USING PANEL DATA TO ESTIMATE THE EFFECT OF THE NORTH AMERICAN FREE TRADE AGREEMENT ON EMPLOYMENT AND WAGES AT THE STATE LEVEL

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I determine the effect of NAFTA on employment and wages in the United States. I use a panel-data set of 50 states for 1980-2000, and a two-stage least squares, fixed effects model. I estimate equations for employment and wages. Empirical results indicate that NAFTA had a negative effect on employment and a positive effect on wages.   Chow Test results suggest that there is a break in both the employment and wage relationships in 1994, the year NAFTA became effective.

I. INTRODUCTION

On January 1, 1994, the North American Free Trade Agreement (NAFTA), a trilateral agreement between Canada, the U. S., and Mexico that established a free-trade area in North America, took effect. Many tariffs were eliminated on January 1, 1994, while others were scheduled to be reduced over a 5, 10, or 15-year period. Quotas and import licenses were also eliminated. In addition to trade liberalization, there were side agreements that dealt with such topics as environmental safeguards and child labor.

NAFTA is one of the most controversial trade agreements ever ratified by Congress. Since it was first proposed in the early 1990s, organized labor, environmentalists, and even self-made billionaires have rallied against NAFTA. Ross Perot, the Texas billionaire Presidential Candidate in 1992, urged Congress to defeat NAFTA; he believed that all that would be heard after the passage of NAFTA would be a "giant sucking sound," which would be the sound of thousands, if not millions, of U.S. jobs moving to Mexico. In addition, environmentalists believed that NAFTA would loosen environmental regulations throughout North America and would shift production of goods to Mexico, where environmental safeguards are less stringent than in the U.S.

Most of the existing research on NAFTA has dealt with anecdotal evidence or sectoral studies; few studies have used robust statistical analyses to determine how NAFTA has affected the U.S. economy. I

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attempt to fill that void and focus on how NAFTA affects employment and wages at the state level. I use data from 50 states over the period 1980-2000 and a two-stage least squares, fixed effects model to determine if, after controlling for all other factors, NAFTA has positively or negatively affected employment and wages at the state level. My study differs from prior research in that it focuses on state-level data. Since most prior research has focused on sectoral studies, my work is unique in this regard. Finally, I use the most recent data set of any study on this topic.

II. LITERATURE REVIEW

As noted previously, most prior research has not employed rigorous statistical analysis to assess how NAFTA affects employment and wages. Most prior research has either been produced by self-interested lobbyist groups and think tanks or has focused on very narrow issues, such as the Maquiladora Program or on NAFTA's sectoral effects.

Imada-Iboshi and McCleery (1994) used a general equilibrium model with 1988 trade data to determine if NAFTA would affect production, trade, or employment in the three signatory countries. Results suggested that low-technology industries should experience slower growth in the U.S., although no industries are expected to contract. Trade would increase, and production in Mexico and Canada would increase in some industries.

Martin (1995), in an article in *Challenge*, examined Mexican-U.S. migration and attempted to determine how NAFTA would affect this migration. Using anecdotal evidence and relying primarily on the results of other studies, he stated that it is very difficult to determine how NAFTA affects labor migration. Nonetheless, he claimed that, based on the results of other studies, Mexican immigration to the U.S. would initially increase after the passage of NAFTA and would then decline.

Dorantes and Huang (1997) used a panel-data set from 10 major industries over the period 1983-1994 in a random effects model to ascertain the determinants of the unemployment rate at the sectoral level. Using explanatory variables such as interest rates and unionization rates, they found that unemployment rates are explained by a number of factors at the industry level, chiefly the extent of unemployment insurance coverage and interest rates. As an afterthought, the authors used a Chow Test to determine if NAFTA affected unemployment rates; they reported that there was no statistically significant difference in the regression coefficients between the periods 1983-1993 and 1994. Hence, Dorantes and Huang concluded that NAFTA did not affect sectoral unemployment rates.

