For the period covered in this paper, the survey covers about 6000[7] establishments. The survey excludes firms in the maquiladora industry, basic petrochemicals, petroleum refining, and firms with fifteen or fewer employees (*microindustria*). Variables include employment, hours, and wages for production (*obreros*) and nonproduction (*empleados*) workers, as well as the value of production and sales.

[6] See *Banco de Información Económica* at http://www.inegi.gob.mx.
[7] Over the sample period, the survey covers between 5,587 and 6,884 establishments.

The U.S. Current Employment Statistics program covers about 300,000 employer units for a coverage of over 35% of total payroll employment. The survey is conducted by the U.S. Bureau of Labor Statistics in cooperation with individual states. The data include average hourly wages and employment for production workers, but do not include value of production or earnings of nonproduction workers. As a result, monthly production value is not available at the industry level.[8] Hours and earnings data are available for about 850 industries, although the number of industries with complete data is much smaller.

The Mexican and the U.S. data are matched industry-by-industry at the most detailed level possible. 30 industries were successfully matched at various levels of aggregation. The matched 4-digit industries, NAICS codes, and English descriptions are listed in the Appendix. The level of aggregation ranges from 3 to 5 digit NAICS, with 23 industries matched at the 3-digit level, 88 industries matched at the 4-digit level, and 183 matched at the 5-digit level.

Summary Statistics

Total manufacturing employment in the United States is in the neighborhood of twelve million workers. In Mexico, total manufacturing employment is in the neighborhood of three million workers. Mexicans tend to work more hours per week. As such, we measure employment in mean monthly hours by industry. Mexican mean monthly hours worked is about one third of U.S. mean monthly hours worked.

Table 2 contains summary statistics on average hourly wages for U.S. and Mexican production workers and Mexican nonproduction workers. The means are listed by year from

[8] The Board of Governors of the Federal Reserve Board releases monthly production indices at the industry level. These indices are not usually direct measures of output. Instead, for much of manufacturing, the output indices are constructed functions of the Current Employment Statistics employment data.

2007 to 2017. Real wages are calculated using the domestic consumer price index for each country, and all currency is set to a base year of 2017 USD.

There is no clear trend in average U.S. hourly wages from 2007 to 2017. U.S. supervisor wages range from US$36.44 in 2012 to US$39.19 in 2017. U.S. non-supervisor wages range from US$19.88 in 2014 to US$20.55 in both 2009 and 2010. On the other hand, real dollar-valued Mexican wages appear to decline over time. Mexican non-supervisor wages range from US$1.75 in 2017 to US$2.61 in 2007, and Mexican supervisor wages range from US$4.40 in 2017 to US$6.68 in 2007. None of the trends, however, are statistically significant.

Estimation issues

Several estimations issues arise with this approach. First, the errors of the system are probably correlated. Therefore, Zellner's Seemingly Unrelated Regression approach is appropriate. Second, to control for possible fixed effects in our panel, estimates of equation (4) include industry-specific fixed effects.

Third, the labor demand theory technically implies symmetry across the three equations. Specifically, theoretic-imposed symmetry implies that $\alpha_2 = \beta_1, \alpha_3 = \gamma_1,$ and $\gamma_2 = \beta_3$. The results presented below include those with the symmetry restriction imposed during estimation. The results without symmetry are discussed in the text in the robustness section and provided in an estimation appendix.

Fourth, to compare U.S. and Mexican wages, we transform Mexican peso-valued wages into U.S. dollar wages using the current exchange rate and the U.S. consumer price index (base year 2017). Adjusting with the exchange rate may be problematic for several reasons. First, the

peso may not fully adjust to offset differences in inflation rates.[9] Second, Mexican non-maquila producers may make decisions based on pesos, while U.S. producers probably do not. The summary statistics in Table 2 and the main results use dollar-valued wages, and estimates using Mexican compensation measured in pesos are very similar.

Results

Table 2 contains the results for the estimates of the system in (3) using aggregate manufacturing data for the 2007-2017 period. The results include SUR estimation with cross-equation symmetry imposed. The first three columns therefore include the results from three simultaneously-estimated equations. There are several important results from Table 2. The first is that the own-price effects (the diagonal terms starting from the first estimated coefficient in the upper left corner) are all negative and significant, as expected. The results suggest that labor demand in the United States is more elastic than labor demand in Mexico. The second result is that nonproduction workers are substitutes for both kinds of production workers, which also is intuitive. That is, the coefficients involving Mexican nonproduction workers and the two production workers are positive.

In terms of the question posed by this paper, however, the main result is in the upper right corner of each set of three columns. The negative estimate of the relationship between U.S. production workers and Mexican production workers suggests that the U.S. and Mexican production workers are complements. These results are consistent with the results shown in Figures 1a and 1b that show that employment generally moves in similar ways in the two countries rather than falling in the United States and rising in Mexico.

[9] Robertson, Kumar, and Dutkowsky (2009), however, find that purchasing power parity, or the adjustment of prices and exchange rates necessary to keep product prices comparable across countries, is stronger as products become more precisely identified in Mexico and the United States (i.e. disaggregated products).

The second set of three columns in Table 2 contains the results from estimating the system in equation (4): the total effect estimates that exclude output. The results similar in several important ways. The own-price effects are again negative and the coefficients for the nonproduction and production workers again suggest that these worker types are substitutes. The U.S. and Mexican production workers, however, are estimated to be complements (with an estimated coefficient that is larger in absolute value). Excluding output reduces the estimated R-squared value, but overall the equations are strongly consistent with theory. The remainder of the paper explores the robustness of this basic result.

Robustness

There are several ways in which to explore the robustness of the main results. This section contains results from relaxing the symmetry assumption, different aggregation levels, different industries, and different time periods.

Relaxing Symmetry

Estimates of systems (3) and (4) without imposing symmetry are found in Appendix Table 2a. The own-price effects are all negative and five of the six are statistically significant. The U.S. and Mexican production worker own-price effects are statistically significant and greater than one. Without imposing symmetry, the U.S. responsiveness to Mexican production-worker wages estimate is 0.-342, while the Mexican production worker responsiveness to the U.S. production worker wage is -2.110. These estimates suggest that Mexican employment is both elastic and much more responsive to the changes in the U.S. production worker wage. In other words, these results suggest that the U.S. wages drive Mexican employment much more (by more than a factor of six) than Mexican wages drive U.S. employment. These results are consistent with the United States being the driving force of North American global value chains

and that labor demand in Mexico may take the U.S. shocks as exogenous (which helps with our identification).

The difference between the U.S. and Mexican production worker estimates is statistically significant (a t-test rejects the null that the coefficients are equal). The t-test results for the pair-wise symmetry restrictions are found in Appendix Table 2b. The null that the Mexican production and nonproduction worker coefficients are the same is not rejected (with coefficients of 0.092 and 0.622). Although the null that they coefficients are equal is rejected for other pairs, we proceed with the imposed symmetry constraints because they are mandated by theory.

