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Local Labor-Market Effects of NAFTA in Mexico: Evidence from Mexican Commuting Zones

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Abstract

This paper estimates the effects of NAFTA on labor and wages in Mexico using a local labor-markets approach. While NAFTA offered greater export opportunities to Mexican firms that may raise employment, it also opened the door to increased import competition that may dampen employment gains. This paper finds that in the first decade of its existence, NAFTA had a net positive impact on domestic employment of 870,000 workers, an increase of 13.7%. Production workers in Mexican gained significantly, with employment increasing by 32.8%. The impacts of NAFTA varied by region, with employment gains accruing mostly to states in the northeast, northwest, and central east regions of Mexico, which traded more with NAFTA countries.

Key words: International trade, NAFTA, import competition, local labor markets

JEL: F14, F16, F66, J23

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1. INTRODUCTION

When NAFTA entered into force on January 1, 1994, economists widely expected the agreement to have a positive impact on employment in Mexico, particularly in manufacturing industries. Relative to the United States and Canada, Mexico specialized in unskilled-labor-intensive manufacturing industries. The implementation of NAFTA increased the ability of all three countries to engage in regional production-sharing, with Mexico serving as the region's source of unskilled-labor-intensive intermediate inputs and a center for processing and assembly of final goods to be exported to the north. Coupled with steep tariff declines in manufacturing industries in all three countries that lowered the cost of goods crossing borders, employment of workers involved in the production of manufacturing goods in Mexico stood to gain.

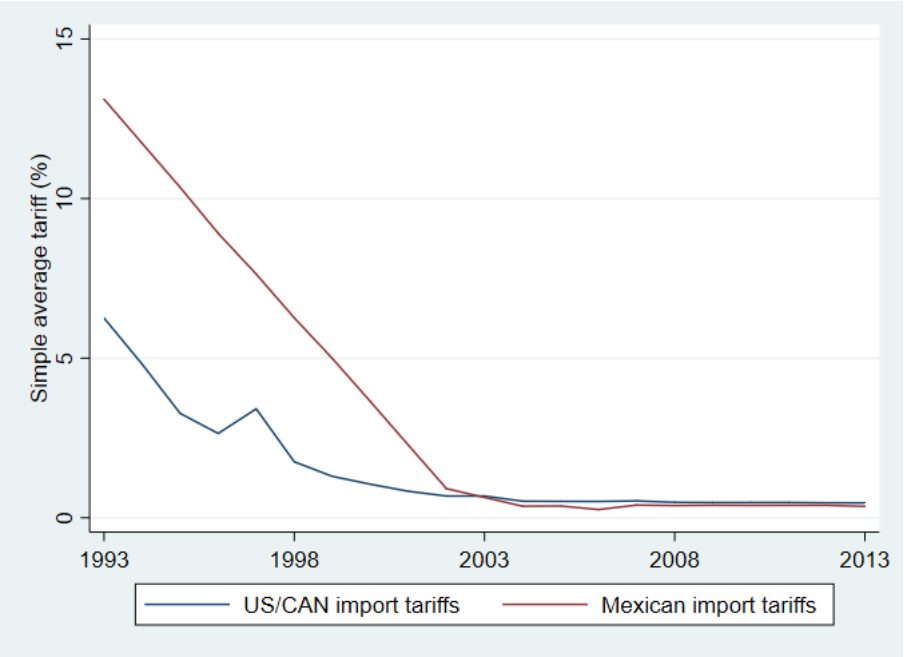
Although employment of manufacturing workers was expected to increase, the potential for negative impacts on labor markets from import competition still remained. In the years before the implementation of NAFTA, Mexico had undertaken a period of sweeping trade liberalization after years of pursuing import substitution industrialization policies that protected domestic industries and kept its external sector relatively closed. Import competition impacted labor markets, including by widening wage gaps between skilled and unskilled workers and creating downward pressure on employment (Hanson and Harrison, 1999; Revenga, 1997). NAFTA might have had a similar negative impact on workers in industries exposed to import competition from the United States and Canada, dampening any employment gains from the agreement. Furthermore, the employment impact of NAFTA could vary across regions, industries, occupations, or worker skill levels, creating winners and losers within Mexico.

In this paper, I analyze how NAFTA impacted employment in Mexico. I consider two channels through which this may have happened: expanded opportunities to export to NAFTA countries and increased import competition from NAFTA countries. I utilize variation in the composition of industries at the local labor-market level to calculate the exposure of labor markets to imports from and exports to NAFTA countries. I estimate the employment impact of NAFTA trade flows, following the approach in Autor, Dorn, and Hanson (2013). I find that NAFTA resulted in a net positive impact on employment in Mexico. In the first decade of its existence, NAFTA increased total employment in the formal sector by 870,000 workers. This number masks heterogeneous impacts across different groups of workers and regions. Production workers experienced a large net increase in employment of 940,000 workers during the first decade of NAFTA. Contract employment increased slightly, while nonproduction workers experienced small net losses. Employment in regions in the northeast, northwest, and central east of the country gained significantly from NAFTA.

2. BACKGROUND

NAFTA further liberalized Mexico's trade regime, with large declines in tariffs among Mexico, Canada, and the United States. Figure 1 shows the average applied tariffs on NAFTA trade. The blue line shows the simple average tariff on Mexican imports applied by the United States and Canada, which dropped from around 6% to near 0% in the first decade of NAFTA. Mexican tariffs applied to imports from the United States and Canada experienced a more extreme decline from over 13% to near 0% during this period.

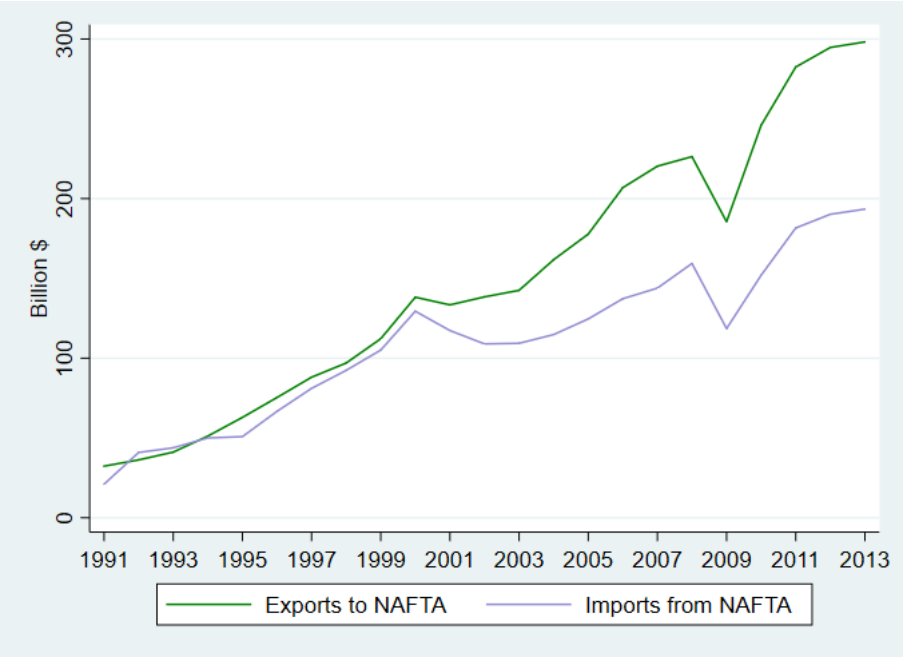
FIGURE 1. MEXICO-NAFTA TARIFFS, 1993–2013



Source: Author's calculations using an unreleased World Bank dataset

Trade between Mexico and NAFTA partners grew dramatically upon NAFTA's implementation. Figure 2 shows the rise in Mexico's exports to and imports from the United States and Canada. Although trade with the United States and Canada was relatively balanced in the early 1990s, Mexico has enjoyed a trade surplus with its NAFTA partners since NAFTA's implementation. Mexico's trade surplus widened in the 2000s, suggesting the agreement boosted Mexico's export opportunities even if the agreement led to heightened import competition.

