Has NAFTA Increased Labor Market Integration between the United States and Mexico?

Raymond Robertson

This article analyzes three criteria for labor market integration between Mexico and the United States before and since the North American Free Trade Agreement: the responsiveness of Mexican wages to US wage shocks, the speed at which relative wages return to a long-run differential, and changes in the rate of convergence of absolute wages. Tests for increased integration using these three criteria generate mixed results, which are then explored by directly incorporating trade, foreign direct investment (FDI), and migration. The results suggest that trade and FDI did in fact positively contribute to integration but that the increase in border enforcement depressed Mexican wages, masking the positive benefits.

Labor market integration has been one of the primary hopes and fears for the North American Free Trade Agreement (NAFTA). Most of the debate over the labor market integrating effects of NAFTA has focused on wage equalization, and the persistent gap between Mexican and US wages raises the question of whether NAFTA has enhanced integration between these diverse labor markets. Wage equalization, however, is only one measure of labor market integration. Other measures include the responsiveness of Mexican wages to US wage shocks, the rate of convergence of Mexican and US wages to a long-run differential after a shock, and the rate of convergence of Mexican and US wages to equality. Since Mexican and US wages have not equalized since NAFTA, this article uses household surveys to evaluate labor market integration using these three other measures.

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The article begins with the criteria used by Robertson (2000) in estimating the responsiveness of Mexican wages to US wage shocks and the rate at which Mexican wages returned to the long-run differential over the years 1987–97. This study adds five years of data (through 2002) and shifts the focus to the long-run differential that Robertson (2000) takes as given.[1]

Reynolds (1992) summarizes the expectation for wage convergence in the context of NAFTA. Rising trade and foreign direct investment (FDI) as a result of the agreement would increase the demand for labor in Mexico and increase Mexican wages relative to US wages. The presumption that trade raises income has much support. Frankel and Romer (1999) suggest that countries that trade more enjoy higher living standards. Noguer and Siscart (2005) verify and strengthen this result, finding a large and positive effect of trade on income per capita. Trade theory suggests that wages, which are determined by supply, demand, productivity, government policies, and other factors, could equalize as a result of trade liberalization.

In addition to increasing trade, NAFTA was intended to increase the demand for labor by encouraging FDI. The size of Mexico's *maquiladora* sector is used as a proxy for FDI. While both trade and maquiladora activity were rising before NAFTA, the levels and growth rate have increased since NAFTA. To the extent that these factors contribute to labor market convergence, and to the extent that NAFTA contributed to the rise in both flows, it seems reasonable to expect evidence of greater labor market integration since NAFTA.

The peso crisis of December 1994, however, complicates the analysis. The significant recession and income contraction that characterized the crisis could give the impression of less labor market integration. Recovery began relatively quickly, however, giving rise to several possible measures to control for the crisis. This article employs several measures of integration and various controls for the crisis, and the overall results seem robust. While there is some evidence of increased integration since NAFTA, the difference seems to be very small. In fact, in some cases labor markets seem to be less integrated since NAFTA, even when the crisis is controlled for.

Mexican and US wages were converging before NAFTA and the peso crisis. The crisis caused wages to fall significantly in Mexico until about 1998, when they began to recover. While the basic conclusions of Robertson (2000) are evident, the two criteria employed in that study offer, at best, mixed evidence of increased integration since NAFTA. Furthermore, the rate of absolute convergence during the recovery period is generally not significantly higher than the rate of convergence before 1994.

But if trade and FDI have increased since NAFTA, why is there not more evidence of labor market integration? This question is addressed here by including a third

1. Absolute wage convergence has often been used as a proxy for labor market integration. It is useful when discussing the removal of barriers to migration (such as the fall of the Berlin Wall) or in areas in which barriers to migration are relatively small (Boyer and Hatton 1994; Moazzami 1997; Collins 1999).

factor that could contribute to integration: labor migration. Robertson (2000) concludes that migration may be a significant factor integrating labor markets based on the pattern of integration, but he does not formally pursue this hypothesis. Because migration between Mexico and the United States is often illegal,[2] and therefore difficult to measure, several studies have used border enforcement as a proxy for migration flows.[3] Border enforcement hours are used here to formally compare the effects of trade, FDI, and migration in a single regression framework.

This article also seeks to identify forces that integrate labor markets. The relative contributions of trade, migration, and capital flows in integrating labor markets have created significant debate.[4] Using real wages, GDP per worker-hour, and GDP per capita, Williamson (1996) finds that the main cause of convergence is migration.[5] Using the coefficient of variation of wages, Mokhtari and Rassekh (1989) find that commodity price convergence (using openness as a proxy) shows a strong impact on factor-price equalization for the period observed (1961–84).

The results here suggest that increased border enforcement may have had the opposite effect on wages as that expected from trade and investment. Therefore, trade and FDI may indeed have had positive effects on wage convergence that were hidden by the large effects of increased US border enforcement.

I. Theoretical Foundations of Integration Criteria

This section begins by briefly reviewing the theoretical basis for the two integration measures and the model used in Robertson (2000). Mexican labor demand is posited to be a function of Mexican and US wages, w^{mx} and w^{us}, which capture the effects of forces that integrate markets, such as trade and capital flows, that may not have instant effects on equilibrium wages. Labor supply is also posited to be a function of Mexican and US wages. This specification is based on the assumption that labor supply is a function of migration, which quickly reacts to wage differentials. Assuming an equilibrium in which labor supply equals labor demand, this approach generates an estimation equation whose parameters capture two criteria for evaluating labor market integration. Defining the difference operator as Δ, this equation can be written as

$$\Delta w_{it}^{mx} = \alpha_0 + \alpha_1 \Delta w_{it}^{us} + \alpha_2 [w^{mx} - \lambda w^{us}]_{it-1} + \mu_{it}. \tag{1}$$

2. According to INS (2000), the US Immigration and Naturalization Service apprehended more than 1.8 million aliens in fiscal 2000—approximately 96 percent of them Mexican.

3. For example, see Hanson and Spilimbergo (1999) and Hanson, Robertson and Spilimbergo (2002).

4. See, for example, O'Rourke and Williamson (1994), O'Rourke, Taylor and Williamson (1996), Saint-Paul (1997, 1999), and Mokhtari and Rassekh (1989).

5. The correlation is weaker when capital is allowed to 'chase' labor in the computable general equilibrium models.

The first criterion is the response of Mexican wages to US wage shocks (α_1). The second is the rate of convergence back to the assumed equilibrium differential (α_2). This simple model is then modified to allow for different regions within Mexico in order to analyze the possibility that the Mexican border region is more integrated with the United States than the rest of the country is.

The subscript *i* indexes different labor types. As in Robertson (2000), the wages of workers who fall into narrowly defined age-education cohorts are considered here. There are several advantages to focusing on specific labor cohorts. It allows wage movements of workers with similar characteristics to be compared without looking at average wages. Assuming strong separability of worker types prevents misinterpreting changes in labor force composition or changes in inequality as wage convergence. For example, a sharp increase in the relative wage of skilled workers may increase average wages while masking wage divergence for other workers. Second, identifying the effects of trade, FDI, and migration (which enters through labor supply) by focusing on narrowly defined cohorts is a natural extension of Borjas (2003), who suggests that such a focus on narrowly defined cohorts is an appropriate way to identify the effects of migration on US wages.

One shortcoming of Robertson (2000) is that he analyzes only 1987–97 data, which does not allow time for a recovery from the peso crisis. Therefore, the first step in the empirical work here is to use this framework to analyze 1987–2002 data, extending the sample period by nearly 50 percent.