Aggregation levels

If industries are linked through outsourcing or production fragmentation, then we might expect that the results of complementarity might be starker as we disaggregate from overall manufacturing. Table 3 shows the results of estimating (4) using matched industries aggregated at the 4-digit level. As earlier, the own-price effects are negative and significant, and the production-nonproduction coefficients are positive. The U.S. and Mexican production worker coefficient is negative and statistically significant and the estimate is more precisely measured than in Table 2. The overall R-squared estimates are also very high.

Results for the 3-digit and 5-digit industry levels are available upon request, but the results are similar. In particular, at the 5-digit level, the estimate of complementarity between U.S. and Mexican production workers is -0.044 (significant at the 1% level). The smaller result at the 5-digit level than the 4-digit level (which, in turn, is smaller than the estimate at the 1-digit level) might suggest that there is integration across narrowly-defined industries. The results at the 3-digit level still imply complementarity (i.e. the estimated coefficient is negative), but is

only marginally significant (p-value of just over 10%). The relatively large standard errors at the 3-digit level may imply heterogeneity across industries, which we explore in the next section.

Industries

Assuming that vertical integration is predominantly within in the same industry, it is interesting to consider estimates of complementarity for specific industries. In this section, we consider the results for apparel, food products, and the automobile industry.

Apparel

Apparel is a particularly important industry in the global value chain literature (Robertson et al. (2009) and was one of the early industries to restructure vertically between Mexico and the United States (Bair 2002). Apparel is also a labor-intensive industry and therefore often in the popular spotlight as one whose jobs are especially sensitive to imports and international competition. Since NAFTA, however, the industry has become an example of vertical integration, with Mexican assembly plants using U.S. designs and fabrics. In the early 2000s competition with China reduced employment in Mexico, but China's wage growth and slowing exports have corresponded to a resurgence of Mexican apparel production.

Table 5a contains the results from estimating (4) for just the apparel industry. The own-price effects are again negative and significant, and the results imply that production and nonproduction workers are substitutes. The estimates also imply that that U.S. and Mexican production workers are complements. The apparel estimates contrast with previous estimates in that the estimate of complementarity is not estimated as precisely, which may reflect the structure of the integration between the countries. That is, it may be that Mexico is producing apparel from U.S. textile goods, and within apparel there may be less room for complementarity of labor as in other sectors.

Food Products

Vertical integration in U.S. food manufacturing industries is not new (Livesay and Porter 1969), but current estimates of the degree of vertical integration in the U.S. food products industry suggest that the degree of vertical integration is quite low (Bhuyan 2005). Table 5b contains the results for the food products industry (311). The results are consistent in some ways with earlier tables. In particular, the own-price effects are negative, although statistically significant for two of the three factors. The other coefficients, however, flip signs. In particular, production and nonproduction workers are now estimated to be complements, and U.S. and Mexican production workers are estimated to be substitutes. In other words, Table 5b shows that the complementarity result from other tables is not simply an artifact of the estimation approach. Note that this result does not suggest that there is no vertical integration in agricultural industries (some agricultural industries have significant vertical integration), but overall U.S. and Mexican production workers are not complements.

Automobiles

The global automobile industry is one of the most significant examples of vertically-structured value chains (Stugeon, Van Biesebroeck, and Gereffi 2008) and has received considerable attention for innovation and structure (Novak and Stern 2007, Hashmi and Van Biesebroeck 2010, Van Biesebroeck 2006). Vertical integration in the North American automobile industry advanced considerably with the Mexican maquiladora program that attracted investment in light assembly of automobile parts (especially wiring harnesses) along Mexico's Northern border. Mexico moved from the third largest supplier to the United States of automobile parts in 1990 to first by 2005 (Sturgeon and Van Biesebroeck 2010).

Table 5c shows two sets of results for the automobile industry. The three columns show the results of estimating (4), just as in previous tables. Again, the own-price effects are negative

and significant. They also imply that demand for U.S. production workers is much more elastic than the demand for Mexican workers in the automobile industry. The results also suggest that that the production workers are complements, but only weakly. This result seems surprising for a highly vertical industry so closely integrated with the United States. Sturgeon and Van Biesenbroeck (2010) suggest that the financial crisis of 2007-2008 hit the U.S. automobile industry especially hard – more so than in any other U.S. industry other than banking and finance. Furthermore, they show that the crisis affected the two countries asymmetricially. In particular, during the crisis the U.S. growth was -17.58%, while Mexico only contracted 4.44%.

Based on these results, the second set of results in Table 5c show the results with an additional control for the financial crisis. The results show that the U.S. demand becomes less elastic (which is intuitive), but the Mexican own-price effects are nearly identical. In terms of complementarity, the results with the crisis control show that the complementarity result is statistically significant. These results imply that U.S. and Mexican automobile workers outside of Mexico's maquiladora industry are working together in a common value chain rather than competing for jobs.

Post-NAFTA to current survey: 1994-2005

The sensitivity of the automobile industry to the financial crisis, as well as the gradual phase-in of the provisions of the North American Free Trade Agreement, raise the question about whether these results are robust to other time periods. Survey changes within Mexico make earlier datasets difficult to compare (and merge) directly with the current data, but data do exist for the time period beginning with the implementation of NAFTA and 2005. The source of these data are the same Mexican surveys as the 2007-2017 data (Mexico's Monthly Industrial Survey).

To carry out the analysis for the earlier period, the earlier data are again matched with the U.S. Current Employment Statistics surveys and used to estimate (4).

Table 6 contains summary statistics. Real wages are calculated using the domestic consumer price index for each country. All currency is set to a base value of 1990 USD. The dataset has 10,872 observations across all industry aggregation levels. The data cover 80 different industries. On average, the wages of American white-collar workers, Mexican white-collar workers, and Mexican blue-collar workers went up over this 12 year period. Employment for white-collar workers in both the United States and Mexico went down slightly in this period, but employment for Mexican blue-collar workers stayed about the same.

The constrained results for both the constant output and total effect are presented in Table 7. Many of the results are similar to the 1987-2004 data. The own price effects are negative and are similar to the magnitudes suggested by Hamermesh (1993). The output effects are also all positive. The results for Mexican nonproduction workers and production workers are again positive. The main result, however, is that Mexican production workers and U.S. production workers are complements, and the estimated coefficients are statistically significant. The coefficient magnitudes are smaller than those in Table 2. While the difference between Table 2 and Table 7 are not statistically significant, the smaller magnitudes are consistent with the idea that during this period both economies were going through the restructuring process. That is, Mexico was becoming integrated into the North American value chain beyond the maquiladora sector. This result emerges with and without including the value of production. In fact, the estimates are very similar in absolute magnitude and statistical significance with and without production included.

