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TESTING MAQUILADORA FORECAST ACCURACY

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TESTING MAQUILADORA FORECAST ACCURACY

by

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THESIS

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Chapter 1

Introduction

Maquiladora forecasts are a fundamental tool for understanding potential economic conditions of markets located along the U.S.-Mexico international border. Such forecasts have been utilized for the region commonly referred to as the borderplex. This area, comprised of the El Paso, Texas-Ciudad Juarez, Chihuahua border region, has become increasingly reliant upon cross border trade in recent years. Due to the importance of the high volume of trade conducted in this area, these forecasts reflect general economic conditions prevailing in the United States. Despite the importance of maquiladora activity in the regional economy, limited empirical efforts have been dedicated to checking the predictive accuracy of their forecasts.

Formal empirical testing of maquiladora forecasts can prove helpful in identifying weaknesses within the borderplex model. It can also help highlight the risks and overall reliability of these out of-sample simulation data. Accordingly, the objective of this study is to examine the historical accuracy of the structural equation maquiladora forecasts generated using the Borderplex Econometric Forecasting Model. Those forecasts are three year simulations that are published annually by the Border Region Modeling Project at the University of Texas at El Paso

Data used in this study are the taken from Borderplex Economic Outlook reports published from 1999 through 2006. Maquiladora variables included are: total employment, plants in operation, total value added, and average hourly wages. These variables are analyzed for both Ciudad Juarez, Chihuahua and Chihuahua, Chihuahua. Comparative data benchmarks are generated using a random walk procedure.

Subsequent sections of the study are presented in the following order. The second chapter provides a literature review of prior research that has been completed on related topics. That chapter is followed by a description of the data and methodology utilized to construct the study. Next, forecast accuracy results are discussed. The final chapter highlights the results obtained herein and provides suggestions for future studies.

Chapter 2

Literature Review

Literature concerning forecast accuracy for Mexican economic data is scarce. Given that, this review also includes relevant points within existing studies of United States economic forecast accuracy at both the national and regional levels. The first part of the review discusses prior efforts specific to the maquiladora industry. The next part covers macroeconomic forecast studies. That is followed by a brief discussion of forecast accuracy studies at the regional level.

Maquiladora data are difficult to model because they are affected by regional, national and international business cycles (Fullerton, 1998). In existence since 1965, employment grew from 76,000 in 1974 to almost 1.3 million in 2000 (Truett and Truett, 2007). Maquiladora payroll expansion accelerated in response to the North American Free Trade Agreement(NAFTA) that became effective on 1 January 1994 (Flores, 2001) and in response to rapid economic growth in the United States (Truett and Truett, 2007). In-bond manufacturing activities are primarily located in northern areas of Mexico due to geographic proximity to the United States. The largest concentration of jobs and output is in Ciudad Juarez, Chihuahua (Calderon and Mendoza, 2001). A fairly large volume of jobs and output are also located in Chihuahua, City (Fullerton and Torres Ruiz, 2004).

Merchandise exports from northern Mexico’s maquiladora sector have caused the volume of cargo vehicle flows through the border metropolitan areas to expand (Fullerton and Tinajero, 2002). As noted by Hanson (2001), growth in this sector also led to greater integration between border city pairs. From a business cycle perspective, there is a strong positive correlation between cross-border employment and export production in the neighboring Mexican city. That pattern is especially prevalent for smaller cities located along the international boundary separating the two countries. Other studies that have attempted to forecast maquiladora data such as employment have found that fluctuations can be sizeable and abrupt. Contributing factors include: currency devaluations, business cycle fluctuations, structural change, and trade policy (Coronado, Fullerton and Clark, 2004).These studies find many strong correlations between employment and real wages, maquiladora plants, United States industrial activity, and the real exchange rate of the peso. Plant size and production specialization have also been identified as important influences on employment levels.

The role of wages is currently being debated. Evidence exits that direct foreign investment leads to substantially higher wages in maquiladora region labor markets (Feenstra and Hanson, 1997). Given that, questions have been raised regarding the impacts of higher wages on employment. Empirical results reported in Mollick and Wvalle-Vazquez (2006) indicate that higher wages in Mexico do not reduce employment in a meaningful manner.

Forecast accuracy performance may be evaluated using statistical benchmarks for bias, efficiency, and/or rationality (Coronado, Fullerton and Clark, 2004). Forecasts may also be tested against other models, whether they are structural or naive (McNees, 1978). These structural models are often large and can involve complicated data sets, while the opposite holds for random walk forecasts. A random walk forecast utilizes the last available historical observation as the projected value for current and future periods (Pindyck and Rubinfeld, 1998). Random walk forecasts have historically provided fairly good competition to structural models of regional economies (Fullerton, 2004). Vector autoregressive (VAR) and univariate time series models also provide popular benchmarks due to overall flexibility (Lupoletti, 1986; Clements, and Hendry, 1995). Several studies have documented the relative precision of these types of “simpler” models (Ashley, 1988; Fair, 1990).

A widely used metric that gauges the absolute difference between the predicted change and the actual change is the Theil inequality coefficient (Stekler, 1968). Based on root mean square error (RMSE) calculations, it ranges in value from zero to one, where zero indicates perfect predictive accuracy (Leuthold, 1975). In general, error structures associated with forecasting make statistical inference difficult, so descriptive measures tend to predominate. When degree of freedom constraints are not binding, some formal tests can be employed (Ashley, Granger, and Schmalensee, 1980; Diebold and Mariano, 1995).

There is a growing body of work that deals with regional econometric forecast accuracy (West and Fullerton, 1996; Lenze, 2001; West, 2003). One recent study examines the track record of borderplex transportation forecasts (Fullerton, 2004). None of the studies to date, however, have analyzed the historical accuracy of metropolitan maquiladora industry forecasts. This study attempts to partially fill that gap in the literature using data for Ciudad Juarez and Chihuahua City.

Chapter 3

Data and Methodology

Eight variables are included in the Maquiladora block of the Borderplex Econometric Forecasting Model. These eight variables are for Ciudad Juarez, Chihuahua and Chihuahua, Chihuahua. The specific data series are total maquiladora employment, operating plants, average hourly wages, and total value added. Table 1, lists has the mnemonics and descriptions for the variables for both markets. Annual frequency data are utilized. Employment is reported in thousands. Maquiladora hourly wages are reported in nominal dollars and include benefits. The wages estimates take into account the industry standard work week of 45 hours. Maquiladora value-added data are expressed in millions of nominal dollars (Fullerton and Molina, 2007).

