AN EMPIRICAL STUDY OF THE RELATIONSHIP BETWEEN FOREIGN DIRECT INVESTMENT AND KEY MACROECONOMIC VARIABLES IN MEXICO

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ABSTRACT

In this study, we investigate the relationship between foreign direct investment (FDI) in Mexico and key economic variables: GDP growth rate, unemployment rate, total export (as percent of the GDP), total industry production, export to the US, import from the US, and total factor productivity. Time series and auto-regression techniques were employed in the analysis. Results from both analyses indicated that FDI in Mexico had a significant negative relationship with import from the US. There was no clear indication that FDI had any significant relationship with the other economic variables listed above. Possible factors contributing to these results are discussed.

INTRODUCTION

Foreign direct investment (FDI) has been a significant factor in the world economy. It has contributed to its growth and integration. FDI is considered important because it brings in needed capital and presumably enhances employment and economic growth (Borensztein et al., 1998; De Mello, 1999).

An increasing proportion of FDI flows have been to developing countries, such as those of Latin America and the Caribbean (Ramirez, 2001). The introduction of economic liberalization policies and trade promotion in Mexico has helped in attracting foreign direct investment. Mexico has been open to foreign direct investment (FDI) in most of its economic sectors and has been the largest recipient of FDI among developing countries.

According to the United Nations Conference on Trade and Development Report (UNCTAD, 2006), FDI flow into Mexico places it among the top 13 in the world and the top four among developing countries. The largest share of the FDI inflow into the country comes from the United States. These investments were mostly in manufacturing, retail/commerce, and financial services. Foreign direct investment has been largely concentrated in the states close to the US border, and in Mexico City and its surrounding areas (Political Risk Yearbook, 2011).

After the NAFTA treaty in 1994, most of the FDI coming into Mexico from the US went into the Border States maquiladora industry where plants can import from the US material and equipment duty-free and export the manufactured products back to the US. This kind of supply chain may have had little effect on developing the Mexican economy. Further, Mexico has lagged behind in the development of its infrastructure and in the skilled work force, which are essential for reaping full economic benefits from FDI (Stracke, 2003). Also, cheaper labor in China did not help the Mexican economy in that it reduced foreign direct investment in the manufacturing sector.

The literature is not in agreement with regard to the effect of FDI on the economy in Mexico. The effect of FDI on economic growth in Mexico is an open question. While FDI benefits may have been regional, the question remains as to whether the regional concentration of FDI has had an effect on the Mexican economy as a whole.

In this empirical study, we use time series methodology in order to investigate the relationship of FDI to key macroeconomic variables in Mexico: GDP growth rate, unemployment rate, total export, export to and from the US, total industry production and total factor productivity.

LITERATURE REVIEW

In a study on factors determining foreign direct investment in Mexico, Romano and Gamboa (2013) reported that higher education levels (or years of schooling) and lower delinquency rates were significant factors in attracting FDI. Other important determinants were GDP, proximity to the US (Border States), Mexico City, wages, industrial units, infrastructure, and FDI in neighboring regions.

Jordaan and Rodriguez-Oreggia (2012) investigated the effects of agglomeration and FDI on regional growth in Mexico under trade liberalization. Indicators of agglomeration used in the multiple regression model were regional number of manufacturing employees, regional population size, regional level of density of manufacturing, and regional population density. The authors concluded that both agglomeration and FDI generated positive as well as negative regional economic growth. Regional density of manufacturing had a positive effect on growth. On the other hand, population density, as a measure of total economic activity, had a negative growth effect. Total regional FDI had a positive regional growth effect, especially in the Border States, while the level of foreign participation in regional manufacturing (measured as the level of regional employment in manufacturing from foreign-owned manufacturing firms) had a negative effect on regional growth.

Jordaan (2008) used multiple regression to identify regional characteristics that influenced the locational choice of FDI. Results indicated that infrastructure, level of schooling of labor, wages, good communication network, regional demand, and agglomeration had an influence on FDI flow. States with a high level of manufacturing and with foreign manufacturing firms had a positive effect on FDI inflow.

Waldkirch et al. (2009) investigated the effect of FDI on employment in Mexico's non-maquiladora manufacturing. Results showed that FDI had a significant but modest positive effect on employment (both blue and white collar) in the non-maquiladora manufacturing sector.
FDI had more of a positive effect on employment in export-oriented industries. In capital-intensive industries, FDI had an enhancing effect on blue collar employment, but not white collar. It was emphasized that labor market rigidity and lack of skilled labor limited the demand for labor and hindered the enhancing effect of FDI on employment.

In a study of the effect of infrastructure on FDI in Mexico, Mollick et. al. (2006) reported that the most important infrastructure inductive to FDI was international in nature, namely telephone lines. This was by far more important than domestic infrastructure, such as interstate and secondary roads.

