THE TRUE PRICE OF NAFTA

An Analysis of Manufacturing Employment Changes Induced by NAFTA's Tariff Reductions

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INTRODUCTION

The North American Free Trade Agreement, or NAFTA, has been the subject of intense debate both during its negotiation and since its enactment. In substance, it eliminated the vast majority of tariffs on products originating and traded within the USA-Canada-Mexico bloc. In context, it represented a major step forward in a greater trend of trade reform. The elimination of trade barriers and the adoption of formalized dispute resolution mechanisms (for example, intellectual property or investor state dispute settlement) represents a broader movement of trade liberalization both between developed countries and between developed and developing countries (witness CUSFTA before NAFTA, and CAFTA and TPP afterward).

The economic impacts of NAFTA were generally theorized by mainstream academics to be modest and slightly positive for the United States (Kehoe and Kehoe 1994). Though trade flows have shifted significantly since the implementation of NAFTA, by many accounts it is not clear that NAFTA has had a significant effect on employment. Rather, the question of employment effects has become a subject of intense debate, with politicians from both sides of the political spectrum maligning the deal for the effect it has had on the United States.

One pronounced effect of NAFTA that has made it particularly susceptible to anathema is the phenomenon of the maquiladora. This is the Mexican manufactory situated near the American border that creates minimal value added, merely assembling American inputs and exporting the finished product back to the United States. The magnitude of this phenomenon can be seen in the doubling of the population of the border city of Juarez, Chihuahua during the 1990s, and its conspicuousness has attracted the attention of critics. The manufacturing industry in the United States has been in decline since the 1970s, falling over 40% as a proportion of the population from 1979 to 2007. However, focus has centered on the effect of maquiladoras in perpetuating this decline in manufacturing. In this paper I attempt to address this politically sensitive question, measuring the decline in employment in the manufacturing industry as a function of tariff reductions imposed by NAFTA. It is admittedly a ham-handed approach, as NAFTA affected other non-tariff aspects of trade, but it does not in any way purport to answer with complete certitude the question of whether or not NAFTA wielded the sword that decimated manufacturing.

I use a fixed-effects quasi-DID model to estimate the marginal effect of tariff reductions on employment change in the manufacturing industry, then I use post-hoc bootstrap and Monte Carlo techniques to more substantively address the employment effects of NAFTA. From this analysis, I find that there was no discernable employment change caused by the trade agreement.

RELATED LITERATURE

This paper fits into a very broad literature surrounding NAFTA. Prior to the finalization of the deal, focus centered on partial and general equilibrium models predicting the economic benefit to each of the three countries involved (Cox 1994, Wylie 1995 and Kehoe 1994, for example). Analyses range from economy-wide effects to effects on a single industry. Kehoe and Kehoe discuss the impacts on the automobile industry and predict modest gains for both the United States and Canada, with a markedly larger gain for Mexico.

Much analysis post-NAFTA has centered on examining the ways in which trade flows changed between the three partner countries. Hillberry and McDaniel (2002) find through firm-level trade decomposition that growth has come in several forms: more units of each good are traded, unit prices of traded goods are rising, and the variety of goods traded is increasing. Burfisher, Robinson, and Thierfelder (2001) try to address a spate of questions about trade flows raised pre-NAFTA, particularly about automobiles, agriculture, and textiles. Ernesto Lopez-

Cordova (2002) takes a different tack, examining how productivity in Mexican manufacturing changed during the 1990s.

In the broader scope of the literature examining the effects of trade on the manufacturing industry, Pierce and Schott (2016) examine how China's entrance into the WTO and subsequent normalized trade relationship with the United States affected manufacturing employment. That paper in many ways is a basis for this one, as it models manufacturing employment changes as a function of tariff reductions. This paper attempts to fit into the literature surrounding NAFTA and manufacturing by providing an econometric analysis of employment changes in a wide array of manufacturing industries, rather than any particular one.

DATA SOURCES

Data on manufacturing was acquired from the National Bureau of Economic Research's NBER-CES manufacturing industry database. It contains historical employment information for the manufacturing industry dating back to 1959, as well as other important sectoral characteristics such as employment (both production and non-production), capitalization, productivity, investment, value added, etc. The aggregation level is by four-digit SIC. There are 383 four-digit SIC codes considered part of the manufacturing industry.

Tariff data was collected from the World Bank's World Integrated Trade Solution (WITS). The portal serves as an interface to the TRAINS dataset, which aggregates data on trade and tariff rates between all countries. Data was pulled on American tariffs imposed on Mexican products, both MFN and preferential tariff rates. Data was again aggregated to the four-digit SIC level, and data for the entire 1990s was downloaded.