FIGURE 2. MEXICO-NAFTA TRADE, 1991–2013



Source: Author's calculations using data from UN Comtrade.

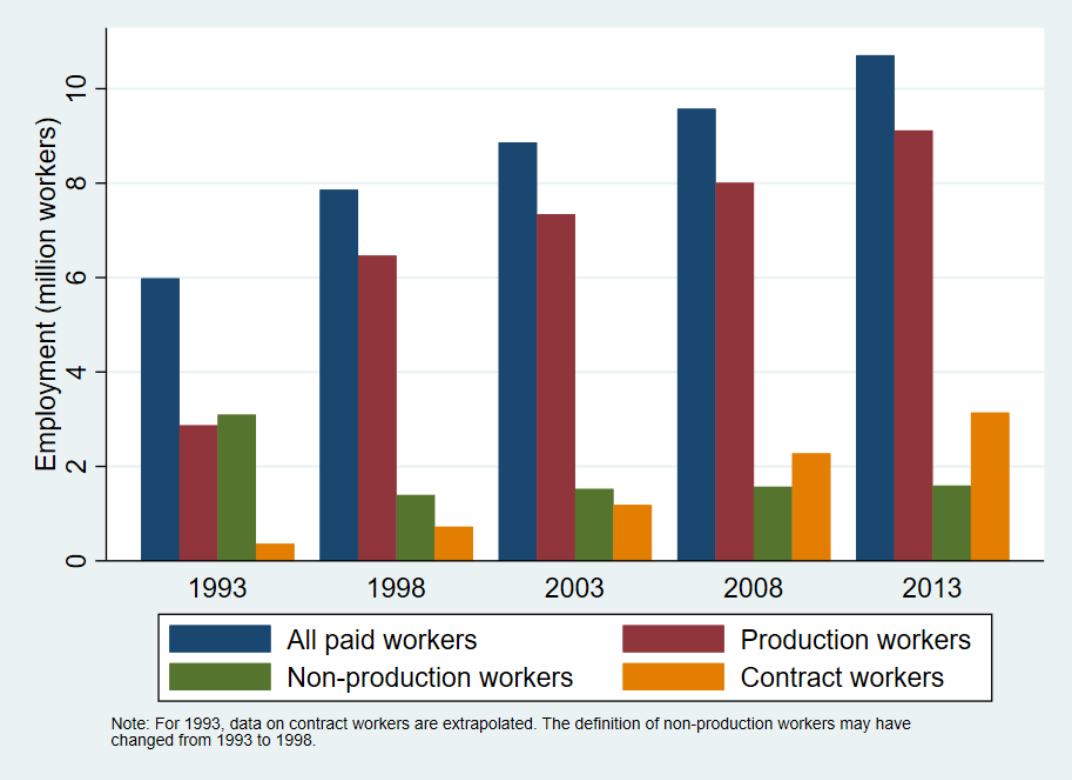
Figure 3 shows four different measures of employment in the formal sector in Mexico in five-year intervals from 1993 to 2013, paid workers, production, nonproduction, and contract workers. Employment of paid workers—which comprise all production and nonproduction workers—increased from approximately 6 million to almost 11 million workers from 1993 to 2013, an increase of 79%. During the same period, the working-age population (the number of people between ages 15 and 64) increased by only 45%. The rise in paid workers is driven by a dramatic increase in production workers in the 1990s, coinciding with the implementation of NAFTA.

During the same period, the reported data shows a decline in nonproduction workers from 1993 to 1998, although this may be due to differences in data collection between the 1993 and 1998 censuses.[2] After 1998, nonproduction workers experience only a modest increase in employment in Mexico's formal sector, increasing from 1.4 million in 1998 to 1.6 million in 2013.

Figure 3 also shows that contract employment increases significantly in Mexico during this time, going from less than 500,000 to over 3.1 million workers from 1993 to 2013.[3] Workers in the contract sector are not covered by labor regulations governing the minimum wage and social security. The growth in the contract sector might explain the sluggish growth of nonproduction workers during this period. As contract employment becomes more common, firms might be more likely to hire less costly contract workers in nonproduction jobs.

From figure 3, it is clear that Mexico's formal sector enjoyed substantial employment growth in the post-NAFTA period, particularly in production employment. This paper explores to what extent NAFTA was responsible for this increase in production workers and whether import competition from NAFTA countries resulted in any losses to employment.

FIGURE 3. LABOR MEASURES, 1993–2013



Source: Author's calculations using economic census data from the Instituto Nacional de Estadística y Geografía (INEGI).

[2] Additionally, because no explicit data on contract workers were collected for 1993, it is possible that the large number of nonproduction workers in 1993 reflects both nonproduction and contract workers.

[3] Employment for contract workers in 1993 is extrapolated from later years because of missing data in that year.

3. LITERATURE REVIEW

A number of papers have examined employment and wage outcomes in Mexico in the context of its trade liberalization of the 1980s, finding that both employment and wages adjusted to increased import competition. Revenga (1997) notes that between 1985 and 1988, Mexico's maximum tariff dropped from 100% to 20% while the average tariff decreased from 25% to 12%. Hanson and Harrison (1999) find that because tariffs were initially high in unskilled-labor-intensive industries, tariff reductions in the 1980s had a disproportionately negative effect on the earnings of unskilled workers and widened the wage gap between skilled and unskilled workers. Similarly, Revenga (1997) finds that liberalization was associated with declines in wages at the firm and industry level in manufacturing sectors, which are intensive in unskilled labor, because wage premiums declined when lower tariffs reduced rents, disproportionately affecting unskilled workers who did not have enough bargaining power to capture a larger share of rents. Revenga (1997) also shows that trade liberalization that resulted in lower industry demand put downward pressure on employment at the firm level in Mexico. On the other hand, Esquivel and Rodriguez-Lopez (2003) conclude that trade liberalization from 1988 to 1994 led to a reduction in the gap between skilled and unskilled workers, as certain trade models (i.e. Heckscher Ohlin) predict, but that this reduction was overshadowed by an increase in the wage gap due to technological change.