A second shortcoming is that it takes the equilibrium differential as given. In the steady state, in which wage changes are zero, equation 1 reduces to

$$w_{it}^{mx} - w_{it}^{us} = -\frac{\alpha_0}{\alpha_2}, \tag{2}$$

which is assumed to be a constant. Clearly, an alternative proxy of integration is the evolution of the absolute wage differential over time in both level and trend. Therefore, the evolution of the absolute differential is also considered. The US government dedicates considerable resources to prevent migration from Mexico. Indeed, patrolling the border is commonly justified as necessary to maintain the wage differential.

A third shortcoming is that he does not formally compare the effects of trade, FDI, and migration. The sections that follow compare these effects in two ways. First, the evolution of trade, FDI, and migration are compared with changes in the absolute wage differential. Second, a simple regression framework is used to compare the relative effects of trade, FDI, and migration.

This framework is derived from a simple supply and demand model of the labor market. Labor demand (L) in country n (Mexico or United States) for labor type i at time t in city c can be represented as a function of a constant term, time trend, the log wage (w), total trade (exports plus imports, TT), and FDI:

$$L_{ict}^{n} = \alpha_0^n + \alpha_1^n w_{ict}^n + \alpha_2^n t + \alpha_3^n TT_t^n + \alpha_4^n FDI_{ct}^n. \tag{3}$$

The wage is assumed to be country-, city-, labor type-, and time-specific. FDI is assumed to be country-, city-, and time-specific, as in Feenstra and Hanson (1997), who examine the link between FDI and wage inequality.

Exports and imports are a problematic proxy for trade because trade theory predicts that prices, rather than quantities, matter for labor markets. Nevertheless, the volume of trade is a commonly used proxy for the effects of trade.[6] Differentiating exports and imports may seem intuitive, but the increasing importance of production fragmentation makes interpreting these proxies difficult. For example, rising imports of intermediate goods may increase the demand for labor, and rising exports of intermediate goods may be correlated with the loss of domestic production farther down the production chain. To avoid these problems, total trade flows are used as a proxy for the effect of trade on labor demand.[7]

The supply and demand approach used here follows the labor economics tradition of assuming a single industry,[8] and therefore, changes in relative prices matter less than aggregate imports and exports. The effects of trade are also assumed not to be city-specific for two reasons. First, prices do not vary much across Mexican regions (Rogers and Smith 2001), so trade-induced price changes are unlikely to have large regional effects. Second, trade data are not available by region.

Labor supply is assumed to be a function of the log wage, a time trend, and migration (*MIG*):

$$L^n_{ict} = \beta^n_0 + \beta^n_1 w^n_{ict} + \beta^n_2 t + \beta^n_3 MIG^n_{ict}. \tag{4}$$

At each time t country n's labor supply is assumed to equal its labor demand so that the equilibrium wage in each country can be solved for as a function of the explanatory variables:

$$w^n_{ict} = \frac{1}{\left(\beta^n_1 - \alpha^n_1\right)}\left[(\alpha^n_0 - \beta^n_0) + (\alpha^n_2 - \beta^n_2)t + \alpha^n_3 TT^n_t + \alpha^n_4 FDI^n_{ct} - \beta^n_3 MIG^n_{ct}\right]. \tag{5}$$

This equation can be expressed more simply for Mexico and the United States as

$$\begin{aligned} w^{mx}_{ict} &= \gamma_0 + \gamma_1 t + \gamma_2 TT^{mx}_t + \gamma_3 FDI^{mx}_{ct} + \gamma_4 MIG^{mx}_{ct} \\ w^{us}_{ict} &= \theta_0 + \theta_1 t + \theta_2 TT^{us}_t + \theta_3 FDI^{us}_{ct} + \theta_4 MIG^{us}_{ct}. \end{aligned} \tag{6}$$

6. Robertson (2004) offers a more detailed analysis of the effects of trade-induced price changes on Mexican labor markets by focusing on wage inequality and changes in relative prices.

7. As a robustness check in the estimation section, exports are separated from imports and the results discussed.

8. Examples of the dichotomy between the labor and trade approaches to analyzing the effects of trade on labor markets include Richardson (1995), Freeman (1995), and Slaughter (1999).

Under this system FDI, trade, and migration link labor markets. A useful but extreme simplification of these mechanisms would be to assume that FDI flows from the United States to Mexico, that only trade between these two countries matters, and that migration flows from Mexico to the United States. These assumptions imply the following restrictions:

$$\begin{aligned} TT_t^{us} &= TT_t^{mx} \\ FDI_{ct}^{mx} &= -FDI_{ct}^{us} \\ MIG_{ct}^{mx} &= -MIG_{ct}^{us}. \end{aligned} \tag{7}$$

The conditions in equations 6 and 7 can be combined to generate an expression for the wage gap between Mexico and the United States.

$$\begin{aligned} w_{ict}^{mx} - w_{ict}^{us} = (\gamma_0 - \theta_0) + (\gamma_1 - \theta_1)t + (\gamma_2 - \theta_2)TT_t^{mx} + (\gamma_3 + \theta_3)FDI_{ct}^{mx} \\ + (\gamma_4 + \theta_4)MIG_{ct}^{mx}. \end{aligned} \tag{8}$$

Equation 8 contains several intuitive predictions about labor market integration. First, increases in FDI and migration unambiguously close the wage gap.[9] The effects of FDI may be small in the United States (θ_3 may be small or zero) and still reduce the wage gap. Migration may also have a large, small, or nil effect on the United States (θ_4 may be large, small, or zero) and still reduce the wage gap.

This framework also suggests that the effects of trade depend on the relative effect on each country. If trade has a greater effect on Mexico than on the United States, the expected effect of trade on the wage gap is positive. This seems likely because trade's share in GDP is higher in Mexico than in the United States and because Mexico trades more with the United States (as a share of Mexico's total trade) than the United States trades with Mexico (as a share of US total trade).

This framework allows testing of several hypotheses about how localized the integration effects are. For example, a local migration shock may affect wages in neighboring regions. Examining the effects of a migration, shock to area *c* on other areas could explain how localized the effects are. Several researchers (for example, Hanson and Spilimbergo 1999) suggest that increasing border enforcement in one area of the border shifts migration to other areas, which means that increasing border enforcement in one area could depress wages in neighboring regions.

The empirical approach in the next section has three parts. The first focuses on wage shocks and convergence speeds (the first two integration criteria) and shows that there is evidence of wage convergence over time but little, if any, detectable effect from NAFTA on measures of convergence. Given the lack of significant change in convergence since NAFTA, the second part briefly examines

9. FDI may have an ambiguous effect on average wages if low-skilled jobs in the United States are high-skilled jobs in Mexico. In this case, however, these movements would unambiguously close the wage gap between similar workers. Moving a job that requires, say, 10 years of education from the United States to Mexico is an unambiguous change in the demand for workers with 10 years of education in both countries and therefore has an unambiguous effect on the wage gap for these workers.

absolute wage differentials. The third part looks at changes in trade, FDI, and migration before and after NAFTA to compare trends and breaks in these variables with trends and breaks in matched average wages. It also formally estimates equation 8 to identify the effects of these three forces on labor market integration.

