Productivity Analysis of Foreign Direct Investment and Capital Formation on Developed and Developing Countries

By

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Resumen

Este estudio examina el efecto de la inversión extranjera directa y la formación de capital en la productividad total de los factores del país utilizando el modelo de regresión de mínimos cuadrados ordinarios y análisis de data de panel para el periodo anual de 1950-2010. Se analiza si estos efectos varían entre un país desarrollado y un país en desarrollo, para este análisis Estados Unidos y Méjico, respectivamente. La literatura existente demuestra que, individualmente, la inversión extranjera directa y la formación de capital parecen tener un efecto positivo en la productividad total de un país. Los resultados del modelo de regresión indican que la inversión extranjera directa no tiene un efecto significativo en la productividad total de Méjico, más sin embargo, tiene un efecto negativo y significativo en Estados Unidos. Por el contrario, la formación de capital sí parece tener un efecto significativo en la productividad de ambos países.

Abstract

This study examines the effect of Foreign Direct Investment and Capital Formation on the country's Total Factor Productivity using Ordinary Least Square regression model and panel data analysis for the period of 1950-2010. This study analyzed if these effects vary from a developed to a developing country, for this analysis, United States and Mexico, respectively. Existent literature shows that when studied individually Foreign Direct Investment and capital formation do have a positive effect on a country's total productivity. Results from the regression model concluded that Foreign Direct Investment does not have a significant effect on México's total productivity, while it seemed to have a negative and significant effect on US productivity.. Furthermore, Capital Formation does seem to have a significant effect on both country's productivity.

In loving memory of my mother, Marilyn

Thank you for give me the memories to build up my dreams…
I will love you and **miss** you every day of my life… This one is for you.
"We all have our time machines. Some take us back, they're called memories. Some take us forward, they're called dreams" Jeremy Irons

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List of Abbreviations

ARRA	American Recovery and Reinvestment Act
CPI	Consumer Price Index
DEA	Data Envelopment Analysis
FDI	Foreign Direct Investment
FE	Fixed Effects
FTA	Foreign Trade Agreement
GDI	Gross Domestic Investment
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
HST	Hausman Specification Test
II	Internal Investment
ISI	Import substitution Industrialization
LM	Lagrange Multiplier
MRM	Multivariate Regression Model
NAFTA	North American Free Trade Agreement
OECD	Organization for Economic Cooperation and Development
OLS	Ordinary Least Squares
PPP	Purchasing Power Parity
PWT	Penn World Table
R&D	Research and Development
RE	Random Effects
RGDP	Real Gross Domestic Product

RTA	Regional Trade Agreement
SNA	System of National Accounts
TFP	Total Factor Productivity
UK	United Kingdom
UNCTAD	United Nations Conference on Trade and Development
UNIDO	United Nations Industrial Development Organization
USA	United States of America
VIF	Variance Inflation Factor
WBD	World Bank Database

Chapter 1: Introduction

1.1 Introduction

A country's productivity can be measure in two ways, either partially or as a total aggregate. Partial productivity is defined as "the amount of goods and services produced from each hour of a workers time" (Gouranga et al, 2009). On the other hand, total productivity is defined as the output that an institute, company, or country can produce with a limited input, given the state of technology (Baumol & Blinder, 2009). Likewise, productivity either partial or total, is an efficiency measure that use the relationships derived from actual performance comparison to similar organizations over time. A country's total productivity can be improved in different ways and by different factors, such as the amount of foreign investment it receives and the capacity for internal investment of this country. Therefore, is our interest to study the effect of these factors over time into the country's total productivity. Total factor productivity can be defined as the amount of output not explained by the inputs used in production.

Foreign Direct Investment (FDI) is defined as *"an investment involving a long-term relationship and reflecting a lasting interest and control by a resident entity in one economy in an enterprise resident in an economy other than that of the foreign direct"* (UNCTAD 2010). In this globalized economy, FDI have been gaining more interest than ever before. In the midst of a global economic slowdown, the September 11th attacks against the United States, and a stock market slump which have negatively impacted the dissemination of foreign investments (WIR 2010), developed and developing countries are raising more interest on receiving FDIs. Countries are realizing the advantages extend far beyond economic inflows, into improved infrastructure, higher employment rates, and increased technological advances (Haskel et al., 2007). These indirect effects, or "spillovers," can bring the host region valuable economic gains,

since these foreign firms tend to be more productive than domestic firms (Doms & Jensen, 1998), thus transmitting these productivity levels into the host country region. The influence of FDIs can promote productivity in a specific industry such as manufacturing (Driffield, 2001), or in the country's macro-economic level (Haskel et al., 2007).

This study aims to analyze the effects of FDIs on productivity using the Total Factor Productivity (TFP) as indicator of the country productivity. It will also contribute to the limited research done on the country's productivity changes as a result of new foreign capital into the country.

1.2 Justification

The world economic situation within the last decades has encouraged interest in FDI distribution, and its effect on the host country. Therefore, research on this subject and the analysis of its economic impact on a country's economy has advanced extensively. FDI can directly result in better infrastructure, knowledge, technology transfer, and higher productivity growth, which in turn promotes a higher macro-economic well-being for the country. FDI also influences the country's internal investment.

FDI effects on a country's productivity have been widely studied at the industry level, whereas the examination on the impact of FDI on a country's productivity at the macro-level is limited. Previous research has studied the impact of FDI on a country's growth, using Gross Domestic Product[1] (GDP) as a common measure. For example, (Hsiao & Hsaio, 2006) analyze the relationship between GDP, exports and FDI among China and concluded that FDI does have

[1] Gross Domestic Product is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products (World Bank).

an effect on the country's GDP and exports. On the other hand, Bakare (2011) use GDP to analyze the relationship between capital formation and economic growth in Nigeria[2]. His findings suggest that there is a siginificant relation between these two variables, but its necessary for the government to promote savings to produce a multiplied effect in the level of economic activity as they boost capital formation and promote economic growth.

This study presents a comparative analysis of the impact FDI and Capital Formation has on both a developed and developing country's total productivity. United States has been chosen as a representative of a developed country while Mexico represents a developing country[3]. Even though the economic development between these two is far from comparable, Regional Trade Agreements (RTA) in recent decades, such as NAFTA, has been a key element, making these two countries a target for analysis. The reason for this selection relies on the fact that these trade relations have caused a change in the economy of these two countries which directly impacts their productivity. This study also contributes to the limited research of the impact FDI and Capital Formation has on a country's productivity.