The statistic used to measure the tariff gap imposed by NAFTA is the difference between pre-NAFTA MFN rate and post-NAFTA preferential rate. NAFTA imposed these preferential tariff rates as a near-zero incentivized rate for products containing sufficiently many inputs originating in the NAFTA bloc. These rules of origin (ROO) rates imposed by NAFTA are the essence of the tariff difference imposed. Some MFN rates were lowered as a result of NAFTA, but the reduction was variable among industries. Analysis by Anson et al. (2005) shows that utilization rates—the proportion of manufacturers claiming ROO for their products—for manufacturing industries was generally high, around 75%. Thus, the preferential rate more or less represents the actualized tariff savings for manufactured goods. More discussion around ROO will follow in the next section, but my claim is that the high utilization rate substantiates the use of the preferential tariff as a baseline rate post-NAFTA.

EMPIRICAL STRATEGY

OLS estimates were used to fit a fixed-effects model, with the tariff differential expressing itself only post-NAFTA. The goal was to model the year-over-year percentage change in employment for two years, one before and one after NAFTA. The two years chosen were 1993 and 1997. I call it a quasi-DID model because fixed effects are included for industry and year, with an interaction term between the two representing the marginal effect of tariff reduction.

Employment change was regressed on a variety of covariates—fixed effects like year and major manufacturing category (the first two digits of the four-digit SIC represent the major category under which a product falls), and industry-specific characteristics like skill and capital intensity. Skill intensity is measured as the log of non-production workers to total employment. Capital intensity is measured as the log of the ratio of real book value to total employment. Each of these characteristics can be calculated from the NBER-CES database. The tariff differential discussed above (expressed as $MFN_{1993} - Preferrential_{1997}$) is the regressor that is interacted with a dummy variable for year in order to create the quasi-DID term, such that it is only allowed to predict employment for observations after NAFTA. Figure 1 shows histograms of various model variables.

Some cleaning was necessary to ensure there were observations for each industry for both 1993 and 1997. First, a left join was performed on the data aggregated from WITS, attaching the employment data for the given sector and year to each row of the WITS data. From that, variables for skill and capital intensity were calculated, then year-over-year employment changes calculated using a Map-Reduce paradigm. Data for years 1993 and 1997 were then selected, and only industries that had observations of all model variables for both years were taken. This reduced the count of eligible industries from 383 to 331. The model that was estimated was

$$\Delta E_{it} = \beta_0 + \beta_1 \Delta T_i * dYear + \alpha_1 logSkill_{it} + \alpha_2 logCap_{it} + \delta_i + \delta_t + \epsilon_{it}$$

for years $t = \{1993,1997\}$. The dependent variable ΔE_{it} is the percentage change in employment for the ith industry from time $t-1$ to time t, i.e. $\frac{E_{it}-E_{it-1}}{E_{it-1}}$. The regressor ΔT_i is the tariff differential (theoretically unbounded but realistically ranging from 0 to 1), with *dYear* taking value zero when $t = 1993$ and one when $t = 1997$. The regressors logSkill and logCap are the skill and capital intensity metrics, specific to industry *i* at time *t*. The two δ variables are the fixed effects for major industry and year. The coefficient of interest is β_1, which represents the quasi-DID effect of tariff reductions post-NAFTA.

COMMENTARY ON MODEL

As previously stated, this model only attempts to measure employment changes as the result of tariff reductions imposed by NAFTA. The coefficient β_1 measures the marginal effect of tariff reductions on employment—or the total change in employment perpetuated by a reduction in tariffs from 100% to 0%. There are other significant non-tariff aspects that NAFTA addressed, such as the imposition of tighter regulations for the purpose of protecting the environment. Importantly, the tariff change is also contingent on the rules of origin change.

The ROO burden, the increased standard of proof for showing inputs originate in the NAFTA bloc in order to claim the preferential tariff rates, can represent a significant barrier, in particular to Mexican manufactories looking to export their products to the United States. Thus, taking the gross change from MFN rates in 1993 to preferential rates in 1997 does not tell the full story of how tariff changes impacted trade flows. Anson et al. do show that utilization rates are high in the manufacturing sector, but a utilization of 75% still implies that fully a quarter of Mexican exporters are exporting at the higher MFN rate—an implication that there are hidden obstacles that keep firms from realizing the reductions envisioned by NAFTA. By being transparent about the shortcomings of my model, I'm not attempting to discredit it but rather give the model place in the larger discussion surrounding the trade deal. Trade economics is fickle: I only claim to measure employment change as a function of ostensible tariff changes, controlling for the small set of characteristics that I mention.