Pre-NAFTA: 1987-1994

The finding that the estimated coefficients that measure the degree of complementarity between U.S. and Mexican production workers was smaller in the 1994-2005 period than in the 2007-2018 period raises the question of the degree of complementarity prior to NAFTA. The Mexican Monthly Industrial Census was revised in 1993. In the revision, the sample of industries changed to accommodate a new industrial classification system. Prior to the change, another sample of the EIM guided Mexican manufacturing statistics. That is, data exist from the pre-NAFTA period but are not strictly comparable to the later two samples. The earlier sample covered 129 industries and 3,172 manufacturing firms in 1987. The data represent a balanced panel of 129 industries over the period 1987-1994.

To analyze the 1987-2004 period, the same matching exercise combines the Mexican data with the U.S. data described earlier using the same 80 industries described in Appendix 1. The combined data are then applied to the same estimation equations as the later data set. Table 8 contains data from the 1987-1994 survey. Real wages are calculated using the domestic consumer price index for each country. All currency is set to a base of 1990 USD.

Table 9 contains the results for the 1987-1994 period with the symmetry restriction imposed. Some of the features of Table 9 are consistent with earlier tables. Specifically, all of the own-price effects are negative and are within the range suggested by Hamermesh (1993). Two key differences emerge. The first is that nonproduction and production workers are now estimated as complements. The main difference, however, is that the pattern of complementarity that emerge in the 1994-2005 and 2007-2017 periods reverses. Table 9 suggests that in the 1987-1994 period, U.S. production workers were substitutes with Mexican production workers. Differences in the sample, or differences in the sample period (or both), could explain the differences in the results. That said, however, it is interesting that the results

suggest that, prior to NAFTA, U.S. and Mexican production workers outside of the Mexican maquiladora sector are estimated to be substitutes and that NAFTA may have contributed to a restructuring of North American production into a single production unit.

Conclusions

As stated in the preamble, NAFTA's goals included increasing trade, investment, and integration between Canada, Mexico, and the United States. As such, NAFTA had the potential to increase labor market integration in North America by increasing trade and foreign direct investment. While other papers have considered complementarities of North American workers in terms of migration and foreign directly investment, few, if any, papers have focused on trade's role in facilitating complementarity or substitutability in North American labor markets outside of Mexico's maquiladora sector. This is surprising, given the fact that one of the key reasons for popular resistance of NAFTA was the popular belief that Mexican workers are substitutes for U.S. workers. That is, it was widely believed that free trade with relatively low-wage Mexico would induce displacement of U.S. workers as cheaper products arrived from the south.

There are many obvious examples of U.S. and Mexican communities that have been adversely affected by trade. Current literature shows that adjustment to changes in trade policy and trade flows is extremely costly and that specific markets were adversely affected by rising trade flows from developing countries (e.g. Artuc, McLaren, and Chaudhuri 2010, and Hakobyan and McLaren 2016). The result of this painful adjustment was a restructuring of North American production into value chains that might make Mexican workers complements with U.S. workers rather than substitutes. Whether U.S. and Mexican workers are complements or substitutes is the

question this paper asks. The main results suggest that U.S. and Mexican workers are currently complements and not substitutes.

In addition, this paper evaluates whether or not Mexican and U.S. workers are complements or substitutes before and after the NAFTA period. The main results indicate that, during the NAFTA period, U.S. and Mexican production workers are complements, while U.S. production and Mexican nonproduction workers are substitutes. This has significant implications for North American labor market integration. The United States and Mexico seem to act more like a single production unit rather than competing units. One may conclude from this result that, while some job displacement is inevitable as economies adjust, North American economic interests are closely tied and that policy makers would do well to think of Mexico as an economic partner rather than a competitor.

References

Artuc, Erhan, Subham Chaudhari, and John McLaren. 2010. "Trade Shocks and Labor Adjustment: A Structural Empirical Approach" *American Economic Review* 100(3): 1008-45.

Bair, Jennifer. 2002. "Beyond the Maquila Model? NAFTA and the Mexican Apparel Industry." *Industry and Innovation* 9 (3): 203-225.

Bernard, Andrew, J. Bradford Jensen, and Peter K Schott. 2006. "Survival of the Best Fit: Competition from Low Wage Countries and the (Uneven) Growth of US Manufacturing Plants." *Journal of International Economics* 68 (1): 219-237.

Blomstrom, Magnus, Gunnar Fors, and Robert E Lipsey. 1997. "Foreign Direct Investment and Employment: Home Country Experience in the United States and Sweden." *The Economic Journal* 107 (445): 1787-1797.

Borjas, G. J. 2003. "The Labor Demand Curve is Downward Sloping: Reexamining the Impact of Immigration on the Labor Market." *Quarterly Journal of Economics* 118 (4): 1335-1374.

Borjas, G. J. 1987. "Immigrants, minorities, and labor market competition." *Industrial and Labor Relations Review* 40 (3): 382-392.

Brainard, S. Lael, and David A. Riker. 1997a. "Are U.S. Multinationals Exporting U.S. Jobs?" NBER Working Paper No. 5958.

Brainard, S. Lael, and David A. Riker. 1997b. "U.S. Multinationals and Competition from Low-Wage Countries." NBER Working Paper No. 5959.

BLS Handbook of Methods, Chapter 2. "Employment, hours, and earnings from the establishment survey". http://www.bls.gov/opub/hom/homch2_itc.htm.

Bhuyan, Sanjib. 2005. "An Empirical Evaluation of Factors Determining Vertical Integration in U.S. Food Manufacturing Industries." *Agribusiness*, 21(3): 429-45.

Chen, Tain-Jy, and Ying-Hua Ku. 2003. "The Effect of Overseas Investment on Domestic Employment." NBER Working Paper No. 10156.

Clark, Don P., Thomas M. Fullerton, and Duane Burdorf. 2001. "Intra-Industry Trade Between the United States and Mexico: 1993-98." *Estudios Económicos* 16 (2): 167-183.

Dolado, J. J., R. Duce, and J. F Jimeno-Serrano. 1996. "The Effects of Migration on the Relative Demand of Skilled Versus Unskilled Labour: Evidence from Spain." CEPR Discussion Papers. http://www.cepr.org/pubs/dps/DP1476.asp.

Dorantes, C. A., and W. Huang. 1997. "Unemployment, Immigration, and NAFTA: A panel Study of Ten Major U.S. Industries." *Journal of Labor Research* 18 (4): 613-619.

Engel, Charles, and John H. Rogers. 1996. "How Wide is the Border?" *American Economic Review 86:* 1112-1125.

Feenstra, Robert, and Gordon Hanson. 1996. "Globalization, Outsourcing, and Wage Inequality." *American Economic Review* 86(2): 240-45.

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

Feenstra, Robert, and Gordon Hanson. 1999. "The Impact of Outsourcing and High-Technology Capital on Wages: Estimates for the United States, 1979-1990" *Quarterly Journal of Economics* 114(3): 907-40**.**

Gavosto, A., A. Venturini, and C. Villosio. 1999. "Do Immigrants Compete with Natives?" *Labour* 13(3): 603-621.