II. Evaluating Labor Market Integration

The Mexican National Survey of Urban Employment (ENEU) and the US Current Population Survey (CPS) are used to formally compare wages between Mexico and the United States. While data from the CPS are available since 1979, data from the ENEU are available only since 1987. The ENEU and CPS are similar in many respects, but one important difference is that the ENEU follows households for five quarters before dropping them from the sample. While matching individuals across periods may seem desirable, in practice it is very difficult because households, and not individuals, are revisited. To approximate the panel effect, the pseudo panel approach described by Deaton (1985) is employed here. Wage averages are generated for different groups in the population and tracked over time. This approach has the advantage of allowing 'individuals' to be followed over the entire sample period.

The data used to estimate equation 1 are the mean log wages for matched Mexican–US age-education cells. As in Robertson (2000), Mexican wages are converted to dollars using the nominal peso–dollar exchange rate. To implement the pseudo-panel technique, workers in each city were divided into 40 groups defined by five education levels and eight age groups. The education levels are based on a continuous years of education variable that is sorted into the following categories: 0–6 years, 7–9 years, 10 years, 11–12 years, and more than 12 years. The age groups span five years each, starting at age 15, except for the last group, which includes workers aged 50–65 years.[10] As is customary in the pseudo-panel technique, the age group boundaries advance through time to follow cohorts. Using the CPS, the average wages were calculated for the same age-education groups in the United States, and then cohorts were paired with their demographic counterparts in Mexico. National US data were then matched with data for six Mexican urban areas.[11] The four border cities (Tijuana, Ciudad Juarez, Matamoros, and Nuevo Laredo) and Monterrey (an intermediate city) were included as interaction effects, leaving the main effects to reflect Central Mexico.[12] As in Robertson (2000), relatively high rates of migration and FDI in the border

10. The results were very similar when six education groups (for a total of 48 categories) were used.

11. One may prefer to match US border cities with Mexican border cities. The problem with this is the relatively small sample size of US border cities. Using matched US state data generates similar results.

12. Central Mexico includes Mexico City, Mexico State, and Guadalajara. Monterrey was also included in these regressions as a separate city but was not reported because the results are very similar to those for Central Mexico.

cities explain the difference in results between the border and the interior.[13] The data are quarterly and run from 1987 to 2002.

Shock and Convergence Speed Results

Equation 1 can be modified to formally test the differences in the estimated coefficient values across regions. The significance and sign of coefficients estimated from region dummy variables interacting with the relevant variables reveals whether differences across regions are statistically significant and whether certain regions are more integrated with the United States.

The results for the basic model (table 1), which includes regional effects for the entire sample period[14] for all workers, workers with more than 12 years of education (more education), and workers with 12 or fewer years of education (less education), are basically consistent with those of Robertson (2000). The shock term is positive and significant for Central Mexico for more educated

TABLE 1. Effects of NAFTA on Shock and Convergence Estimates

Variable	All Education	More Education	Less Education
Shock (Central Mexico)	−0.015 (0.034)	0.332 (0.092)**	−0.042 (0.035)
Tijuana	0.025 (0.068)	−0.077 (0.139)	0.052 (0.075)
Ciudad Juarez	0.033 (0.055)	0.258 (0.174)	0.037 (0.060)
Matamoros	0.059 (0.061)	0.029 (0.092)	0.069 (0.064)
Nuevo Laredo	−0.056 (0.046)	−0.172 (0.160)	−0.022 (0.051)
Convergence (Central Mexico)	−0.038 (0.011)**	−0.206 (0.023)**	−0.012 (0.010)
Tijuana	−0.060 (0.019)**	−0.154 (0.017)**	−0.002 (0.016)
Ciudad Juarez	−0.038 (0.019)	−0.121 (0.022)**	0.007 (0.022)
Matamoros	−0.030 (0.014)*	−0.132 (0.020)**	0.011 (0.011)
Nuevo Laredo	−0.053 (0.013)**	−0.153 (0.031)**	−0.023 (0.014)
Constant	−0.018 (0.025)	−0.435 (0.057)**	0.038 (0.019)
Number of observations	13,683	5,993	7,690
R^2	0.14	0.25	0.14

*Significant at the 5 percent confidence level.
**Significant at the 1 percent confidence level.

Note: All equations include year effects. Robust standard errors are in parentheses. Monterrey, which exhibits less integration than the border cities, is included but not reported. Three time trend terms and a dummy variable for the peso crisis are also included as described in the text.

Source: Author's analysis based on data from the Mexican National Survey of Urban Employment (ENEU) and the US Current Population Survey (CPS).

13. Traditionally, Tijuana has the highest rates of migration and *maquiladora* establishments and Ciudad Juarez the most *maquiladora* employment. It is important to note that migration from these cities is likely to be 'stage' migration, in which migrants from other parts of Mexico first migrate to the border before entering the United States. See Robertson (2000) for more details.

14. The regressions also included broken trend terms and a dummy variable to account for the peso crisis. These components are justified later in the text.

workers, and the estimated effects of US wage shocks are generally larger (although not significantly so) in the border cities. The convergence term is negative and significant, as expected, and the rate of convergence is larger for the border cities. The cities with the highest rates of migration and most maquiladora establishments (Tijuana and Ciudad Juarez) have the highest rates of convergence to the equilibrium differential. These results are weakest for less educated workers.

The peso crisis in 1994–95 may affect the results because the nominal value of the peso is used to calculate the dollar value of Mexican wages. In addition, the extreme movements of the peso may have affected wages in ways that could be mistaken for the effects of trade liberalization because the peso crisis occurred in the first year of NAFTA. Wages fell sharply during the crisis but started to recover in 1996. Two approaches were employed as a robustness check to control for the crisis. First, a control variable for the fourth quarter of 1994 and all of 1995 was included, as noted earlier. Second, data for 1995 were dropped, which generated stronger results in the sense that the main shock term was positive and significant for more educated workers and border effects were also somewhat larger for all three groups. The basic results are robust to both crisis controls.

The effects of NAFTA are estimated by modifying the basic model equation to include a dummy variable equal to 1 for the post-NAFTA years (1994 and later). In addition to the main effect, the NAFTA dummy variable is interacted with the shock and convergence terms from table 1. Two main conclusions can be drawn from these results (table 2).[15] First, the main effects are qualitatively similar to those for the basic model (table 1). Second, the NAFTA effects are ambiguous at best. The NAFTA interaction with the main shock term is negative for all groups—and large and significantly negative for more educated workers—which suggests that Mexican wages are less responsive to US shocks since NAFTA. By contrast, the estimate of the rate of convergence since NAFTA suggests faster convergence in the pooled sample but slower convergence for more educated workers. In general, the evidence of a change in the rate of wage convergence during the NAFTA period is mixed.

The results are also mixed when the data are broken down by industry. As an alternative specification, age-education categories were redefined to accommodate industries using four education groups (0–6 years, 7–10 years, 11–12 years, and more than 12 years), two age groups (ages 15–34 and ages 35–65), and five industry groups: construction (the base industry), machinery and transport equipment, other manufacturing, commerce (wholesale and retail trade), and other services. The manufacturing industries were subdivided because the

15. Every analysis of NAFTA is complicated by the contemporaneous peso crisis, but this complication may be mitigated by the fact that the crisis seems to have been a temporary event with a relatively quick recovery. By contrast, the effects of NAFTA are probably more lasting because NAFTA was gradually phased in and has not been reversed. Both the crisis controls from table 1 were applied to the analysis in table 2 and yielded similar results.