Ramirez (2001), in an assessment of the economic impact of FDI flow into Mexico, reported that Mexico's FDI flow was to operations in the manufacturing sector. In this regard, FDI had a positive and significant effect on average labor productivity in the maquiladora sector. This impact was especially important in the auto and engine assembly industry. Moreover, there was evidence of a spillover effect from subcontracting for parts and repair from local suppliers.

Cole and Ensign (2005) reported that FDI in Mexico was tending toward lower environmental polluting industry. There was no indication that industry movement to Mexico favored either skilled or unskilled workers. It was proposed that the reason being that both skilled and unskilled workers in Mexico had equal comparative advantage over US workers in wage and productivity.

Oladipo and Galán (2009) investigated the effect of FDI on economic growth in Mexico using an autoregressive vector analysis. They reported that FDI effect on growth was not as strong as the export effect on growth. The impact of FDI was smaller than that of domestic investment. The reason given was that FDI was concentrated in industries like the maquiladora industries with limited link to local suppliers. Key factors having positive effects on economic growth were FDI in manufacturing, domestic investment, labor force, and human capital.

Waldkirch (2010) investigated the effect of FDI flows into Mexico on total factor productivity and wages in the post-NAFTA period, 1994-2010. Results of the study showed that FDI had a positive effect on total factor productivity. However, FDI had no effect on wages and perhaps a negative effect on wages with regard to the maquiladora firms. The disconnect between productivity and wages may not be due to FDI, but rather to the time period which was characterized by a severe economic crisis.

Ramirez and Ramirez (2000), using a co-integration analysis and an error correction model approach, showed that private investment and lagged FDI as well as export had a significant positive effect on labor productivity. On the other hand, an economically active population was negatively related to labor productivity.

Oladipo (2007), in an empirical investigation of economic growth in Mexico as influenced by FDI, reported that FDI impact on growth was not as strong as the export impact. Also, it was

found that trade liberalization improved FDI flow and that labor force and human capital had significant positive effects on economic growth

Noria (2015) investigated the relative importance of the degree of trade openness (measured in terms of tariff level) and FDI on inter-industry wage differentials (WD) in Mexico. In a regression analysis using data from a national survey of urban employment for the period 1994-2004, the author reported that trade openness had no significant effect on inter-industry wage differentials, whereas FDI had a positive and nonlinear relationship with WD.

METHODS

In order to determine if foreign direct investment is related to different factors in the economy, three analytical procedures (cross correlation, time series, and auto-regression) were utilized using the SAS software. These procedures constitute the correct approach for analyzing the relationship between two time series data where the errors are auto correlated. In such a case, it is known that ordinary regression analysis can give unreliable results.

Cross correlation

The sample cross correlation between two stationary time series y and x is expressed as follows

$$r_k = \frac{\sum_{t=1}^{n-k}(x_t - \bar{x})(y_{t+k} - \bar{y})}{n\, S_x\, S_y} \quad k \geq 0 \qquad (1)$$

where, s_x and s_y are the standard deviations for x and y , $\bar{x}$ and $\bar{y}$ are the sample means and n is the sample size. Calculating the cross correlation between two time series is necessary in order to apply the time series model in the following section.

Time Series Model

A time series model relating a stationary output series y_t to a stationary input series x_i is expressed as

$$y_t = v(B)\, x_t + a_t \qquad (2)$$

where $v(B) = w(B)B^c/d(B)$.

Here, $w(B) = w_0 - w_1B - \ldots - w_sB^s$

$d(B) = 1 - d_1B - \ldots - d_rB^r$.

and c represents the time delay (or lag) until the input variable x_t produces an effect on the output variable y_t.

The function v(B) with its lags is determined from the cross correlations between x_t and y_t, namely the significance at a given lag and the pattern of the cross correlations over lags (Wei, 2006). For instance, if the correlation is significant at only lag 0, then Equation 2 can be written as

$y_t = w_0 x_t + a_t$. On the other hand, if the correlation is significant at only lag 1, then one has

$y_t = w_0 x_{t+1} + a_t$

Once v(B) is identified, one can express a_t in Equation 2 as

$$a_t = y_t - v(B)\, x_t \qquad (3)$$

and identify the appropriate time series model for Equation 3. With a_t known, one can determine the final model in Equation 2.

Auto-regression

The auto-regression model employed takes the form

$$y_t = a + bx_t + n_t \qquad (4)$$

Where n_t is an auto-regressive process of the first order, $n_t = \theta n_{t-1} + e_t$ ($|\theta| < 1$), where e_t is random error. The order was determined using the Durbin-Watson statistic.