There are a number of empirical papers analyzing the impact of NAFTA on Mexico, generally finding a mostly positive impact on outcomes such as employment and welfare with some evidence that NAFTA also increased wage inequality, particularly between regions. In a general equilibrium analysis, Caliendo and Parro (2015) find that NAFTA tariff reductions resulted in an increase in welfare in Mexico, with trade in intermediate goods, an important facet of intra-NAFTA trade, being a particularly important factor in the increase in welfare. Chiquiar (2008) and Hanson (2003) both find NAFTA increased wage gaps between regions in Mexico, driven by a region's access to international trade opportunities. Chiquiar (2008) also finds that even though wage gaps are rising between regions, wage premiums for skilled workers in regions most exposed to international trade decline as a result of NAFTA. Esquivel and Rodriguez-Lopez (2003) attribute the rise in skill premium in the post-NAFTA period to technological changes, finding that trade liberalization from 1994 to 2000 had no impact on the wage gap between skilled and unskilled workers.

Most relevant to this paper is Chiquear, Covarrubias, and Salcedo (2017), who use the local labor-markets approach of Autor, Dorn, and Hanson (2013) to analyze the impact of NAFTA and Chinese import competition on Mexican labor markets. The authors use metro areas in Mexico as the local labor-market unit of analysis and focus on the impact of Mexico's exports to the United States instead of considering imports from and exports to both NAFTA countries. They find that NAFTA decreased unemployment and increased wages in Mexico, with gains in the metro areas along the US–Mexico border that are more exposed to trade and in manufacturing industries such as autos.

Several related papers also employ a local labor-markets approach. Hakobyan and McLaren (2018) examine the employment impact of Mexican NAFTA tariff reductions but focus their labor-market analysis on blue-collar workers in the United States who are differentially exposed to Mexican tariff reductions depending on their industry of employment. The authors find US workers in industries or locations exposed to larger Mexican tariff reductions show slower wage growth compared to other workers, which they suggest might be due to offshoring. Blyde et al. (2018) utilize a local labor-markets approach to examine the effect of Chinese import competition on Mexican employment, finding a net reduction in Mexican employment.

This paper builds on the existing literature in several ways. First, I use the detailed commuting zones from Blyde et al. (2018) as the local labor-market unit of analysis, allowing me over 600 observations in a cross-sectional analysis. Second, I consider the employment impact of Mexico's imports from and exports to the United States and Canada. I calculate the net impact of NAFTA and quantify national and state employment changes resulting from NAFTA. While there are several papers estimating the impact of NAFTA on wages and inequality, there are relatively few estimates of the employment impact of NAFTA on Mexico. With the state-level results, I am able to analyze the heterogeneous impact of NAFTA on Mexican regions, highlighting major discrepancies across regions due to historical and geographical factors. In addition to providing novel estimates of the employment impact of NAFTA, this paper

contributes to a growing literature on the spatial dimension of the impacts of trade liberalization, discussed in the context of Mexico in Baylis, Garduno-Rivera, and Piras (2012), Chiquiar (2008), Hanson (2003) and Chiquear, Covarrubias, and Salcedo (2017), among others.

4. EMPIRICAL STRATEGY

This paper analyzes the impact of NAFTA using two types of variation at the local labor-market level in Mexico: the import and export exposure of a local labor market. Both import competition and expanded export opportunities are important channels through which NAFTA impacted Mexican employment. I follow the local labor-markets approach in Autor, Dorn, and Hanson (2013) to construct terms representing the changes in import and export exposure per worker of Mexican local labor markets over the first ten years of NAFTA, using the set of commuting zones in Blyde et al. (2018) as local labor markets. I then analyze the impact of changes in import and exposure in the first decade of NAFTA on a number of labor and wage outcomes at the commuting zone level. Because of the potential for endogeneity between changes in trade flows and outcomes in local labor markets in Mexico, I use two-stage least squares (2SLS) estimation and instrument for changes in Mexico's trade flows with NAFTA countries with changes in tariffs from other FTAs implemented by NAFTA members.

A. Data

The data I use comes from a number of sources. Trade flows between Mexico and its NAFTA partners are from UN Comtrade and available at the HS-6 level. Tariff data at the HS-6 level are from an unreleased World Bank database of world tariffs harmonized across time to HS 1992 6-digit codes. Trade and tariff data is mapped to 5-digit NAICS 2002 industries using a concordance from Pierce and Schott (2012).

Data on employment and wages come from Mexico's Economic Census, available for 5-digit NAICS industries and municipalities from the Instituto Nacional de Estadística y Geografia (INEGI). Several indicators of employment and wages are available in the Economic Census. This paper makes use of employment data for all paid workers, production workers, nonproduction workers, and contract workers and wage data for all paid workers, production workers, and nonproduction workers. All employment and wage outcome variables are for the formal sector and are considered relative to the working-age population in the local labor market. The working-age population (the number of people between 15 and 64) is from Mexico's Population Census, also available from INEGI. Economic Census data is available every five years from 1988 to 2013, while data from the Population Census is available in five-year intervals from 1990 to 2015. I match 1988 Economic Census data with the 1990 Population Census, 1993 Economic Census data with the 1995 Population Census and so on, as in Blyde et al. (2018).

I also use data from the Population Census to construct the share of the population with secondary education to use as a control variable. Additional data on the routine task intensity of an industry are from Costinot, Oldenski, and Rauch (2011) and used as a control variable, as in Blyde et al. (2018).

Economic Census and Population Census data is mapped from municipalities to commuting zones using the mapping in Blyde et al. (2018). There are 789 commuting zones in Mexico. The average commuting zone has a population of 125,000 and covers an area equal to 2,521 square kilometers (Blyde et al., 2018). In order to analyze trends among regions and states in Mexico, I map each commuting zone to a state and region. Commuting zones were assigned to states based on the number of municipalities in the commuting zone that fall into a particular state. Each state is assigned to one of five regions: northeast, northwest, central east, central west, and south.

B. Import and export exposure

The local labor-markets approach assumes that commuting zones that were initially more specialized in industries that experience an import or export shock respond to the shock to a greater degree than industries that were less specialized. For example, commuting zones that were initially more specialized in exporting industries will be more affected by the expanded export opportunities from NAFTA and will increase output and employment by more than commuting zones that are less specialized in exporting industries. Similarly, commuting zones that were initially

specialized in import-competing industries may see employment contract by more than commuting zones that are not as specialized in these industries, in response to a surge of imports from NAFTA countries. In Autor, Dorn, and Hanson (2013) and other similar analyses, the commuting zone's share of an industry's national employment is used to describe how specialized a commuting zone is in a particular industry.