Gereffi, Gary. 1999. "International trade and industrial upgrading in the apparel commodity chain." *Journal of International Economics*, 48: 37-70.

Gereffi, Gary. 2014. "Global value chains in a post-Washington Consensus World." *Review of International Political Economy*, 21(1): 9-37.

Greenwood, M. J., and G. L. Hunt. 1995. "Economic Effects of Immigrants on Native and Foreign-born Workers: Complementarity, Substitutability, and Other Channels of Influence." *Southern Economic Journal* 61 (4): 1076-1097.

Hakobyan, Shushanik, and John McLaren. 2016. "Looking for Local Labor Market Effects of NAFTA." *The Review of Economics and Statistics*, 98(4): 728-741.

Hamermesh, D. 1993. *Labor Demand*. Princeton, NJ: Princeton University Press,.

Hanson, Gordon. 1996). "Agglomeration, Dispersion, and the Pioneer Firm*." Journal of Urban Economics* 39: 255- 281.

Hashimi, Aamir Rafique and Johannes Van Biesebroeck. 2010. "Market Structure and Innovation: A Dynamic Analysis of the Global Automotive Industry" NBER Working Paper 15959.

Hijzen, Alexander, and Peter Wright. 2005. "Migration, Trade and Wages." Unpublished manuscript. http://www.cepii.fr/anglaisgraph/workpap/summaries/2005 /wp05-06.htm.

Hummels, David, Jun Ishii, and Kei-Mu Yi. 2001. "The Nature and Growth of Vertical Specialization in World Trade." *Journal of International Economics* 54: 75-96.

Kim, C. 2006. "Immigration, FDI, and International Trade." Working Paper. http://economics.uoregon.edu/papers /UO-2006-3_Kim_Immigration.pdf.

Livesay, Harold C. and Patrick G. Porter. 1969 "Vertical Integration in American Manufacturing, 1899-1948" *Journal of Economic History*, 29(3): 494-500.

Novak, Sharon and Scott Stern. 2007. "How Does Outsourcing affect Performance Dynamics? Evidence from the Automobile Industry" NBER Working Paper 13235.

Robertson, Raymond. 2000. "Wage Shocks and North American Labor Market Integration." *American Economic Review* 90 (4): 742-64.

Robertson, Raymond. 2005. "Defining North American Economic Integration" In *North American Agrifood Market Integration: Situation and Perspectives, Proceedings of the First Annual North American Agrifood Market Integration Workshop,* edited by K.M. Huff, K.D. Meilke, R.D. Knutson, R.F. Ochoa, J. Rude, and A. Yunez-Naude. Winnipeg, Manitoba: Friesen Printers. http://naamic.tamu.edu/cancun/robertson.pdf.

Robertson, Raymond. 2004. "Relative Prices and Wage Inequality: Evidence from Mexico." *Journal of International Economics* 64 (2): 387-409.

Robertson, Raymond, Drusilla Brown, Gaëlle Pierre, and Laura Sanchez-Puerta (eds.). 2009. *Globalization, Wages, and the Quality of Jobs Five Country Studies*. Washington, D.C.: The World Bank.

Robertson, Raymond, and Donald H. Dutkowsky. 2002. "Labor Adjustment Costs in a Destination Country: The Case of Mexico." *Journal of Development Economics* 67 (1): 29-54.

Robertson, Raymond; Kumar, Anil; Dutkowsky, Donald. 2009. "Purchasing Power Parity and Aggregation Bias in a Developing Country: The Case of Mexico" *Journal of Development Economics* November, 90(2): 237-243.

Sotomayor, Maritza. 2016. "Vertical Specialization of Production: Critical Review and Empirical Evidence for the Mexican Manufacturing Industries 1994-2014." *International Journal of Business and Social Research* 6 (2): 11-28.

Sturgeon, Timothy, Johannes Van Biesebroeck, and Gary Gereffi. 2008. "Value Chains, Networks, and Clusters: Reframing the Global Automotive Industry" *Journal of Economic Geography* 8(3): 297-321.

Sturgeon, Timothy, and Van Biesebroeck. 2010. "Effects of the Crisis on the Automotive Industry in Developing Countries A Global Value Chain Perspective." Policy Research Working Paper 5330. World Bank.

Van Biesebroeck, Johannes. 2007. "Complementarities in Automobile Production." *Journal of Applied Econometrics* 22(7): 1315-1345.