Hashemzadeh (1997) reviewed the literature on NAFTA and job losses and described bilateral trade flows between the U.S. and Mexico. He found that almost all economic studies of NAFTA showed that the relaxation of trade barriers between the U.S. and Mexico should increase economic growth for both countries, but that the effect on labor in the first two years of NAFTA would be minimal.

Silvers (2000) studied the Maquiladora Program and attempted to determine whether NAFTA

affected trade linkages between Arizona and Sonora, Mexico. He found a limited linkage between these two areas, with most of the trade going one way, from Arizona to Sonora. NAFTA was expected to have a positive effect on the Mexican demand for U.S. goods but little, if any, effect on U.S. demand for Mexican goods.

Two studies by the Economic Policy Institute (Schott, 2001a; Schott, 2001b) unequivocally claimed that NAFTA cost the U.S. jobs; according to both studies, the U.S. lost over 766,000 jobs from 1994 to 2000 due to NAFTA. These estimates were calculated by examining the effects of trade on employment at the 3-digit SIC industry level. The studies used industry-specific, chain-weighted price indices to deflate trade data and extrapolated trade effects on employment using a 1992 U.S. input-output table.

Yoskowitz et al.(2002) analyzed the impact of NAFTA on employment, per capita income, and the unemployment rate. Looking at the Texas-Mexico border region, they used data from the Department of Commerce and the Texas Workforce Commission; their latest data were from 1998. Using nonparametric tests, they reported that employment and per capita income were lower in the post-NAFTA period but that the unemployment rate was not statistically significantly different between the two periods; these results are only applicable to the South Texas region.

Thorbecke and Eigen-Zucchi (2002) examined the economic effects of NAFTA using a descriptive statistics approach. Extrapolating potential changes in employment from trade data, they asserted that NAFTA had little, if any, effect on U.S. employment. NAFTA's largest impact on the U.S. economy has been in trade between the U.S. and Mexico.

Klein, Schuh, and Triest (2003) looked at the effect of NAFTA on job flows and trade for three industries: textile and apparel, chemical, and automobile. Using descriptive statistics, the authors found that NAFTA had little, if any, effect on employment and gross job flows in these three industries. In addition, the authors state that NAFTA did not affect either net or gross job flows in the United States as a whole. However, they concede this conclusion is tentative.

A more recent study by Hufbauer and Schott (2003) for the Institute for International Economics, reviewed various prior NAFTA studies and found that NAFTA has had a limited effect on both U.S. employment and wages. Although they do not statistically show NAFTA's effect, if any, on employment and wages, their primary contention is that, given the enormous size of the U.S. labor market and the relative insignificance of foreign trade for the U.S. economy, even if NAFTA negatively affected employment and wages, it would be so minor in the aggregate that it would be statistically insignificant.

Finally, Trefler (2004) examined the effect of NAFTA on Canadian industries. For those industries that experienced the largest Canadian tariff cuts, low-productivity plants reduced employment by 12 percent, while overall industry productivity increased by 15 percent. For those Canadian industries that experienced the largest US tariff cuts, productivity increased by 14 percent. Hence, high productivity

plants clearly gain from free trade.

III. EMPIRICAL MODEL

Trade theory suggests that free and open trade increases a nation's welfare. Regarding employment and wages, the relative prices of goods in which a nation has a comparative advantage will increase; this price increase, in turn, increases employment and wages for the export sectors. However, the relative prices of goods in which the nation has a comparative disadvantage will fall; this price decrease, in turn, lowers employment and wages for the import sectors. Consumers benefit because trade increases their consumption possibilities. The overall gain to those who benefit from trade (the exporting sectors and consumers) should more than outweigh the losses of the importing sectors. Hence, nations benefit from free and open trade.