I calculate import exposure as in Autor, Dorn and Hanson (2013) by weighting the change in Mexican imports from NAFTA countries of industry j from 1993 to 2003 by the share of national employment of industry j in commuting zone i and summing over all industries to construct an implied change in NAFTA imports for the commuting zone. Industry employment weights are calculated from pre-NAFTA employment in 1993. The change in imports of commuting zone i is divided by 1993 employment in the commuting zone, so that ΔI_{it}^{NAFTA} represents commuting zone i's change in import exposure per worker.

$$\Delta I_{it}^{NAFTA} = \frac{1}{L_{i,1993}} * \sum_j \frac{L_{ij,1993}}{L_{j,1993}} * \Delta Imports_{jt}^{NAFTA} \quad (1)$$

I construct a similar term for the change in export exposure per worker but use the share of the national value-added of industry j from commuting zone i in 1993 instead of using the employment weight above. This change removes some of the correlation between ΔI_{it}^{NAFTA} and ΔE_{it}^{NAFTA} that could potentially influence regression results. As with the import exposure term, however, I continue to divide the implied change in commuting zone i's exports by 1993 employment to create the change in export exposure per worker in commuting zone i.

$$\Delta E_{it}^{NAFTA} = \frac{1}{L_{i,1993}} * \sum_j \frac{V_{ij,1993}}{V_{j,1993}} * \Delta Exports_{jt}^{NAFTA} \quad (2)$$

C. OLS

Equation 3 shows the OLS specification. The specifications in this paper are cross-sections over approximately 600 Mexican commuting zones. Changes are from 1993 to 2003 unless specified elsewhere. A number of controls are included in $\mathrm{X'_{it}}$, including the share of the population with secondary education, an index capturing the routine task intensity of the industries in commuting zone i, a pretrend for the change in manufacturing employment from 1988 to 1993, and the change in commuting zone i's trade with the rest of the world. A region dummy γ_r takes one of five values, capturing whether the commuting zone is in the northeast, northwest, central east, central west, or south. Each regression is weighted by a commuting zone's start of period employment (1993), as in Autor, Dorn, and Hanson (2013).

$$\Delta L_{it} = \alpha + \beta_1 \Delta I_{it}^{NAFTA} + \beta_2 \Delta E_{it}^{NAFTA} + \mathrm{X'_{it}} B + \gamma_r + \epsilon_{it} \quad (3)$$

The change in employment of all workers per working-age population in commuting zone i from 1993 to 2003 (ΔL_i) is on the left-hand side. I also use changes in employment of production workers (ΔL_{prod}), nonproduction workers ($\Delta L_{nonprod}$), and contract workers (ΔL_{con}) as outcome variables. Paid workers are the sum of production and nonproduction workers. All workers, or total employment, is the sum of paid workers and contract workers. As noted above in the discussion of figure 3, 1993 employment values were extrapolated from later years and the reported 1993 value of nonproduction workers may be larger than it should be due to differences in data collection between 1993 and 1998. I also consider the impact on wages per working-age population of all paid workers (W_{paid}), production workers (W_{prod}), and nonproduction workers ($W_{nonprod}$).

The coefficients of interest in equation 3 are β_1 and β_2. Since import competition is likely to have a dampening effect on employment, while exports likely encourage employment, I expect $\beta_1 < 0$ and $\beta_2 > 0$. It is not clear a priori which impact will be largest.

D. Two stage least squares identification

Although OLS results are presented below, 2SLS is the preferred estimation method. As with most analyses of trade flows and labor markets, there is a high potential for endogeneity between trade and employment or wage

outcomes. For example, a decline in demand for products from a commuting zone driven by increased import competition is likely to happen simultaneously as employment declines in the commuting zone, making it difficult to estimate the causal impact of the import shock on employment. To robustly identify the causal impact, I instrument the changes in export and import exposure terms with changes in tariffs from the first decade of other agreements the NAFTA parties implemented.

I use tariffs from Mexico's FTA with the European Union to instrument for Mexico's exports to NAFTA partner countries. Specifically, I use the change in tariffs applied to Mexican exports to the European Union from the first ten years of the Mexico-European Union FTA ($\Delta\tau_{it}^{EU,MEX}$) to instrument for the change in Mexican exports to the United States and Canada in the first decade of NAFTA. Similarly, I use changes in tariffs applied to the United States and Canadian exports to Chile, Costa Rica, and Peru in the first ten years of each FTA ($\Delta\tau_{it}^{CCP,USCAN}$) to instrument changes in Mexico's imports from the United States and Canada in the first decade of NAFTA.

The tariff instruments are constructed from industry tariffs using the same method as the import and export exposure terms are constructed from industry trade data. I follow the construction of the trade exposure terms in that a commuting zone's share of the national value-added in the industry is used to weight tariff changes on Mexican exports, while the commuting zone's labor share is used to weight tariff changes on Mexican imports. The value-added and labor weights are lagged five years. The changes in tariffs of industry j applied to the United States and Canadian exports to Chile, Costa Rica, and Peru are weighted by commuting zone i's share of industry j's national employment, and the implied tariff change for commuting zone i is divided by total employment in the commuting zone, also lagged five years.

ΔI_{it}^{NAFTA} instrumented with

$$\Delta\tau_{it}^{CCP,USCAN} = \frac{1}{L_{i,1988}} * \sum_j \frac{L_{ij,1988}}{L_{j,1988}} * \Delta\tau_{jt}^{CCP,USCAN} \quad (4)$$

Similarly, tariff changes applied to Mexican exports to the European Union are weighted by commuting zone i's share of industry j's national value-added and then divided by a five-year lagged value of commuting zone employment. The resulting instruments represent the change in the per worker import and export tariff shocks and instrument for the changes in per worker import and export exposure, respectively.

ΔE_{it}^{NAFTA} instrumented with

$$\Delta\tau_{it}^{EU,MEX} = \frac{1}{L_{i,1988}} * \sum_j \frac{V_{ij,1988}}{V_{j,1988}} * \Delta\tau_{jt}^{EU,MEX} \quad (5)$$

The third-party tariff changes are less likely to impact labor markets in Mexico than the actual NAFTA tariff changes, better satisfying the exclusion restriction. For example, Mexican import tariffs and the pattern of tariff liberalization might be correlated with industries outcomes with steeper tariff liberalizations in already weak industries that more likely to shed employment, obscuring the impact of import competition on employment. Third-party tariff changes are not subject to this criticism.

There is, however, still a concern that potential unobservables exist that are correlated with the third-party tariff changes and also affect Mexican labor outcomes, invalidating the use of third-party tariff changes as an instrument. Identification requires the assumption that no such unobservables exist.

5. RESULTS

A. OLS results

Table 1 presents results for the impact of NAFTA on employment in Mexican commuting zones from a set of OLS regressions. The columns represent different labor outcomes. All regression variables in tables are in level changes. Both the right- and left-hand-side changes are from 1993 to 2003, representing the change from the pre-NAFTA level

of trade and employment to the levels a decade after implementation. Because employment data is only available for the formal sector, all results represent the impact of NAFTA on formal sector employment only.

Column (1) gives results for total employment in a commuting zone, L_i, or the sum of paid (production plus nonproduction) and contract workers. The first two rows show the impact of changes in export and import exposure per worker, respectively, on total employment per working-age population in a commuting zone. As expected, the change in export exposure per worker has a positive effect on total employment per working-age population, while the change in import exposure per worker has a negative impact. Columns (2) and (3) show results for paid and production workers. The magnitude of coefficients is similar across the first three specifications. Because total employment and paid employment both include the group of production workers in column (3), it is likely that production workers are driving the changes in paid and total workers. This is further supported by the results for nonproduction and contract workers in columns (4) and (5). There is no statistically significant impact of either trade exposure term on nonproduction workers, while the impacts for contract workers have the opposite sign, suggesting NAFTA exports may have decreased contract employment per working-age population.