Figure 1a: U.S. Manufacturing Employment and Manufacturing Output

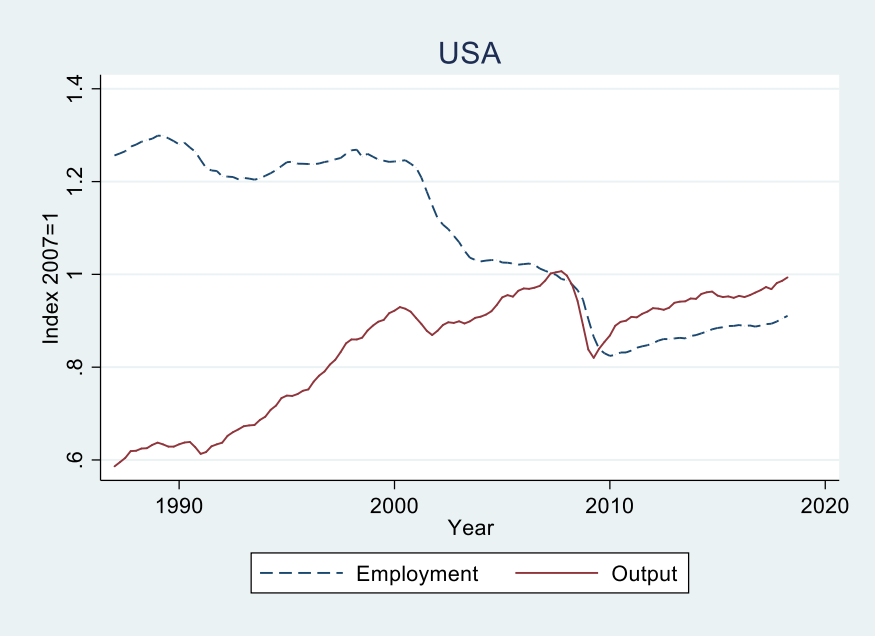
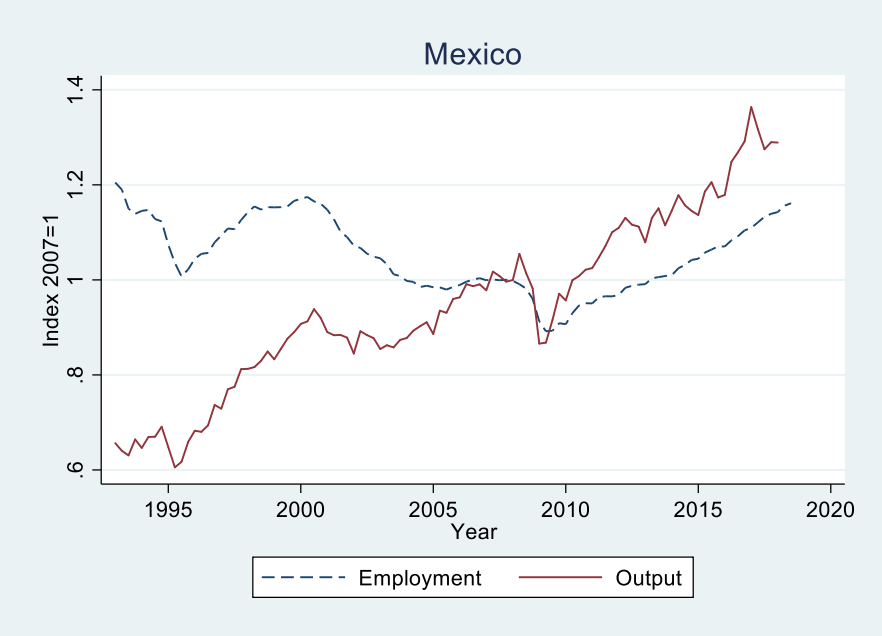
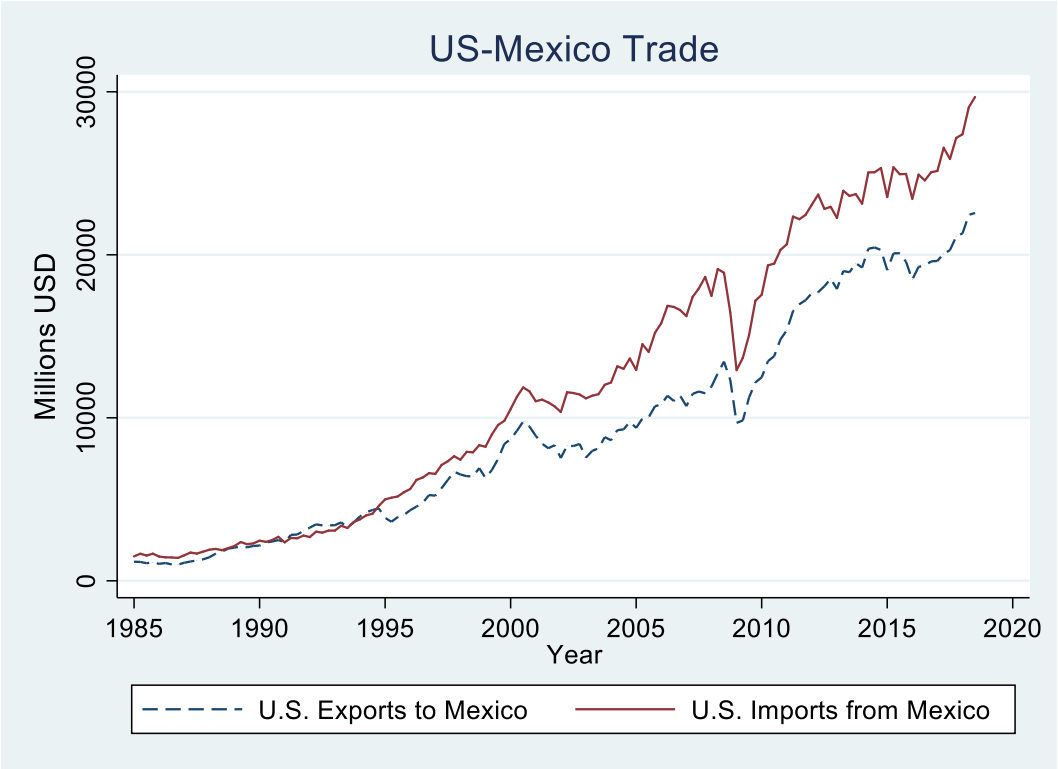


Figure 1b: Mexican Manufacturing Employment and Manufacturing Output



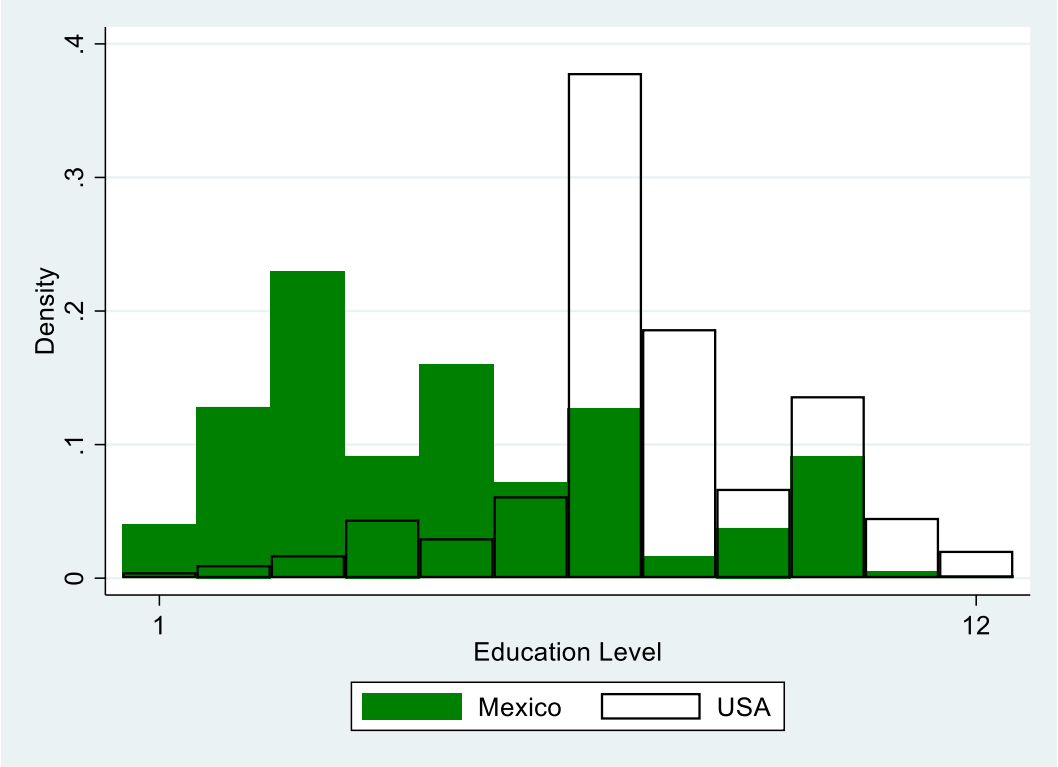
Notes: U.S. Employment and output data come from the FRED at the St. Louis Federal Reserve Bank. See https://fred.stlouisfed.org. Mexican employment and output data come from INEGI and are compiled by INEGI and the authors from several sources, including the Sistema de Cuentas Nacionales de México, the Encuesta Industrial Mensual, and the Encuesta Industrial Anual. All four series are normalized to 1 for 2007 by the author.