Table 1: Acronyms and Descriptions

Series	**Description**
CJTME	Ciudad Juarez Total Maquiladora Employment
CJMP	Ciudad Juarez Maquiladora Plants
CJAHW	Ciudad Juarez Average Hourly Wages
CJTVA	Ciudad Juarez Total Value Added
CCTME	Chihuahua City Total Maquiladora Employment
CCMP	Chihuahua City Maquiladora Plants
CCAHW	Chihuahua City Average Hourly Wages
CCTVA	Chihuahua City Total Value Added

Historical data for all these variables to 2006 are located in Table A of the appendix. General descriptive statistics for the historical values of each series are shown in Table 2. The mean numbers for all the variables in this table are far lower than any of the current figures. That is due to fairly strong rates of expansion over the course of the sample period for maquiladora activities in both cities. Most notably, more than 240 thousand employees are currently on in-bond assembly payrolls in Ciudad Juarez with more than 80 thousand on payrolls in Chihuahua City.

Table 2: Descriptive Statistics for Historical Data

Series	**Mean**	**Standard Deviation**	**Maximum**	**Minimum**	**Number of Observations**
CJTME	99.14	82.07	249.38	0.76	41
CJMP	172.20	100.07	308.00	5.00	41
CJAHW	2.22	1.02	4.20	1.03	32
CJTVA	12382.11	15338.05	41610.07	3.30	29
CCTME	29.32	14.30	51.17	3.70	27
CCMP	55.63	21.24	84.00	17.00	27
CCAHW	2.46	1.30	5.14	0.89	27
CCTVA	3337.76	3987.66	10447.01	0.56	27

The forecast data are the taken from Borderplex Economic Outlook reports published from 1999 through 2006. There are fewer observations for Chihuahua City then for Ciudad Juarez. Forecast data for Ciudad Juarez range from 1996 to 2006. Forecast data for Chihuahua City range from 2000 to 2006.

To examine forecast accuracy, metrics can be calculated based on differences between the predicted change and actual change. Two of the more common forms of doing this include the Theil inequality coefficient (Stekler, 1968) and the Ashley, Granger, and Schmalensee (1980) error differential test. The latter is used when the degree of freedom constraints are not binding.

The Theil inequality coefficient is based on the root mean square error. The root mean square error (RMSE) is a measure of the variation of the simulated variable from its time path (Pindyck and Rubinfeld, 1998). In Equation 1, Y_t^S represents the forecasted value of Yt, Y_t^a represents the actual value, and T is the number of periods.

Equation 1: Root Mean Square Error

$$\text{rms error} = \sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(Y_t^s - Y_t^a\right)^2}$$

RMSEs are unbounded from above. Theil coefficients range from zero to one. The closer the number is to zero, the better the predictive accuracy of the model, while the closer it is to one, the worse the predictive performance (Leuthold, 1975). Equation 2 presents the formula for calculating U-statistics.

Equation 2: Theil Inequality Coefficient

$$U = \frac{\sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(Y_t^s - Y_t^a\right)^2}}{\sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(Y_t^s\right)^2} + \sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(Y_t^a\right)^2}}$$

A Theil Inequality Coefficient can be decomposed into 3 separate proportions: U^M, U^S, and U^C. They, respectively, represent bias, variance, and covariance proportions; together they add up to one.

Equation 3:

$$U^M + U^S + U^C = 1$$

Equation 4: Bias Proportion

$$U^M = \frac{\left(\overline{Y^s} - \overline{Y^a}\right)^2}{(1/T)\sum\left(Y_t^s - Y_t^a\right)^2}$$

Equation 5: Variance Proportion

$$U^S = \frac{\left(\sigma_s - \sigma_a\right)^2}{(1/T)\sum\left(Y_t^s - Y_t^a\right)^2}$$

Equation 6: Covariance Proportion

$$U^C = \frac{2(1-\rho)\sigma_s\sigma_a}{(1/T)\sum\left(Y_t^s - Y_t^a\right)^2}$$

The bias proportion (U^M) measures systematic error using the difference between the average forecast values model and actual values. The optimal value of U^M is zero, in which case there is no bias present in the forecasts of the variable of interest. The variance proportion (U^S) measures the ability of the projections to mirror the variability of the actual values. The optimal value of U^M is zero, in which case the fluctuations of the simulated values are identical to those of the actual value. The covariance proportion (U^C) measures unsystematic errors in the forecasts. U^C is rarely expected to be zero since out-of-sample simulations will almost never be perfect. Given that, the optimal value for U^C is one so that U^M and U^S can equal zero. Thus, the preferred values of the proportions are: $U^M = U^S = 0$ and $U^C = 1$ (Pindyck and Rubinfeld, 1998).

Theil inequality statistics are useful, but are descriptive, only. An alternative methodology that does have formal statistical tests associated with it will also be utilized. The error differential regression equation is specified below (Ashley, Granger, and Schmalensee, 1980). As with the Theil inequality coefficient, it also employs mean square error (MSE) calculations.

Equation 7:

$$\mathrm{MSE}(e_1) - \mathrm{MSE}(e_2) = \left[\mathrm{S}^2(e_1) - \mathrm{S}^2(e_2)\right] + \left[\mathrm{m}(e_1)^2 - \mathrm{m}(e_2)^2\right]$$

The MSE of the competing forecast errors (e_1, e_2) represent, respectively, the mean square error of the random walk benchmark ($MSE(e_1)$) and the mean square error of the structural model (RSEM) ($MSE(e_2)$). S^2 represents the sample variance and m represents the sample mean for the simulation period.

The null hypothesis tested is the following,

Equation 8:

$$H_0: MSE(e_1) = MSE(e_2),$$

Letting

Equation 9:

$$\Delta_t = e_{1t} - e_{2t} \text{ and } \sum{}_t = e_{1t} + e_{2t},$$

Equation 8 can be rewritten as follows,

Equation 10:

$$MSE(e_1) - MSE(e_2) = [cov\ (\Delta,\sum)] + [m(e_1)^2 - m(e_2)^2],$$

where *cov* denotes sample covariance for the simulation period.

If the joint null hypothesis

Equation 11:

$$\mu(\Delta) = 0 \text{ and } cov\ (\Delta,\sum) = 0$$

can be rejected in favour of the alternative hypothesis, the structural model (RSEM) will be determined to be superior.