TABLE 1. IMPACT OF NAFTA ON LABOR OUTCOMES, OLS, 2003–1993

	(1) ΔL_i	(2) ΔL_{paid}	(3) ΔL_{prod}	(4) $\Delta L_{nonprod}$	(5) ΔL_{con}
ΔE_{it}^{NAFTA}	0.34*	0.43***	0.40**	0.04	-0.10*
	(0.17)	(0.16)	(0.16)	(0.09)	(0.05)
ΔI_{it}^{NAFTA}	-0.66***	-0.73***	-0.58***	-0.15	0.07
	(0.19)	(0.18)	(0.17)	(0.10)	(0.06)
Specification	OLS	OLS	OLS	OLS	OLS
Region FE	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
Observations	614	614	614	614	614

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Coefficients represent the effect for the average commuting zone. The net impact of NAFTA trade flows on employment in a commuting zone depends on the relative magnitudes of import and export exposure in addition to the coefficient values. The magnitude of results and the implication for national and regional employment will be discussed for the 2SLS results in the next section.

Equation 3 also includes several control variables. Both the share of the population in a commuting zone with a secondary education and the routine task intensity index of the industries in a commuting zone enter significantly into all regressions and have the expected signs—positive for secondary share and negative for routine task intensity. The change in Mexico's trade balance with the rest of the world from 1993 to 2003 and the pre-NAFTA change in manufacturing employment in the commuting zones from 1988 to 1993 do not significantly impact labor outcomes.

Table 2 presents the results from OLS regressions of the trade exposure per worker terms on total wages paid per working-age population for paid, production, and nonproduction workers. Import exposure per worker has a negative impact on total wages per working-age population for all groups of workers. The impacts of export exposure are less clear. Total wages paid to production workers per working-age population experience an increase, but wages paid to the group of paid workers appear to decline because of declines in wages to nonproduction workers.

TABLE 2. IMPACT OF NAFTA ON WAGE OUTCOMES, OLS, 2003–1993

	(1) ΔW_{paid}	(2) ΔW_{prod}	(3) $\Delta W_{nonprod}$
ΔE_{it}^{NAFTA}	-2.43***	4.94***	-0.40
	(0.74)	(1.37)	(0.71)
ΔI_{it}^{NAFTA}	-3.61***	-3.03**	-2.04***
	(0.81)	(1.50)	(0.78)
Specification	OLS	OLS	OLS
Region FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Observations	614	614	614

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

B. Two-stage least squares results

As mentioned previously, two-stage least squares is a more robust estimation method because of the potential for endogeneity between labor outcomes and trade flows. Table 3 presents 2SLS for the same set of labor outcomes as in table 1. The results in table 3 confirm the patterns from OLS estimation. Increases in import exposure per worker in a commuting zone decrease commuting zone employment, while increases in export exposure per worker raise employment.

As with OLS, the results for the composite groups of all workers in column (1) and paid workers in column (2) are both driven by the impacts on one type of worker, production workers, which are presented in column (3). The coefficient of 3.10 in column (3) of table 3 indicates that a $1,000 exogenous increase in a commuting zone's export exposure per worker raises production employment per working-age population by 3.10 percentage points. Similarly, a $1,000 increase in import exposure per worker reduces employment per working-age population by 1.73 percentage points. The net impact in a commuting zone depends on the relative sizes of the commuting zone's import and export exposure per worker.

TABLE 3. IMPACT OF NAFTA ON LABOR OUTCOMES, 2SLS ESTIMATION, 2003–1993

	(1) ΔL_i	(2) ΔL_{paid}	(3) ΔL_{prod}	(4) $\Delta L_{nonprod}$	(5) ΔL_{con}
ΔE_{it}^{NAFTA}	2.83***	3.09***	3.10***	-0.04	-0.26
	(1.09)	(1.06)	(1.08)	(0.37)	(0.34)
ΔI_{it}^{NAFTA}	-1.54	-2.19**	-1.73*	-0.42	0.65*
	(1.09)	(1.06)	(0.96)	(0.43)	(0.36)
Specification	2SLS	2SLS	2SLS	2SLS	2SLS
Region FE	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
Observations	614	614	614	614	614

Standard errors are in parentheses and clustered at the state level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

There are no significant impacts on nonproduction workers, while contract workers experience the opposite effects. An increase in import exposure per worker of $1,000 raises a commuting zone's contract employment per working-age population by 0.65 percentage points. A rise in export exposure per worker decreases contract employment per working-age population, although the impact is not significantly different from zero. Import competition increases the number of contract workers in Mexico, perhaps because industries faced with increased competition from foreign goods reduce costs by hiring contract workers who are less costly because they are not governed by labor regulations, including minimum wage and social security laws. When analyzing the impact of Chinese import competition on Mexican employment, Blyde et al. (2018) similarly find the employment of informal sector workers rises.

The impact on total workers is presented in column (1). A $1,000 increase in a commuting zone's per-worker export exposure results in a 2.83% increase in total formal sector employment, while a $1,000 increase in import exposure per worker results in a 1.54% decrease in employment, although the result is not significant, likely because the total worker group includes nonproduction and contract workers where the results are, respectively, insignificant and of the opposite sign.

Appendix tables 8 and 9 provide robustness on the coefficients in table 3. Table 8 excludes the commuting zone containing the Federal District (Mexico City). Results excluding the Federal District are consistent with those presented here with one exception: in the contract workers specification, the coefficient on the import exposure term changes sign and loses significance, suggesting that the increased use of contract workers as an adjustment to import competition primarily occurs in the Federal District. Table 9 excludes all commuting zones in the northeast and northwest regions of Mexico, those states that border or are more likely to have closer economic links to the United States and Canada. In all the specifications, the coefficients on the import exposure term are negative but not significant, while the coefficients on the export exposure term remain positive and significant for production workers (and consequently remain positive and significant for the composite groups containing production workers). The results in table 9 suggest that production job losses from NAFTA import competition were concentrated in the north; removing these observations from the regressions does not lead to a significant negative impact on employment.

TABLE 4. IMPACT OF NAFTA ON WAGE OUTCOMES, 2SLS ESTIMATION, 2003–1993

	(1) ΔW_{paid}	(2) ΔW_{prod}	(3) $\Delta W_{nonprod}$
ΔE_{it}^{NAFTA}	3.37	17.53***	2.38
	(7.72)	(6.80)	(4.60)
ΔI_{it}^{NAFTA}	-14.30**	-10.18	-8.15
	(7.06)	(6.95)	(5.15)
Specification	2SLS	2SLS	2SLS
Region FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Observations	614	614	614

Standard errors are in parentheses and clustered at the state level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4 presents the 2SLS results for total wages paid per working-age population. The results display similar but not identical patterns as OLS. Increased export exposure results in a rise in wages per increase in working-age population for production workers, while import competition decreases wages for production and nonproduction workers, although the effect is only significant when the two groups are considered together in all paid workers. The results could be consistent with declining wage gaps between skilled (nonproduction) and unskilled (production) workers, but the precision of the regressions is not high enough for a definitive interpretation.