TABLE 2. Effects of NAFTA on Shock and Convergence Estimates

Variable	All Education	NAFTA Dummy Variable	More Education	NAFTA Dummy Variable	Less Education	NAFTA Dummy Variable
Shock	0.027 (0.044)	−0.089 (0.061)	0.553 (0.090)**	−0.514 (0.184)*	−0.023 (0.042)	−0.038 (0.062)
(Central Mexico)						
Tijuana	0.095 (0.091)	−0.102 (0.095)	0.291 (0.139)	−0.576 (0.319)	0.113 (0.099)	−0.100 (0.098)
Ciudad Juarez	0.007 (0.095)	0.054 (0.110)	0.013 (0.274)	0.682 (0.551)	0.032 (0.102)	0.011 (0.107)
Matamoros	0.122 (0.069)	−0.129 (0.116)	0.184 (0.208)	−0.366 (0.410)	0.131 (0.077)	−0.122 (0.124)
Nuevo Laredo	−0.120 (0.055)*	0.139 (0.079)	−0.436 (0.186)*	0.636 (0.314)	−0.062 (0.055)	0.081 (0.075)
Convergence	−0.014 (0.008)	−0.043 (0.012)**	−0.260 (0.037)**	0.036 (0.023)	−0.009 (0.008)	−0.006 (0.012)
(Central Mexico)						
Tijuana	−0.046 (0.017)**	−0.022 (0.006)**	−0.142 (0.017)**	−0.021 (0.008)*	0.000 (0.015)	−0.001 (0.005)
Ciudad Juarez	−0.032 (0.019)	−0.011 (0.001)**	−0.132 (0.021)**	0.023 (0.005)**	0.013 (0.023)	−0.009 (0.002)**
Matamoros	−0.028 (0.014)*	−0.005 (0.003)	−0.129 (0.018)**	−0.000 (0.006)	0.009 (0.011)	0.004 (0.003)
Nuevo Laredo	−0.045 (0.015)**	−0.020 (0.004)**	−0.139 (0.028)**	0.050 (0.011)**	−0.009 (0.014)	−0.028 (0.003)**
Constant	0.030 (0.017)		−0.582 (0.091)**		0.046 (0.015)**	
Number of observations	13,683	5,993	7,690			
R^2	0.15	0.27	0.15			

*Significant at the 5 percent confidence level.

**Significant at the 1 percent confidence level.

Note: Robust standard errors are in parentheses. Monterrey, which exhibits less integration than the border cities, is included but not reported. Three time trend terms are also included as described in the text. NAFTA and main city effects are included but not reported.

Source: Author's analysis based on data from the Mexican National Survey of Urban Employment (ENEU) and the US Current Population Survey (CPS).

majority of maquiladora employment is in metal products, machinery, and equipment.[16] Regional controls were not included.

These results, available upon request, generate two main conclusions. First, the model works well in the sense that the main shock and convergence terms have the expected signs and are statistically significant for more educated workers. Second, no consistent evidence emerges of increased integration during the NAFTA period. Integration does not seem to differ across industries, suggesting either that workers are very mobile across industries[17] or that industry-specific mechanisms (such as industry-concentrated FDI) are not driving labor market integration.

These mixed results might seem to be more consistently explained by inadequate crisis controls. If Mexican wages are simply recovering from the crisis, they may seem to be less responsive to wage shocks and to converge more quickly because they are 'catching up.' This hypothesis suggests that absolute wages are converging more quickly to US wages after the crisis. Since absolute wage convergence is an alternative proxy for labor market integration, the next section focuses on the evolution of absolute wages.

Absolute Wage Convergence, 1982–2002

When comparing wages across countries with very different monetary and exchange rate policies, it is important to address exchange rates. With freely floating exchange rates, different currencies are easily compared using the nominal exchange rate because it accounts for inflation differences between the two countries. The Mexican exchange rate, however, has been freely floating only since the peso crisis in December 1994. Fixing the peso increases dollar-valued Mexican wages (Robertson 2003) and may suggest a bias toward convergence.

Comparing the ratios of Mexican wages to US wages in dollars and in real terms shows the adverse effect of the 'Lost Decade' of the 1980s on Mexican wages (figure 1). The recovery from the debt crisis began in 1986, coinciding with the availability of ENEU data, which are used here to more formally analyze wage convergence.

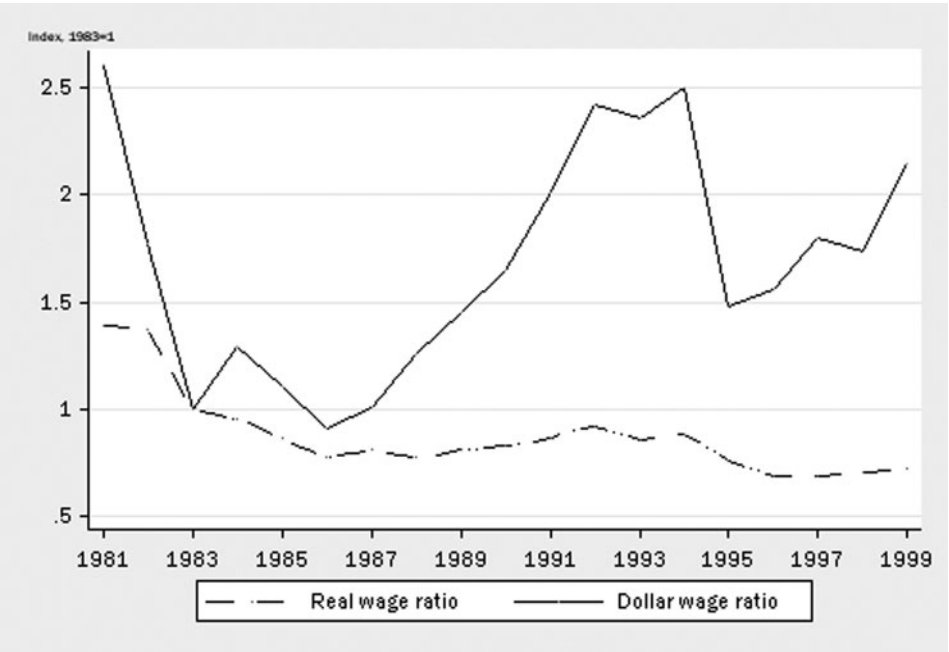
To generate comparable quarterly wage measures, ENEU and CPS data are used to calculate real wages in the United States and Mexico using the consumer price index of each country (with 1992 as the base year).[18] Figure 2 shows the evolution of the ratio of the Mexican (normalized) wages (for Tijuana, Central Mexico, Ciudad Juarez, and Matamoros) to US (normalized)

16. The average share of *maquiladora* employment in metal products, machinery, and equipment over 1990–2001 is 65.3 percent.

17. Robertson and Dutkowsky (2002) estimate labor market adjustment costs for Mexico and find that labor market adjustment costs are an order of magnitude smaller in Mexico than in developed countries.

18. Although city-specific price indices are available, the national price index is used here to deflate wages. The correlation coefficient of the city-specific price indices for the cities used here is above 0.999 for each city pair.

FIGURE 1. Long-run Comparison of Mexican–US Average Wages



Note: The real wage series for each country is deflated by the domestic inflation index. The dollar wage series uses real US wages and nominal Mexican wages converted to dollars using the nominal peso–dollar exchange rate.