Theory thus dictates that the U.S. and its trading partners gain from NAFTA. Note, however, that the gains from trade include both the benefit to the exporting sectors and to consumers. My work is important because it specifically examines employment and wages and thus attempts to determine if free trade is beneficial to labor. In addition, it is important to note that removal of trade barriers does not confer immediate benefits on a nation and especially on its labor force. Rather, there may be several painful adjustment periods in the labor market as import-competing sectors shrink and export sectors expand. Terminated workers in the import-competing sectors may not find new positions quickly; hence, the gains or benefits from free trade cannot be seen as occurring instantaneously after the removal of trade barriers.

To construct a model that examines the effect of NAFTA on employment and wages, I use labor market theory. Theory suggests that employment and wages are affected by product prices, marginal products, and worker's preferences with regards to trade-offs between leisure and work (substitution and income effects). Because wages and employment are determined simultaneously, I use two-stage least squares. For employment, I estimate the following two regressions:

First Stage:

$$LOG(WAGE) = a_1 NAFTA + a_2 LOG(WHITE) + a_3 LOG(RURAL) + a_4 T$$
$$+ a_5 LOG(COLLEGE) + a_6 LOG(ROADS) + a_7 NAFTAC + a_8 NAFTAM \quad (1)$$
$$+ a_9 LOG(NCOLLEGE) + a_{10} LOG(EDUC) + u$$

Second Stage:

$$LOG(EMPLOY) = a_1 NAFTA + a_2 LOG(WHITE) + a_3 LOG(RURAL) + a_4 T$$
$$+ a_5 LOG(COLLEGE) + a_6 LOG(ROADS) + a_7 NAFTAC + a_8 NAFTAM \quad (2)$$
$$+ a_9 LOG(WAGE) + u$$

For wages, I estimate the following two equations:

First Stage:

$$\text{LOG(EMPLOY)} = a_1\text{NAFTA} + a_2\text{LOG(WHITE)} + a_3\text{LOG(RURAL)} + a_4\text{T}$$
$$+ a_5\text{LOG(COLLEGE)} + a_6\text{LOG(ROADS)} + a_7\text{NAFTAC} + a_8\text{NAFTAM} \qquad (3)$$
$$+ a_9\text{LOG(NCOLLEGE)} + a_{10}\text{LOG(EDUC)} + a_{11}\text{LOG(AGE65)} + u$$

Second Stage:

$$\text{LOG(WAGE)} = a_1\text{NAFTA} + a_2\text{LOG(WHITE)} + a_3\text{LOG(RURAL)}$$
$$+ a_4\text{LOG(COLLEGE)} + a_5\text{LOG(ROADS)} + a_6\text{NAFTAC} + a_7\text{NAFTAM} \qquad (4)$$
$$+ a_8\text{LOG(NCOLLEGE)} + a_9\text{LOG(EDUC)} + a_{10}\text{LOG(EMPLOY)} + u$$

In the above regressions, *WAGE* and *EMPLOY* are endogenous variables.

Variables are defined as follows: *EMPLOY* is the ratio of employment to the total adult population in the state; employment is the total number of employees in non-agricultural establishments; *NAFTA* is a dummy variable equal to one for 1994-2000 the period when NAFTA was in effect, and zero otherwise; *WHITE* is the percentage of the state's population that is white; *RURAL* is the percentage of state's population that lives in rural areas; *ROADS* is the ratio of total highway mileage in the state to total area of the state; *COLLEGE* is the share of the state's population age 25 and older with a college degree; *NAFTAC* equals one if a state borders Canada and the year is 1994 or later; *NAFTAM* equals one if a state borders Mexico and the year is 1994 or later; *T* is a time trend variable; *WAGE* is the average hourly wage; *NCOLLEGE* is an interactive variable between *NAFTA* and *COLLEGE*; *EDUC* is the per capita amount spent on primary and secondary education at the state level; and u is a normally distributed random error term.