C. NAFTA's impact on national employment

The results presented above show that export opportunities from NAFTA had a positive impact on relative employment among commuting zones while import competition reduced relative employment in some instances. It is possible to calculate the net impact on employment in Mexico during the first decade of NAFTA by computing the net impact for each commuting zone and summing over all commuting zones, as in equation 6. The net impact on a commuting zone is calculated as the sum of the effects from import and exposure, multiplied by the working-age population. Estimates are calculated using the coefficients in column (1) of table 3.[4] The estimated βs are divided by 1,000 to match the coefficient's units with the left-hand side variables. The national and state-level estimates presented below rely on the assumption that NAFTA changed the absolute level of employment rather than affecting only the relative levels between commuting zones, which is a reasonable assumption given the employment trends seen in figure 3.

$$NetEffect = \sum_i \left[(\beta_1 * \Delta I_{it}^{NAFTA} + \beta_2 * \Delta E_{it}^{NAFTA}) * Pop\right] \qquad (6)$$

Although not every commuting zone experiences a net positive impact, the economy-wide effect is a net gain in total employment of 870,000 workers, seen in column (1) of table 5, which presents the export, import, and net effects on employment of various groups. For all workers, expanded export opportunities generated 1.3 million jobs in the first

[4] Estimates from column (1) were chosen to calculate the net impact on total employment rather than the impact on only production, nonproduction, paid, or contract workers. While the coefficient on the export exposure term in column (1) is significant, the coefficient on the import exposure term is not significant, potentially limiting its interpretative power in an exercise such as this. However, columns (3) through (5) allow us to see the results for the groups comprising total employment in column (1), highlighting the differential impacts of import exposure on production, nonproduction, and contract workers. After reviewing the coefficients in columns (3) through (5), it appears that 1.54 in column (1) is a reasonable estimate for the average effect on all workers, even though it is not statistically significant. Confidence intervals of 95% were calculated around all results using estimated coefficients.

decade of NAFTA, while import competition resulted in a loss of 456,000 jobs, resulting in the net gain of 870,000. The net gain represents a 13.7% change in employment from pre-NAFTA levels in 1993 with a lower bound of 10.1% and upper bound of 16.7%. Table 6 gives the percentage change in employment and a lower and upper bound on the percentage change in employment, calculated from the 95% confidence intervals on the coefficients in table 3.[5]

TABLE 5. NATIONAL CHANGE IN EMPLOYMENT DUE TO NAFTA, THOUSAND WORKERS, 1993–2003

	Net effect	Export effect	Import effect
All workers	870	1,325	-456
Production workers	940	1,453	-513
Nonproduction workers	-144	-18	-125
Contract workers	70	-122	192

Source: Author's calculations.

The employment changes for total employment mask heterogeneity in effects among the different groups of workers. From the second row of table 5, it is clear that the total employment change is driven by increases in the employment of production workers, who experienced a large net gain in employment of 940,000 jobs, a 32.7% increase. Exports to NAFTA countries resulted in a gain of over 1.4 million production jobs, while imports decreased production employment by only 513,000. Nonproduction workers, on the other hand, experienced a net decline in employment of 144,000 jobs, a decrease of 4.7%, due to NAFTA. Both expanded export opportunities and import competition resulted in employment declines for nonproduction workers. The decline in nonproduction employment could be due to several factors. Production-sharing arrangements might have resulted in resources and international investment shifting to the production of manufacturing goods, making it more difficult for other industries to remain competitive or for workers in nonproduction jobs to remain in demand. Additionally, tariff reductions and nontariff concessions in NAFTA would have allowed industries from the United States and Canada greater access to Mexican markets, possibly forcing some local service industries out of business. Finally, it is possible that some formally employed nonproduction workers remained in employment but as contract workers. The last row of table 5 shows that contract workers experienced a net gain of 70,000 workers due to NAFTA, an increase of 19.3%. Curiously, expanded export opportunities to NAFTA countries resulted in a decline in contract employment, while import competition resulted in a net increase, suggesting import competition may have forced Mexican firms to reduce costs by hiring contract workers, similarly to Blyde et al.'s (2018) finding of a positive impact on informal sector workers in an analysis of Chinese import competition on Mexican workers.

TABLE 6. NATIONAL CHANGE IN EMPLOYMENT DUE TO NAFTA, PERCENTAGE CHANGE, 1993–2003

	Net effect	Lower bound	Upper bound
All workers	13.7%	10.7%	16.7%
Production workers	32.7%	26.5%	39.0%
Nonproduction workers	-4.7%	-6.9%	-2.4%
Contract workers	19.3%	2.5%	36.1%

Source: Author's calculations.

D. NAFTA's impact on employment by state

In this section, Mexico's net gain in total employment of 870,000 workers is broken down by state. Table 7 shows the changes in total employment due to NAFTA in every state as a percentage and level change. Detailed import and export effects by state are in appendix table 10. States are grouped according to region. Lower and upper bounds on

[5] Upper and lower bounds calculated from implied level upper and lower bounds of net employment changes. The net employment change is the sum of two normally distributed random variables (the import and export effects). The sum of two normal distributions is also normal with variance equal to the sum of both variances. Upper and lower bounds in net employment changes were calculated around the net effect using a standard error derived from the sum of both variances.

the percentage change in employment are given. It is clear that the impact of NAFTA on total employment is heterogeneous among states. States in the northern and central east regions of Mexico experience the largest effects on employment, while employment in states in the south and central west is not affected greatly by NAFTA, with some exceptions.