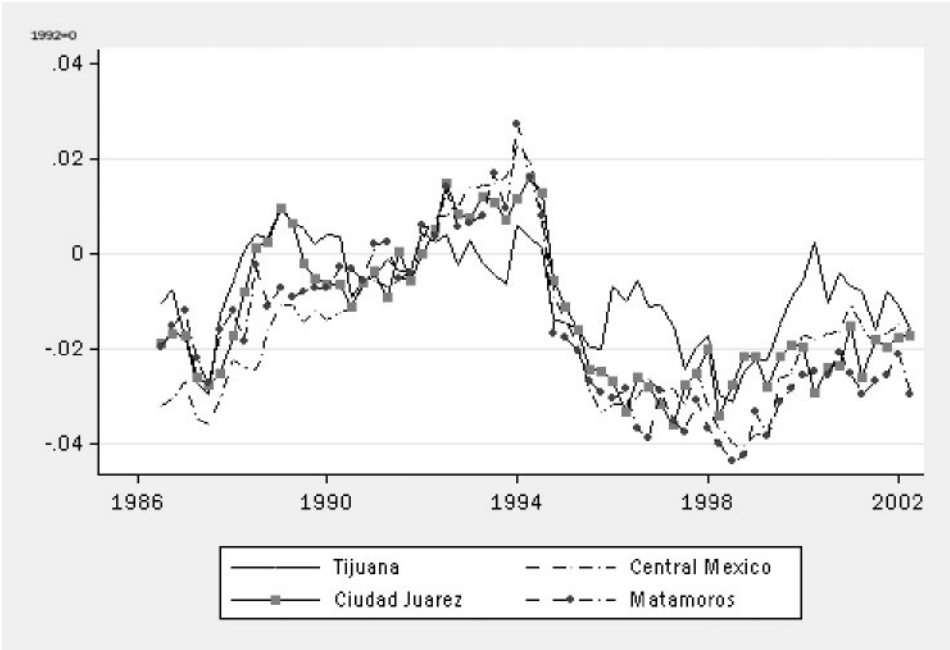
Source: Author's analysis based on Mexican wage data from Wilke, Alemán, and Ortega (1999), Mexican inflation data from Banco de México (various years), and US wage and inflation data from IMF (various years).

wages. Wages in Central Mexico are more volatile. They rise more before the crisis and fall more during the crisis, raising the possibility that proximity to the US economy mitigates domestic economic fluctuations much like living next to the ocean mitigates domestic temperature fluctuations.[19] Relative wages in Tijuana begin to decline around 1991, while wages in the other cities rise until the crisis.

The general pattern that emerged in the average wage series remains when the wage series are decomposed by industry and education. Before NAFTA wages rose more quickly in the interior (Central Mexico) than in the border region. The drop in wages because of the peso crisis was larger in the interior. To illustrate this point, the evolution of relative wages by industry (figure 3) and by education group (figure 4) is examined for Central Mexico

19. Wages exhibit more recovery in dollar terms than in peso terms, again suggesting that perhaps the peso is not fully adjusting to offset domestic inflation.

FIGURE 2. Mexican–US Normalized Wage Ratios



Note: Wage ratios are the difference between the Mexican and US normalized wage values, with 1992 as the base year and Central Mexico as the base region for Mexico. The wages are the population-weighted average of the worker–category wage ratio for each metropolitan area. Nuevo Laredo, excluded here for clarity, is more similar to Central Mexico than to Tijuana.

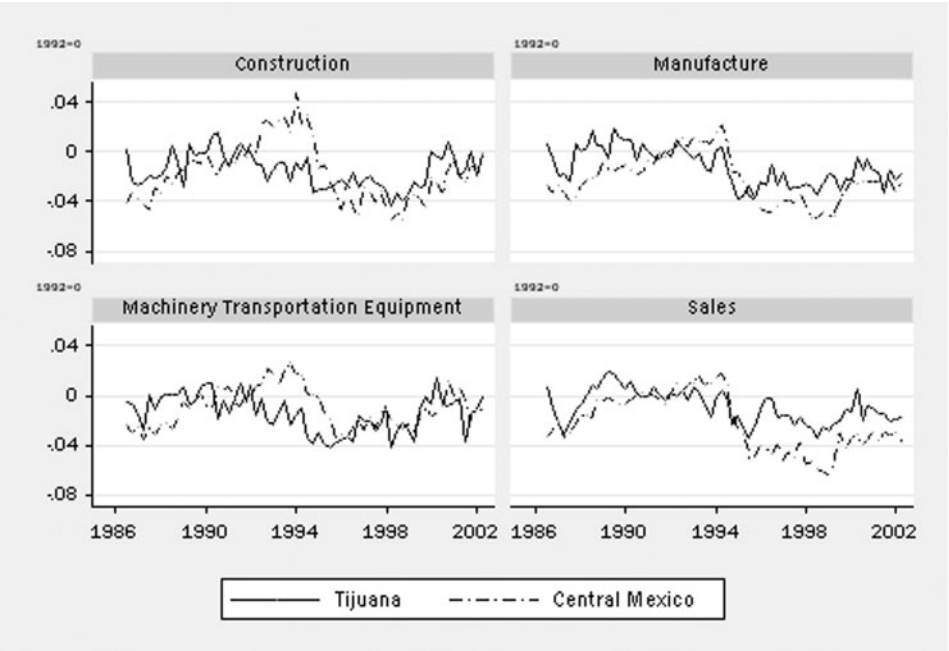
Source: Author's analysis based on data from the Mexican National Survey of Urban Employment (ENEU) and the US Current Population Survey (CPS).

and Tijuana.[20] While there are some differences across industries and education groups, the basic pattern is very similar. Wages in the interior rise faster before, and fall more during, the peso crisis. In all industries and education groups the decline in relative wages in Tijuana begins before the crisis.

If NAFTA did contribute to increased labor market integration, it seems likely that the rate of wage convergence would have increased during the recovery from the peso crisis. The first step in comparing trends before and after the crisis is to determine the actual trend breaks, recognizing that the timing of the trend breaks may differ across regions. There are three ways to determine the breaks. The most obvious way is to use prior information. The December 1994 peso crisis is an obvious candidate, but using this date for all regions rules out the possibility that the effects of the crisis differed

20. Figure 2 suggests that wage patterns in Matamoros and Ciudad Juarez fall between the wage series for Tijuana and Central Mexico. Since this also holds for the education and industry breakdowns, figures 3 and 4 show the wage series only for Central Mexico and Tijuana.

FIGURE 3. Normalized Wage Ratios by Industry for Tijuana and Central Mexico



Note: Wage ratios are the difference between the Mexican and US normalized wage values, with 1992 as the base year and Central Mexico as the base region for Mexico. The wages are the population-weighted average of the worker–category wage ratio for each metropolitan area and industry.

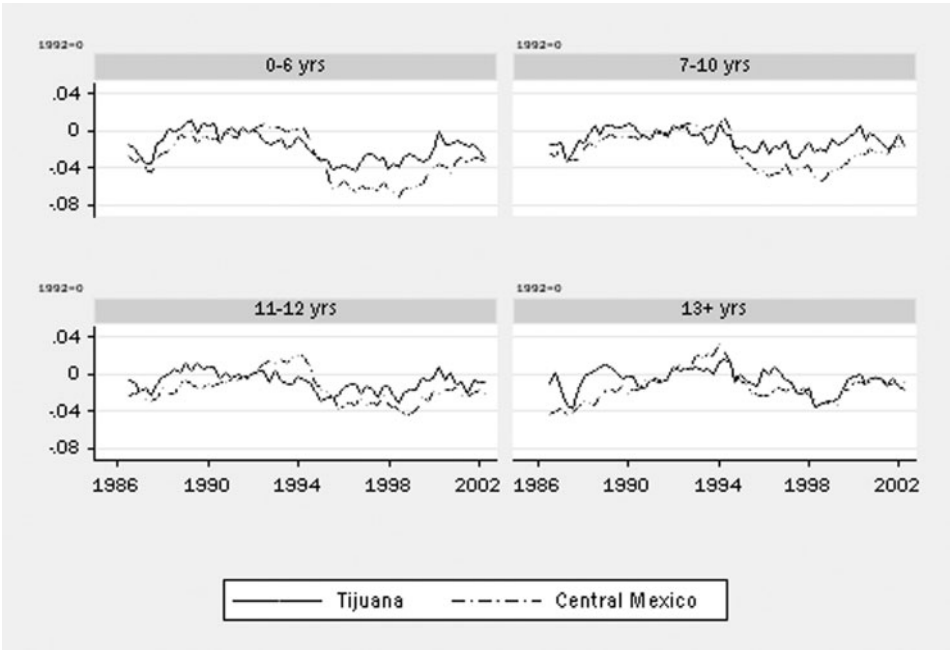
Source: Author's analysis based on data from the Mexican National Survey of Urban Employment (ENEU) and the US Current Population Survey (CPS).

