

## **Are Mexican, Canadian, and U.S. Workers Complements or Substitutes? Some Preliminary Results**

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May 2008

Keywords: labor demand, Mexico, trade and labor markets

**Abstract:** Fears of NAFTA in the U.S. were largely based on the belief that Mexicans are substitutes for U.S. workers: lowering barriers in the U.S. would allow cheaper competing products into the U.S. and cause U.S. workers to lose their jobs. These fears were less prevalent in Canada, where trade with Mexico was traditionally smaller. While these fears were consistent with neoclassical Heckscher-Ohlin trade theory, "new" trade theory based on intra-industry trade and outsourcing predict the opposite. Production specialization between Mexico, Canada, and the U.S. may suggest that Mexican, Canadian, and U.S. workers are complements. This paper formally tests these two theories using match high-frequency data for Mexico, Canada, and the U.S. The main results suggest that, during the NAFTA period, Mexican and U.S. production workers (and Mexican and Canadian production workers) are complements, rather than substitutes, suggesting that both countries could benefit from viewing the economies as partners rather than competitors.

## 1. Introduction

Over the last 25 years, U.S. manufacturing employment has been falling. Figure 1 shows the evolution of U.S. manufacturing employment from 1979 to 2005. The graph shows that employment falls steeply during recessions and tends not to recover, leading to the cumulative decline. The most recent decline (since 2000) has been 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). During the debate over NAFTA, and again during the debate over the Central American Free Trade Agreement, opponents raised the possibility that these agreements would hasten the loss of U.S. manufacturing jobs.

Changes in global production technology - such as production fragmentation, outsourcing, and offshoring - raise the possibility, however, that domestic and foreign workers are complements, rather than substitutes. Foreign investment may actually induce an increase in domestic employment if the cost savings were great enough to have an output effect large enough to increase domestic employment (Chen and Ku 2003).

Most previous studies focus on the role of foreign investment (usually by multinationals).<sup>1</sup> Production fragmentation, however, does not necessarily require foreign direct investment. Foreign producers may independently design parts and products that can be used as inputs into production in other countries. Falling trade barriers therefore potentially contribute to expanding trade in final, intermediate, and capital goods that facilitate production fragmentation.

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<sup>1</sup> For example, see Brainard and Riker (1997a,b),

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 and substitutabilities. Trade and migration also play a role. There is a literature on outsourcing, and a literature on migration, but few, if any, previous papers step back to ask the question whether workers of two countries, as a whole, are complements or substitutes when focusing on just trade.

The U.S.-Mexican case provides an excellent opportunity to examine this question for several reasons. First, integration with Mexico is an ongoing policy concern for the United States. Second, there is an established and growing literature on North American labor market integration. Robertson (2000) shows that the labor markets of the U.S. and Mexico are closely integrated, but does not identify specific mechanisms. Feenstra and Hanson (1997) illustrate foreign direct investment's role in linking the U.S. and Mexican economies and implicitly argue that U.S. production workers and Mexican *skilled* workers are substitutes. Several papers find that immigrants to the United States and U.S. workers are substitutes (Borjas 1987, 2003).<sup>2</sup> Third, the North American Free Trade Agreement is being evaluated as a model for economic integration in the Western Hemisphere, and understanding the relationship for NAFTA countries may help us understand and predict the relationships throughout the rest of the hemisphere.

The remainder of the paper unfolds in three additional sections. The next section describes the data. Section 3 contains the estimation approach and results. In this section, we also examine the robustness of the results by considering alternative measures

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<sup>2</sup> 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).

of wages, specifications, and analyzing the relationship of U.S. production workers and Mexican maquiladora workers. The final section concludes.

## 2. Data

This paper combines 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 Nacional de Estadística, Geografía, e Informática*, or *INEGI*) conducts the survey.

Aggregated data for 205 industries are available on the internet<sup>3</sup> and cover the 1994-2005 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<sup>4</sup> 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.

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 with 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

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<sup>3</sup> See *Banco de Información Económica* at <http://www.inegi.gob.mx>.

<sup>4</sup> Over the sample period, the survey covers between 5,587 and 6,884 establishments.

production value is not available at the industry level.<sup>5</sup> Hours and earnings data are available for about 850 industries.

The Mexican and the U.S. data are matched industry-by-industry at the most detailed level possible. Eighty (80) industries were successfully matched. The matched industries, NAICS codes, and English descriptions are listed in Table 1. The level of aggregation ranges from 3 to 6 digit NAICS, with 41 industries matched at the 4-digit level and 31 matched at the 5-digit level.

### *Summary Statistics*

We use data from Mexican *non-maquiladora* manufacturing plants. This is important because it abstracts from, and extends, prior literature on the effects of FDI on employment. Table 2 contains summary statistics of hourly wages and employment for the three worker types. Real wages are calculated using the domestic consumer price index for each country. For the purpose of Table 2, the Mexican wages are first converted to real values (base year 1990) and then converted to dollar values using the current peso-dollar exchange rate.<sup>6</sup> The relative wage rates reveal that Mexican production workers earn about 20% of what U.S. production workers earn. Mexican nonproduction workers earn about 55% of what U.S. production workers earn. The drop in real wages from the 1994 peso crisis is evident in the summary statistics. Wages of both types of Mexican workers fall about 37% between 1994 and 1995, but then begin to

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<sup>5</sup> 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.

<sup>6</sup> In the estimation, we present results for both real peso and real dollar valued Mexican earnings.

recover. Over the sample period, the relative wage of nonproduction workers rises from 1994 to 1997, but then falls until the end of the sample, consistent with Robertson (2004).

The employment figures are in the last three columns of Table 2. The employment statistics are thousands of workers and represent survey employment statistics. The December 1994 peso crisis is again evident in these series. What is interesting, however, is the precipitous drop in the employment of all three worker types starting in 2000. Figure 3 illustrates this trend by normalizing all three series to 1 in 1994. While there is no discernable drop in the United States employment around the time of the peso crisis, all three series seem to move together in their decline near the end of the sample.

As an additional robustness check, we also test the relationship between Mexico and Canada. To offer some information about the behavior of the Canadian employment series (hourly workers in manufacturing), Figure 2b illustrates how employment has changed over time. Aside from the obvious seasonal component, there is a pattern that lies somewhat between the Mexican and U.S. series in the sense that manufacturing employment seems to be rising until approximately the end of the 20<sup>th</sup> century. There seems to be a precipitous decline after that.

### 3. Empirical Approach and Estimation Results

Papers that focus on outsourcing often model production with a single international production function. International production fragmentation implies that North America can be thought of as a single production unit. Other papers (e.g. Feenstra and Hanson 1997) use this assumption to focus on outsourcing specifically by focusing

on the Mexican *maquildora* sector. This paper steps back from the outsourcing question and asks whether Mexican *non-maquila* workers are complements or substitutes for U.S. workers.