Data

Data on GDP growth rate, unemployment rate, total export (as percent of the GDP), and total industry production (index with 2010 = 1) were obtained from the Federal Reserve in the Saint Louis (FRED) website. Foreign direct investment data (in millions of dollars) were obtained from the World Bank Data on line. Data for Export to the US (millions of dollars) and import from the US (millions of dollars) were obtained from the US. Bureau of Economic Analysis, US. Bureau of the Census. The total factor productivity index source was Feenstrac et al. 2013. Plots of the time series data are presented in the Appendix.

RESULTS

For the time series analysis, we checked for stationarity using the autocorrelation and partial autocorrelation dampening pattern approach (Wei, 2006). Results indicated that all series, except for growth rate, were not stationary. However, first differences were stationary. The time series analysis was conducted using the stationary series.

Foreign direct investment (FDI)

The time series analysis using the model in Equation 2 showed that FDI had no significant effect on the variables: total export, export to the US, total factor productivity, total industry production, unemployment rate, and growth rate.

The variable FDI at lag 2 had a negative and significant effect on import from the US (w_0 in the model = $--1.11x10^{-1}$). This was also confirmed by the auto-regressive analysis (b in the model = $-1.10x10^{-1}$ when both year and FDI were in the model). This can be interpreted as every increase of one million dollars in FDI reduces import by about 0.11 million dollars.

For import from the US as the dependent variables and FDI as the independent variable, the time series model from the analysis in Equation 2 is expressed as:

$$impUS(1)_t = 717.93 - 0.111\ FDI(1)_{t+2} + e_t \quad (5)$$

Here, $impUS(1)_t = impUS_t - impUS_{t-1}$

Analysis using the auto-regression approach of Equation 4 showed that FDI had a significant positive relationship with total industry production. However, this effect became insignificant when year entered the model with FDI. On the other hand, FDI at lag 2 was significantly related to import from the US. FDI was not significantly related to any of the other economic variables: growth rate, unemployment rate, total export, export to the US, and total factor productivity.

For import from the US as the dependent variable and FDI as the independent variable, Equation 4 takes the form

$$impUS_t = -1425416 + 717.89\ year - .110\ FDI_{t+2} + n_t \quad (6)$$

Where $n_t = e_t/(1-0.82B)$

It is interesting to see that the time series analysis and the auto regression analysis gave the same results in the sense that FDI at lag 2 was significantly related to Import from the US. The coefficients for FDI at lag 2 in Equations 5 and 6 were - 0.111 and – 0.110, respectively. The time series model in Equation 2 is more general than the model in Equation 4. They do agree when $v(B) = w_0$ as was the case. This was further indication of the reliability of results.

Time series characterization

In this section, we examine the time series that had no relation to FDI in order to gain an understanding of their dynamic behavior over time. The differenced stationary series that were white noise were characterized as to whether they were white noise with no drift or white noise with drift. The plot of a series over years that is white noise with a drift factor D has a deterministic trend with slope D, which over time can dominate and cause the series to follow a deterministic pattern (Wei, 2006) as indicated by Figures 4, 5, and 6 in the Appendix.

White noise series

Total export and unemployment rate are white noise when differenced. This means that each original series before differencing is represented by a random walk, $X_t = X_{t-1} + e_t$, and that changes in a series over time are random with no predictable direction.

White noise series with drift

Differenced or stationary series with drift include the following series: Export to the US (expUS), total industrial productivity (tip), and growth rate (GR). This means that each original series (not differenced), is represented by a random walk with drift factor D, $X_t = X_{t-1} + D + e$. This implies that the present value of the series depends on its past value plus a constant drift term plus or minus an error term. In other words, changes in the value of the series are equal to a constant D plus or minus a random error.

The time series equations with drift are as follows:

$$GR_t = 2.507 + e_t \quad (7)$$

$$expUS_t = expUS_{t-1} + 771.84 + e_t \quad (8)$$

$$tip_t = tip_{t-1} + 0.0156 + e_t \quad (9)$$

Also, the total factor productivity (tfp) is represented by an autoregressive process of order one, AR(1).

$$Tfp_t = 0.365tfp_{t-1} + e_t \quad (10)$$

DISCUSSION

This study is a comprehensive quantitative analysis involving the relationship of FDI with key macroeconomic variables in Mexico. It is of interest to find that FDI had little to no relationship to a number of important economic variables: growth rate, unemployment rate, total export, export to the US, total factor productivity, and total industry production.

Equation 7 shows that the growth rate is a white noise with drift, which indicates that the growth rate is on average 2.5 per year. Equations 8 and 9 show that export to the US, and total industry production are random walks with drift. The drift or constant component D is the slope of the growth curve over time. This indicates that these variables are growing over time, perhaps due to other factors, but not to FDI.