Figure 2: Change in total trade between US and Mexico



Notes: Data represent U.S. trade in goods with Mexico and come from https://www.census.gov/foreign-trade/balance/c2010.html#2018. As noted on that page, all figures are in millions of U.S. dollars on a nominal basis, not seasonally adjusted unless otherwise specified. Details may not equal totals due to rounding. Table reflects only those months for which there was trade.

Figure 3: 1994 U.S. and Mexico Education Levels



Notes: Education levels are sorted into 12 categories. Mexican data are from the 1994 Encuesta Nacional de Empleo Urbano. U.S. data are from the 1994 Monthly Outgoing Rotation Groups of the Current Population Surveys. Education levels are: 1 = Less Than 1st Grade , 2 = 1st,2nd,3rd Or 4th Grade, 3 = 5th Or 6th Grade, 4 = 7th Or 8th Grade, 5= 9th Grade, 6= 10^{th}, 11^{th}, and 12^{th} Grade (no diploma), 7 = High School Grad-Diploma Or Equiv (GED), 8 Some College But No Degree, 9 = Associate Degree-Occupational/Vocational or Associate Deg.-Academic Program, 10 = Bachelor's Degree(ex:ba,ab,bs), 11 = Master's(ex:MA,MS,MEng,MEd,MSW), 12 = Professional School Deg(ex:MD,DDS,DVM) or Doctorate Degree(ex:PhD,EdD).

Table 1
Summary Statistics for the 2007-2017 dataset

Year	US production hourly wage	MX non production hourly wage	MX production hourly wage
2007	20.25	6.69	2.64
2008	20.00	6.54	2.58
2009	20.58	5.72	2.24
2010	20.58	6.09	2.39
2011	20.23	6.14	2.40
2012	19.99	5.89	2.32
2013	19.98	6.18	2.40
2014	19.97	6.08	2.36
2015	20.36	5.29	2.06
2016	20.59	4.66	1.80
2017	20.55	4.54	1.77

Notes: Wages are the average real dollar-valued hourly wage across the entire sample. Mexican wage values are converted with the nominal exchange rate and the U.S. consumer price index (CPI). U.S. values are converted to real using the U.S. CPI.

Table 2
SUR Results for the 2007-2017 data
Aggregate Manufacturing

VARIABLES	(1) US Blue Collar Workers Hours	(2) Mexican White-Collar Workers Hours	(3) Mexican Blue-Collar Workers Hours	(4) US Blue Collar Workers Hours	(5) Mexican White-Collar Workers Hours	(6) Mexican Blue-Collar Workers Hours
US Blue Collar Wages	-0.789*	0.295***	-0.291***	-0.737**	0.421***	-0.368***
	(0.417)	(0.090)	(0.108)	(0.322)	(0.076)	(0.082)
Mexican White-Collar Wages	0.295***	-0.456***	0.266***	0.421***	-0.431***	0.312***
	(0.090)	(0.062)	(0.070)	(0.076)	(0.064)	(0.070)
Mexican Blue-Collar Wages	-0.291***	0.266***	-0.689***	-0.368***	0.312***	-0.614***
	(0.108)	(0.070)	(0.082)	(0.082)	(0.070)	(0.077)
Output	1.644*	1.857***	3.222***			
	(0.883)	(0.388)	(0.592)			
Constant	3.971	4.443	-4.167	17.218***	19.301***	22.499***
	(8.092)	(3.267)	(4.922)	(0.995)	(0.225)	(0.247)
Observations	126	126	126	126	126	126
R-squared	0.163	0.345	0.411	0.121	0.177	0.289

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Hours are the monthly hours and wages are the real dollar-valued hourly wage. Mexican values are converted with the nominal exchange rate and the U.S. CPI. U.S. values are converted to real using the U.S. CPI.

Table 3: SUR Results for the 2007-2017 data
4-digit Industries

VARIABLES	(1) US Blue Collar Workers Hours	(2) Mexican White-Collar Workers Hours	(3) Mexican Blue-Collar Workers Hours
US Blue Collar Wages	-0.065*	0.100***	-0.070***
	(0.034)	(0.010)	(0.011)
Mexican White-Collar Wages	0.100***	-0.209***	0.025***
	(0.010)	(0.007)	(0.006)
Mexican Blue-Collar Wages	-0.070***	0.025***	-0.245***
	(0.011)	(0.006)	(0.008)
Output	0.949***	3.229***	3.690***
	(0.068)	(0.063)	(0.068)
Constant	8.088***	6.323***	7.060***
	(0.200)	(0.159)	(0.170)
Observations	5,538	5,538	5,538
R-squared	0.968	0.992	0.991

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All estimation contains industry fixed effects. Hours are the monthly hours and wages are the real dollar-valued hourly wage. Mexican values are converted with the nominal exchange rate and the U.S. CPI. U.S. values are converted to real using the U.S. CPI.

Table 5a: Industry Specific Results
Apparel

VARIABLES	(1) US Blue Collar Workers Hours	(2) Mexican White-Collar Workers Hours	(3) Mexican Blue-Collar Workers Hours
US Blue Collar Wages	-1.287***	0.339***	-0.139*
	(0.235)	(0.072)	(0.072)
Mexican White-Collar Wages	0.339***	-0.356***	0.206***
	(0.072)	(0.054)	(0.050)
Mexican Blue-Collar Wages	-0.139*	0.206***	-0.428***
	(0.072)	(0.050)	(0.050)
Output	7.110***	7.229***	8.144***
	(0.920)	(0.839)	(0.670)
Constant	-5.040**	-3.793*	-3.064*
	(2.525)	(2.101)	(1.682)
Observations	126	126	126
R-squared	0.542	0.365	0.457

NOTES: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The Apparel industry is represented by NAICS 315. Hours are the monthly hours and wages are the real dollar-valued hourly wage. Mexican values are converted with the nominal exchange rate and the U.S. CPI. U.S. values are converted to real using the U.S. CPI.

Table 5b: Industry Specific Results
Food Products

VARIABLES	(1) US Blue Collar Workers Hours	(2) Mexican White-Collar Workers Hours	(3) Mexican Blue-Collar Workers Hours
US Blue Collar Wages	-0.462*	-0.205***	0.135**
	(0.237)	(0.061)	(0.058)
Mexican White-Collar Wages	-0.205***	-0.106***	-0.020
	(0.061)	(0.035)	(0.035)
Mexican Blue-Collar Wages	0.135**	-0.020	-0.054
	(0.058)	(0.035)	(0.036)
Output	-2.808***	1.250***	0.529
	(0.753)	(0.379)	(0.336)
Constant	21.408***	14.649***	16.699***
	(2.320)	(1.070)	(0.962)
Observations	126	126	126
R-squared	0.137	0.259	0.235

NOTES: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The Food industry is represented by NAICS 311.. Hours are the monthly hours and wages are the real dollar-valued hourly wage. Mexican values are converted with the nominal exchange rate and the U.S. CPI. U.S. values are converted to real using the U.S. CPI.