We 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 ( $N^{mx}$ ), and Mexican production workers ( $U^{mx}$ ). Mexican and U.S. workers enter into a single production function. Representing output as  $Y$ ,

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

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 derivation that follows assumes wages are exogenous. The corresponding cost function can be represented as

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

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).

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

The signs of the estimated coefficients determine 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). In the structure above, we expect that the own-price effect is negative ( $\alpha_1 < 0, \beta_2 < 0, \gamma_3 < 0$ ).

The system in equation (3) includes Mexican industrial output.<sup>7</sup> 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 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

$$\begin{aligned}
 L_{it}^{us-u} &= \alpha_0 + \alpha_1 w_{it}^{us-u} + \alpha_2 w_{it}^{mx-s} + \alpha_3 w_{it}^{mx-u} + \varepsilon_{it} \\
 L_{it}^{mx-s} &= \beta_0 + \beta_1 w_{it}^{us-u} + \beta_2 w_{it}^{mx-s} + \beta_3 w_{it}^{mx-u} + \lambda_{it} \\
 L_{it}^{mx-u} &= \gamma_0 + \gamma_1 w_{it}^{us-u} + \gamma_2 w_{it}^{mx-s} + \gamma_3 w_{it}^{mx-u} + \zeta_{it}
 \end{aligned} \tag{4}$$

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, I estimate a variant of (3) and (4) that includes industry-specific fixed effects. The theory suggests the additional restrictions of symmetry ( $\alpha_2 = \beta_1, \alpha_3 = \gamma_1, \gamma_2 = \beta_3$ ) and homogeneity (non-

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<sup>7</sup> The value of production in real (1990) pesos.

intercept coefficients in (4) sum to zero). These restrictions follow from the specification of the functional form of the cost function, which may or may not be accurate.

Therefore, we present estimates with and without these restrictions in the tables that follow.

The preliminary estimation results are found in Table 3. The results in Table 3 include neither symmetry nor homogeneity restrictions. The first three columns of Table 1 include the results from estimating (3) jointly as a system. These are the constant-output estimations that inform us about the curvature of the isoquant.

Several results in these columns fit very well with our prior expectations. The own-price effect is negative for U.S. and Mexican production workers, and the size of these coefficients are generally within the range presented by Hamermesh (1993) for similar studies. The production effect is significant and positive. Production is measured in real pesos, and is positively correlated with U.S. production worker employment. As expected, production exerts a stronger effect on Mexican production workers, possibly reflecting lower adjustment costs for these workers (Robertson and Dutkowsky 2002).

This study is most interested in the cross-price effects. The first row of the second and third columns contains our estimates of the effect of the U.S. production worker wages on employment of Mexican nonproduction and production workers. These estimates suggest that, holding output constant, rising U.S. production worker wages reduces the demand for Mexican workers. In other words, holding output constant, Mexican and U.S. workers are p-complements. Interestingly, however, the symmetry implied by theory does not emerge in these results. Mexican nonproduction worker wages positively effect U.S. production worker employment, suggesting that these two

worker types are substitutes. The results for production workers, however, suggest complementarity.

The last three columns of the table present the total effects (excluding production in the estimation equation). The results are generally very similar. The U.S. production wage implies complementarity with both Mexican worker types, while only Mexican production worker wages imply complementarity.

The theoretically appropriate estimation approach would be to impose symmetry. Table 4 contains the results that emerge when we impose symmetry. With the symmetry restriction, all of the own-price effects are negative. Furthermore, we also find that the two Mexican worker types are substitutes for each other, while in the previous table the evidence was mixed. The results with and without production are very similar. The main message, however, that emerges is that U.S. production workers and Mexican production workers are complements, and U.S. production workers and Mexican nonproduction workers are substitutes.

Table 5 contains the results that emerge when we impose symmetry and homogeneity. These results are somewhat problematic for several reasons. First, the own-price effect of U.S. production workers is positive. Second, given the absence of capital it is not clear that the homogeneity restriction is appropriate. Third, the relationship between Mexican nonproduction workers and U.S. production workers changes sign. It is interesting, however, that the two Mexican labor types are still substitutes and Mexican production and U.S. workers are still complements.

Excluding the industry fixed effects also changes the signs of the cross-wage effects. Therefore, it is worth evaluating the appropriateness of the fixed effects. When

using panel data, excluding fixed effects allows the estimates to be based on cross-section variation, which is difficult to interpret. As long as there are industry-specific effects that remain unobserved (capital intensity, for example), the fixed effects specification is appropriate. The next several subsections contain other aspects of robustness, including using dollar-valued Mexican wages, looking at the pre-NAFTA period, and applying the approach to the Mexican maquiladora sector.

### *Dollar-Valued Wages*

One may wonder about valuing Mexican wages and production in pesos and U.S. wages in dollars. Adjusting for the exchange rate is problematic for several reasons. First, the peso does not adjust to fully offset differences in inflation rates. Second, Mexican non-maquila producers may make decisions based on pesos, while U.S. producers probably do not. To construct dollar-valued estimates, we use the current peso-dollar exchange rate to convert Mexican wages and production value into dollars (matching the summary statistics in Table 2).

The unconstrained results, shown in Table 6, are very similar in several respects. First, the own-price effects of U.S. production workers and Mexican production workers are negative. The effects for nonproduction workers are mixed, and the U.S. and Mexican production workers emerge as clear complements. The total effects, shown in the last three columns, are also similar.

As with the earlier results, more sensible results emerge when symmetry is imposed, as seen in Table 7. In Table 7, all of the own-price effects are negative and are within the range suggested by Hamermesh (1993). When output is included, the two

Mexican worker types do not emerge as substitutes. This may be reasonable if few Mexican producers actually base hiring decisions on dollar-valued wages. The total effect results in the last three columns do suggest that the two Mexican worker types are substitutes.

More importantly for this paper, however, is that Mexican production workers again emerge as complements with U.S. workers, and Mexican nonproduction workers emerge as substitutes. These results are consistent with the earlier tables, and therefore suggest that the overall pattern of complementarity is robust to expressing all Mexican values in dollars.

#### *Pre-NAFTA: 1987-1994*

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. This 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 using these data, I combine the Mexican data with the U.S. data described earlier using the same 80 industries described in Table 1. The combined data are then applied to the same estimation equations as the later data set.

The unconstrained results are presented in Table 8. Many of the results are similar. The own price effects are negative and fall within the magnitudes suggested by Hamermesh (1993) for two of the three worker types. The output effects are also all positive. The results for Mexican nonproduction workers and U.S. production workers

are again mixed (since symmetry is not imposed), as are the results for the two types of Mexican workers. The main difference is that Mexican production workers and U.S. production workers now emerge as substitutes. This result emerges with and without including the value of production.

Table 9 contains the results for the 1987-1994 period with the symmetry restriction. When symmetry is imposed, all of the own-price effects are negative and are within the range suggested by Hamermesh (1993). The two Mexican worker types, however, emerge as weak complements. The other main difference, however, is that the pattern of complementarity that emerges in the 1994-2005 period reverses. Table 9 suggests that in the 1987-1994 period, U.S. production workers were complements with Mexican nonproduction workers, and were substitutes with Mexican production workers. It is possible that differences in the sample, or differences in the sample period, or both, generate these results. These differences will be explored in detail in the next version of the paper.