1.3 Objective

This study analyzes the effects of FDIs and internal investments (capital formation) on a host country's productivity– specifically United States and Mexico. There are a number of

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[2] Capital formation is the increase in the stock of both material and human capital by making available a part of society's currently available resources

[3] A developed country is characterized by having a relatively high level of economic growth and security, while a developing country has lower income levels. Some of the most common criteria for evaluating a country's degree of development are per capita income or gross domestic product (GDP), level of industrialization, country is characterized by having an average income much lower than in industrial nations.

studies which investigate the effects FDIs have on a country's growth and the effects of these investments on a country's GDP ((Hall & Jones, 1999), (Easterly & Levine, 2001), (Laureti & Postiglione, 2005) & (Qin, Cagas, Quising, & He., 2006). However, there is limited literature and research regarding the effects of FDI on a country's productivity.

FDIs bring new capital assets and frequently enable the transfer of new technology resources into the host country. Under this assumption, we investigate the impact of these two variables: FDIs and internal investments on a country's productivity. The macro-economic variables utilized for this study are the TFP, which will represent the country's productivity, the FDI, and the investment share of real GDP, which represents the country's investment share of total production.

1.4 Limitations

The main limitation for this research is related to data availability. FDI historical data is usually provided in an annual basis. Therefore, observations collected for analysis are only able to capture annual changes. Related to this, is the limitation in updating available data for the productivity variable. Although is out of our control, it is worthwhile to mention that due to the complexity of the macroeconomic variables used in the study, it takes time for this variables to show a specific impact in the host country's economy.

1.5 Thesis Outline

The remainder of this research is composed of four chapters. Chapter two discusses literature assessment and empirical evidence surrounding the effects of FDI and Capital Formation on the country's productivity, as well as other factors that may have impacted these variables, such as trade agreements, economic and country changes. Chapter three describes the

methodology employed for this research to analyze the effect of these variables on productivity. Chapter four provides the empirical results obtained and the interpretation of these results. Chapter five presents concluding remarks and recommendations for further study.

Chapter 2: Literature Review

2.1 Overview

A country's productivity often contributes to attract FDI into the host country. Productivity of a country's labor force can be explain as the amount of output an employee can do a in certain amount of time (Baumol & Blinder, 2009). It would be logical to say then, if a country's labor force productivity is higher, the country's total productivity will also be higher, thus making this country more economically efficient. Efficiency leads to income savings that can later be invested to improve capability and income, which translate in a higher capital formation for the country. Emphasis into these variables has increase in the last decades due to the challenges of the unstable global economic situations, as well as the close relation that they have with one another seems to be evident. Therefore, if a country's productivity is high this country is said to be more efficient, then is reasonable to think that this country will be a preferred FDI destination. Multinationals are chasing after production bargains, outsourcing their assembly facilities and services anywhere in the world that can provide any savings. This is one of the reasons most of the research to determine the impact of FDI and capital formation has been done at the industry level. However, a macro-level analysis will help determine if FDI and capital investment are in fact significant to the country's productivity, and whether there is significant variation between countries economically heterogeneous.

2.2 FDI, Capital Formation and Productivity

FDI effects and its consequences to the host country have been analyzed from many different approaches over the years. At macro-level, host economies expect to benefit from FDI knowledge spillovers wrapped around the new technology, research and development, and skills

that the new capital will bring into the country. This spillover may come as, introduction or transfer of new technology into the country, gaining knowledge of new processes and even higher capital accumulation. As the country's physical and human capital improve, so its productivity, since the country learns how to be more efficient with its inputs. But these enrichments which also contribute to the country's economic growth, sometimes seems to rely upon several factors. At times, the effect on economic growth from FDI seems to be conditional to different local factors such as policy environment (Balasubramanyan, *et al*, 1996), and human capital (Borensztein, *et al.,* 1998). Alfaro, *et al.* (2009) found that countries with well develop financial markets will benefit greatly from FDI through productivity improvement than factor accumulation. Likewise, Mello (1999) provided evidence using OECD and Non-OECD time-series and panel data concluding that country specific factors such as; trade regimes differences, policies and political risk levels, which are not commonly taken into account can be crucial on unseen growth factors. Once these factors were considered the relation between FDI and capital accumulation shift to be positive between the two groups. Sometimes productivity is associated with specific conditions. Criuelos & Wang (2005) studied OECD and developing countries and found that FDI does benefit developing countries, but they must contain considerable human capital. This is similar to Borensztein *et al.* (1998) findings that the benefits from home countries will be determined by its absorptive ability. Haskel *et al.* (2007) analyze productiviy effects of FDI using plant level data for all the manufacturing sector in U.K. and its findings indicate that these spillovers will have a positive correlation with FDI when the spillovers occurs among industry lines. Other sectors that have been found to have a positive relation with FDI are the electronics, machinery and transportation industries (Moran , 2001).

The general thought can be that FDI will primarily benefits the host country through investment injection, but neither less to think that the principal objective of the multinationals is either make or save money. Evidence has been found about how the home and host country benefits from this type of investment. Braunerhjelm *et al.* (2005) stated that FDI can be seen as a booster mechanism that improves capital allocation and therefore it will benefit the home and the host country. In this same line, Romer (1993), argued that FDI can increase productivity not only to the host country but to the home country as well, stating that multinational profits from the idea's exchange will close the gap between developed and developing economies.

As FDI and capital formation seem to be the result or the cause for changes in the country's productivity, extensive research has been done between these three although not all together. Choe (2003) study the causal relation between FDI, capital formation and economic growth and concluded that the causality between growth and capital formation runs only from growth to capital formation, but that causality between economic growth and FDI runs in either direction. Ericsson & Irandoust (2001) studied the relation between FDI and TFP between four Scandinavian countries and concluded that FDI and TFP growth were closely related for Norway and Sweden, and there was no relation on these variables for Denmark and Finland. However, the rate of capital formation may determine the rate of economic growth of the host country (Levine & Renelt, 1992). Erdal and Tatoglu (2002) signaled FDI as one the main factors in the globalization on the international economy. Yao & Wei (2007) also found that at national level FDI provided significant effect on production and economic growth.