across regions. Alternatively, one could guess at the breaks for different regions based on the analysis of the series in figure 2. This approach is arbitrary and subjective. Vogelsang and Perron (1998) propose a more formal approach, which they employ in the unit root context. The basic purpose of their tests is to evaluate the statistical significance of successive t-statistics on estimated parameters of trend break terms that are moved through the sample using the following equations:

$$
\begin{aligned}
y_t &= \mu + \beta_t + \theta DU_t + \gamma DT_t + \tilde{y}_t^2 \\
\tilde{y}_t^2 &= \sum\nolimits_{i=0}^{k} \omega_i D(T_b)_{t-i} + \alpha \tilde{y}_{t-1}^2 + \sum\nolimits_{i=0}^{k} c_i \Delta \tilde{y}_{t-i}^2 + u_t.
\end{aligned}
\tag{9}
$$

For a time-series variable at time t represented by y_t and defining the break period as T_b, $DU = 1(t, > T_b)$, $DT = 1(t > T_b)(t - T_b)$, and $D(T_b) = 1(t = T_b + 1)$. The variables μ, β, θ, γ, ω, α, and c are estimated parameters, and u is an error term.

FIGURE 4. Normalized Wage Ratios by Education Level for Tijuana and Central Mexico



Note: Wage ratios are the difference between the Mexican and US normalized wage values, with 1992 as the base year and Central Mexico as the base region for Mexico. The wages are the population-weighted average of the worker–category wage ratio for each metropolitan area and education group.

Source: Author's analysis based on data from the Mexican National Survey of Urban Employment (ENEU) and the US Current Population Survey (CPS).

Figure 2 suggests that the wage series may actually exhibit two trend breaks that surround the peso crisis. The test described above supports this idea. Table 3 shows the break points suggested by the *t*-statistic on the trend break terms for both dollar and indexed wage ratios. Dollar wages are included because the earlier analysis left open the possibility that those results are driven by a more rapid rate of convergence after the peso crisis. Indexed wages are included because of the previously described problems with the Mexican peso.

The test statistics in both wage categories (dollars and indexes) roughly match the intuition about where the breaks in the series occur. The first break occurred very close to the peso crisis. Two notable exceptions are that relative wages in Tijuana began falling in 1990, and in Ciudad Juarez the break occurred in 1993.

Using these data-determined trend break points, testing whether the recovery trend is steeper than the pre-NAFTA trend is straightforward. The last two columns of table 3 compare the slope before NAFTA with the slope since NAFTA

TABLE 3. Trend Breaks in Relative Wages

Wage Ratio	Break 1	Break 2	Net Recovery Trend	*p*-value
Dollar wages				
Central	1994q4	1998q2	0.0018	0.028
Monterrey	1994q4	1998q1	0.0014	0.070
Tijuana	1993q1	1998q2	0.0001	0.889
Ciudad Juarez	1993q3	1997q3	0.0000	0.991
Matamoros	1994q4	1998q2	0.0017	0.036
Nuevo Laredo	1994q4	1998q2	0.0015	0.033
Indexed wages				
Central	1994q4	1998q3	0.0007	0.025
Monterrey	1995q1	1998q3	0.0004	0.233
Tijuana	1990q4	1997q4	−0.0011	0.003
Ciudad Juarez	1993q4	1997q3	−0.0004	0.054
Matamoros	1995q1	1998q2	0.0007	0.026
Nuevo Laredo	1994q3	1998q2	−0.0001	0.867

Source: Author's analysis based on data from the Mexican National Survey of Urban Employment (ENEU) and the US Current Population Survey (CPS).

by testing the difference of the trend coefficients before and after the first trend break.[21] A positive value suggests that the trend coefficient was larger during the recovery. All values for dollar wages are positive, but three of six are statistically insignificant at the 5 percent level. The statistically significant higher net recovery trends in Central Mexico and Matamoros are consistent with the possibility that the results in table 2 for these cities are driven by inadequate control for a faster rate of recovery from the crisis, even though a separate trend term for the city-specific recovery period was included. In all cases, however, the difference in trends is very small (less than 0.2 percent).

The results for indexed wages suggest that the recovery trend for most cities is slightly greater than before NAFTA and the crisis, but, again, the difference is very small. The recovery trend for Tijuana and Ciudad Juarez is less steep during the NAFTA and recovery period. That is, wage convergence in real terms is slower in Tijuana and Ciudad Juarez during the recovery period (and the difference is statistically significant at the 1 percent level for Tijuana and the 6 percent level for Ciudad Juarez). By contrast, Central Mexico and Matamoros exhibit the steepest recovery trends.

The difference between dollar wages and indexed wages is due to the relative lack of adjustment in the peso (see Robertson 2003 for a more detailed discussion of the peso movements). Inflation rises more than the peso falls during the recovery period, allowing wages, in dollar terms, to rise relatively more. Therefore, the

21. Each series was regressed with three linear trend terms. The first is a linear trend increasing from 1 at the beginning of the sample, the second starting at 1 (and 0 earlier) at the first trend break, and the third starting at 1 (and 0 earlier) at the second trend break.

dollar wage results are biased toward convergence to the degree that the peso does not move to offset relative inflation in Mexico.

Overall, however, the recovery trends for every city are positive, suggesting that Mexican and US wages are converging (due more to rising Mexican wages than to falling US wages), but there is little evidence of economically significant increases in convergence rates since NAFTA once the peso crisis is taken into account. This result suggests that the mixed results in the previous section are not likely to be driven by more rapidly converging wages in the NAFTA period. Even if they were, however, the lack of stronger and more consistent evidence of increased integration (especially wage convergence) is surprising, given the rise in FDI and trade that has occurred since NAFTA. Thus, the next section directly compares the effects of the various forces that affect labor market integration.