#### *U.S. Workers and Mexican Maquiladoras*

Feenstra and Hanson (1997) argue that foreign direct investment related to outsourcing or production fragmentation contributes to North American labor market integration in a particular way. Low skilled jobs in the U.S. are high-skilled jobs in Mexico. The implication of this model is that U.S. production workers and Mexican skilled workers are substitutes, and U.S. production workers and Mexican production workers would be complements. While they do not explicitly take this approach, their results suggest that U.S. investment in the Mexican maquiladora sector can increase wage inequality in both countries by increasing the demand for skill in both countries.

As an additional robustness check to the methodology applied in this paper, we can formally test whether U.S. production workers and Mexican workers are complements or substitutes. Mexican maquiladora data are available on the internet from INEGI for the 1990-2005 period. These data include many variables, including production workers (and their monthly earnings), value added in the maquila sector, and two different nonproduction worker categories ( *tecnicos* and administrative workers) and their monthly wages. Hours for individual worker types are not included.

These data are also available for eleven industry categories that presumably span maquiladora activity: food products, textiles and apparel, footwear (shoes), furniture, chemicals, transportation equipment, tools, electric equipment (including appliances), electric materials, toys, and services. The first nine industries are matched to the U.S. data described above, aggregated to the NAICS 3-digit equivalent in most cases.<sup>8</sup>

Figure 5 contains the comparisons of total maquiladora employment and U.S. production worker employment over the 1990-2005 period by industry. There is clearly heterogeneity across industries. Employment in most maquiladora industries follows a similar pattern, rising from 1990 until 2000, and then falling. In some cases, employment recovers. Shoes and textiles do not recover, but other, possibly more skill-intensive industries, increase employment.

To evaluate whether or not maquiladora workers are complements or substitutes with U.S. production workers, we estimate a four-equation system similar to (3). The system in (3) is modified so that we have four employee types: U.S. production workers, Mexican administrative workers (MX white collar), Mexican *tecnicos* (MX tech), and Mexican production workers (MX blue). U.S. production worker wages are hourly,

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<sup>8</sup> Textiles and apparel are matched to NAICS 313-315. Shoes are matched to NAICS 3162.

while, due to data limitations, Mexican wages are calculated as the total monthly wage bill for each kind of worker divided by the total monthly employment of each type of worker. Mexican maquiladora value added is used to control for Mexican output in the same way the value of production was used in the earlier regressions.

The system is estimated with Zellner's SUR with industry fixed effects. Table 11 contains the results with the symmetry (but not homogeneity) restrictions imposed. In all regressions, the own-price wage effects are negative and significant. The main results of interest, however, are that Mexican white collar and Mexican *tenicos* are both substitutes for U.S. production workers. Mexican blue-collar workers are complements. These results are consistent with Feenstra and Hanson's (1997) model of production fragmentation.

Clearly these results could be explored more fully by breaking the sample into pre- and post-NAFTA, disaggregating the results by industry, and incorporating more input data to fill out the cost function. These extensions are left for future versions.

### *Mexican and Canadian Workers*

The bulk of the analysis thus far focuses on the Mexican-U.S. relationship because this was clearly the most contentious aspect of the NAFTA. Canadian and U.S. issues had already been raised in the U.S.-Canadian Free Trade Agreement several years before, and Canadian-Mexican trade was simply tiny (although growing) compared to U.S.-Mexican trade. Nevertheless, the potential relationship between Canada and Mexico remains very interesting for several reasons. First, Canada and the U.S. have similar factor endowments, suggesting that Canada provides an interesting robustness

check for the theoretical aspects of the paper. Second, Canada-Mexican trade is growing so there is reason to be increasingly interested in this relationship. Third, it is a logical extension of the paper: the analysis of NAFTA is incomplete without explicitly focusing on Canada, and the Canadian-Mexican relationship has received much less attention than the U.S.- Canadian relationship.

To analyze the employment relationships between these two countries, we use monthly Canadian data for hourly workers. These workers are the closest analog to production workers in high-frequency Canadian data. These data are classified under a different classification system than the Mexican and U.S. data, making a direct comparison at a detailed level impossible. Therefore, to compare the employment between Canada, we aggregate up to the lowest level at which we are 100 percent confident of the industry match. This generates nine (essentially two-digit) industries: Food, Beverages, and Tobacco, Textiles and Apparel, Wood Products (including furniture), Paper and Printing, Non-metallic Minerals (a.k.a. Stone, clay, and glass), Chemical Products, Basic Metals, Metal Products and Machinery (including automobiles), and Other Manufacturing (including toys). We matched the data and applied basically the same estimation approach as in the earlier tables: SUR with fixed effects and imposed symmetry constraints.

The results are shown in Table 12. The results are very similar to the U.S.- Mexican results. The diagonal terms (the own-wage elasticities) are negative and statistically significant, as expected. More interesting, however, is the results implied by the off-diagonal terms. Mexican production workers and Canadian production workers appear to be complements during this period. Interestingly, Mexican *nonproduction*

workers and Canadian production workers also seem to be complements. The total employment results are similar, but weaker. In particular, the own-price wage elasticity for Canadian employment is positive but not statistically significant, raising doubts about the validity of the total employment effects.

Given the relative size of Canadian-Mexican trade, the strength of these results is somewhat surprising. They are, of course, conditional to the same caveats given for the other analysis: there may be significant problems with serial correlation that would need to be addressed before any significant conclusions could be drawn. Nevertheless, these results offer no support to the hypothesis that Mexican production workers and Canadian production workers are substitutes.

#### 4. Conclusions

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. This is surprising, given the fact that one of the key reasons for popular resistance of NAFTA was the idea 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.

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 U.S. 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.