The regression equation used to test the null hypothesis is affected by the signs of the error means. There are a total of two regression equations that are extracted from equation 10 and each of the extracted regression equations has two interpretations. The interpretations depend on which error mean is positive and which is negative.

The regression equation used to test the joint null hypothesis when the error means are of the same sign, is:

Equation 12:

$$\Delta_t = \beta_1 + \beta_2[\sum_t - m(\sum_t)] + u_t,$$

where u_t is a randomly distributed error term. The joint null hypothesis is captured within the coefficients of β_1 and β_2. The interpretation of β_1 embodies the test for $\mu(\Delta) = 0$, while the interpretation of β_2 embodies the test for cov $(\Delta,\sum) = 0$.

When β_2 is positive, the variance of the random walk forecast errors (e_1) will always be larger than the variance of the structural equation model forecast errors (e_2), showing model superiority. The signs of the error means dictate how β_1 is interpreted. Econometric forecast superiority occurs when the joint null hypothesis is rejected and both of the error means are positive. If either of the coefficients (β_1 or β_2) is significantly negative, the econometric forecast cannot be considered more accurate than its random walk benchmark. If one of the estimates is insignificantly negative and the other is positive, a one tailed t-test should be performed to test for significance. When both estimates are positive, an F-test can be used to test if they are jointly different from zero (Ashley, Granger, and Schmalensee, 1980).

When both error means are negative, the same method is used as above however the interpretation of β_1 changes. If β_1 is found to be significantly negative, and β_2 is either insignificant or significantly positive, the structural equation forecasts are deemed to be more accurate then the random walk benchmark. Otherwise, the converse holds.

If the error means of the forecasts are of opposite signs, a different regression equation must be employed to test the null hypothesis. It is related to equation 10.

Equation 13:

$$\sum_t \;=\; \beta_1 + \beta_2[\Delta_t - m(\Delta_t)] + u_t$$

The interpretation of the β_2 coefficient is the same as when the error means of the forecasts are of the same sign, but the interpretation of the β_1 now depends on which of the error means is positive and which is negative.

The first of the two possibilities is that the random walk has a negative error mean while the structural equations forecasts has a positive error mean. If β_1 is significantly negative, with β_2 being insignificant or significantly positive, the structural equation model forecast is superior. The structural model is also seen as superior when β_1 is insignificant while β_2 is significantly positive. The random walk forecasts are seen more accurate when $\beta 1$ is significantly positive, or β_2 is significantly negative.

The second possibility is when the random walk has a positive error mean while the structural equations forecasts has a negative error mean. When this case arises, if β_1 is significantly positive or there is an insignificant β_2 the structural forecast is superior. However, if either of the equation parameters is significantly negative, the random walk forecasts are deemed as superior (Kolb and Stekler, 1993).

Chapter 4

Results

Theil inequality statistics and mean square error differential regression results are shown in Tables 3 and 4. Each set of forecasts has Theil U-statistics that are close to zero in Table 3.

Table 3: Theil Inequality Statistics

Forecast	**RMSE**	**U-Stat**	**U-bias**	**U-var**	**U-cov**
Total Maquiladora Emp. In Juarez					
Structural	29.30	**0.020**	0.178	0.001	0.821
Random-Walk	28.84	0.021	0.010	0.000	0.990
Random-Walk w/ Drift	57.43	0.039	0.008	0.401	0.591
Maquiladora Plants in Juarez					
Structural	20.94	**0.010**	0.071	0.001	0.928
Random-Walk	27.83	0.014	0.000	0.074	0.926
Random-Walk w/ Drift	64.98	0.033	0.038	0.501	0.461
Average Hourly Wages in Juarez					
Structural	0.49	**0.187**	0.339	0.001	0.659
Random-Walk	0.53	0.216	0.472	0.002	0.526
Random-Walk w/ Drift	0.77	0.336	0.019	0.498	0.483
Total Value Added in Juarez					
Structural	428.31	**0.007**	0.040	0.386	0.574
Random-Walk	609.08	0.010	0.412	0.200	0.388
Random-Walk w/ Drift	1260.38	0.020	0.038	0.619	0.343
Total Maquiladora Emp. in Chih. City					
Structural	6.39	0.040	0.478	0.071	0.451
Random-Walk	4.36	**0.028**	0.080	0.062	0.858
Random-Walk w/ Drift	13.48	0.081	0.082	0.621	0.297
Maquiladora Plants in Chih. City					
Structural	7.84	0.022	0.723	0.013	0.264
Random-Walk	4.76	**0.014**	0.443	0.004	0.553
Random-Walk w/ Drift	8.67	0.025	0.315	0.308	0.377
Average Hourly Wages in Chih. City					
Structural	0.79	**0.218**	0.292	0.008	0.700
Random-Walk	0.86	0.267	0.215	0.029	0.756
Random-Walk w/ Drift	1.74	0.485	0.098	0.534	0.368
Total Value Added in Chih. City					
Structural	146.22	**0.013**	0.149	0.176	0.675
Random-Walk	138.27	**0.013**	0.056	0.212	0.732
Random-Walk w/ Drift	396.60	0.032	0.276	0.580	0.144

However, when comparing the U-Statistics across the different forecasting techniques the structural model is superior for more than half of the variables. The best overall structural performance is obtained for Ciudad Juarez. The random walk predictions are more competitive in the case of Chihuahua City. The scale of the in-bond manufacturing market is more limited in that regional market and the history of the industry much shorter then in the larger neighbor to the north. Of most interest to international investors, model-based predictions of hourly wages are relatively accurate for both, markets.

The covariance proportion of the U-Statistic represents the largest component of the total error for all of the forecast techniques. This large measurement of the unsystematic error is deemed a positive statistic, in that it implies lower bias and variance proportions. This is in line with the optimal value of the proportions: $U^M = U^S = 0$ and $U^C = 1$ (Pindyck and Rubinfeld, 1998). The bias and variance proportions are fairly low for six of the eight sets of previously published forecasts. The forecast errors for Chihuahua City employment and factories both exhibit relatively high levels of bias.

The mean square error differential regression technique provides another way to test which set of forecasts is superior. The exact form of the test is determined by the signs of its regression coefficients in combination with the signs of the means of the competing sets of prediction errors (Ashley, Granger, and Schmalensee, 1980). Table 4 reports the results of the mean square error differentiated regression tests.