At the micro level, a positive correlation has been found between FDI and plant productivity in the manufacturing industry (Sourafel & Wakelin, 2001). Mullen & Williams

(2005) stated that FDI have a major impact in regional productivity and economic growth. Other studies have been conducted sustaining that there is a positive relationship between FDI and productivity (The McKinsey Global Institute (2003), Luis Guasch (2002), Clive Harris (2003), while privatizations and regulations can lead to reduced resources and returns (Palmade & Anayiotas, 2004). High competitive industries seemed to be attracted to FDI, this competition can be positive as the productivity and technology rates increase and prices decrease. Free trade drove Mexico to be principal destination for several industries (Hanson 1996, 1998a, b; Krugman and Livas- Elizondo 1996). One example is the automobile industry where the stronger competition, encourage by facilities expansion multinationals mergers[4] increasing competition on this industry (Palmade & Anayiotas, 2004). But there are studies that provide contradictory evidence. For instance, Gorg & Greenaway (2004) concluded that FDI effects are negative to the host country, while Blomström & Kokko, (2003) argue that spillover benefits from FDI will only occur if the host country has the capacity to invest in foreign technologies and empower the learnnig from this activities.

FDI can also promote export diversification in the host country sectors with low export activity (Banga 2006). But according to Dunning (1998) export performance will be impacted by the type of FDI the country receives. Another spillover effect that may occur is the fixed costs reductions when these products are introduced on international markets. However, these effects and impacts may vary meaningfully by host country. Banga (2006) found that US FDI led to a

[4] In 1987 Ford bought 75 percent of Aston Martin and acquired full ownership in 1994., In 1979 Ford acquired a 25 percent stake in Mazda, and spent $484 million in 1996 to raise that to 33.4 percent. GM and Isuzu first formed an alliance in 1971. GM acquired a 49 percent share of Isuzu in 1999; GM acquired half of Saab in 1990 for $600 million and bought the rest for $125 million in 2000. (Source: Forbes)

superior diversification of Indian exports than Japanese FDI. In China, Yao & Wei (2007) found that FDI have a positive effect in the contry's productivity and exports.

The intense competition for achieving higher productivity in the micro-economic level has lead countries to reshape their monetary policies. Political and economic stability will still be taking into consideration, but investments decisions will be highly influenced by the economic conditions of the sector the home country is evaluating to invest. FDI bring more positive impact in sectors where competition is stronger, such as the automobile industry that showed stronger competition which increase productivity that led to dropping prices (Palmade & Anayiotas, 2004). Regional country characteristics seem to have a potential outcome on FDI as well. Demand variations by regions, wages rate variations, education level differences, and communication network are linked with FDI distribution disparity (Jordaan 2008). Shan (2002) found that FDI causes differences in the economic development of eastern and western areas in China. Furthermore, industrial competitiveness of state-owned enterprises in the global markets increases the amount of FDI which the state received (Leichenko & Erickson, 1997). FDI studies its benefits on jobs, salaries and industrial structure has also gain interest over the past decades ((Schoenberger & , 1986), (Glickman & Woodward, 1988), (Coughlin C. C., 1992), (Graham & Krugman, 1995)). FDI distribution of state-owned business has also seem to take into account factors such as agglomeration economies, market potential, business climate and taxes has influence state-owned companies FDI distribution (Friedman, Gelowski, & Silberman, 1992), (Coughlin & Cartwright, 1987) (McConnell, 1980).

As previously mentioned, there are a number of studies on the effects of FDI and capital formation on a country's or industry's productivity. Even though, there has been a shifted focus

to plant level analysis, it remains important to analyze the impact on the country's productivity by these elements and evaluate its effects at a macro-level perspective.

2.3 Developed and Developing Countries

Research on the productivity effects from FDI and capital formation on developed and developing countries seems to be diverse. The increase in domestic capital stock and technology diffusion is a key element from which FDI contributes to economic growth. These outcomes can have an impact on productivity increasing the human capital accumulation and stimulating technological progress. Developing countries have benefited from this inwards in terms of transfers of more updated technology into the country and more capital (Stocker 2000). Similarly, Hajeazi & Safarian (1999) concluded that a considerable part of technology difussion in OECD countries is affected by FDI distribution. However, Borensztein *et al.* (1998) in their cross country analysis concluded that for the host country to have a positive growth effect, it needs specific human capital capacity. Blomström *et al.* (1994) findings indicate that the most deprived developing countries will not profit from technology spillovers as much as middle-income developing countries. Van Loo (1977) also found a positive relationship between FDI and capital formation. However, not all literature supports these findings. For example, Aitken & Harrison, (1999) analyzed plant level data for Venezuela and concluded that the productivity effect on local plants was higher within plants that receive FDI, while lowering the productivity of domestic plants that do not receive FDI. Lipsey (2000) did not found any significant evidence of the impact of FDI on capital formation on developed countries. Other effects, such as wage spillovers into the host country have been examined as a result of foreign investments. Tomohara & Takii (2011), used panel data to analyze whether wage inequality in the host country of

foreign institutions affects the local wage levels. Their findings reveal that foreign establishments does have positive externalities on local wage levels, since local establishements tend to make efforts to match foreign wage levels. A higher wage level is the result of higher marginal labor product.

2.3.1 Mexico

There has been a continuous increase of developing and transition economies as main targets for FDI. They accounted for more than 50 percent of global flows (WIR10). One reason for this is that most Latin American countries have rich deposits of natural resources such as metals and agriculture, and also possess a vast high-tech manufacture machinery such as for the automobile sector. High-tech manufacturing countries such as Argentina, Brazil, Chile, Colombia, Costa Rica and Mexico increased production by 93 percent over the last decades (Hill, 2002). This accelerated growth in high-tech manufacturing is the result of the Latin America's exposure to new investment opportunities and privatization policies that promote economic growth.

In 1950's the Mexican economy was promising. High investments were made in key sectors of the economy such as the banking, mining and steel industries. The favorable economic conditions arrived from the continuous flow of exports and capital imports which facilitated the financing of external imbalances. However, Mexico's 1970's and early 1980's economic crisis stimulated a change in its development strategy, stressing its interest in the attraction of FDI into the country. One initiative towards this was the North American Free Trade Agreement (NAFTA), signed in 1994, which allowed the free trade between United States, Mexico and Canada. This agreement opened new trade opportunities for these three countries. NAFTA was

the first Regional Integration Agreement (RIA) reached between a developed country and a developing country. This trade bloc provided the North American region a better competitive position against other nations (e.g. Trans Pacific) and obtained more economic sustainability for investment, making it a unique region (Fry and Bybee, 2002).