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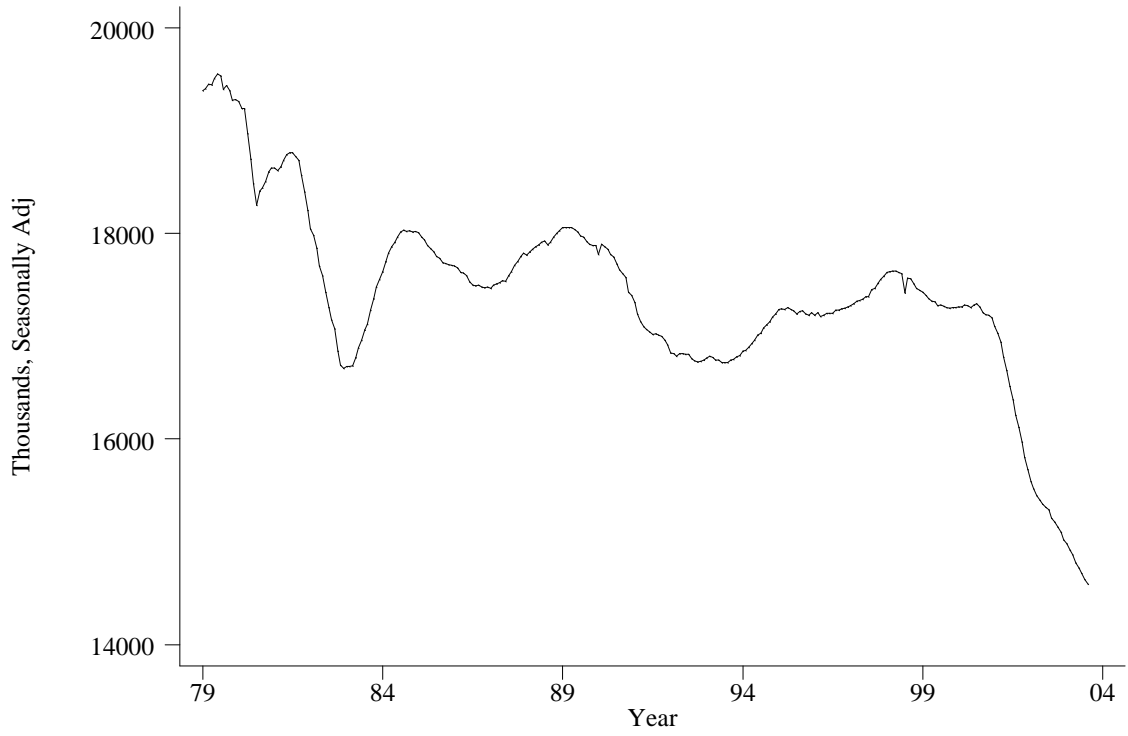
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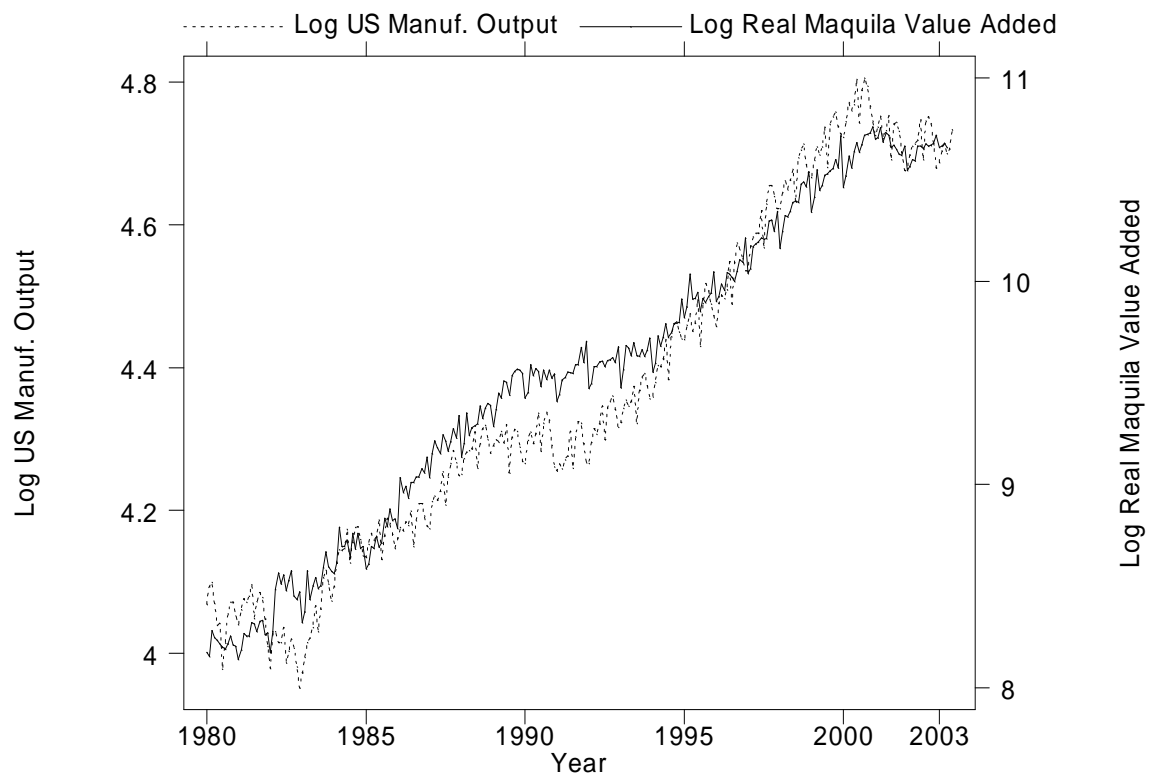
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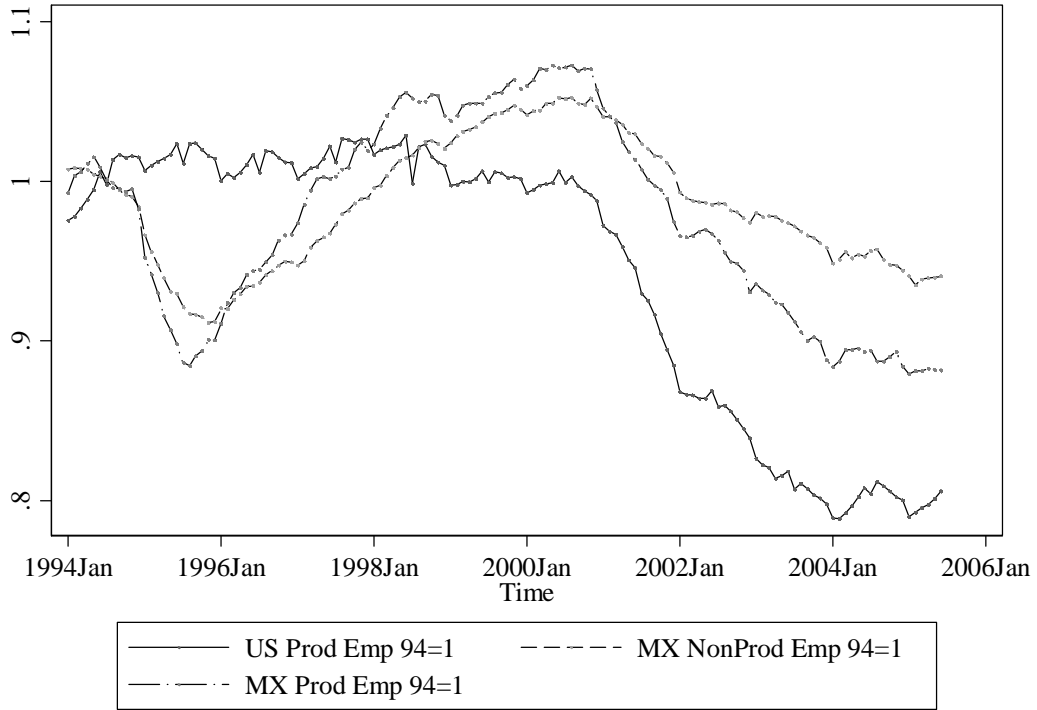
**Figure 1: U.S. Manufacturing Employment**