Table 4: Mean Square Error Differential Regression Technique

Variable	**Result**	**β1 (t-statistic)**	**β2 (t-statistic)**	**Joint F test (sig.)**
CJTME	RW	-15.180	0.040	0.917
		(-6.717)	(0.958)	(0.350)
CJTME with Drift	RSEM	-7.168	0.417	27.643
		(-1.152)	(5.258)	(0.000)
CJMP	RW	-5.762	0.164	16.836
		(-3.047)	(4.103)	(0.001)
CJMP with Drift	RSEM	7.155	0.569	89.857
		(1.487)	(9.479)	(0.000)
CJAHW	INCONCLUSIVE	-0.079	-0.018	0.078
		(-1.656)	(-0.280)	(0.783)
CJAHW with Drift	RSEM	0.178	0.600	9.405
		(1.080)	(3.067)	(0.006)
CJTVA	INCONCLUSIVE	-305.367	0.057	0.893
		(-5.881)	(0.945)	(0.356)
CJTVA with Drift	RSEM	331.193	0.617	41.402
		(2.334)	(6.434)	(0.000)
CCTME	RW	-3.179	-0.052	0.629
		(-5.705)	(-0.793)	(0.439)
CCTME with Drift	RSEM	-0.564	0.512	68.402
		(-0.540)	(8.271)	(0.000)
CCMP	RW	-3.500	-0.083	1.075
		(-6.002)	(-1.037)	(0.315)
CCMP with Drift	RSEM	-1.802	0.321	9.724
		(-1.688)	(3.118)	(0.007)
CCAHW	RSEM	0.030	0.073	0.904
		(0.287)	(0.951)	(0.356)
CCAHW with Drift	RSEM	0.972	0.733	17.069
		(3.112)	(4.132)	(0.001)
CCTVA	RW	-89.107	-0.002	0.002
		(-6.632)	(-0.042)	(0.967)
CCTVA with Drift	RSEM	151.804	0.676	17.874
		(2.523)	(4.228)	(0.001)

The results in Table 4 lead to different conclusions than those in Table 3. There is only one variable in Table 4, CCAHW or Chihuahua City average hourly wage, for which the structural forecasts are judged as more accurate. In two cases, CJAHW or Ciudad Juarez average hourly wage, and CJTVA or Ciudad Juarez total value-added, the results are inconclusive. In the remaining 5 cases, the random walk projections are judged as statistically more accurate then the RSEM forecasts. Interestingly, the random-walk with drift forecasts do not perform better than any of the 8 sets of previously published RSEM forecasts. For an industry that consistently grows as much as the maquiladora sector does in Northern Mexico, that outcome is surprising.

Chapter 5

Conclusion

For the past four decades the maquiladora industry has played a key role in the economic growth of the U.S.–Mexico border region. In-bond manufacturing activities are particularly strong in Ciudad Juarez and Chihuahua City. Maquiladora econometric forecasts are developed annually at the University of Texas at El Paso for each market. Despite the importance of maquiladora activity in the border region, limited empirical efforts have been dedicated to checking the predictive accuracy of the forecasts published for these two markets.

This study examines the historical accuracy of the structural equation maquiladora forecasts generated using the UTEP Borderplex Econometric Forecasting Model. The eight variables that are included come from the Maquiladora block of this Model for both Ciudad Juarez, Chihuahua and Chihuahua, Chihuahua. These forecasts are three year simulations that appear in the Borderplex Economic Outlook reports published from 1999 through 2006. Combined, they provide a total of 21 observations for each variable. The specific data series are total maquiladora employment, operating plants, average hourly wages, and total value added.

The benchmarks that are used to assess the predictive accuracy of the econometric forecasts are random walks. Historically, random walks have generally provided stiff competition to regional econometric forecasts. When the data have growth trends, random walk with drifts are utilized as the appropriate benchmarks.

The two accuracy measures employed for this study are the Theil inequality coefficient (Stekler, 1968) and the Ashley, Granger, and Schmalensee (1980) error differential test. The Theil inequality coefficient is based on the root mean square error. The root mean square error

(RMSE) helps quantify predictive errors, but is descriptive. The error differential method has formal statistical tests associated with it.

Results for the Theil inequality coefficients, indicate overall structural model superiority. The structural forecasts have lower U-statistics than the random walk benchmarks for five of the eight variables and are tied for one variable. The random walk is more accurate for two of the eight variables examined.

Results for the mean squared error differential regression technique point to random walk superiority. Using this approach, the only one variable that is found to exhibit relative structural model forecast precision. Two of the tests are inconclusive. The remaining five cases indicate statistically more accurate random walk forecasts.

Accurate maquiladora forecasts would help clarify overall future economic conditions along the U.S.-Mexico border. The results obtained in this study indicate that achieving that goal may be difficult. Whether this also is true of other maquiladora regional markets such as Tijuana or Matamoros has yet to be determined.