Pre-NAFTA effects were investigated by Blomström M. (1986) which found positive effects - in the form of competition - of FDI in the Mexican manufacturing industries. His findings also suggested that there is a positive correlation between foreign presence and structural efficiency and that structural changes in an industry will only take place on the most developed industry parts. NAFTA effects on the Mexican economy were explored by Waldkirch (2003). In his study, Waldkirch investigated the use of economic integration of a developing country with a developed country as a tactic to boost FDI flow. NAFTA did seem to have an effect on the FDI into Mexico, and it also changed investors' mindset of some fundamental determinants of FDI, such as interest rates and factor prices. Although economic integration does attract more FDI, the majority of these investments will come through the partner countries. Furthermore, geographic proximity between partner countries will have an effect on the investment flow between countries. Hence, integration efforts that do not directly border may not result in greater FDI. Similarly, Ramirez (2002) identified NAFTA and Mexico's proximity to the USA as a major advantage for this country. Ramirez, (2002) used a cointegration analysis to estimate a labor productivity function for the 1955-94 period to investigate the impact of public investment spending on ecomic growth. Ramirez points out that the Mexican economy is one of the main economies in Latin America, two reasons support his statement. First, the enactment of NAFTA gave Mexico a competitive advantange from other Latin American countries. Also the

proximity of Mexico to a developed country such as U.S.A., stands out as an important characteristic in his analysis. His conclusions suggests that growth potential can be maximized through investment in economic and social infraestructure. In the long run, these investments will create positive externalities which will increase private investments and labor productivity. Alpay, Buccola and Kerkvliet (2002) also concluded that as the result of NAFTA agreements, productivity growth rates for Mexico were twice as much as the productivity rates for US. They also state that government inspections programs as well as environmental quality programs stimulated improvements in the Mexican food processing industry.

Mexico's economy has been improving in the last decade. Even though the 2009 global economic crisis aggravated the country's economic conditions, its economy grew more than 5% and GDP grew by 4.2% on 2010. Mexico is also the seventh-larger oil producer worldwide, and the second largest oil supplier to the US. It has been also among the principal destinations of FDI in Latin America and the Caribbean. Out of the $25 billion FDI flows to Central America for 2010, Mexico attracted $19 billion (WIR10).

2.3.2 USA

FDI flow for developed countries has decline substantially. For the first time in 2010, FDI share to these countries fell below 50 percent. Some factors responsible for this decline were the debt crisis, and regulatory concerns on these countries (WIR10). Even then, in North America a FDI increase of 44 percent was observed for this region. In spite of this, FDI outflows from developed countries saw an increase of 10 percent, accounting for 70 percent of the world total FDI outflows. An explanation of this FDI flow shift could be that FDI outflows are more benefitial to multinationals than inflows. Desai *et al.* (2009) provide positive evidence of this

assumption. Desai *et al.,* using U.S. manufacturing data, analyzed the degree to which FDI by multinationals had an impact on its domestic activities. His findings indicated that the manufacturing firms that had foreign operation expansions simultaneously had an expansion in their domestic operation. Even though at times FDI outflows may seem to be more beneficial than inflows, developed countries continue to be an attractive location for FDI; especially USA which for 2010 was the only developed country in receiving more than 100 billion on FDI.

The American economy in the last decades has been very uncertain. In mid-1999 the Federal Reserve began to apply restrictive rates and tighten credit contributing to the US economic slowdown. On the other hand, in the beginning of the new millennium the US economy was anticipated to have a sustainable rate of growth. Product globalization and new technologies innovations led to faster growth during the last part of the 1990s (Baumol & Blinder, 2009). Another major event such as NAFTA, also took place in the 1990s. There is extensive analysis on the effects of this trade agreement on Mexico, but there is limited research on the consequences to the US. Thakkar & Sands, (2011) analyzed the effect of NAFTA in the textile and apparel industry of the American economy. Among NAFTA objectives the elimination of trade barriers and the facilitation of cross-border movements of goods and services between the trade agreements participants was a main concern. To achieve these goals, the authors expressed that the US must develop future markets in developing countries, since market growth in developed countries is limited. Their conclusions also suggested that NAFTA was not a major cause for the unemployment conditions in the US manufacturing sector. Job loss in the textile industry seems to have started before this regional trade agreement came into effect.

The authors also indicate that the positive effects seem to be evident on the Mexican earning power and employment rate.

The beginning of the new millennium was marked in 2001 by the 9/11 terrorist attack to the US. But, have these events affect the US economy? Albala-Bertrand, (1993) analayzed the 28 natural disasters in 26 countries for the period of 1960-1979 and concluded that large-scale natural disasters might not have any significant macro-economic impact in the short run. Results are different when external wars, civil conflits or terrorist attacks come into analysis. Blomberg, *et al.* (2004) studied the macroeconomic consecuences of international terrorism on 177 countries form the period of 1968-2000. Their findings suggested that terrorism does have a significant negative economic effect on real GDP growth, and these events will readdress the country's economic activity from investing to government spending. In this same line, Roberts, (2009) investigated the macro-economic effects of the 9/11 terrorist attacks and concluded that these events had a major negative impact in the US economy, following a decline in the real GDP growth and a growth in the unemployment rate.

The US economy is slowly improving from the global economic crisis. For 2010, GDP grew by 3 percent, with the second largest GDP per capita in the world. Nowadays, the US is the most technologically influential economy worldwide[5] and the principal developed country for FDI inflows destination.