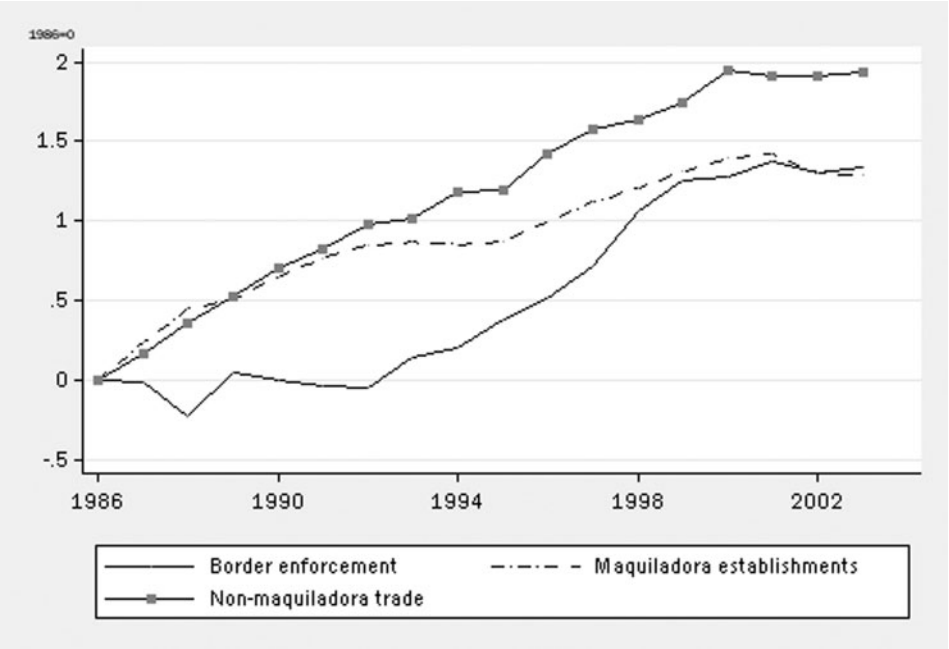
Forces That Contribute to Wage Convergence

The theoretical model hypothesizes that trade, FDI, and migration can integrate labor markets. Dollar-valued monthly Mexican exports and imports are available from the Banco de México (www.banxico.org.mx). Data on monthly maquiladora employment and establishments, a proxy for FDI, are available from the Instituto Nacional de Estadística, Geografía, e Informatica data bank (http://dgcnesyp.inegi.gob.mx/bdiesi/bdie.html). Robertson (2005) shows that the level and growth rate of total Mexican trade has increased since NAFTA. Maquiladora employment and number of establishments have also risen, with a sharper rate of increase since NAFTA than in the years immediately before 1994. Using the same methodology to identify the trend break point suggests that the trend in total non-maquiladora trade increased in the first quarter of 1994. Growth in maquiladora establishments increased in the fourth quarter of 1994, while employment growth increased in the third quarter of 1993. These increases are both statistically significant and correlated with NAFTA, which is not surprising because increasing these factors was an explicit goal of the agreement.

While finding trade and FDI data is relatively easy, obtaining migration data is more problematic because much of the migration from Mexico to the United States is illegal. Instead of actual migration flows, border enforcement hours by the US Border Patrol are used. Ideally, an increase in enforcement hours would lead to a decrease in successful migration, which is required for migration to affect labor markets. Between 1990 and 2000 the United States implemented three major border-control initiatives: Operation Hold the Line, Operation Gatekeeper, and Operation Rio Grand.[22] Operation Hold the Line was implemented in 1993 and focused on El Paso, Texas. Operation Gatekeeper went into effect in October 1994 in San Diego, California. Operation Rio Grand in

22. See http://uscis.gov/graphics/publicaffairs/factsheets/bpops.htm for more information about these initiatives.

FIGURE 5. Factors That Affect Integration over Time



Note: Each series is the log of the difference between the contemporary value and the value of that series in 1986. Border enforcement is the total number of linewatch hours on the Mexican–US border (in El Centro, CA; El Paso, TX; Del Rio, TX; Laredo, TX; Marfa, TX; McAllen, TX; San Diego, CA; Tucson, AZ; and Yuma, AZ).

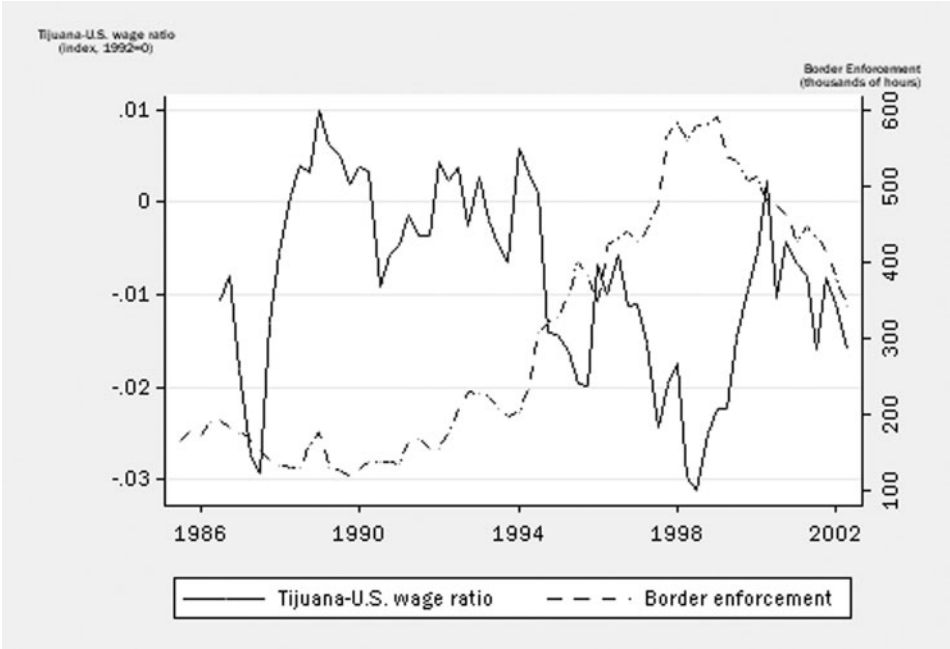
Source: Author's analysis based on trade data from Banco de México, *maquiladora* establishments data from Instituto Nacional de Estadística, Geografía, e Informatica data bank, and border enforcement data from the US Department of Homeland Security.

McAllen, Texas, was launched in August 1997. The initial result of these initiatives was an increase in apprehensions and the cost of migration.

Time-series plots of normalized non-maquiladora trade, maquiladora establishments, and total linewatch border enforcement hours along the Mexican–US border show very similar patterns of steady increases throughout the sample period (figure 5). The rise in the rate of maquiladora establishments starting in 1994 is evident. Border enforcement hours also increased, but the rate of increase for some border sectors rose earlier. Formal tests reveal that the break in the total border enforcement hours occurred in the second quarter of 1994. However, the increase in border enforcement occurred in the second quarter of 1993 in El Paso and in the third quarter of 1991 in San Diego.

The earlier break in the San Diego enforcement series is relatively close to the earlier break detected in the Tijuana–US wage series. A plotting of the Tijuana–US wage gap and changes in border enforcement over the sample period shows

FIGURE 6. Tijuana–US Wages and San Diego Border Enforcement



Note: Wage ratios are the difference between the Mexican and US normalized wage values, with 1992 as the base year and Central Mexico as the base region for Mexico. The wages are the population-weighted average of the worker–category wage ratio for each metropolitan area and industry. Border enforcement is the total number of linewatch hours for the San Diego, CA, sector.

Source: Author's analysis based on wage data from the Mexican National Survey of Urban Employment (ENEU) and the US Current Population Survey (CPS) and border enforcement data from the US Department of Homeland Security.

that the two move in opposite directions over 1988–2001 (figure 6). In 1993, just over 42 percent of all apprehensions by the US Border Patrol were in the San Diego sector, so it seems possible that changes in US border enforcement have a particularly strong effect on wages in Tijuana. Figures 5 and 6 therefore have two main implications. First, the rise in border enforcement is concurrent with a rise in trade and the number of maquiladora establishments. Second, theory suggests that the rise in trade and in maquiladora establishments, reasonably attributed to NAFTA, would have opposite effects on the wage gap from an increase in enforcement that was separate from NAFTA.