It is of interest to see from the statistical analysis that FDI had little to no effect on Mexico's economic variables under study. FDI had a significant positive effect on total industry production, but this effect vanished when year was entered as a control variable. This implies that FDI could not explain an increase in industry production beyond what was already occurring over years.

FDI at lag 2 had a negative effect on import from the US (Equations 5 and 6). This was the case whether the time series model in Equation 2 or the auto-regression model in Equation 4 were used. An increase in FDI could have reduced the dependence of Mexico on US products through direct import. The fact that FDI had little to no effect on Mexico's economy may be explained by the fact that FDI inflows into Mexico was mostly regional, the Border States with the US, and Mexico City. The lack of the so called spill-over effect from the local areas to the economy at the national level may be attributed to factors such as lack of adequate infrastructure, lack of skilled workers, and lack of adequately educated and trained labor. Also, most of the FDI coming into Mexico from the US went into the Border States' maquiladora industry where plants can import from the US material and equipment duty-free and export the manufactured products back to the US. This kind of supply chain may have had little effect on developing the Mexican economy (Stracke, 2003; Salvatore, 2007).

CONCLUSION

In this study, the authors investigated the relationship of foreign direct investment to key economic variables, namely GDP growth rate, export, import from the US, export to the US, unemployment rate, total industry production, and total factor productivity. Results from the statistical analysis, using time series and auto-regression techniques, showed that foreign direct investment had a negative relationship with import from the United States, but no relationship to any of the other economic variables above. It is shown that many of the economic variables that are not related to FDI are characterized by positive drift or constant terms, which represent the slopes of their growth curves over years. This growth must be due to factors, other than FDI, not observed in the data.