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[5] As stated in The World Fact Book Publication of the Central Intelligence Agency. https://www.cia.gov/library/publications/the-world-factbook/geos/us.html

2.4 US – Mexico Relation

Although Mexico and U.S. are two very different countries, the relation between them has been evident. NAFTA implementation has played an important part on these two countries, not only because this was the first RIA between a developed and a developing country, but also because of the high expectations that this agreement envisioned. Mexico could now come up to the level of its Northern neighbors. Earterly *et al.* (2003) analyzed the producvity convergence between Mexico and the U.S through a time series and OLS approach. Their findings indicate that even though technology convergence was already taking place between these two countries, NAFTA did improve the TFP convergence between them. This merge was characterized by increases in R&D expenditures, which show a relationship to the significant increase in the patenting activity in Mexico. Similar to Earterly's, Ito (2010) re-examined US and Mexico NAFTA dilemma incorporating an improved TFP calculation. The Industry Specific Purchasing Power Parity (PPPs) is used for the productivity calculation instead of GDP based PPPs used by Earterly's, which is a more appropriate estimation technique. Ito's findings provided counter-evidence to Earterly's conclusions, and concluded that NAFTA did not seem to contribute to the TFP convergence. Another US–Mexico analysis was performed by Romero (2009), using cointregration analysis, he examined the evolution of the long term relationship between these two countries for the period of 1950-2008. He concluded that the long term GDP growth for Mexico will increase by .94 percent for every one percent increase in the US GDP growth. Romero also concluded that for the time period analyzed the Mexican economy was very dependentt of the American economy.

It is clear that the US-Mexico relation had an effect in both economies. The economic effects on the Mexican economy seem to be more noticeable than for the U.S. Although this relation helped Mexico its economic progress still slow. The global economic conditions in the last decade have not helped the economic stabilization or recovery for any country. This has been palpable for the US economy as well. Even though for the US this relation did not seem to have a major positive impact for the country, there is no evidence that this relation also contributed to the high unemployment rate in these same years.

Chapter 3: Methodology

3.1 Introduction

As FDI play a major role in a country's economy, there have been a number of methods used to determine their impact on a country's economy. This study analyzes the effects of FDI and capital formation into the country's productivity.

Regression analysis is one of the foremost used tools for statistical analysis. Since its introduction by Galton (1886), this concept nowadays is quite different. Regression analysis as stated by Gujarati (2004) is defined as "*the study of the dependence of one variable, the dependent variable, on one or more other variables, the explanatory variables, with a view to estimating and/or predicting the (population) mean or average value of the former in terms of the known or fixed (in repeated sampling) values of the latter*." One type of regression analysis widely used in econometrics and macroeconomics is the Ordinary Least Square (OLS) regression. This regression estimation technique calculates the $\hat{\beta}$s to minimized the sum of the squared residuals. Since our data contain more than one independent variable a Multivariate Regression Model (MRM) will be carry out for the analysis. With this technique we will determine the change in the TFP growth associated with a one unit increase from FDI and capital formation.

In addition to analyze whether FDI or capital formation for a country had a significant impact in the country's productivity, a fixed effect vs. random effect panel data analysis tehcnique will also be perform. Panel data as defined by Balgati (2005) *"refers to the pooling of observations on a cross-section of households, countries, firms, etc. over several time periods."* One benefit of panel data is that since countries are hetereogeneous, panel data analysis allows to

control the unobserved variables of each country, better known as individual heterogeneity (Hsiao, 2003). Hausman especification test for random effect models will be applied to test for orthogonality, and determine if the unique errors (u_i) are correlated with the regressors. Furthermore, Breusch-Pagan Langrange Multiplier (LM) test will check for the existence of heterocedasticity, and determine if there's no significant difference across countries.

A detail description and results from these analyses will be described in the next sections.

3.2 Data Description

For this research, the period of analysis is from year 1950 until 2010. The dependent variable is the change in TFP growth while the independent variables are real Foreign Direct Investment (real FDI) and Capital Formation. The data for these variables (for both United States and Mexico) was gathered from several sources, such as the World Bank Database (WBD), the Penn World Table 7.1 (PWT), and the Total Economy Database (TED).

The World Bank Database provides access to over 7,000 economic indicators from the World Bank data. Established in 1944, the World Bank provides financial and technical assistance to developing countries. The Penn World Table was developed by the National Bureau of Economic Research in Cambridge, Massachusetts in 1991 and it contains about 30 variables of national account economic times series on purchasing power parity for over 189 countries. PWT provides a common currency making possible a *real* quantity comparison between countries over time. The Total Economy Database was developed by The Conference Board (TCB). This database was developed in the early 1990s and provides annual data for GDP, employment, hours and capital services for over 123 countries.

3.2.1 Real FDI

Real FDI is one of two independent variables for this research. FDI at current prices[6] and GDP deflator were obtained from the World Bank Database. The deflating process of the variables involves finding the real value of a monetary amount by dividing this figure by an appropriate price index (Baumol & Blinder, 2009). One example of a price index is the Consumer Price Index (CPI), which is widely used for price level measure and can be used as a deflator to transform non comparable units into comparable figures. Another well-known price index is the GDP deflator, which is defined as a broad calculation of the economy-wide inflation which includes the prices of all goods and services in the economy (Baumol & Blinder, 2009). Any of these two price indexes can be used to deflate nominal FDI. However, GDP deflator is preferred over the Consumer Price Index (CPI) since it is based on a larger market basket, and it also the most used index in research. GDP deflator was converted to 2005 base year to match equal 2005 base year from Penn World Table.

3.2.2 Capital Formation

Capital Formation is the second independent variable in this study. Investment Share of Real Gross Domestic Product obtained from PWT was used as a proxy for the variable Capital formation for each country. This is the share of investment in the total production of a country. This indicator was included due to its association with the process and trends of economic activities. In the System of National Accounts (SNA) this indicator is defined as the "*total value of produced assets used in the production process for more than one year. It includes the total*

[6] FDI at current prices can also be referred as nominal FDI.

value of gross fixed capital formation plus changes in inventories and acquisitions less disposal of valuables."