The timing of the breaks in trade, FDI, border enforcement, and wages seem consistent with the hypothesis that the concurrent increase in border enforcement may have affected wages in the opposite direction of trade and FDI. This hypothesis is formally tested by estimating the effects of these factors on wages

in a single estimation equation (equation 8), modified by adding an error term with the usual assumptions, using both dollar-valued and indexed Mexican–US wage ratios for each of the matched age-education categories described in the previous section (table 4). For migration, border enforcement in San Diego, Ciudad Juarez, Del Rio, Texas, and Laredo, Texas, were jointly included to capture the possibility that increases in border enforcement in one sector divert migration to other parts of the border (Hanson and Spilimbergo 1999).

An increase in the dependent variable, Mexican wages relative to US wages, represents wage convergence. The regressions all include main city effects for all non–Central Mexico cities (but are not shown to conserve space) and the broken trend terms using the endogenously determined breaks as previously described (also not shown to preserve space). Formal tests of linear combinations of the estimated effects of border enforcement were also conducted.

The independent variables are the log of the sum of imports and exports of non-maquiladora trade, the log of the number of maquiladora establishments, and the log of border enforcement (linewatch) hours for San Diego, El Paso, Del Rio, and Laredo. Also included in two of the specifications are interactions of the city dummy variables with maquiladora establishments to allow for the possibility that the effects of changes in maquiladora establishments vary across regions (columns 2 and 4 of table 4).

The regression estimates show large, positive, and statistically significant effects of total trade. Combined with the fact that the level and trend of trade have increased since NAFTA, this suggests that NAFTA has begun to close the wage gap between Mexico and the United States in both dollar and real terms.

The estimated effect of maquiladora establishments is negative, generally statistically significant (three of four cases), and small. When interacted with city effects, the effect of maquiladora investment emerges positively in Monterrey and Tijuana, but negatively everywhere else. The positive effect seems large in Tijuana, especially when wages are measured in dollars. In real terms, however, the positive effect in Tijuana, while statistically significant, is smaller in absolute value than the estimated negative effects in the other border cities. Tijuana has the largest number of maquiladora establishments, so it is not surprising that the positive effects are strongest there, but the estimated negative effects in the other cities remain puzzling.

The estimated effects of border enforcement are mixed. Enforcement is positively correlated with dollar and real wage indices in El Paso and Laredo, but negatively correlated with relative wages in San Diego and Del Rio. The combined effect, however, is negative, statistically significant, and comparable in size to the estimated effect of trade. Given the ambiguous effect of maquiladora investment, these results suggest that border enforcement has worked against the positive effects of the increase in trade since NAFTA.

What about the possible endogeneity of US border enforcement? In early 1994, before the peso crisis, the then US Immigration and Naturalization Service announced a major new border enforcement initiative to increase border

TABLE 4. Comparing Factors That Affect Labor Market Integration

Variable	Dollar Wages		Indexed Value of Wages	
Log of total trade	0.302 (0.047)**	0.351 (0.048)**	0.016 (0.005)**	0.025 (0.005)**
Log of number of *maquiladora* establishments	−0.005 (0.015)	−0.037 (0.017)*	−0.011 (0.002)**	−0.013 (0.002)**
Monterrey × number of *maquiladora* establishments		0.072 (0.030)*		0.003 (0.003)
Tijuana × number of *maquiladora* establishments		0.406 (0.042)**		0.039 (0.004)**
Ciudad Juarez × number of *maquiladora* establishments		−0.306 (0.067)**		−0.054 (0.007)**
Matamoros × number of *maquiladora* establishments		−0.075 (0.068)		−0.044 (0.007)**
Nuevo Laredo × number of *maquiladora* establishments		−0.263 (0.121)*		−0.053 (0.012)**
El Paso	0.038 (0.023)	0.035 (0.023)	0.007 (0.002)**	0.005 (0.002)*
San Diego	−0.339 (0.021)**	−0.251 (0.022)**	−0.020 (0.002)**	−0.010 (0.002)**
Del Rio	−0.642 (0.025)**	−0.581 (0.027)**	−0.036 (0.003)**	−0.029 (0.003)**
Laredo	0.404 (0.022)**	0.359 (0.023)**	0.018 (0.002)**	0.014 (0.002)**
Constant	−0.348 (0.915)	−2.199 (0.930)*	0.154 (0.094)	−0.122 (0.095)
Combined border enforcement	−0.540** (0.033)	−0.438** (0.035)	−0.031** (0.003)	−0.020** (0.004)
Number of observations	13,187	13,187	13,187	13,187
R^2	0.29	0.29	0.14	0.16

*Significant at the 5 percent confidence level.
** Significant at the 1 percent confidence level.
Note: Robust standard errors are in parentheses. Main city effects, broken time trends, and a dummy variable for the peso crisis are included but not reported.
Source: Author's analysis based on data from the Mexican National Survey of Urban Employment (ENEU) and the US Current Population Survey (CPS).

enforcement. The US government may have anticipated the crisis and announced heightened border enforcement in advance, but this seems unlikely. Before the crisis, the expectation was for NAFTA to reduce pressure for migration because migration might have been due to wage differentials that were expected to fall as a result of NAFTA (Hanson and Spilimbergo 1999), so it seems more likely that the US government did not make border enforcement decisions based on Mexican wages per se. First, the timing of the announcement of increased enforcement in early 1994 is not consistent with the idea that enforcement responds to Mexican wages. Alternatively, Hanson and Spilimbergo (2001) suggest that enforcement responds to US sectoral shocks (that is, US demand for illegal immigrants). Second, the correlation of the timing of enforcement with wages (especially in Tijuana) seems more consistent with the idea of enforcement driving wages. Third, Hanson, Robertson, and Spilimbergo (2002) use instrumental variables to control for the possible endogeneity of enforcement and still find that increases in border enforcement are correlated with falling Mexican wages, especially in Tijuana.

III. Conclusions and Policy Implications

This article evaluates labor market integration between Mexico and the United States using three different criteria. All three measures reveal limited, if any, support for the hypothesis that Mexican and US labor markets are significantly more integrated since NAFTA. If trade and FDI integrate markets, this result is puzzling because both the level and rate of increase of trade and FDI (proxied by maquiladora establishments) have increased since NAFTA. One possible explanation is that migration is an important third force integrating labor markets and that the increases in US border enforcement that occurred apart from, but roughly at the same time as, NAFTA mitigated the integrating effects of trade and FDI.

By both examining the timing of trend breaks and directly comparing trade, FDI, and border enforcement in a single regression framework, this article finds support for the hypothesis that migration is an important force integrating North American labor markets. The timing of increases in border enforcement is close to the timing of changes in wages, and, when compared with trade and FDI in a single estimation equation, the effects of border enforcement are negative, significant, and comparable in magnitude to the estimated effects of trade and FDI.

One intriguing conclusion policymakers may draw is that, in fact, NAFTA began to integrate labor markets and close the wage gap and, if not for rising border enforcement, the positive effects of trade might have been more evident. These results provide room for some optimism about the role of trade agreements in other countries with less migration to the United States.

Of course, one may also conclude that trade and investment have not increased enough to have the expected effects. Thus, further investments in infrastructure to promote trade, and institutions to reduce economic risk, as well as additional measures to facilitate investment, may yet yield positive effects. The time frame

studied here may also be too brief to detect the kinds of changes implied by trade and investment. The overall trend in Mexican wages—measured in either dollars or real pesos—is positive, and therefore in the long run one can confidently conclude that, in terms of wages, Mexico is catching up to the United States.

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