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APPENDIX

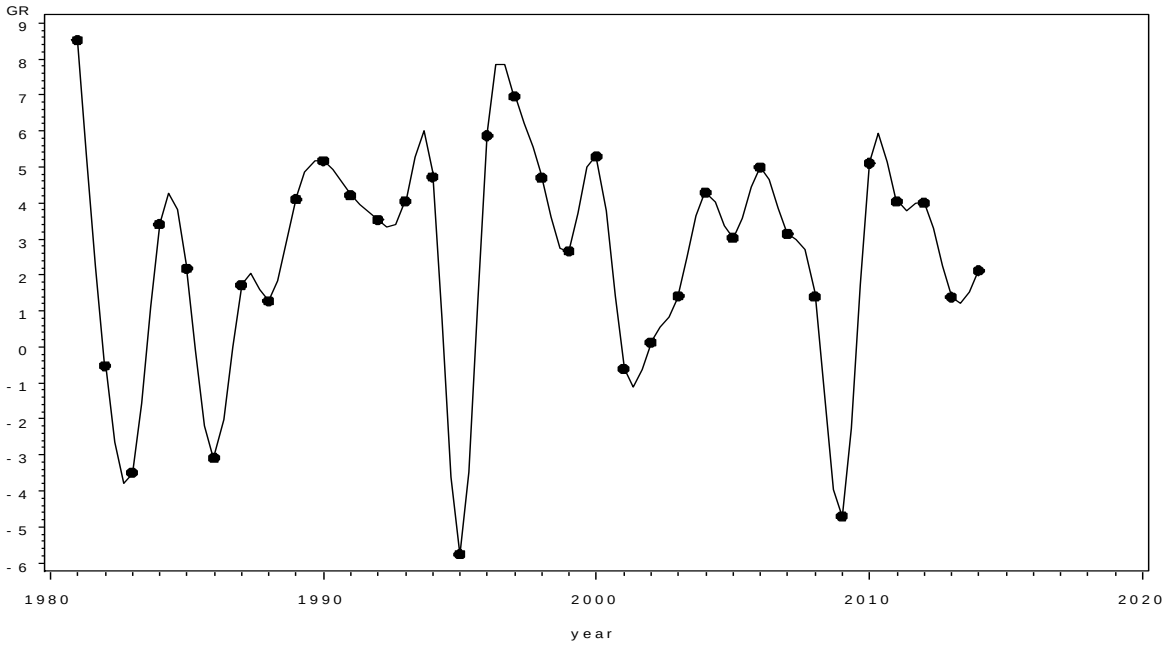


FIGURE 1: PLOT OF GROWTH RATE (GR) OVER YEARS

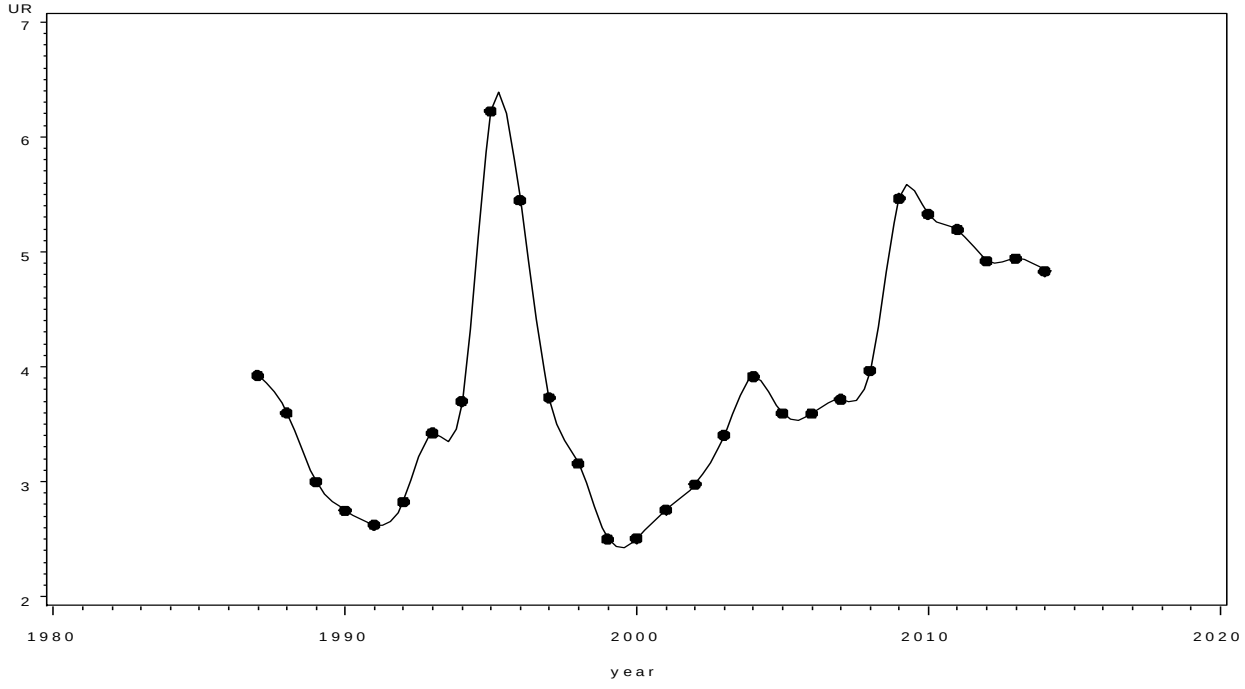