3.2.3 TFP Estimation

The change in Total Factor Productivity growth is the dependent variable in this study. The UNIDO productivity database was going to be the main source for this variable; however, due to the limited time frame that this database includes (1970 - 2000), this database will not be used. Instead, the TFP percentage change was calculated for a 60 year period (1950-2010), using Solow's (1957)'s aggregate production function;

$$Q = A\left(K^{a}L^{\beta}\right) \tag{1}$$

Where$Q$, is the aggregate output (GDP), A is TFP, K^{a} is capital stock, L^{β} represent the labor force, and where $a + \beta = 1$. Taking the natural logarithm of both sides of the equation (1) we can approximate the impact of technological change on production as a residual growth rate;

$$\ln Q = \ln A\,(t) + a \ln K + \beta \ln L \tag{2}$$

$$\Delta \ln Q = \Delta \ln A\,(t) + a\,\Delta \ln K + \beta \Delta \ln L \tag{3}$$

$$\mathrm{y} = \ln Q \Rightarrow \frac{dy}{dq} = \frac{1}{Q} \therefore dy = \frac{dQ}{Q} \tag{4}$$

$$dy = \ln Qt - \ln Qt - 1 = \Delta \ln Q \tag{5}$$

$$\Delta \ln Q = dQQ = Q \tag{6}$$

If we substitute the property of equation (6) into the production equation we get;

$$\dot{Q} = \dot{A} + a\dot{K} + \beta\dot{L} \tag{7}$$

Since $a + \beta = 1$ we can transform equation (7) into;

$$\dot{Q} = \dot{A} + a\dot{K} + \dot{L} - a\dot{L} \quad (8)$$

Let, $= \frac{Q}{L}$, and $k = \frac{K}{L}$, We factorize to get;

$$\dot{q} = \dot{A} + a\dot{k} \quad (9)$$

From equation (9) we can obtain $\dot{A}$, which can be expressed as;

$$\dot{A} = \dot{Q} - (a\dot{K} + \beta\dot{L}) \quad (10)$$

Therefore, Solow's TFP estimate can be described as what is left after labor and capital growth contributions are subtracted from the rate of growth of output using equation (10). Data for Real GDP per capita, Investment Share of Real Gross Domestic Product (RGDP), and population were obtained from the PWT, the amount of total annual hours worked were obtained from the Total Economy Database.

Real capital stock series were calculated using the perpetual inventory method;

$$K_{t+1} = (1 - \delta)K_t + X_t$$

Where δ will be the constant capital depreciation rate and X_t is real investment. Investment series was also computed by multiplying Investment Share of RGDP by total GDP. The estimated depreciation rate is assumed to be .05, which is a standard in the empirical literature. The World Bank has assumed this percentage in their calculation of the aggregate stock (WB, 2004). Academic literature generally assumed this percentage to be between 4-6%. For example, Nehru & Dhareshwar, (1993) use a four percent depreciation rate on their capital stock calculation, while Easterly & Rebelo (1993) use a seven pecent. The initial capital stock for this series (1950) was constructed from the average capital output ratio from 1951 to 1960;

$$\frac{K_{1950}}{Y_{1950}} = \frac{1}{10}\sum_{1951}^{1960}\frac{K_t}{Y_t}$$

3.3 Expected Relationship among Variables

One important aspect of the statistical analysis of economic variables such as; TFP, FDI and Capital formation is the determination of what type of relationship will be expected from these variables. It is logical to expect that if countries invest on better technology and infrastructure, superior education and higher industrialization, the productivity of this country will increase. As foreign countries see these types of investments as strong points on the country's economy they will more likely bring new investments on the host country.

Empirical research have validate that FDI has a positive effect on TFP (Woo, 2009), and that there is a critical linkage between capital formation and economic growth (Khan & Reinhart, 1990) also have a positive impact on TFP. However to our knowledge, there are no prior studies that examine if FDI and capital formation as exogenous variables; when analyzed together, significantly impact our endogenous variable TFP.

The null and alternate hypotheses on both countries for FDI is stated as follows;

H_0: FDI does not affect TFP.

H_ι: FDI affects TFP.

The null and alternate hypotheses on both countries for capital formation is stated as follows;

H_0: Capital formation does not affect TFP.

H_ι: Capital formation affects TFP.

3.4 Ordinary Least Squares (OLS)

As previously stated OLS will be employ to analyze the relationship between of our explanatory variables; FDI and Capital Formation with the dependent variable, TFP. Given that our analysis contains two explanatory variables a MRM, also known as a multiple regression analysis is the appropriate model to follow. The general MRM for each country can be written as:

$$TFP = \beta_0 + \beta_1 FDI + \beta_2 CapitalFormation + \epsilon_i$$

Where β_0 correspond to the intercept, β_1 and β_2 is the parameters associated with FDI and capital formation, respectively. Since there are two explanatory variables β_0 will have three parameters to be estimated. Regardless of the amount of explanatory variables in the model there are always factors that could not be captured, given the constraints of our research, these are contain on ϵ_i , which correspond to the error term in the model.

3.4.1 Ordinary Least Square Assumptions

Before perform a MRM on the variables, basic assumptions on the data have to be examined for the model to be adequate. There are four principal assumptions that validate the use of OLS models. Statistical inference was performed to ensure that the proposed model fulfill each one of these assumptions. Gauss–Markov Theorem addresses these assumptions and states that

> *"In the classical linear regression model, the least squares estimator b is the minimum variance linear unbiased estimator of β whether X is stochastic or nonstochastic, so long as the other assumptions of the model continue to hold.", (Greene, 2002)*

Under Gauss-Markov Assumptions, the OLS estimator is consistent and unbiased. A description of the assumptions will follow.

3.4.1.1 Linearity Assumption

The first assumption to introduce is the Linearity assumption, which presumes that the relationship between TFP and FDI and Capital Formation follows a straight line. This assumption is expressed as;

$$E(\epsilon_i) = 0, i = 1, \dots, n$$

To test for linearity the Variance Inflation Factor (VIF) for each coefficient can be calculated to determine if multicollinearity exists between the variables and measure the changes in the regression coefficient due to collinearity. As a rule of thumb if VIF is greater than 20 there is high multicollinearity between the variables and instability of β and β coefficients (Greene, 2002).

3.4.1.2 Homoscedasticity Assumption

The second assumption to be examined if the variance of ϵ_i is constant (Homoscedastic). This assumption is expressed as;

$$Var(\epsilon_i) = \delta^2$$

Under this assumption ϵ_i is the same for all possible combinations of the explanatory variables. To examine if there's presence of heterostecedasticity in the residuals, the White test will be performed. The null hypothesis (H_0) for the White test is that there is no existence of heterostecedasticity and the alternate hypothesis (H_1) is that heterostecedasticity does exist between the variables. We reject the null hypothesis of no heterostecedasticity when nR^2 value is greater than the significant level of 5%. nR^2 White's heteroskedasticity test represent *the*

probability that you would be incorrect if you rejected the null hypothesis of no heteroskedasticity[7].