Regarding the second-stage employment equation, trade theory suggests that *NAFTA* should have a positive employment effect. *WHITE* should have a positive effect on employment, suggesting that states with large non-white populations suffer from racially discriminatory labor markets; Murphy and Hofler (1984) used a similar variable in their study of geographic unemployment rates. *RURAL* should have a negative effect, suggesting fewer job opportunities in rural states; Blackley (1989) used a similar variable in his study on the determination of state unemployment rates. *ROADS* is a proxy for government fixed assets. Labor theory suggests that states with more government fixed assets per capita would have a more productive labor force, so firms would be more willing to locate there, thus increasing employment. *COLLEGE* should have a positive effect. Blackley (1989) also included this variable in his study. If individuals with more education are more productive, firms would be more willing to locate in states where the workforce is better educated and hence increase employment. *WAGE* should have a negative effect. I include *T* to capture any possible employment changes due to productivity increases, immigration, or other unspecified factors.

NAFTAC should have a positive effect, suggesting that states bordering Canada would experience an employment increase after NAFTA. *NAFTAM* should have a negative effect, suggesting that states bordering Mexico should experience either an employment decrease or less of an employment increase than other regions after NAFTA. *NAFTAC* should have a positive effect because Canada is an inviting market for U.S. goods, and given the relatively minor wage differences between the U.S. and Canada, U.S. firms will have little incentive to relocate to Canada. *NAFTAM* should have a negative effect because factories located in states adjacent to Mexico would move south to take advantage of lower wages and less stringent environmental and safety regulations.

Regarding the second-stage wage regression, theory suggests that *NAFTA* should have a positive effect on wages, assuming that the wages gains in the export sectors outweighs the wage losses in the import-competing sectors. *WHITE* should be positive, once again suggesting the discriminatory nature of the labor markets. *RURAL* should have a negative effect on wages, suggesting that employers do not have to pay their workers as much in rural areas given lower costs of living. *EDUC* and *COLLEGE* should be positive; those states with more educated laborers will have more productive laborers and hence higher wages. *NAFTAC* should have a positive effect on wages, suggesting that an increase in the demand for workers in states bordering Canada will increase wages. *NAFTAM* should be negative since there will be a decrease in demand for workers in states bordering Mexico. *ROADS* will have a positive effect on wages, suggesting that those states with more government fixed assets will have more productive workers and hence higher wages. *EMPLOY* should have a negative effect on wages since the greater the supply of workers, the lower will wages be. *NCOLLEGE* will have a positive effect on wages. Regarding this effect, the Heckscher-Ohlin Theory states that when a nation opens up to trade, the goods that use the nation's relatively abundant factor will see an increase in its price, and the Stolper-Samuelson Theory states that a nation's relatively abundant factor will see an increase in its compensation. Hence, those states that have a relative abundance of college-educated individuals, our nation's relatively abundant factor, will see their average wages increase when trade opens.

As an additional test of the effect of NAFTA on employment and wages, I use a Chow Test to determine if NAFTA altered the employment and wage relationships. This procedure detects whether there is a significant difference between two sets of regression parameters, one set pre-NAFTA and one set post-NAFTA; the variables must be identical in the compared equations. Rejecting a null hypothesis of equality would indicate that the employment and wage relationships differ between the two time periods; this would suggest that NAFTA had an effect on these relationships.

The Chow Test statistic used in the present study is as follows:

$$F = [(SSE_t - (SSE_b + SSE_a))/k] / [(SSE_b + SSE_a)/(t-2k)] \qquad (5)$$

where SSE is the sum of squared residuals, b denotes before NAFTA (pre-1994), a denotes after NAFTA (post-1994), t denotes the entire period (1980-2000), and k is the number of parameters estimated in the model.

IV. DATA AND RESULTS

I obtained all data from various issues of the *Statistical Abstract of the US*, Census Bureau reports, the Bureau of Economic Analysis, and Bureau of Labor Statistics reports. All data were available at the state level and are for the years 1980-2000. I deflated all dollar figures using the Bureau of Labor Statistics' Consumer Price Index, base year 1982-1984. Descriptive statistics are presented on Table 1.