RESULTS

I made a first pass attempt at OLS regression and then checked model assumptions. Slight deviation from normality was observed on the tails of the residuals on a QQ-plot, as well as heterogeneity of error variance between the two years (Figure 2). I decided to use White's Standard Errors in order to create a robust estimate of coefficient standard error. Estimates of the coefficients with robust standard errors are in Table 1. In order to correct the non-normality of errors, I used bootstrapping, which I will discuss below.

My first thought in correcting the heterogeneous error variance was to take a WLS approach, using inverse MLE estimates for the two variances as weights. My concern was the perfect multicollinearity between the year and the expression of β_1. This means that, since there is greater variance exhibited by observations in 1997, less weight would be given to them and hence estimates of β_1 would necessarily be driven towards zero. Since we are interested in the effects of tariff changes on employment and we could estimate the model using only data for $t = 1997$, I decided not to employ WLS in order to preserve the effect of β_1.

My approach in bootstrapping was to use residual resampling rather than case resampling. Case resampling may seem more appropriate because of the heterogeneous variance of the errors observed, since residual resampling makes the assumption that the errors are identically distributed. However, given the fixed nature of the covariates, I decided that residual resampling was more desirable, given that case resampling implicitly assumes that the covariates are randomly distributed as well as the responses.

All other residual plots giving no cause for concern, I proceeded with my bootstrap and Monte Carlo methods. First, I computed bootstrap estimates of β_1 with 10,000 replicates. From each bootstrap sample of residuals, I constructed a new response vector, estimated the fixed-effects model, and extracted the estimate of β_1. Figure 3 shows a histogram of the bootstrapped samples of β_1, with an overlay of the theoretical density given by OLS with robust standard errors. The bootstrap sample looks symmetric and exhibits similar mean as the OLS estimate, however variance is smaller. A 90% upper-tail estimate of β_1 is 0.1908. This means that even an $\alpha = .90$ hypothesis test powered to detect an alternative of $\beta_1 < 0$ would fail to reject the null hypothesis that $\beta_1 \geq 0$.

From there, I wanted to use Monte Carlo methods to estimate the employment effects of NAFTA tariff reductions. This quantity is given by $\beta_1 * \Delta T_i$, with randomness inherent in the estimate of β_1 and not in ΔT_i by traditional OLS assumptions. One reasonable approach would be to sample multiple times from β_1 and then multiply these samples by every observation of ΔT_i. Another, which has the same asymptotic properties, is to re-sample from ΔT_i for every sample of β_1, and take their product as an estimate of the employment effect. This is the approach I used because of the computational simplicity of the problem.

I took 1,000,000 re-samples from ΔT_i and from the bootstrap distribution of β_1 in order to construct a Monte Carlo sample of employment effects. An upper 90% limit on this quantity is 0.00859, i.e. a 0.85% growth in employment as a result of the tariff increases. Hence, I conclude that NAFTA tariff changes did not have any statistically significant impact on employment. The mean employment change detected is -0.34%. A two-tailed 95% confidence interval on the employment change is (-2.89%, 1.86%). There were larger extreme observations with the Monte Carlo sample (in some ways expected), with minimum -21.4% and maximum 15.4%. However, I calculated the probability of experiencing an employment change more extreme than ±5% as 0.00568, a change of magnitude greater than 10% as .000264. For samples within a two-tailed 99% confidence interval (to improve readability of the graph), I plot a histogram in Figure 4.

CONCLUSION

In this model, I estimated the marginal effect of tariff reductions on manufacturing employment, controlling for the effects of skill and capital intensity. Using an exhaustive database of manufacturing employment in the United States, I found that there was no employment differential induced by NAFTA tariff reductions. Most probably, the effect was very modest, and could have even been positive. There are other non-tariff effects of NAFTA that could (and should) be measured using this same model, employing tariff equivalence as a proxy for the magnitude of NAFTA's effect. However, the magnitude of employment effects predicted in this paper speaks to the apparent insignificance of NAFTA on manufacturing employment in the United States.

From this analysis, I conclude that NAFTA did not wield the sword that decimated manufacturing. It was not armed.