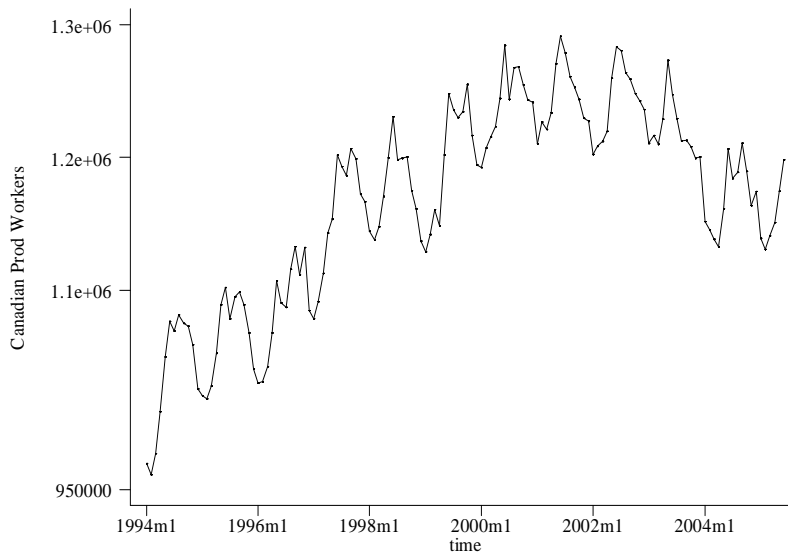
**Figure 2: U.S. Manufacturing Output and Maquiladora Value Added**



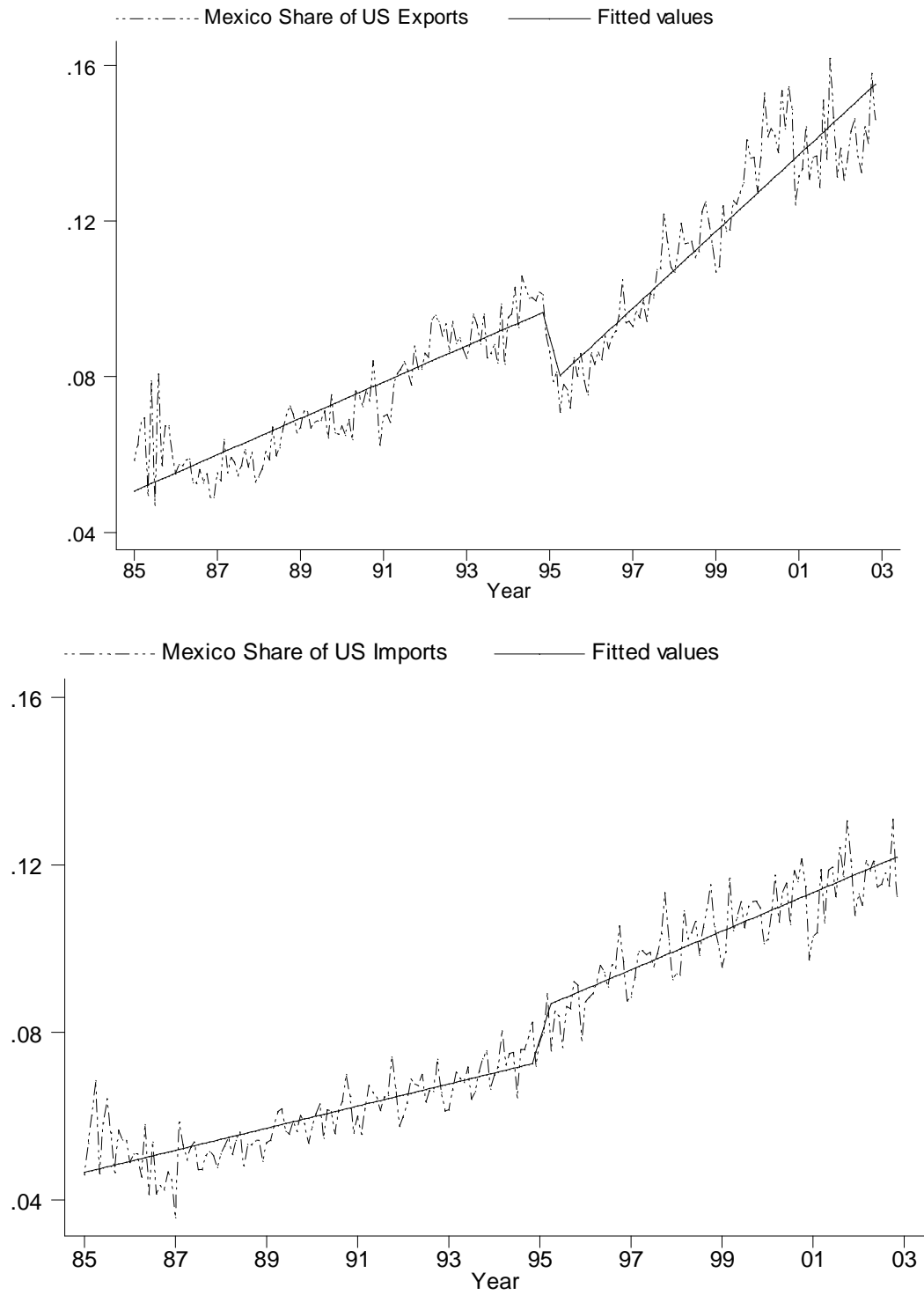
**Figure 3a: U.S. and Mexican Manufacturing Employment  
1994=1**