Table 1		
Descriptive Statistics		
Variable	Mean	Standard Deviation
WAGE (dollars; hourly wage)	8.26	1.2
EDUC (dollars; per capita amount spent on primary and secondary education)	613	165
WHITE (% of population that is white)	0.82	0.133
RURAL (% of population that lives in rural areas)	0.347	0.217
ROADS (miles of roads per square mile)	1.77	1.14
COLLEGE (% of population that has a college degree)	0.206	0.045
EMPLOY (employment-population ratio)	0.762	0.165
N = 1050		

I used a two-stage least squares, fixed effects model to estimate equations (2) and (4). This model is superior to both cross-sectional and time series models for three reasons. First, panel data models control for potentially important but unobservable state-level effects that may be correlated with other employment and wage determinants. If I did not use panel data where appropriate, state-level effects might have been omitted, and omitted variable bias may have resulted. Second, panel data increase the degrees of freedom. Third, I used two-stage least squares because wages and employment are simultaneously determined.

Table 2		
First-Stage Regression for EMPLOY		
Dependent Variable: WAGE		
Functional Form of Equation: LOG-LOG		
Variable	Coefficient	T-Statistic
NCOLLEGE***	0.103	4.06
EDUC**	0.406	26.822
NAFTA***	0.217	5.191
WHITE***	-0.098	-6.681
RURAL***	-0.081	-21.113
T***	-0.0108	-12.216
ROADS***	0.0166	4.509
COLLEGE***	-0.049	-2.892
NAFTAC	0.0036	0.313
NAFTAM	-0.0356	-2.024

R^2 = .61
N = 1050
*** = Significant at 1% level
** = Significant at 5% level
* = Significant at 10% level

Table 3		
Second-Stage Regression for EMPLOY		
Dependent Variable: EMPLOY		
Functional Form of Equation: LOG-LOG		
Variable	Coefficient	T-Statistic
WAGE**	-0.572	-1.93
NAFTA***	-0.169	-4.322
WHITE***	0.09	4.931
RURAL***	0.034	3.582
T***	0.0078	25.359
ROADS	-0.0095	-0.89
COLLEGE***	-0.019	-3.01
NAFTAC*	0.0093	1.846
NAFTAM	-0.0075	-0.987

R^2 = .86
N = 1050
*** = Significant at 1% level
** = Significant at 5% level
* = Significant at 10% level

Empirical results for equations (1) and (2) are presented on Tables 2 and 3. According to these results, *NAFTA* negatively affected employment; in fact, holding all other factors constant, NAFTA reduced the employment-population ratio by 16.9 percent, on average. For those states bordering Canada, the reduction was less severe; the employment-population ratio fell by 15.9 percent. Restating these results in terms of jobs lost, holding all else constant, every state not bordering Canada lost, on average, 370,279 jobs due to NAFTA. For states bordering Canada, the average state lost 348,514 jobs.

Given that the present study examines only six years of post-NAFTA employment experience, it may be possible that the job dislocations and employment adjustments that occur when trade restrictions are removed are still occurring. In addition, since some tariffs and trade restrictions are still in existence in North America, the interim benefits will clearly not be as large in magnitude nor as significant as when all trade barriers are removed. Regarding the significance and signs of the other variables, *WHITE, RURAL,* and *T* had a positive effect on employment, and *COLLEGE* had a negative effect on employment.

Table 4		
First-Stage Regression for WAGE		
Dependent Variable: EMPLOY		
Functional Form of Equation: LOG-LOG		
Variable	Coefficient	T-Statistic
AGE65[***]	0.131	9.124
NAFTA[***]	-0.086	-5.712
WHITE[***]	0.0818	4.666
RURAL[***]	0.0335	4.144
T[***]	0.0049	10.279
ROADS[*]	-0.0168	-1.651
COLLEGE	0.0098	1.296
NCOLLEGE[***]	-0.0485	-5.35
NAFTAC[**]	0.0107	2.263
NAFTAM	-0.0103	-1.408
EDUC[***]	0.0426	3.985
R^2 = .863		
N = 1050		
*** = Significant at 1% level		
** = Significant at 5% level		
* = Significant at 10% level		