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FIGURES AND TABLES

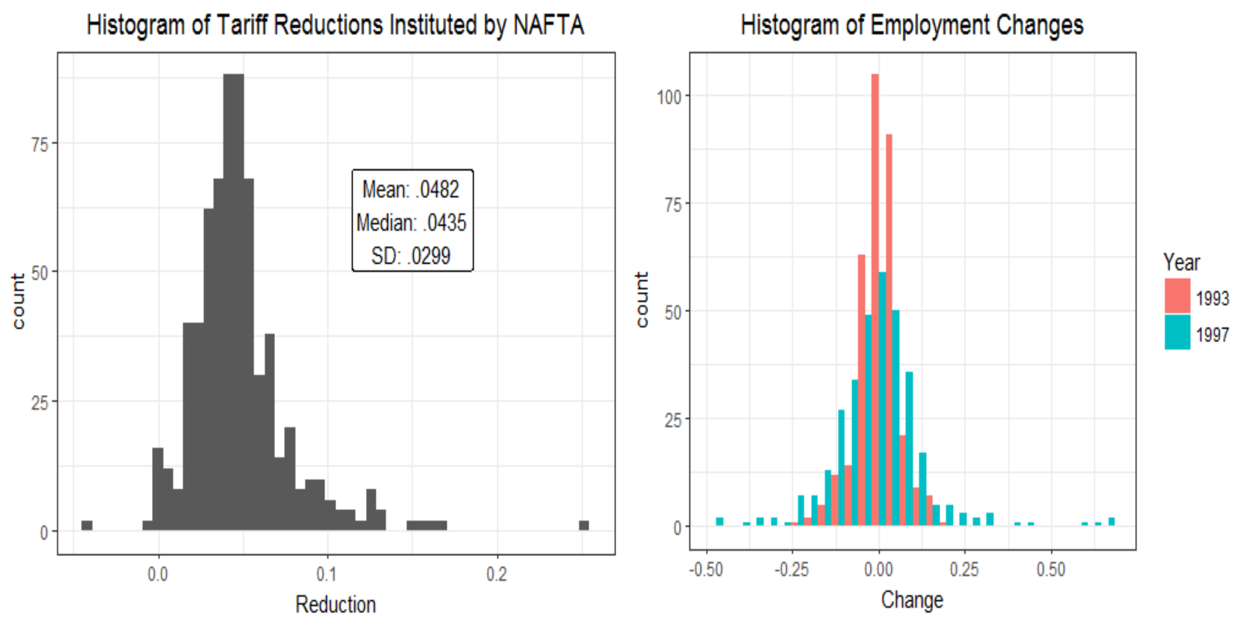

Figure 1: Histograms of Employment and Tariff Changes

	ESTIMATE	STD ERROR	T VALUE	P VALUE
$\boldsymbol{\beta_1}$	-0.06829	0.2221	-0.3075	0.7586
$\boldsymbol{\alpha_1}$	0.01046	0.01482	0.7058	0.4806
$\boldsymbol{\alpha_2}$	-0.03161	0.006321	-5.0004	<.0001