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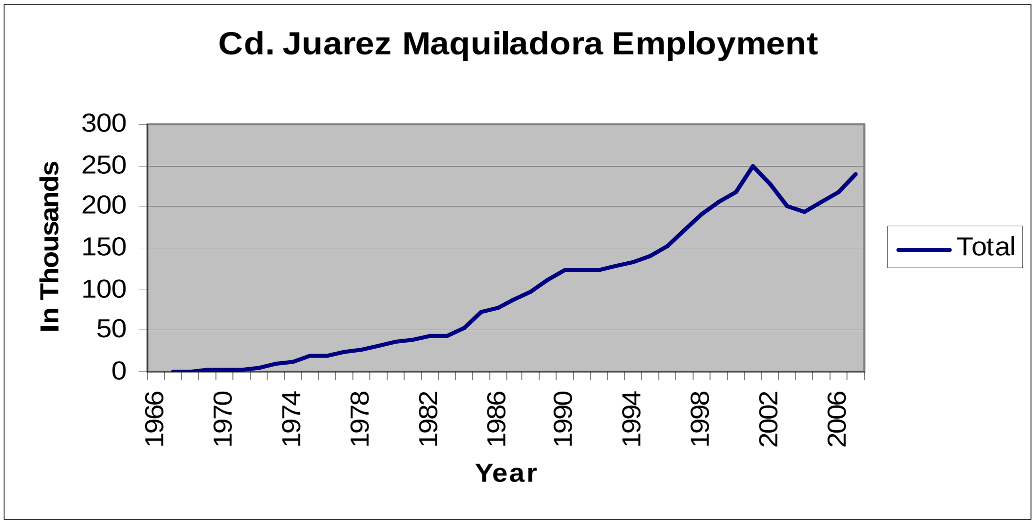
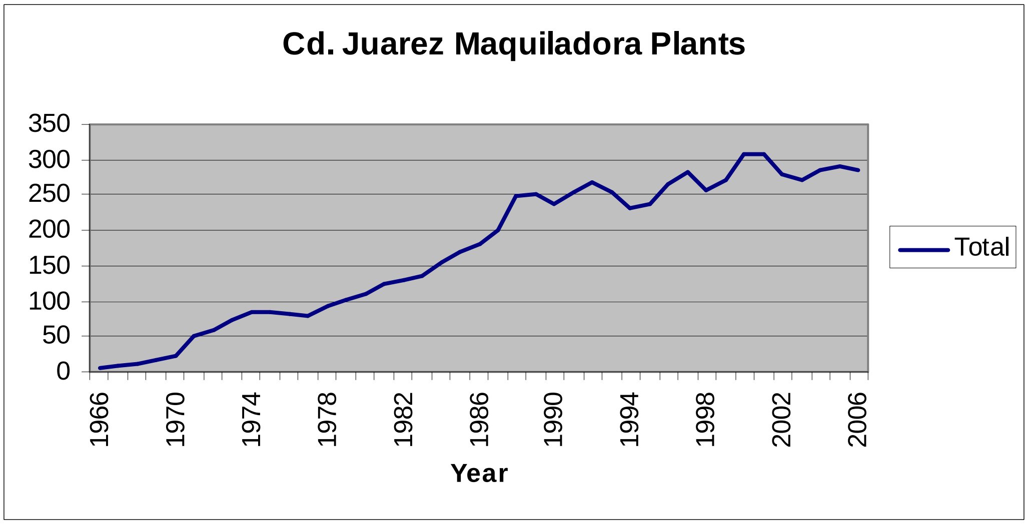
Appendix

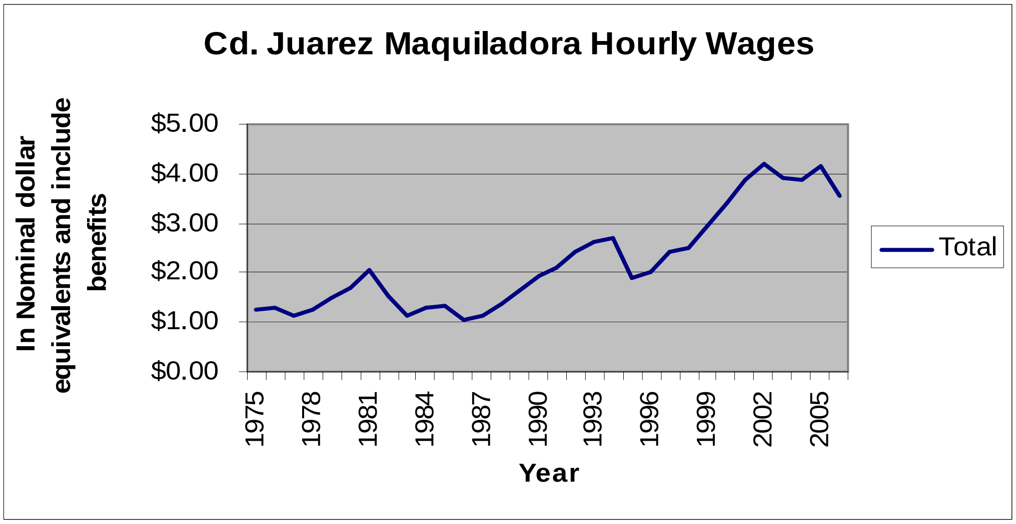
Table A1: Historical data for maquiladora data series

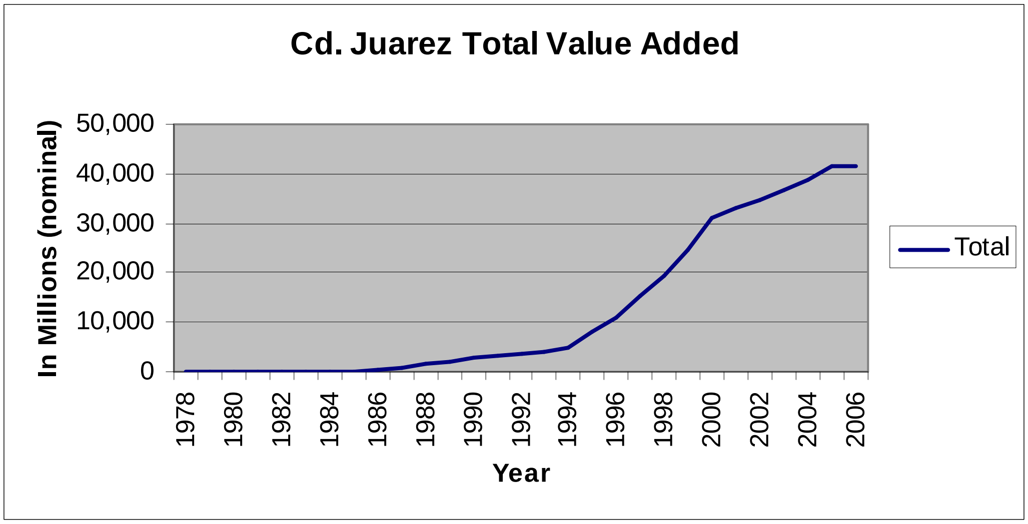
	Cd. Juarez Maquiladora Employment [1]	**Cd. Juarez Maquiladora Plants**	**Cd. Juarez Maquiladora Hourly Wages [2]**	**Cd. Juarez Maquiladora Value- Added [3]**	**Chihuahua Maquiladora Employment [1]**	**Chihuahua Maquiladora Plants**	**Chihuahua Maquiladora Hourly Wages [2]**	**Chihuahua Maquiladora Value- Added [3]**
1966	0.76	5						
1967	0.925	9						
1968	1.502	10						
1969	2.093	17						
1970	3.135	22						
1971	5.617	52						
1972	8.8	58						
1973	12.058	74						
1974	18.483	85						
1975	19.775	84	$1.27					
1976	23.58	81	$1.29					
1977	26.792	80	$1.13					
1978	30.374	92	$1.26	3.302				
1979	36.206	103	$1.49	4.737				
1980	39.402	111	$1.68	6.206	3.697	17	$1.49	0.563
1981	43.994	124	$2.04	9.025	5.038	23	$1.67	0.912
1982	42.695	129	$1.53	17.898	5.092	26	$1.21	1.536
1983	54.073	136	$1.12	37.560	6.292	23	$0.98	3.288
1984	72.495	155	$1.31	73.752	9.875	26	$1.10	8.088
1985	77.592	168	$1.35	125.416	13.307	29	$1.09	16.513
1986	86.526	180	$1.03	279.838	20.751	41	$0.89	49.841
1987	97.805	199	$1.13	761.419	24.236	40	$1.01	149.224
1988	110.999	248	$1.38	1581.000	27.370	47	$1.28	353.222
1989	124.386	252	$1.64	2197.000	29.824	54	$1.66	489.027
1990	122.231	238	$1.92	2775.000	29.307	52	$1.95	607.223
1991	123.971	255	$2.08	3312.000	31.498	57	$2.02	816.879
1992	129.146	267	$2.42	3806.000	33.577	61	$2.22	1007.924
1993	132.046	254	$2.61	3995.562	32.466	58	$2.52	1201.986
1994	140.045	232	$2.69	4837.948	26.722	50	$2.76	1143.335
1995	153.322	237	$1.89	7885.000	24.503	56	$1.95	1368.33
1996	172.926	264	$2.03	10978.877	33.069	67	$2.09	2470.947
1997	190.506	283	$2.41	15234.875	37.329	74	$2.52	3469.952
1998	206.623	258	$2.52	19170.575	40.661	77	$2.54	4561.209
1999	218.456	271	$2.95	24626.934	47.289	82	$2.97	6215.987
2000	249.38	308	$3.38	30895.046	51.170	84	$3.66	8130.855
2001	228.445	307	$3.86	33027.436	42.990	81	$4.65	9262.285
2002	200.891	279	$4.20	34791.817	40.584	74	$5.14	9023.464
2003	194.642	271	$3.91	36803.236	43.627	76	$4.37	10371.644
2004	204.542	286	$3.87	38770.475	42.908	76	$4.16	9585.716
2005	218.349	291	$4.15	41610.074	42.937	74	$4.64	10447.012
2006	239.308	285	$3.53	41463.054	45.411	77	$3.96	9362.685