Table 5c: Industry Specific Results
Automobiles

VARIABLES	(1) US Blue Collar Workers Hours	(2) Mexican White-Collar Workers Hours	(3) Mexican Blue-Collar Workers Hours	(4) US Blue Collar Workers Hours	(5) Mexican White-Collar Workers Hours	(6) Mexican Blue-Collar Workers Hours
US Blue Collar Wages	-1.208***	0.260***	-0.023	-0.731***	0.316***	-0.228***
	(0.266)	(0.056)	(0.061)	(0.211)	(0.055)	(0.057)
Mexican White-Collar Wages	0.260***	-0.511***	0.110*	0.316***	-0.504***	0.021
	(0.056)	(0.054)	(0.057)	(0.055)	(0.050)	(0.052)
Mexican Blue-Collar Wages	-0.023	0.110*	-0.477***	-0.228***	0.021	-0.418***
	(0.061)	(0.057)	(0.064)	(0.057)	(0.052)	(0.058)
Output	1.444**	7.484***	12.524***	5.473***	9.409***	13.196***
	(0.656)	(0.537)	(0.533)	(0.622)	(0.643)	(0.613)
Crisis				0.198***	0.116***	0.070***
				(0.019)	(0.025)	(0.024)
Constant	11.701***	-3.952**	-15.964***	-0.987	-9.426***	-17.037***
	(2.525)	(1.599)	(1.594)	(2.229)	(1.854)	(1.777)
Observations	126	126	126	126	126	126
R-squared	0.439	0.797	0.891	0.650	0.821	0.906

Notes: Standard errors in parentheses. ***p<0.01, ** p<0.05, * p<0.1. The automobile industry is represented by NAICS 336. Hours are the monthly hours and wages are the real dollar-valued hourly wage. Mexican values are converted with the nominal exchange rate and the U.S. CPI. U.S. values are converted to real using the U.S. CPI.

Table 6: Summary Statistics
1994-2005

Year	US hourly wage	MX NP Wage	MX P Wage	US Production workers	MX NP Employment	MX P Employment
1994	11.00	6.44	2.24	115.07	4.62	10.28
1995	10.94	4.06	1.39	116.93	4.30	9.34
1996	10.95	4.22	1.43	116.24	4.32	9.71
1997	11.01	5.10	1.66	117.01	4.49	10.32
1998	11.09	5.04	1.73	117.11	4.68	10.76
1999	11.15	5.70	1.99	115.27	4.79	10.81
2000	11.16	6.61	2.36	114.70	4.84	10.99
2001	11.17	7.46	2.68	107.59	4.74	10.41
2002	11.39	7.62	2,78	98.85	4.55	9.85
2003	11.43	7.11	2.65	93.75	4.54	9.52
2004	11.46	7.01	2.66	92.46	4.45	9.27
2005	11.42	7.26	2.74	92.04	4.39	9.18

Notes: Mexican data are from the Mexican *Encuesta Industrial Mensual* and the U.S. data are from the U.S. Current Employment Statistics. Wages are in real U.S. dollars per hour. Employment are survey sample sizes measured in thousands of workers. In the column headings, P represents production workers and NP represents nonproduction workers.

Table 7: SUR Results for 1994-2005

VARIABLES	(1) US Blue Collar Workers Hours	(2) Mexican White-Collar Workers Hours	(3) Mexican Blue-Collar Workers Hours	(4) US Blue Collar Workers Hours	(5) Mexican White-Collar Workers Hours	(6) Mexican Blue-Collar Workers Hours
US Blue Collar Wages	-0.232***	0.009***	-0.046***	-0.238***	0.013***	-0.040***
	(0.012)	(0.003)	(0.003)	(0.012)	(0.003)	(0.003)
Mexican White-Collar Wages	0.009***	-0.217***	0.003	0.013***	-0.151***	0.075***
	(0.003)	(0.005)	(0.005)	(0.003)	(0.005)	(0.005)
Mexican Blue-Collar Wages	-0.046***	0.003	-0.261***	-0.040***	0.075***	-0.143***
	(0.003)	(0.005)	(0.005)	(0.003)	(0.005)	(0.005)
Output	0.024***	0.333***	0.453***			
	(0.002)	(0.005)	(0.005)			
Constant	3.314***	3.533***	3.226***	3.606***	7.398***	8.517***
	(0.032)	(0.060)	(0.061)	(0.026)	(0.017)	(0.018)
Observations	9,900	9,900	9,900	9,900	9,900	9,900
R-squared	0.940	0.981	0.978	0.939	0.972	0.960

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All estimation contains industry fixed effects. Hours are the monthly hours and wages are the real dollar-valued hourly wage. Mexican values are converted with the nominal exchange rate and the U.S. CPI. U.S. values are converted to real using the U.S. CPI.

Table 8:
Summary Statistics for 1984-1994

Year	US Wage	MX NP Wage	MX P Wage	US P Emp	MX NP Emp	MX P Emp
1987	11.47	1.98	0.98	91.78	3.22	7.49
1988	11.33	2.64	1.22	94.22	3.20	7.45
1989	11.10	3.25	1.37	94.47	3.25	7.71
1990	11.14	3.84	1.50	116.37	3.25	7.74
1991	11.04	4.70	1.77	111.88	3.25	7.61
1992	11.01	5.91	2.13	110.61	3.16	7.31
1993	10.98	6.90	2.42	111.06	2.98	6.73
1994	11.00	7.03	2.44	113.63	2.82	6.43

Notes: Mexican data are from the Mexican *Encuesta Industrial Mensual* and the U.S. data are from the U.S. Current Employment Statistics. Wages are in real U.S. dollars per hour. Employment are survey sample sizes measured in thousands of workers. In the column headings, P represents production workers and NP represents nonproduction workers. The strong growth in dollar-valued wages is partially explained by real peso appreciation during this period.