**Figure 3b: Canadian Hourly Manufacturing Employment**

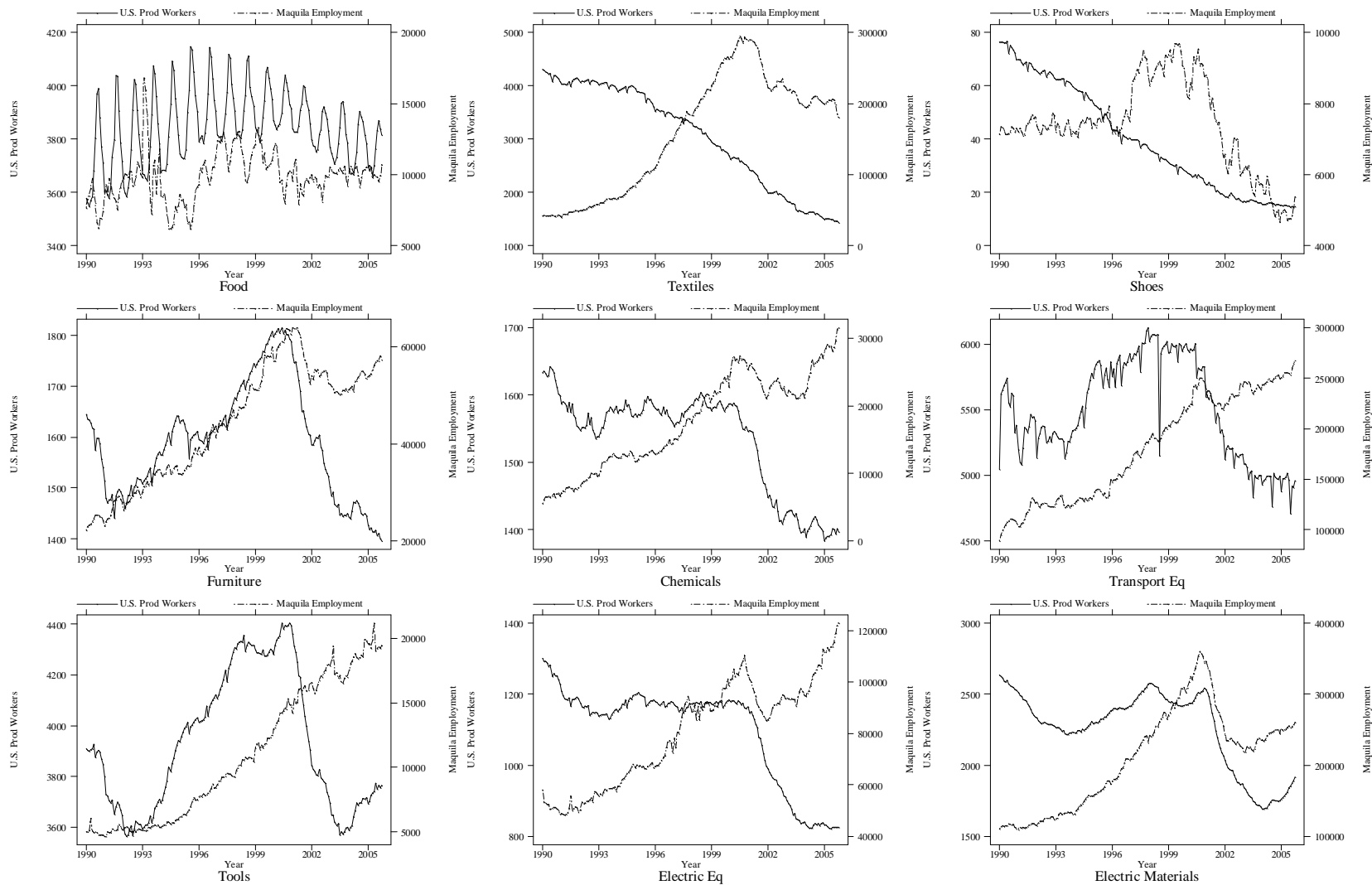


**Figure 4: Trade Between Mexico and the U.S.**



**Source:** See Robertson (2005).

**Figure 5: U.S. Production Workers and Maquiladora Employment by Industry**



**Table 1: Matched U.S. and Mexican Industries**  
(page 1 of 2)

Industry	NAICS Code	Description
1	3114	Fruit and vegetable preserving and specialty
2	3112	Grain and oilseed milling
3	3116	Animal slaughtering and processing
4	3115	Dairy products
5	3117	Seafood product preparation and packaging
6	3118	Bakeries and tortilla manufacturing
7	31132,3	Chocolate confectioneries
8	31192,3,4,9	Miscellaneous food products
9	312111	Soft drinks
10	3111	Animal food
11	31212,3,4	Breweries, wineries, and distilleries
12	3122	Tobacco and tobacco products
13	3131	Fiber, yarn, and thread mills
14	31412	Curtain and linen mills
15	3132	Fabric mills
15	3133	Textile and fabric finishing mills
16	31511	Hosiery and sock mills
17	31411	Carpet and rug mills
18	3152	Cut and sew apparel
19	3162	Footwear
20	3211	Sawmills and wood preservation
21	337	Furniture and related products
22	3221	Pulp, paper, and paperboard mills
23	32221	Paperboard containers
24	32222	Paper bags and coated and treated paper
25	323	Printing and related support activities
26	32513	Synthetic dyes and pigments
27	32511,2	Petrochemicals and industrial gases
28	3251	Basic chemicals
29	3253	Agricultural chemicals
30	32521	Resin and synthetic rubber
31	3252	Resin, rubber, and artificial fibers
31	325211	Plastics materials and resin
31	325212	Synthetic rubber
32	3255	Paints, coatings, and adhesives
33	3254	Pharmaceuticals and medicines
34	32561	Soaps and cleaning compounds
35	32562	Toilet preparations
36	32621	Tires
37	32612	Plastics pipe, fittings, and profile shapes
38	32611	Plastics packaging materials, film and sheet
39	3271	Clay products and refractories
40	327211,2	Flat glass and other pressed and blown glass and glassware

**Table 1: Matched U.S. and Mexican Industries**  
(page 2 of 2)

Industry	NAICS Code	Description
41	327213	Glass containers
42	3273	Cement and concrete products
43	32731,3,9	Other cement and concrete products
44	32732	Ready-mix concrete
45	3311	Iron and steel mills and ferroalloy production
46	3312	Steel products from purchased steel
47	33142	Rolled, drawn, extruded, and alloyed copper
48	3313	Alumina and aluminum production
49	33149	Nonferrous metal, except CU and AL, shaping
50	3324	Boilers, tanks, and shipping containers
51	3327	Machine shops and threaded products
52	3326	Spring and wire products
53	3328	Coating, engraving, and heat treating metals
54	33311	Agricultural implements
55	33312	Construction machinery
55	33313	Mining and oil and gas field machinery
56	3332	Industrial machinery
57	3333	Commercial and service industry machinery
58	334	Computer and electronic products
59	33392	Material handling equipment
60	33391	Pumps and compressors
61	33291	Metal valves
62	3334	HVAC and commercial refrigeration equipment
63	335312	Motors and generators
64	3343	Audio and video equipment
65	3346	Magnetic media manufacturing and reproduction
66	3342	Communications equipment
67	3353	Electrical equipment
68	3352	Household appliances
69	33591	Batteries
70	3351	Electric lighting equipment
71	33593	Wiring devices
72	3361	Motor vehicles
73	3362	Motor vehicle bodies and trailers
74	33631	Motor vehicle gasoline engine and parts
75	33635	Motor vehicle power train components
76	33633	Motor vehicle steering and suspension parts
77	33634	Motor vehicle brake systems
78	33632	Motor vehicle electric equipment
79	33636	Motor vehicle seating and interior trim
79	33637	Motor vehicle metal stamping
79	33639	Other motor vehicle parts
80	3366	Ship and boat building