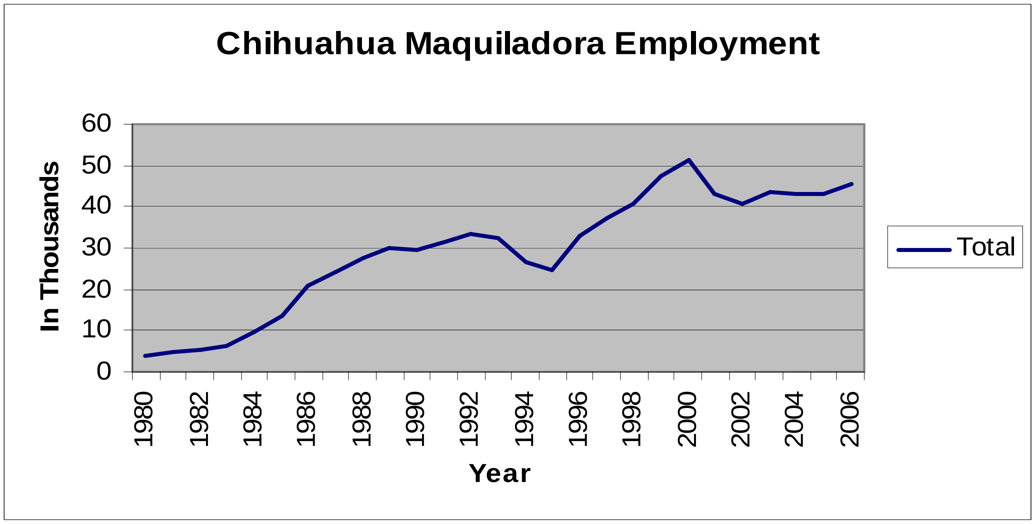
Notes: 1. Employment data are reported in thousands.
2. Maquiladora hourly wages are reported in nominal dollar equivalents and include benefits.
3. Maquiladora industry standard work week is 45 hours.
4. Maquiladora value-added data are expressed in millions of nominal dollars.

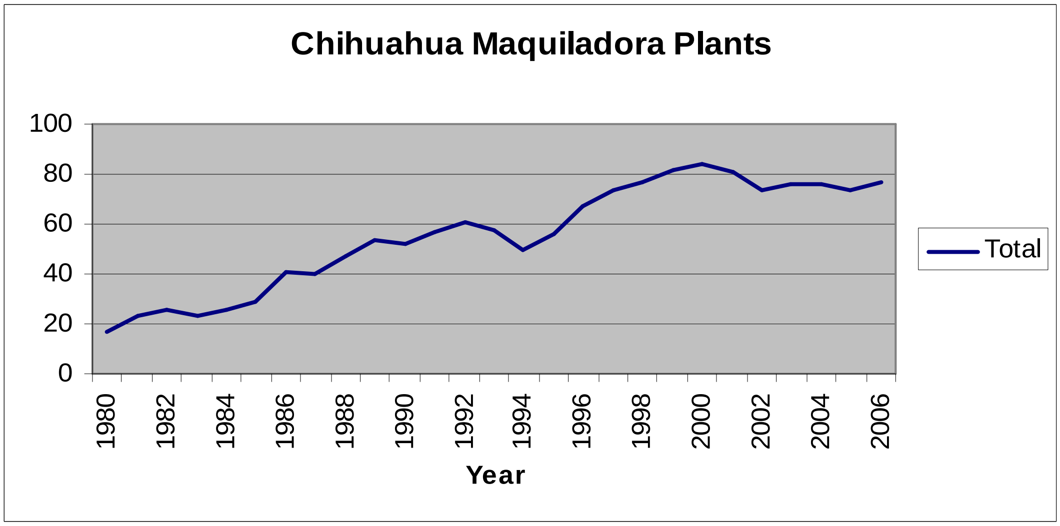

Cd. Juarez Maquiladora Employment
In Thousands
300
250
200
150
100
50
0
1966
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
Year
Total