Table 5		
Second-Stage Regression for WAGE		
Dependent Variable: WAGE		
Functional Form of Equation: LOG-LOG		
Variable	Coefficient	T-Statistic
NAFTA***	0.1806	6.916
WHITE	0.0147	0.475
RURAL***	-0.0563	-4.045
EMPLOY***	-0.914	-9.795
ROADS	-0.0059	-0.329
COLLEGE***	-0.0762	-5.679
NCOLLEGE***	0.092	5.668
NAFTAC	-0.005	-0.637
NAFTAM	-0.0116	-0.908
EDUC***	0.254	13.45
R^2 = .861		
N = 1050		
*** = Significant at 1% level		
** = Significant at 5% level		
* = Significant at 10% level		

Empirical results for equations (3) and (4) are presented on Tables 4 and 5. *NAFTA* had a positive and statistically-significant effect on wages; due to NAFTA and holding all other factors constant, hourly wages increased by 18 percent. This increase is even greater for those states that have a greater share of college-educated individuals; for those states, the increase is 27.2 percent. Restating these results in terms of gained income, the hourly wage in those states not having large shares of college-educated individuals went up by $1.46, on average, due to the passage of NAFTA. For states with substantial numbers of college-educated individuals, the hourly wage went up by $2.21, on average. These results corroborate trade theory. In addition, *EDUC* positively affected wages, whereas *EMPLOY* and *RURAL* negatively affected wages; all of these results corroborate theory.

It is important to note that, although it appears that multicollinearity may be an issue in these regressions, it was not found to be statistically relevant. First, one of the primary indicators of muticollinearity is that the R^2 is high but few, if any, of the independent variables are significant. As was seen in the results, that is clearly not the case in the present study. Second, high pair-wise correlations among the regressors may also indicate the presence of multicollinearity. When a correlation matrix was estimated, it was found that the highest pair-wise correlation was between *RURAL* and *ROADS*; this correlation was -0.516. Most of the others were considerably lower, usually below 0.25. Combining these rather low pair-wise correlations with the fact that many of the independent variables were

significant supports the view that multicollinearity is not an issue in the present study. Finally, in order to eliminate any vestiges of multicollinearity from the regressions in the present study, the data were transformed by using natural logarithms. This transformation was supported by a hypothesis test of linearity versus loglinearity (Davidson and Mackinnon (1981)).

Regarding the final test of the impact of NAFTA on employment and wages, Chow Test results are as follows:

EMPLOY Chow Test F-Statistic = 106.21

WAGE Chow Test F-Statistic = 72.003

The critical value at the 5 percent level of significance for the F-distribution with (6,1038) degrees of freedom is 2.10. The critical value at the 5 percent level of significance for the F-distribution with (7,1036) degrees of freedom is 2.01. The null hypothesis that the regressions for the pre-NAFTA and post-NAFTA time periods are statistically identical is rejected. These results suggest that NAFTA had a statistically-significant effect on the employment and wage relationships; there clearly was a structural break in 1994, the year NAFTA became effective.

V. CONCLUSION

I attempted to determine the effect of NAFTA on employment and wages in the United States. Using a panel data set of 50 states for 1980-2000 and a two-stage least squares, fixed effects model, I estimated two equations. Results indicate that NAFTA negatively affected employment and positively affected wages. Although NAFTA reduced employment for the entire nation, for those states bordering Canada, NAFTA had less of negative effect. Results also showed that NAFTA had a positive effect on wages, especially in those states with large shares of college-educated individuals. Finally, as an additional test of the effect of NAFTA on employment and wages, I used a Chow Test to determine if there was a change in these relationships after NAFTA took effect. The Chow Test result suggested that NAFTA did have a statistically-significant effect on both wages and employment. The results of the present study are significant since this study is one of the first that uses panel data to examine the effect of NAFTA on both wages and employment at the state level.

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