FIGURE 2: PLOT OF UNEMPLOYMENT RATE (UR) OVER YEARS

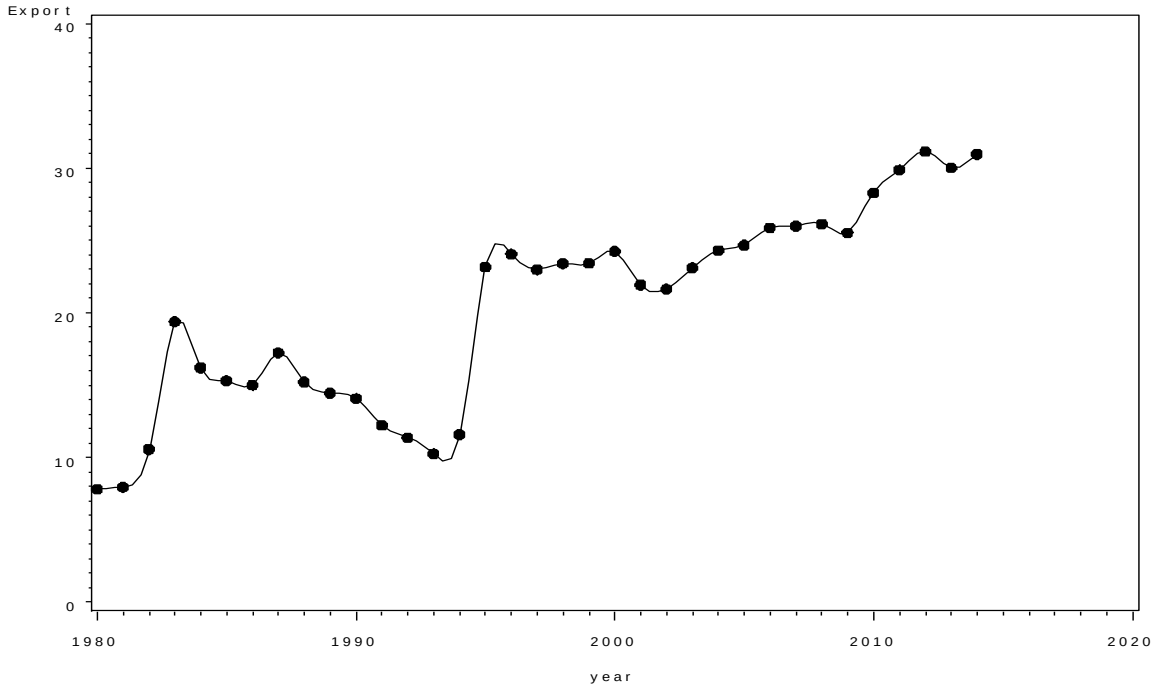


FIGURE 3: PLOT OF TOTAL EXPORT OVER YEARS

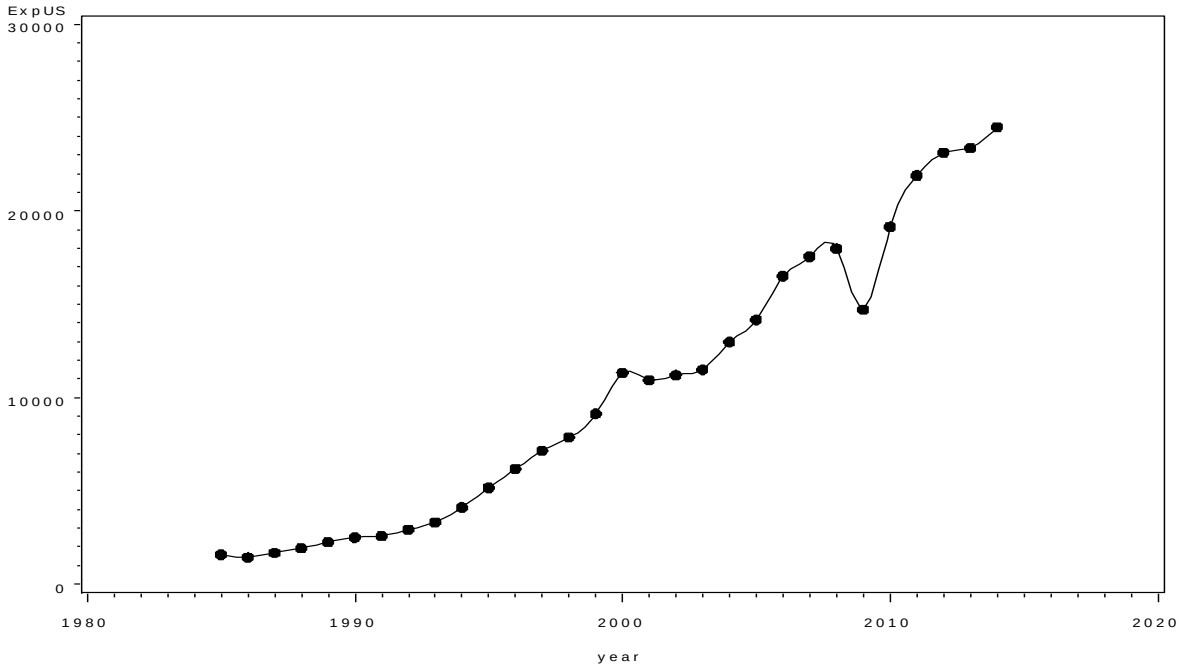


FIGURE 4: PLOT OF EXPORT TO THE US (EXPUS) OVER YEARS