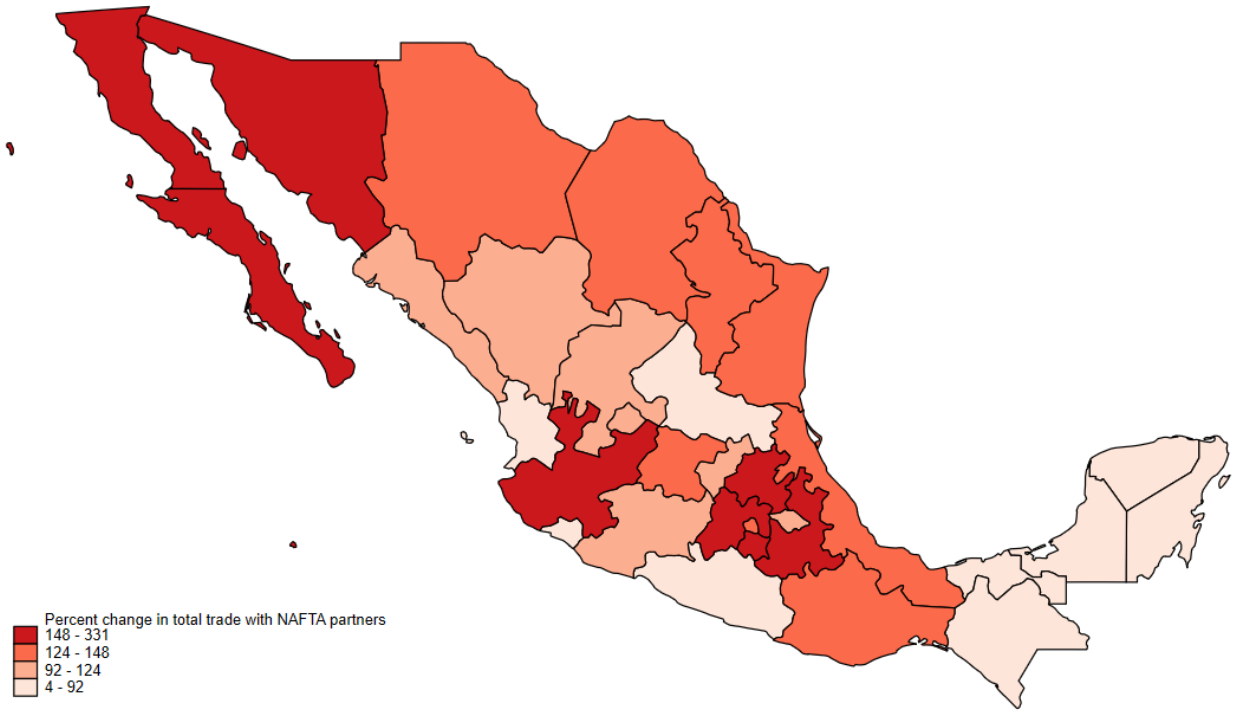
TABLE 7. NET CHANGE IN TOTAL EMPLOYMENT DUE TO NAFTA, BY STATE, 1993–2003

Region	State	Percentage change	Lower bound	Upper bound	Level change
***Northeast**	Chihuahua	16.6	14.8	18.4	54,109
	Coahuila	11.2	9.1	13.3	17,947
	Nuevo León	13.2	11.5	15.0	61,473
	Tamaulipas	18.7	16.2	21.2	45,081
***Northwest**	Baja California	19.2	17.1	21.3	47,202
	Baja California Sur	2.0	-1.1	5.0	615
	Durango	4.5	1.8	7.1	6,715
	Sinaloa	3.5	-0.1	7.2	4,517
	Sonora	22.6	20.0	25.3	37,866
***Central East**	Federal District	12.7	10.7	14.7	235,038
	Hidalgo	9.7	4.2	15.3	7,840
	México	52.0	47.5	56.5	71,502
	Morelos	47.2	43.8	50.6	38,308
	Puebla	16.0	11.9	20.1	38,290
	Tlaxcala	5.5	0.6	10.5	1,654
***Central West**	Aguascalientes	8.7	6.3	11.0	6,995
	Colima	1.6	-2.2	5.4	366
	Guanajuato	7.5	4.3	10.8	19,666
	Jalisco	21.3	18.7	23.9	102,000
	Michoacán	1.3	-4.8	7.3	1,570
	Nayarit	1.0	-4.6	6.6	308
	Querétaro	7.6	4.7	10.4	7,644
	San Luis Potosí	7.0	3.1	11.0	8,089
	Zacatecas	-0.3	-6.5	5.9	-113
***South**	Campeche	0.9	-4.2	6.0	273
	Chiapas	0.8	-8.4	10.0	762
	Guerrero	7.6	2.0	13.1	7,364
	Oaxaca	36.8	27.9	45.6	26,294
	Quintana Roo	0.4	-1.6	2.5	251
	Tabasco	1.8	-3.5	7.1	878
	Veracruz	7.1	1.9	12.3	17,345
	Yucatán	1.6	-1.9	5.1	1,960

Source: Author's calculations.

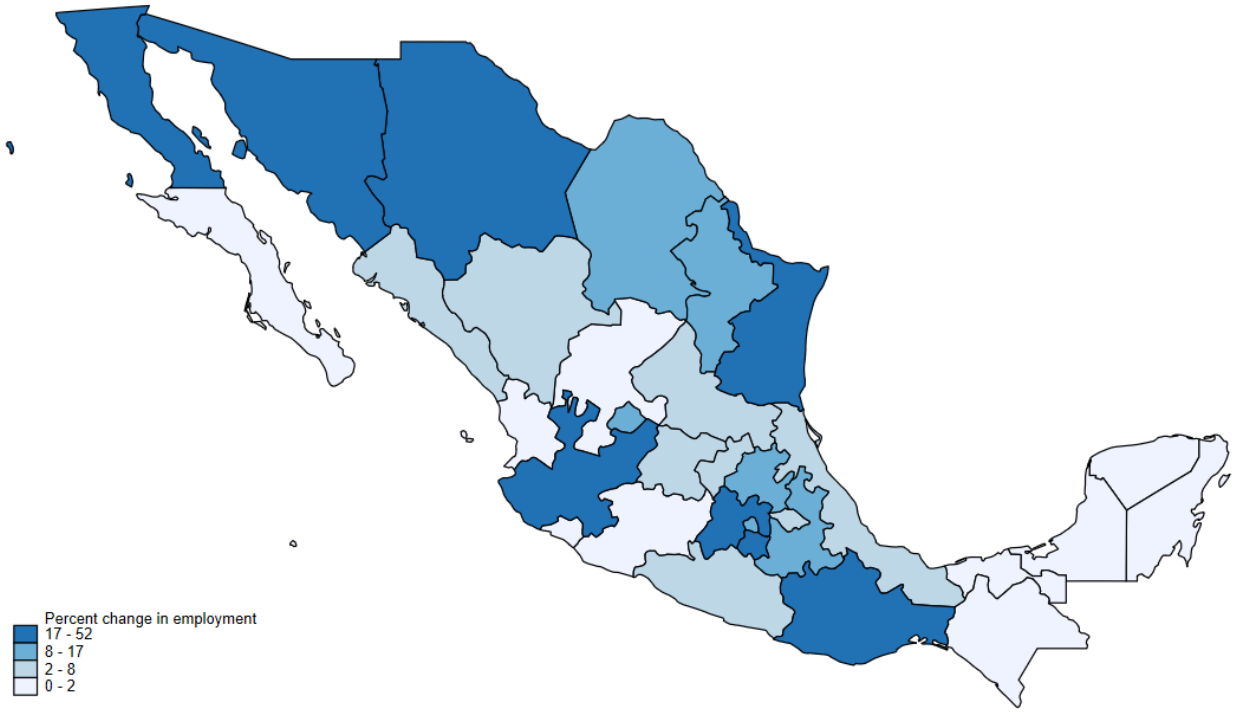
This pattern is explained by regional differences in the concentration of industries participating in international trade, which has its roots in historical and geographical factors. Figure 4 shows a heat map of Mexico with the percentage change in total trade (exports plus imports) with NAFTA countries from 1993 to 2003. The states whose participation in NAFTA trade increased by the most are in the northern regions near the United States border or clustered around Mexico City in the central part of the country. In Chihuahua, for example, total trade increased by 144%, on par with other border states. Near Mexico City, changes in total trade with NAFTA partners were as high as over 300% in Hidalgo and Morelos, with a 143% increase in total trade in Mexico City itself. By contrast, states in the south saw much lower increases in NAFTA trade, ranging from 92% in Yucatán to just 4% in Quintana Roo.

FIGURE 4. PERCENTAGE CHANGE IN TOTAL TRADE WITH NAFTA COUNTRIES, BY STATE, 1993–2003



Source: Author's calculations.