Table 1: Coefficient Estimates using White Standard Errors

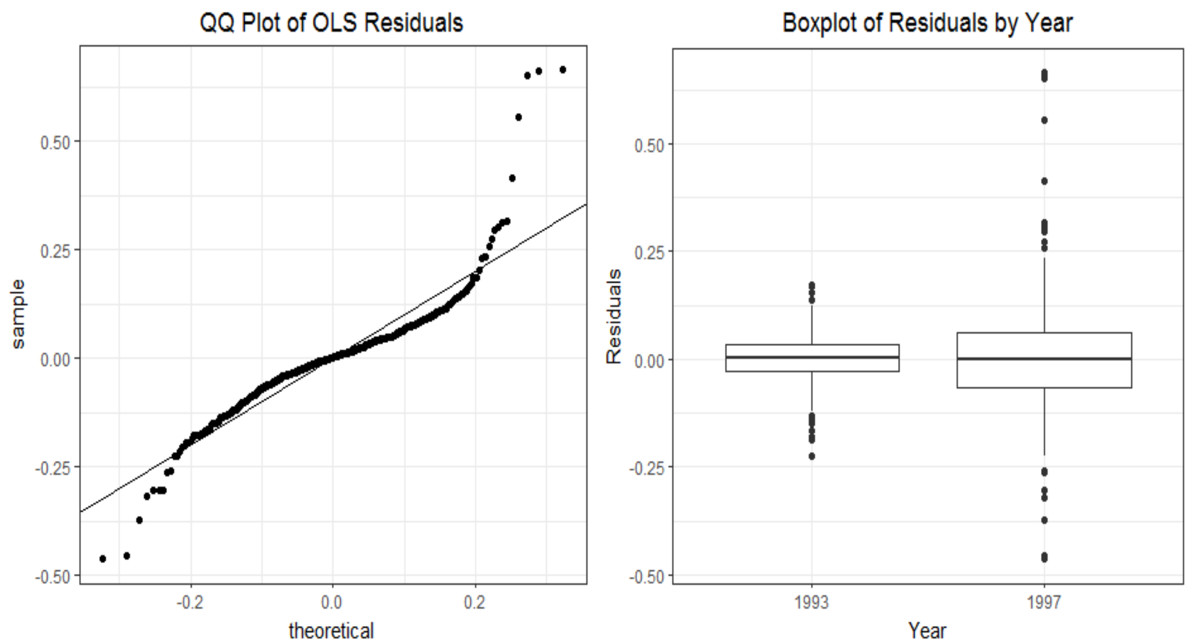

Figure 2: Diagnostic Plots for OLS Estimates

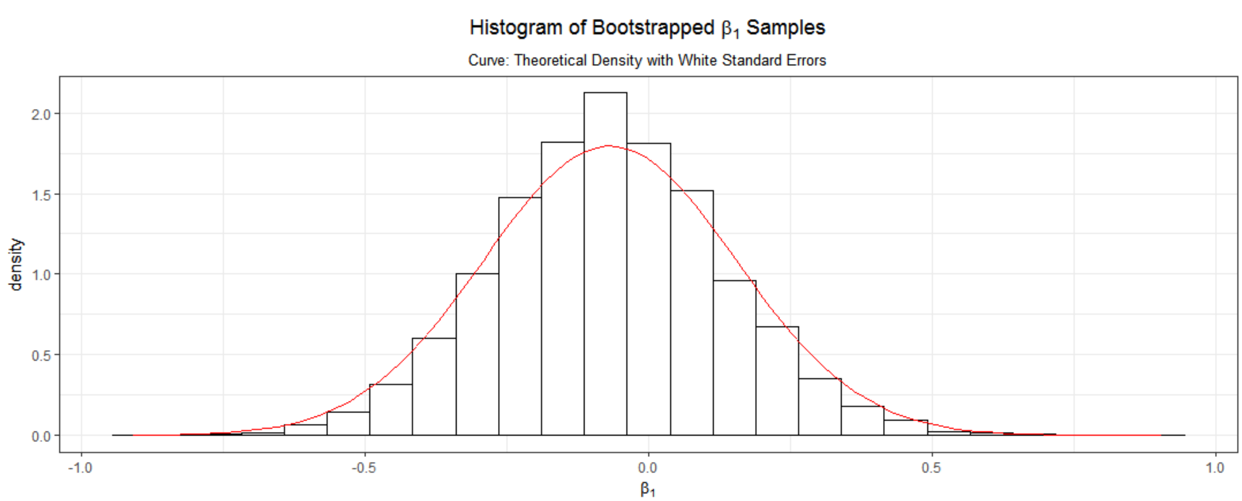

Figure 3: Residual Resampled Coefficient Estimate

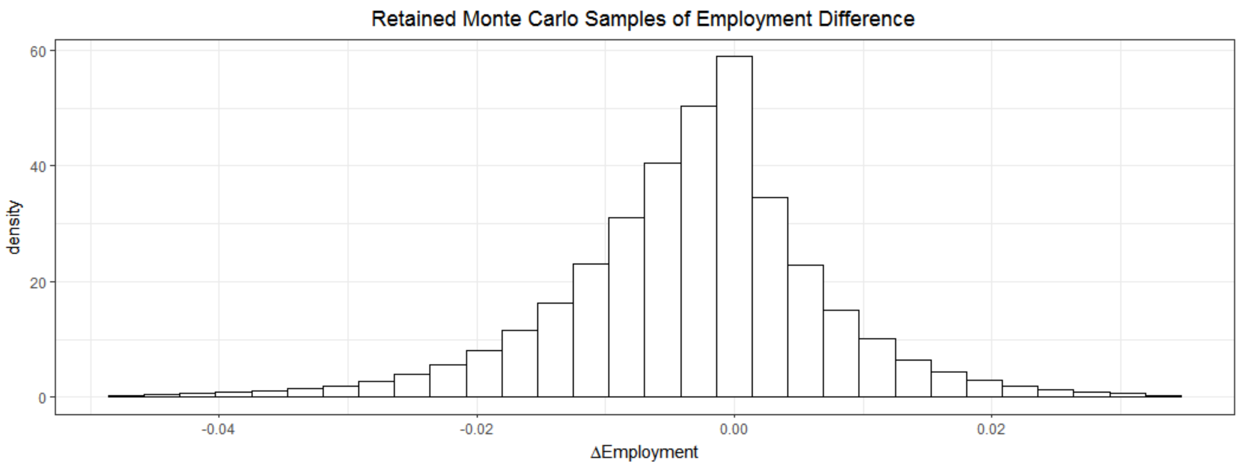

Figure 4: Monte Carlo Estimates of Disemployment Effect of Tariffs