Table 9: SUR Results for 1987-1994

VARIABLES	(1) US Blue Collar Workers Hours	(2) Mexican White-Collar Workers Hours	(3) Mexican Blue-Collar Workers Hours	(4) US Blue Collar Workers Hours	(5) Mexican White-Collar Workers Hours	(6) Mexican Blue-Collar Workers Hours
American White-Collar Workers	-0.203***	-0.020***	0.019***	-0.206***	-0.018***	0.020***
	(0.018)	(0.003)	(0.004)	(0.018)	(0.003)	(0.004)
Mexican White-Collar Workers	-0.020***	-0.307***	-0.019***	-0.018***	-0.286***	0.014**
	(0.003)	(0.006)	(0.007)	(0.003)	(0.006)	(0.007)
Mexican Blue-Collar Workers	0.019***	-0.019***	-0.381***	0.020***	0.014**	-0.349***
	(0.004)	(0.007)	(0.008)	(0.004)	(0.007)	(0.008)
Output	0.009***	0.181***	0.227***			
	(0.002)	(0.008)	(0.009)			
Constant	3.485***	5.078***	5.302***	3.591***	7.095***	7.825***
	(0.054)	(0.093)	(0.099)	(0.041)	(0.021)	(0.023)
Observations	4,715	4,715	4,715	4,715	4,715	4,715
R-squared	0.954	0.973	0.973	0.954	0.971	0.969

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All estimation contains industry fixed effects. Hours are the monthly hours and wages are the real dollar-valued hourly wage. Mexican values are converted with the nominal exchange rate and the U.S. CPI. U.S. values are converted to real using the U.S. CPI.

Appendix
Industry List – 4 digit NAICs codes

US	Industry Name	MX
3111	Animal food	3111
3112	Grain and oilseed milling	3112
3113	Sugar and confectionery products	3113
3114	Fruit and vegetable preserving and specialty	3114
3115	Dairy products	3115
3116	Animal slaughtering and processing	3116
3117	Seafood product preparation and packaging	3117
3118	Bakeries and tortilla manufacturing	3118
3119	Other food products	3119
3121	Beverages	3121
3122	Other miscellaneous nondurable goods	3122
3131	Fiber, yarn, and thread mills	3131
3132	Fabric mills	3132
3133	Textile and fabric finishing mills	3133
3141	Textile furnishings mills	3141
3149	Other textile product mills	3149
3151	All other apparel manufacturing	3151
3152	Cut and sew apparel	3152
3159	All other apparel manufacturing	3159
3211	Sawmills and wood preservation	3211
3212	Plywood and engineered wood products	3212
3219	Other wood products	3219
3221	Pulp, paper, and paperboard mills	3221
3222	Converted paper products	3222
3251	Basic chemicals	3251
3252	Resin, rubber, and artificial fibers	3252
3253	Agricultural chemicals	3253
3254	Pharmaceuticals and medicines	3254
3255	Paints, coatings, and adhesives	3255
3256	Soaps, cleaning compounds, and toiletries	3256
3259	Other chemical products and preparations	3259
3261	Plastics products	3261
3262	Rubber products	3262
3271	Clay products and refractories	3271
3272	Glass and glass products	3272
3273	Cement and concrete products	3273
3274	Lime, gypsum, and other nonmetallic mineral	3274
3279	Lime, gypsum, and other nonmetallic mineral	3279
3311	Iron and steel mills and ferroalloy production	3311
3312	Steel products from purchased steel	3312
3313	Alumina and aluminum production	3313

3314	Other nonferrous metal production	3314
3315	Foundries	3315
3321	Forging and stamping	3321
3322	Cutlery and hand tools	3322
3323	Architectural and structural metals	3323
3324	Boilers, tanks, and shipping containers	3324
3325	Hardware, spring, and wire products	3325
3326	Hardware, spring, and wire products	3326
3327	Machine shops and threaded products	3327
3328	Coating, engraving, and heat treating metals	3328
3329	Other fabricated metal products	3329
3331	Agricultural, construction, and mining machinery	3331
3332	Industrial machinery	3332
3333	Commercial and service industry machinery	3333
3334	HVAC and commercial refrigeration equipment	3334
3335	Metalworking machinery	3335
3336	Turbine and power transmission equipment	3336
3339	Other general purpose machinery	3339
3341	Computer and peripheral equipment	3341
3342	Communications equipment	3342
3343	Miscellaneous computer and electronic products	3343
3344	Semiconductors and electronic components	3344
3345	Electronic instruments	3345
3346	Miscellaneous computer and electronic products	3346
3351	Electric lighting equipment	3351
3352	Household appliances	3352
3353	Electrical equipment	3353
3359	Other electrical equipment and components	3359
3361	Motor vehicles and parts	3361
3361	Motor vehicles	
3362	Motor vehicles and parts	3362
3362	Motor vehicle bodies and trailers	
3363	Motor vehicles and parts	3363
3364	Aerospace products and parts	3364
3365	Railroad rolling stock and other transportation	3365
3366	Ship and boat building	3366
3369	Railroad rolling stock and other transportation	3369
3371	Household and institutional furniture	3371
3372	Office furniture and fixtures	3372
3379	Other furniture-related products	3379
3391	Medical equipment and supplies	3391
3399	Other miscellaneous durable goods	3399

Appendix Table 2a
SUR Results for the 2007-2017 data
Aggregate Manufacturing
Without Imposing Symmetry

VARIABLES	(1) US Blue Collar Workers Hours	(2) Mexican White-Collar Workers Hours	(3) Mexican Blue-Collar Workers Hours	(4) US Blue Collar Workers Hours	(5) Mexican White-Collar Workers Hours	(6) Mexican Blue-Collar Workers Hours
US Blue Collar Wages	-2.316***	-0.815***	-2.110***	-2.228***	-1.045***	-2.570***
	(0.601)	(0.295)	(0.476)	(0.459)	(0.227)	(0.367)
Mexican White-Collar Wages	0.376	-0.266	0.622*	0.410	-0.357*	0.441
	(0.425)	(0.208)	(0.337)	(0.397)	(0.196)	(0.317)
Mexican Blue-Collar Wages	-0.324	0.092	-1.026***	-0.369	0.210	-0.788**
	(0.474)	(0.232)	(0.375)	(0.429)	(0.212)	(0.343)
Output	-0.251	0.655	1.312			
	(1.104)	(0.542)	(0.875)			
Constant	24.101**	17.515***	16.729**	21.743***	23.681***	29.067***
	(10.466)	(5.134)	(8.291)	(1.287)	(0.635)	(1.029)
Observations	126	126	126	126	126	126
R-squared	0.204	0.413	0.475	0.204	0.406	0.465

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Hours are the monthly hours and wages are the real dollar-valued hourly wage. Mexican values are converted with the nominal exchange rate and the U.S. CPI. U.S. values are converted to real using the U.S. CPI.

Appendix Table 2b:
P-Values for Symmetry Tests

	With Output	Without Output
U.S. Production Workers-Mexican NonProduction Workers	0.025	0.005
U.S. Production Workers-Mexican Production Workers	0.007	0.000
Mexican NonProduction Workers-Mexican Production Workers	0.336	0.651

Notes: The table contains the results for the test of symmetry. The null is that the difference between the estimated coefficient pairs in each row is equal to zero (i.e. that the coefficients are equal). P-values below 0.05 indicate a rejection of the null hypothesis at the 95% level of confidence.