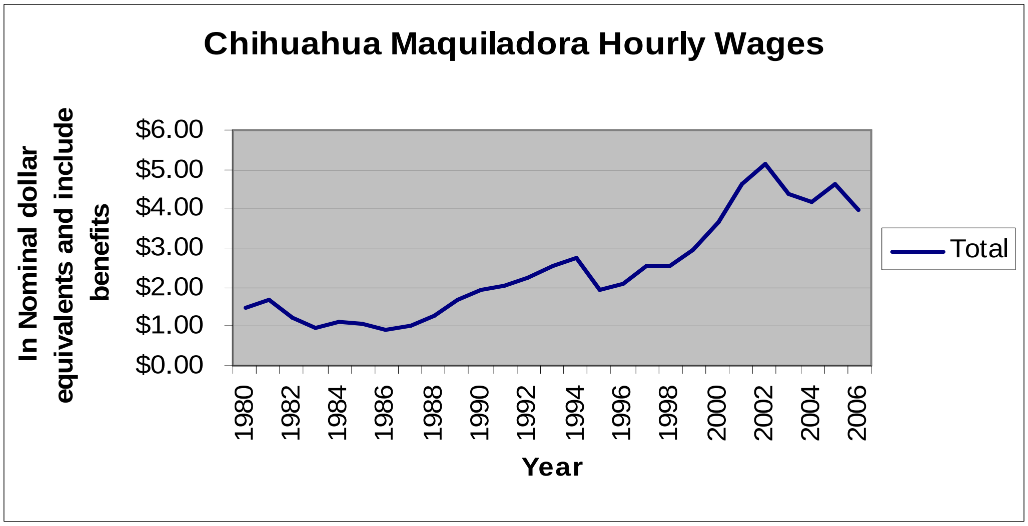

Cd. Juarez Maquiladora Plants
350
300
250
200
150
100
50
0
1966
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
Year
Total

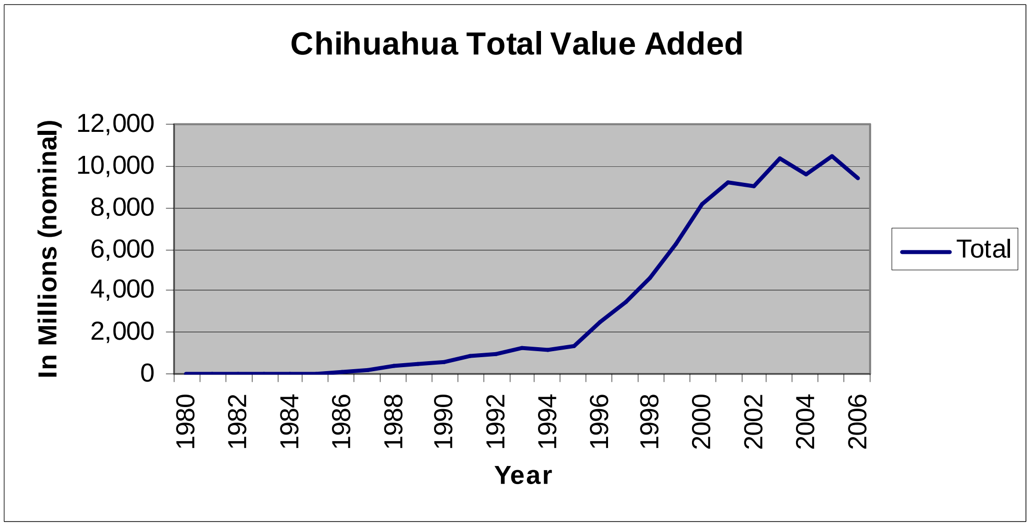

Cd. Juarez Maquiladora Hourly Wages
In Nominal dollar equivalents and include benefits
$5.00
$4.00
$3.00
$2.00
$1.00
$0.00
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
Year
Total

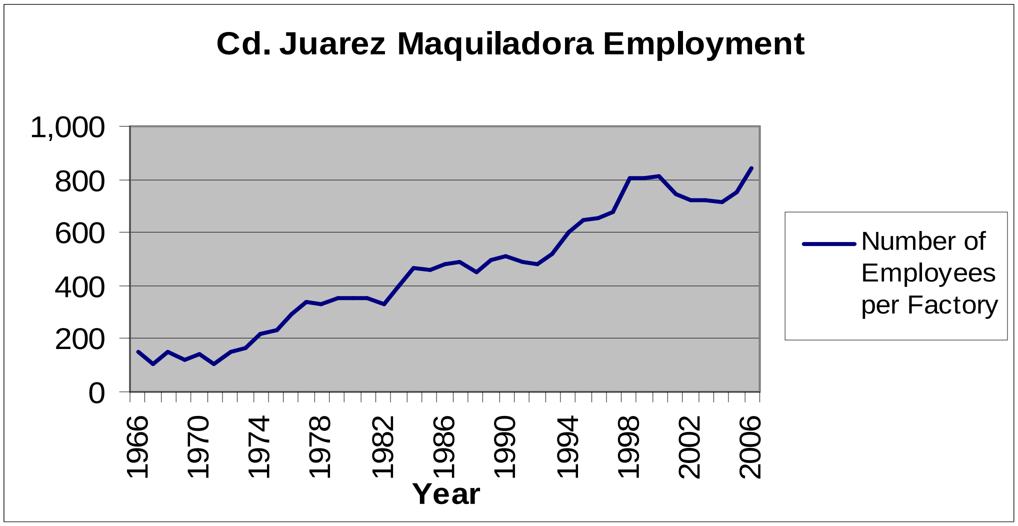

Cd. Juarez Total Value Added
In Millions (nominal)
50,000
40,000
30,000
20,000
10,000
0
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
Year
Total