**Table 2: Summary Statistics**

	US Wage	MX NP Wage	MX P Wage	US Emp	MX NP Emp	MX P Emp
1994	11.00	6.44	2.24	115.073	4.620	10.282
1995	10.94	4.06	1.39	116.929	4.298	9.341
1996	10.95	4.22	1.43	116.239	4.325	9.707
1997	11.01	5.10	1.66	117.012	4.485	10.319
1998	11.09	5.04	1.73	117.108	4.684	10.757
1999	11.15	5.70	1.99	115.265	4.793	10.814
2000	11.16	6.61	2.36	114.704	4.843	10.987
2001	11.17	7.46	2.68	107.589	4.739	10.406
2002	11.39	7.62	2.78	98.847	4.549	9.850
2003	11.43	7.11	2.65	93.754	4.544	9.521
2004	11.46	7.04	2.66	92.457	4.453	9.273
2005	11.42	7.26	2.74	92.040	4.394	9.179

**Table 3: SUR Results with Fixed Effects  
1994-2005**

	(1)	(2)	(3)	(4)	(5)	(6)
	Constant Output US Blue Collar Employment	Constant Output MX White Collar Employment	Constant Output MX Blue Collar Employment	Total Effect US Blue Collar Employment	Total Effect MX White Collar Employment	Total Effect MX Blue Collar Employment
US Hourly Wage Blue	-1.108 (0.033)**	-0.035 (0.034)	-0.325 (0.034)**	-1.150 (0.035)**	-0.111 (0.039)**	-0.426 (0.042)**
MX Hourly Wage White	0.127 (0.010)**	0.027 (0.010)**	0.131 (0.010)**	0.127 (0.010)**	0.028 (0.012)*	0.132 (0.013)**
MX Hourly Wage Blue	-0.183 (0.010)**	-0.009 (0.011)	-0.142 (0.011)**	-0.200 (0.011)**	-0.040 (0.012)**	-0.183 (0.013)**
Production Value	0.164 (0.005)**	0.295 (0.005)**	0.395 (0.005)**			
Constant	5.333 (0.102)**	-1.763 (0.106)**	-1.238 (0.106)**	7.521 (0.078)**	2.171 (0.088)**	4.017 (0.096)**
Observations	9900	9900	9900	9900	9900	9900

Standard errors in parentheses

\* significant at 5%; \*\* significant at 1%

**Table 4: SUR with Fixed Effects and Symmetry  
1994-2005**

	(1)	(2)	(3)	(4)	(5)	(6)
	Constant Output US Blue Collar Employment	Constant Output MX White Collar Employment	Constant Output MX Blue Collar Employment	Total Effect US Blue Collar Employment	Total Effect MX White Collar Employment	Total Effect MX Blue Collar Employment
US Hourly Wage Blue	-1.072 (0.032)**	0.110 (0.008)**	-0.171 (0.009)**	-1.077 (0.032)**	0.101 (0.008)**	-0.180 (0.009)**
MX Hourly Wage White	0.110 (0.008)**	-0.042 (0.006)**	0.059 (0.005)**	0.101 (0.008)**	-0.055 (0.006)**	0.038 (0.006)**
MX Hourly Wage Blue	-0.171 (0.009)**	0.059 (0.005)**	-0.077 (0.006)**	-0.180 (0.009)**	0.038 (0.006)**	-0.102 (0.007)**
Production Value	0.165 (0.005)**	0.298 (0.005)**	0.397 (0.005)**			
Constant	5.274 (0.101)**	-2.025 (0.075)**	-1.505 (0.075)**	7.401 (0.073)**	1.816 (0.028)**	3.607 (0.029)**
Observations	9900	9900	9900	9900	9900	9900

Standard errors in parentheses

\* significant at 5%; \*\* significant at 1%

**Table 5: SUR with Fixed Effects, Symmetry, and Homogeneity  
1994-2005**

	(1)	(2)	(3)	(4)	(5)	(6)
	Constant	Constant	Constant	Total Effect	Total Effect	Total Effect
	Output	Output	Output	US Blue	MX White	MX Blue
	US Blue	MX White	MX Blue	Collar	Collar	Collar
	Collar	Collar	Collar	Collar	Collar	Collar
	Employment	Employment	Employment	Employment	Employment	Employment
US Hr Wage Blue US\$	0.031	-0.015	-0.015	0.027	-0.016	-0.012
	(0.006)**	(0.004)**	(0.004)**	(0.006)**	(0.004)**	(0.004)**
MX Hr Wage White US\$	-0.015	-0.059	0.074	-0.016	-0.054	0.070
	(0.004)**	(0.005)**	(0.004)**	(0.004)**	(0.005)**	(0.004)**
MX Hr Wage Blue US\$	-0.015	0.074	-0.059	-0.012	0.070	-0.058
	(0.004)**	(0.004)**	(0.005)**	(0.004)**	(0.004)**	(0.005)**
Production Value US\$	0.179	0.297	0.400			
	(0.006)**	(0.005)**	(0.005)**			
Constant	2.804	-1.712	-1.939	5.074	2.041	3.128
	(0.072)**	(0.070)**	(0.070)**	(0.013)**	(0.014)**	(0.015)**
Observations	9900	9900	9900	9900	9900	9900

Standard errors in parentheses

\* significant at 5%; \*\* significant at 1%

**Table 6: SUR with Fixed Effects  
Dollar Valued Mexican Wages and Production  
1994-2005**

	(1)	(2)	(3)	(4)	(5)	(6)
	Constant	Constant	Constant	Total Effect	Total Effect	Total Effect
	Output	Output	Output	US Blue	MX White	MX Blue
	US Blue	MX White	MX Blue	US Blue	MX White	MX Blue
	Collar	Collar	Collar	Collar	Collar	Collar
	Employment	Employment	Employment	Employment	Employment	Employment
US Hr Wage Blue US\$	-0.897 (0.035)**	-0.185 (0.037)**	-0.620 (0.036)**	-0.858 (0.035)**	-0.077 (0.041)	-0.462 (0.045)**
MX Hr Wage White US\$	0.059 (0.010)**	0.006 (0.011)	0.131 (0.010)**	0.064 (0.010)**	0.021 (0.012)	0.153 (0.013)**
MX Hr Wage Blue US\$	-0.231 (0.010)**	-0.119 (0.010)**	-0.272 (0.010)**	-0.202 (0.010)**	-0.039 (0.011)**	-0.154 (0.012)**
Production Value US\$	0.088 (0.005)**	0.245 (0.005)**	0.358 (0.005)**			
Constant	5.973 (0.093)**	-0.562 (0.100)**	0.137 (0.098)**	6.924 (0.078)**	2.096 (0.092)**	4.022 (0.100)**
Observations	9900	9900	9900	9900	9900	9900