3.4.1.3 Normal Distribution Assumption

The third assumption to discuss assumes that the residuals of the explanatory variables are normally distributed. This assumption is stated as;

$$\epsilon \sim N(0, \delta^2)$$

The normal distribution of the data will be observed using a histogram and calculating the *p*-value. The histogram is a crude density estimator it consist of tabular frequencies of equal length intervals and adds up the observations that fall into each bin (Greene, 2002). Since the sample size is added the frequency count in the bins, we can calculate the density estimator that satisfies a requirement for a density which sums up to one by dividing each by the total sample size.

The null hypothesis (H_0) for the normal distribution assumption is that data follow a normal distribution. The alternate hypothesis (H_1) for this assumption is that data do not follow a normal distribution. We reject the null hypothesis if the calculated *p*-value is lower than our significance level of 5%.

[7] Eviews 7 Users Guide.

3.4.1.4 Independence Assumption

The fourth assumption to discuss is the independence assumption which states that an error from one observation (ϵ_i) is independent of the error from another observation (ϵ_j). This assumption suggests that the explanatory variables will not contribute for the prediction of ϵ_i. This assumption is stated as

$$E\left[\epsilon_i |\, x_{j1}, x_{j2}, \ldots x_{jk}\right] = 0$$

The Breusch-Godfrey Lagrange Multiplier (LM) test will be used to examine the presence of autocorrelation in the errors of the MRM. This test is preferred over the Durbin Watson (WB) test since it overcomes the dependency of no correlation on the data matrix *x* and the annulation of WB if the dependent variable is lagged. The null hypothesis (H_0) for the Independence assumption is that there is no serial correlation. The alternate hypothesis (H_1) for this assumption is that there is serial correlation in the MRM. We reject the null hypothesis if the calculated *p*-value is lower than our significance level of 5%.

3.5 Panel Data

Panel data in statistics and economics refers to the collection of observations of a number of different variables such as income, countries or firms over various time periods better known as longitudinal data (Balgati, 2005). The increase interest in panel data is due to several reasons. Klevmarken (1989) and Hsiao (2003) present various advantages that panel data can provide. One of these benefits is that panel data allow controlling for individual heterogeneity that is not necessarily done in time series and cross section studies. With the use of panel data, analysis yield more information, variability and less collinearity than time series studies. The *dynamics of adjustments* such as the changes due to cross-sectional distributions, such as unemployment and

poverty, are better captured through panel data. It also allow for a better measure and identification of effects not detectable on cross-section data. More complex models can be analyzed with panel data such as technical efficiency as studied by Baltagi & Griffin (1988), and Cornwell *et al.* (1990).

However panel data analysis has some limitations as well. One limitation of this technique is the complexity of the designs of panel surveys and data management, which include coverage problems lack of cooperation of the respondents or interviewer errors. Analysis errors also occur when there are unclear questions on the surveys or intentional erroneous questions are provided for analysis. Also, misleading conclusions may happen when macro panels on countries that do not account for cross-country dependence are analyzed.

The next sections will describe the fixed effects model and random effects models utilize on this study.

3.5.1 The Fixed Effects Model

Fixed Effects model (FE) is useful to analyze the behavior variables on specific set of *N* firms or countries. The inference of the analysis is conditional on the particular *N* firms, countries or any other item we want to analyze. Under FE, ϵ_i are assumed to be fixed parameters for estimation and the rest are independent and identically distributed, therefore all significant factors share the same effect size.

The equation for FE model is:

$$TFP_{it} = \propto_i + FDI'_{it}\,\beta + CapitalFormation'_{it}\,\beta + \epsilon_{it} \quad i = 1, \dots, N; t = 1, \dots T \tag{11}$$

Where TFP_{it} is the dependent variable, $\propto_i$ is the unknown intercept for each country, $X'_{it}\,\beta$ represent the explanatory variable and β is the coefficient for that variable, and ϵ_{it} correspond to the error. The fixed effect model considers $\propto_i$ in the regression as a group-define constant and do not vary over time.

By using binary variables the fixed effect model equation, which is equivalent to equation (1) can also be expressed as follows:

$$TFP_{it} = \beta_0 + FDI'_{it}\,\beta_1 + CapitalFormation'_{it}\,\beta_2 \ldots + \beta_k\,FDI_{k,it} + \beta_k\,II_{k,it} + TFP_2E_2 + \cdots + TFP_nE_n + \epsilon_{it} \quad (12)$$

Where TFP_{it} is the dependent variable, $X_{k,it}$ represent the independent variables and β_k correspond to their coefficients, ϵ_{it} is the error, E_n represent entity n, - which in our case they are Mexico and US - since they are binary or dummies the entities included in the model have n-1 entities, and Y_2 is the coefficient of the entities. By adding the dummy variable for each country the estimation has the pure effect of x1 through the control of heterogeneity.

To validate the fitness of the model, the *p*-value of the F test is going to be compared against the significance level of 5%. If the calculated *p*-value is less than 5%, all coefficients in the model are different than zero and the fixed effects model is adequate.

Recent studies have employed the fixed effects model to examine the productivity convergence between two countries (Ito, 2010) and the effects of FDI on industrial productivity on one country (Zhao & Zhang, 2010). These studies have also complemented their investigation with OLS estimation as part of their variable analysis. This study will follow these techniques for the variables analysis.

3.5.2 The Random Effects Model

Random Effects (RE) models (unlike FE model) assumed the variation across entities to be random and uncorrelated with the explained variable. Greene (2005) explains in more detail the distinction between these two models as follow:

> *"the crucial distinction between these two cases is whether the unobserved individual effect embodies elements that are correlated with the regressors in the model, not whether these effects are stochastic or not"*

The RE model should be used when there is a motive to consider that the explained variables are influenced by the difference across entities. RE effects can include time invariant variables such as gender that FE intercept will take in.

The equation for RE model is:

$$TFP_{it} = \propto_i + FDI'_{it}\,\beta + CapitalFormation'_{it}\,\beta + \epsilon_{it} + v_{it} \qquad (13)$$

Where TFP_{it} is the dependent variable, $\propto_i$ is the unknown intercept for each country, $X'_{it}\,\beta$ represent the explanatory variable and β is the coefficient for that variable, and ϵ_{it} correspond to the error which is assumed to be independent of v_{it} and X'_{it}, while being independent from each other as well.