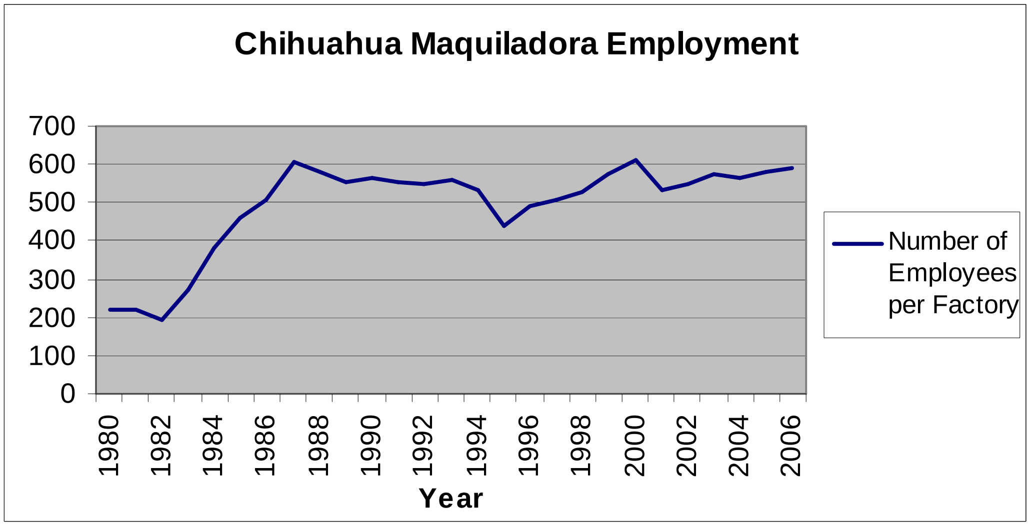

Chihuahua Maquiladora Employment
In Thousands
60
50
40
30
20
10
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
Year
Total

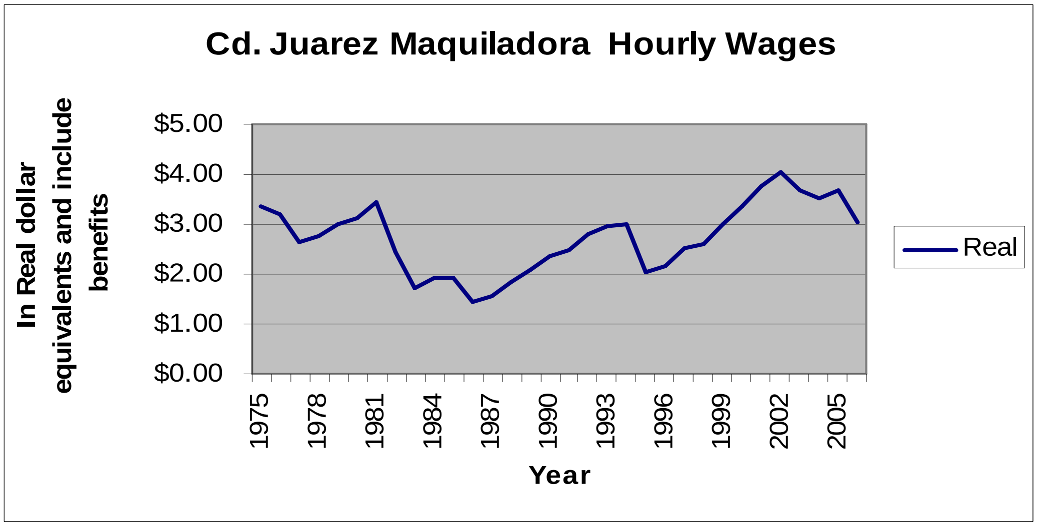

Chihuahua Maquiladora Plants
100
80
60
40
20
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
Year
Total

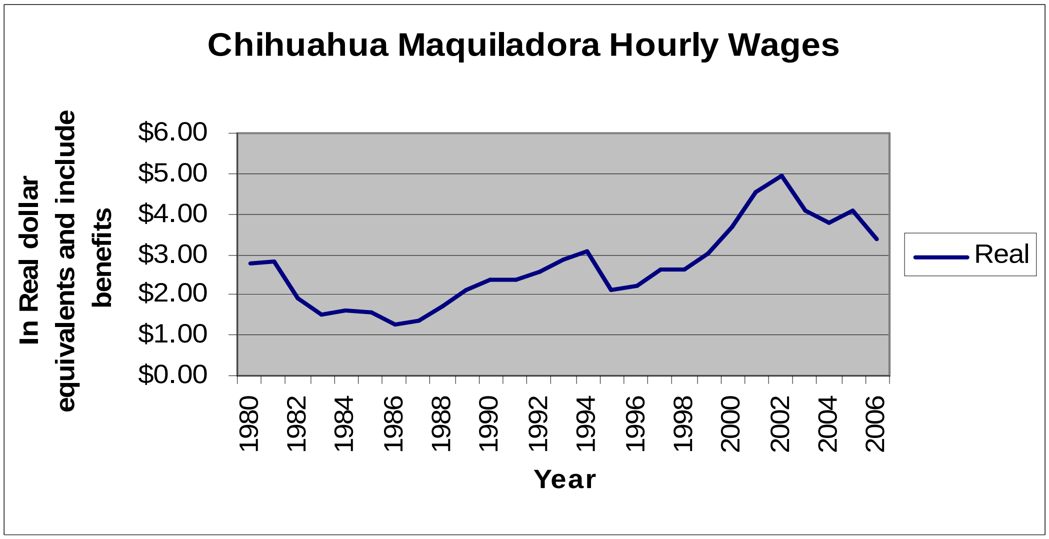

Chihuahua Maquiladora Hourly Wages
In Nominal dollar equivalents and include benefits
$6.00
$5.00
$4.00
$3.00
$2.00
$1.00
$0.00
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
Year
Total


Chihuahua Total Value Added
In Millions (nominal)
12,000
10,000
8,000
6,000
4,000
2,000
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
Year
Total


Cd. Juarez Maquiladora Employment
1,000
800
600
400
200
0
1966
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
Year
Number of Employees per Factory


Chihuahua Maquiladora Employment
700
600
500
400
300
200
100
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
Year
Number of Employees per Factory


Cd. Juarez Maquiladora Hourly Wages
In Real dollar equivalents and include benefits
$5.00
$4.00
$3.00
$2.00
$1.00
$0.00
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
Year
Real


Chihuahua Maquiladora Hourly Wages
In Real dollar equivalents and include benefits
$6.00
$5.00
$4.00
$3.00
$2.00
$1.00
$0.00
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
Year
Real

Curriculum Vitae

George Novela was born in El Paso, Texas on December 23, 1983, the youngest child of George and Magdalena Novela. He graduated from Ysleta High School in the spring of 2002 and enrolled in The University of Texas at El Paso the following semester. As an undergraduate he was heavily involved in student government and Greek life. He graduated with his Bachelors' of Business Administration in Economics in the fall of 2006 and enrolled in graduate school at the University of Texas at El Paso the following spring semester. While attending graduate school in pursuit of a Masters of Science in Economics degree, he worked as a Research Assistant for the Border Region Modeling Project and as the Research Coordinator for the City of El Paso's Department of Economic Development. He currently works for El Paso Electric as a Load Research Specialist.

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