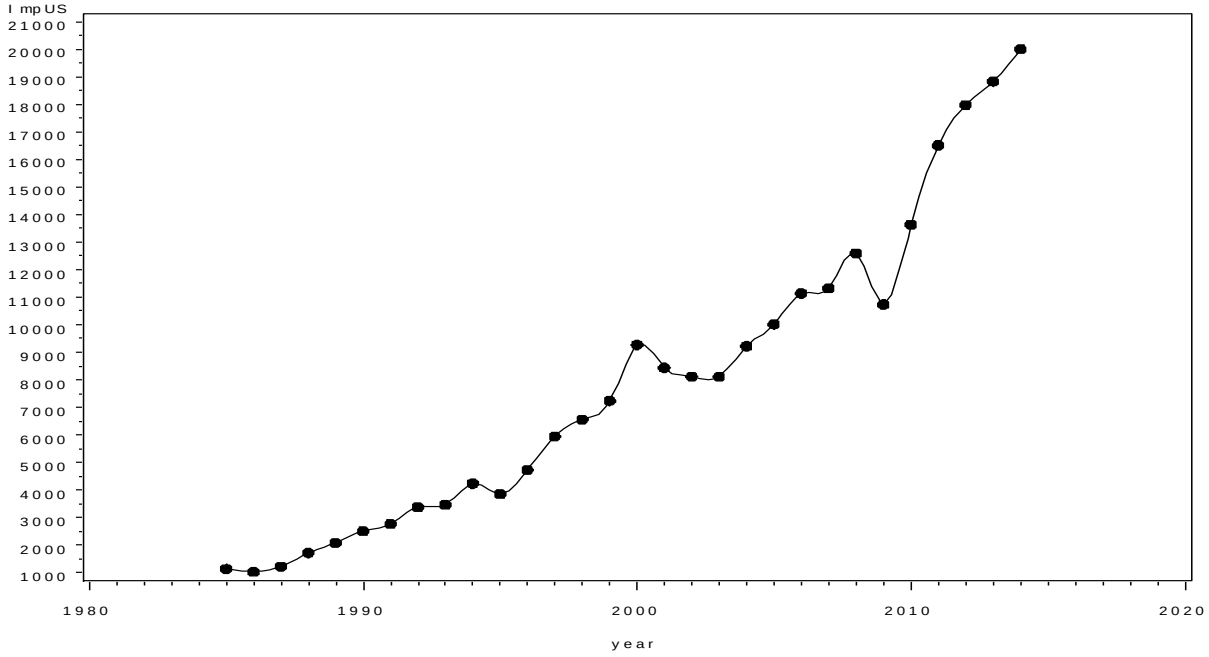


FIGURE 5: PLOT OF IMPORT FROM THE US (IMPUS) OVER YEARS

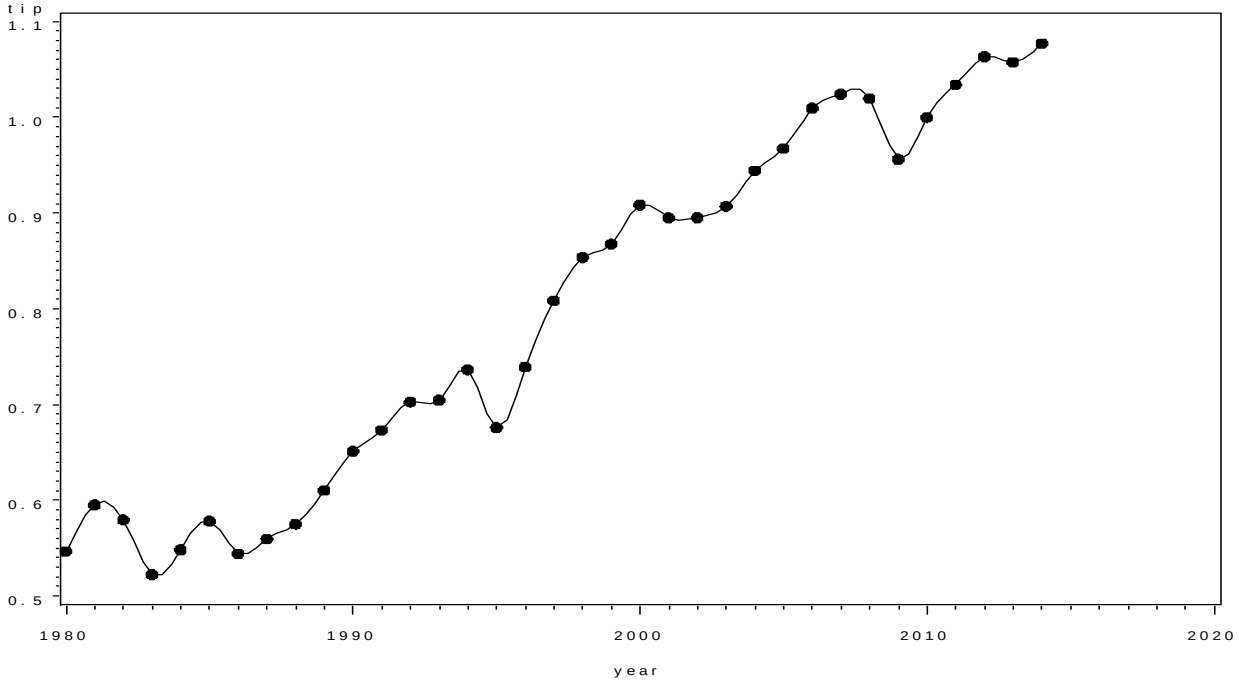
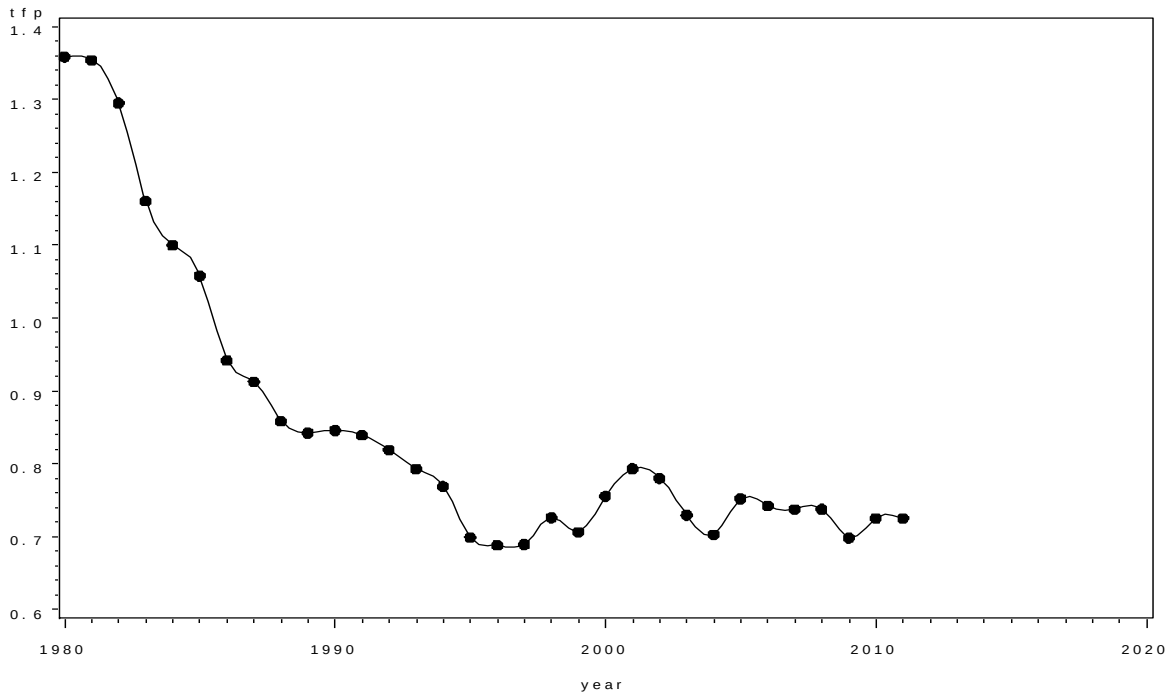