FIGURE 5. PERCENTAGE CHANGE IN TOTAL EMPLOYMENT DUE TO NAFTA, BY STATE, 1993–2003



Source: Author's calculations.

Figure 5 presents another heat map of Mexico with each state's percentage change in employment from column (1) of table 7. A similar pattern emerges as in figure 4. The darkest areas on the map again are in the northern border

states and surrounding Mexico City in the central part of the country. For example, the states of México and Morelos near Mexico City experience increases in employment of over 50%. Along the border, changes in employment due to NAFTA range from 12% in Coahuila to 25% in Sonora. States in the south see barely any change in employment. NAFTA increased employment by only 0–2% in Tabasco, Chiapas, Campeche, Yucatán, and Quintano Roo. The state of Oaxaca in southern Mexico is one exception. Employment increased by 36.8%, with 75% of the gain of 26,294 workers accruing to one commuting zone, Tehuantepec, which is a large agricultural producer and likely benefited from reductions in agricultural tariffs in the United States and Canada.

The regional disparity in the impacts of NAFTA is consistent with findings in Baylis, Garduno-Rivera and Piras (2012), Chiquiar (2008), Hanson (2003) and Chiquear, Covarrubias, and Salcedo (2017), all of which find that trade liberalization had a differential impact on regions based on a region's exposure to international trade. The high participation in international trade of states in the northeast and central east are due to historical factors influencing the location of manufacturing firms in these regions. An Inter-American Development Bank (IDB) report finds that trade liberalization resulted in a deconcentration of firms away from the central east states surrounding Mexico City, where firms historically located under import substitution industrialization due to a focus on the domestic market that made it advantageous to be near customers, suppliers, and workers. The northeastern states benefited from this relocation of export-oriented firms due to existing transport networks and lower domestic transport costs than other regions. The IDB report finds that transport costs are particularly high in southern states below Puebla and in the northwestern states of Baja California, Baja California Sur, Sinaloa, and Durango. While northwestern states may be able to overcome high transport costs due to proximity to the United States, states in the south continue to have a low concentration of firms participating in importing or exporting. The small number of firms engaged in international trade affects the degree to which regions experienced a meaningful employment impact from NAFTA, explaining why NAFTA generated large employment gains in some states but barely impacted employment in others.[6]

6. CONCLUSION

This paper analyzes the impact of NAFTA on employment and wages in Mexico using a local labor-markets approach that utilizes variation in the industries located in a commuting zone to determine the exposure of the commuting zone to expanded export opportunities to and import competition from NAFTA countries. Expanded export opportunities generally raise employment, while import competition lowers employment in most instances. Results confirm pre-NAFTA predictions that the agreement would help production workers and boost overall employment in Mexico. This paper finds that Mexico experienced a net gain in employment of 870,000 workers due to NAFTA, an increase of 13.7%. In particular, production workers gained significantly, with employment increasing by 32.7%. Employment of contract workers also grew significantly as an adjustment mechanism to increased import competition. Nonproduction workers experienced small declines in employment due to NAFTA.

The employment impact of NAFTA varies across states. NAFTA had a large impact on employment in states in the northeast and central east regions because firms participating in international trade are concentrated in these states and therefore were more easily able to take advantage of tariff declines, although they were also more exposed to import competition. States in the south and some states in the central west experienced only very small impacts because firms in these areas are less likely to participate in international trade than firms in the north and central east.

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[6] This paper does not attempt to analyze any spillover or general equilibrium effects that may have further impacted states in the south.

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APPENDICES

A. Robustness

TABLE A.1. IMPACT OF NAFTA ON LABOR OUTCOMES, 2SLS ESTIMATION, 2003–1993, EXCLUDING THE FEDERAL DISTRICT

	(1) ΔL_i	(2) ΔL_{paid}	(3) ΔL_{prod}	(4) $\Delta L_{nonprod}$	(5) ΔL_{con}
ΔE_{it}^{NAFTA}	2.77***	3.05***	3.07***	-0.05	-0.05
	(0.98)	(1.00)	(1.04)	(0.37)	(0.37)
ΔI_{it}^{NAFTA}	-1.58	-2.22**	-1.76*	-0.43	-0.43
	(1.12)	(1.10)	(0.98)	(0.43)	(0.43)
Specification	2SLS	2SLS	2SLS	2SLS	2SLS
Region FE	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
Observations	613	613	613	613	613

Standard errors are in parentheses and clustered at the state level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

TABLE A.2. IMPACT OF NAFTA ON LABOR OUTCOMES, 2SLS ESTIMATION, 2003–1993, EXCLUDING NORTHEAST AND NORTHWEST

	(1) ΔL_i	(2) ΔL_{paid}	(3) ΔL_{prod}	(4) $\Delta L_{nonprod}$	(5) ΔL_{con}
ΔE_{it}^{NAFTA}	2.32**	2.46***	2.49**	-0.07	-0.07
	(1.04)	(0.86)	(1.00)	(0.30)	(0.30)
ΔI_{it}^{NAFTA}	-0.75	-1.24	-0.87	-0.34	-0.34
	(1.09)	(0.93)	(1.03)	(0.28)	(0.28)
Specification	2SLS	2SLS	2SLS	2SLS	2SLS
Region FE	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
Observations	496	495	495	495	495

Standard errors are in parentheses and clustered at the state level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

B. Additional state employment results

TABLE B.1. IMPORT AND EXPORT EFFECTS OF NAFTA, BY STATE, 1993–2003 (NUMBER OF WORKERS)

Region	State	Net effect	Import effect	Export effect
***Northeast**	Chihuahua	54,109	-22,412	76,521
	Coahuila	17,947	-7,240	25,187
	Nuevo León	61,473	-33,976	95,449
	Tamaulipas	45,081	-21,266	66,346
***Northwest**	Baja California	47,202	-31,507	78,710
	Baja California Sur	615	-872	1,487
	Durango	6,715	-8,374	15,089
	Sinaloa	4,517	-1,707	6,224
	Sonora	37,866	-11,214	49,080
***Central East**	Federal District	235,038	-142,009	377,046
	Hidalgo	7,840	-15,728	23,568
	México	71,502	-19,098	90,600
	Morelos	38,308	-5,060	43,368
	Puebla	38,290	-20,544	58,834
	Tlaxcala	1,654	-5,058	6,712
***Central West**	Aguascalientes	6,995	-4,148	11,143
	Colima	366	67	298
	Guanajuato	19,666	-16,944	36,611
	Jalisco	102,000	-26,709	128,709
	Michoacán	1,570	-7,213	8,783
	Nayarit	308	-232	540
	Querétaro	7,644	-14,246	21,891
	San Luis Potosí	8,089	-5,244	13,333
	Zacatecas	-113	-1,216	1,103
***South**	Campeche	273	-182	455
	Chiapas	762	-2,169	2,931
	Guerrero	7,364	-2,952	10,316
	Oaxaca	26,294	-13,670	39,964
	Quintana Roo	251	70	181
	Tabasco	878	-36	914
	Veracruz	17,345	-12,834	30,178
	Yucatán	1,960	-1,833	3,793