Standard errors in parentheses

\* significant at 5%; \*\* significant at 1%

**Table 7: SUR with Fixed Effects and Symmetry  
Dollar-Valued Mexican Wages and Production  
1994-2005**

	(1)	(2)	(3)	(4)	(5)	(6)
	Constant	Constant	Constant	Total Effect	Total Effect	Total Effect
	Output	Output	Output	US Blue	MX White	MX Blue
	US Blue	MX White	MX Blue	US Blue	MX White	MX Blue
	Collar	Collar	Collar	Collar	Collar	Collar
	Employment	Employment	Employment	Employment	Employment	Employment
US Hr Wage Blue US\$	-0.802 (0.033)**	0.050 (0.008)**	-0.229 (0.008)**	-0.800 (0.033)**	0.055 (0.008)**	-0.197 (0.008)**
MX Hr Wage White US\$	0.050 (0.008)**	-0.123 (0.005)**	-0.003 (0.004)	0.055 (0.008)**	-0.073 (0.005)**	0.045 (0.005)**
MX Hr Wage Blue US\$	-0.229 (0.008)**	-0.003 (0.004)	-0.164 (0.005)**	-0.197 (0.008)**	0.045 (0.005)**	-0.067 (0.005)**
Production Value US\$	0.088 (0.005)**	0.237 (0.005)**	0.351 (0.005)**			
Constant	5.777 (0.089)**	-0.820 (0.063)**	-0.467 (0.063)**	6.809 (0.073)**	1.930 (0.023)**	3.584 (0.023)**
Observations	9900	9900	9900	9900	9900	9900

Standard errors in parentheses

\* significant at 5%; \*\* significant at 1%

**Table 8: SUR with Fixed Effects  
1987-1994**

	(1)	(2)	(3)	(4)	(5)	(6)
	Constant	Constant	Constant	Total Effect	Total Effect	Total Effect
	Output	Output	Output	US Blue	MX White	MX Blue
	US Blue	MX White	MX Blue	Collar	Collar	Collar
	Collar	Collar	Collar	Collar	Collar	Collar
	Employment	Employment	Employment	Employment	Employment	Employment
US Hr Wage Blue US\$	-1.207	0.539	0.136	-1.225	0.478	0.065
	(0.041)**	(0.064)**	(0.069)*	(0.042)**	(0.067)**	(0.073)
MX Hr Wage White US\$	-0.078	-0.261	-0.148	-0.091	-0.304	-0.198
	(0.009)**	(0.013)**	(0.014)**	(0.009)**	(0.014)**	(0.015)**
MX Hr Wage Blue US\$	0.079	0.118	-0.052	0.079	0.116	-0.053
	(0.010)**	(0.015)**	(0.016)**	(0.010)**	(0.016)**	(0.017)**
Production Value US\$	0.056	0.195	0.227			
	(0.006)**	(0.009)**	(0.009)**			
Constant	7.273	-1.685	-0.159	8.016	0.918	2.868
	(0.123)**	(0.190)**	(0.203)**	(0.098)**	(0.158)**	(0.170)**
Observations	4715	4715	4715	4715	4715	4715

Standard errors in parentheses

\* significant at 5%; \*\* significant at 1%

**Table 9: SUR with Fixed Effects and Symmetry  
1987-1994**

	(1)	(2)	(3)	(4)	(5)	(6)
	Constant	Constant	Constant	Total Effect	Total Effect	Total Effect
	Output	Output	Output	US Blue	MX White	MX Blue
	US Blue	MX White	MX Blue	Collar	Collar	Collar
	Collar	Collar	Collar	Employment	Employment	Employment
	Employment	Employment	Employment	Employment	Employment	Employment
US Hr Wage Blue US\$	-1.208	-0.044	0.040	-1.224	-0.051	0.033
	(0.041)**	(0.008)**	(0.009)**	(0.041)**	(0.008)**	(0.009)**
MX Hr Wage White US\$	-0.044	-0.173	-0.017	-0.051	-0.194	-0.043
	(0.008)**	(0.008)**	(0.007)*	(0.008)**	(0.008)**	(0.007)**
MX Hr Wage Blue US\$	0.040	-0.017	-0.204	0.033	-0.043	-0.234
	(0.009)**	(0.007)*	(0.009)**	(0.009)**	(0.007)**	(0.010)**
Production Value US\$	0.058	0.197	0.234			
	(0.006)**	(0.009)**	(0.009)**			
Constant	7.208	-0.491	-0.190	7.970	1.990	2.761
	(0.122)**	(0.117)**	(0.123)**	(0.096)**	(0.033)**	(0.035)**
Observations	4715	4715	4715	4715	4715	4715

Standard errors in parentheses

\* significant at 5%; \*\* significant at 1%

**Table 10: SUR with Fixed Effects, Symmetry, and Homogeneity  
1987-1994**

	(1)	(2)	(3)	(4)	(5)	(6)
	Constant	Constant	Constant	Total Effect	Total Effect	Total Effect
	Output	Output	Output	US Blue	MX White	MX Blue
	US Blue	MX White	MX Blue	Collar	Collar	Collar
	Collar	Collar	Collar	Employment	Employment	Employment
	Employment	Employment	Employment	Employment	Employment	Employment
US Hr Wage Blue US\$	-0.107	0.048	0.059	-0.112	0.050	0.062
	(0.006)**	(0.005)**	(0.005)**	(0.006)**	(0.005)**	(0.005)**
MX Hr Wage White US\$	0.048	-0.105	0.057	0.050	-0.106	0.056
	(0.005)**	(0.006)**	(0.005)**	(0.005)**	(0.006)**	(0.005)**
MX Hr Wage Blue US\$	0.059	0.057	-0.116	0.062	0.056	-0.118
	(0.005)**	(0.005)**	(0.007)**	(0.005)**	(0.005)**	(0.007)**
Production Value US\$	0.077	0.219	0.260			
	(0.006)**	(0.009)**	(0.009)**			
Constant	4.325	-1.193	-0.796	5.262	1.472	2.363
	(0.077)**	(0.109)**	(0.116)**	(0.014)**	(0.020)**	(0.022)**
Observations	4715	4715	4715	4715	4715	4715

Standard errors in parentheses

\* significant at 5%; \*\* significant at 1%



**Table 12: Canadian and Mexican Workers  
SUR with Fixed Effects and Symmetry  
1994-2005**

	(1)	(2)	(3)	(4)	(5)	(6)
	Constant	Constant	Constant	Total	Total	Total
	Output	Output	Output	Effect	Effect	Effect
Can PW	-0.060 (0.020)**	-0.015 (0.004)**	-0.006 (0.006)	0.015 (0.015)	-0.006 (0.003)	-0.008 (0.004)
Mex Emp		-0.003 (0.003)	-0.006 (0.003)*		-0.005 (0.003)	-0.005 (0.003)
Mex PW			-0.022 (0.004)**			-0.023 (0.004)**
Can Output	0.085 (0.008)**	-0.003 (0.002)	-0.013 (0.003)**			
Mexican Output	-0.012 (0.004)**	0.005 (0.001)**	0.007 (0.002)**			
Constant	0.250 (0.163)	0.229 (0.060)**	0.721 (0.094)**	1.133 (0.133)**	0.222 (0.049)**	0.542 (0.073)**
Observations	1232	1232	1232	1232	1232	1232

**Notes:** Standard errors in parentheses. \* significant at 5%; \*\* significant at 1%. Data include two-digit manufacturing industries, monthly observations between 1994 and 2005. One lagged dependent variable was included in each regression.