FIGURE 6: PLOT OF TOTAL INDUSTRY PRODUCTION (TIP) OVER YEARS



FIGURES 7: PLOT OF TOTAL FACTOR PRODUCTIVITY (TFP) OVER YEARS

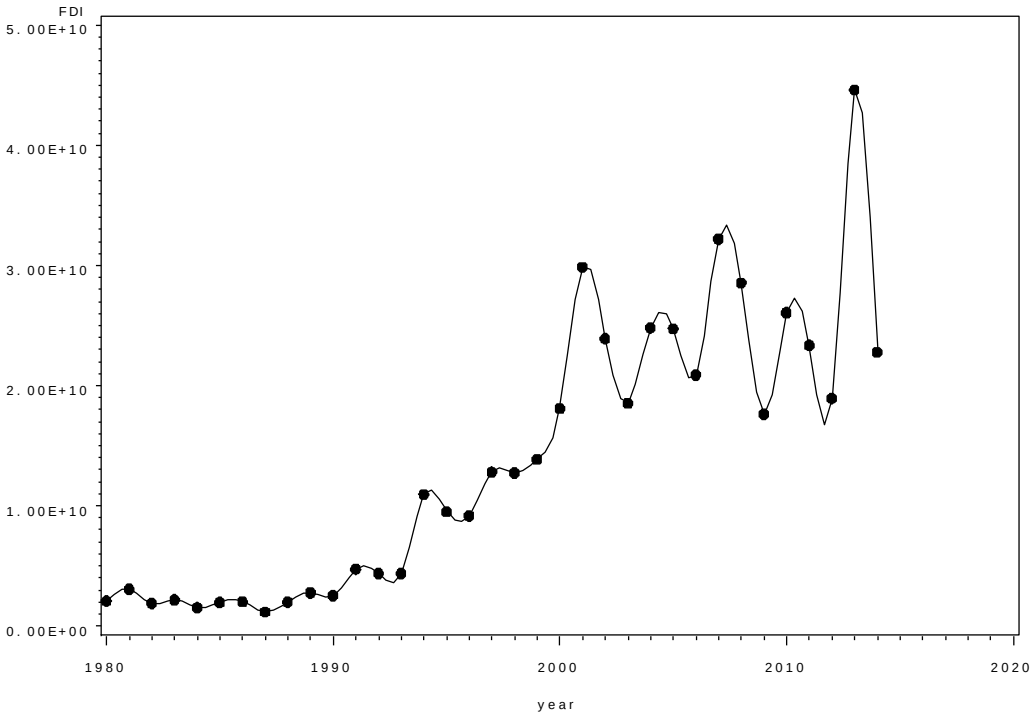


FIGURE 8: PLOT OF FOREIGN DIRECT INVESTMENT (FDI) OVER YEARS

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