To validate the fitness of the model the *p*-value of the F test is going to be compared to the significance level of 5%. If the calculated *p*-value is less than 5% significance level, all coefficients in the model are different than zero making the RE model an adequate one.

Recent studies have employed the RE model to examine the effects of FDI on industrial productivity on one country (Zhao & Zhang, 2010) , to examine the relation between different country economic variables for a country (Hsiao & Hsaio, 2006) or to examine the regional

productivity of a country (Kuo, Yeh, & Chang, 1992). Therefore we will employ the RE method for our variable analysis.

3.5.3 Hausman Specification Test for Random Effect Models

The Hausman Specification Test (HST) is used to determine whether RE or FE should be used. HST compares the covariance matrix of the regressors in the FE model with those in the RE model. The central question to be answer out of HST is the extent of significant correlation between individual-specific effect and the regressors. If this correlation is low then RE is the appropiate model to follow.

The key element under this test is the covariance difference of the vector, $[\boldsymbol{b} - \hat{\beta}]$, which under HST the *"covariance of an efficient estimator with its difference from an inefficient estimator is zero"* (Greene, 2002). Therefore the simplify covariance matrix for this test is;

$$Var[\boldsymbol{b} - \hat{\beta}] = Var[\boldsymbol{b}] - Var[\hat{\beta}] = \Psi$$

The null hypothesis (H_0) for HST states that individual effects are uncorrelated with the other regressors in the model. The null hypothesis will be rejected if the significant level from chi-squared is lower than the significance level of 5%, then the differences between the covariance matrices between the models are not statistically significant. Thus the correlations of the RE model with the regressors are not statistically significant and the FE model is preferred.

HST has been a key instrument on empirical research for the selection of FE and RE models. Zhao & Zhang (2010) use HST when they analyze the impact of FDI in China's indiustrial productivity. Hsiao & Hsaio (2006) also used this test when they analyzed the direction in which FDI affect gowth.

3.5.4 Breusch-Pagan Lagrange Multiplier (LM) Test

The Breusch-Pagan Lagrange Multiplier (LM) Test derived from the Goldfeld–Quandt allows the variance of the disturbance variance with a set of regressors. Through a simple regression the LM test examines two different models and determines which one is the most adequate. LM test examines the RE model based on the OLS residuals. We will apply the LM test as done by Zhao & Zhang (2010) and Baltagi (1981) to identify which model is most adequate.

The simple regression for this model according to Greene (2002) can be stated as:

$$LM = \frac{1}{2}\,[g'\,Z(Z'Z)^{-1}\,Z'g]^{8}$$

The null hypothesis (H_0) for the LM test is that variances components across sections are zero, and there's presence of homoscedasticity, where all the vector variables share the same infinite variance and there's no panel effect or significant difference across countries. We will reject the null hypothesis of homoscedasticity if the significant level from chi-squared is lower than the significance level of 5%, and conclude that there is evidence of significant differences across countries and apply the RE model.

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[8] Greene (2002) describe **Z** as *"be the n × P matrix of observations on (1, $\mathbf{z}_i$), and let **g** be the vector of observations of $g_{2i} = e_i / (\mathbf{e}'\mathbf{e}/n) - 1$"*

3.6 Summary

This chapter presented the different models, assumptions and tests employed to analyze the effect of FDI and Capital Formation on TFP. The two models used to analyze this effect were OLS and Panel data. The assumptions analyzed for the OLS model were: linearity, homoscedasticity, normal distribution and independence. For the panel data analysis, two tests were presented to identify which model was preferred. The Hausman test was used to choose between FE and RE model, and the LM was applied to determine between RE or OLS, which model was more adequate for the analysis.

Chapter 4: Results and Analysis

4.1 Overview

This chapter presents the analysis performed through OLS and panel data analysis to determine whether FDI and capital formation have an impact on the country's TFP. A graphic analysis was conducted to observe the variation on all the variables throughout the period of analysis. The relation between the variables was also determined using a correlation matrix analysis and a pair wise scatter plot.

The results of the OLS analysis to determine if the explanatory variables had a major impact on the country's productivity are presented in this chapter. As well as, results from a multi-dimensional analysis using panel data analysis (via a FE and RE model). Panel data analysis will allow for the longitudinal analysis of different observations across time for Mexico and United States. Hausman and Lagrange tests were performed to help decide the appropriate model for the study.

4.2 Variables Behavior

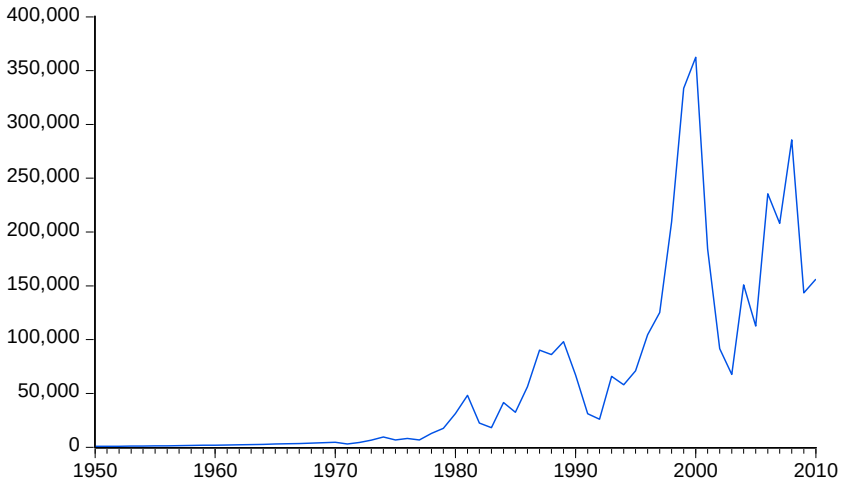
An illustrative analysis was performed for each country to examine the behavior of Foreign Direct Investment, Capital Formation and Total Factor Productivity across time. This analysis will help ensure a better understanding on the behavior of these variables and visually examine their variation throughout the analyzed period.

4.2.1 USA Variables Behavior

Figure 4.1 shows the calculated annual real FDI for the United States for the period under analysis. From 1950-1980 real FDI for US was around nine percent of the world's total FDI, on the contrary, FDI outflows from US before the 1970s accounted for more than half of total FDI

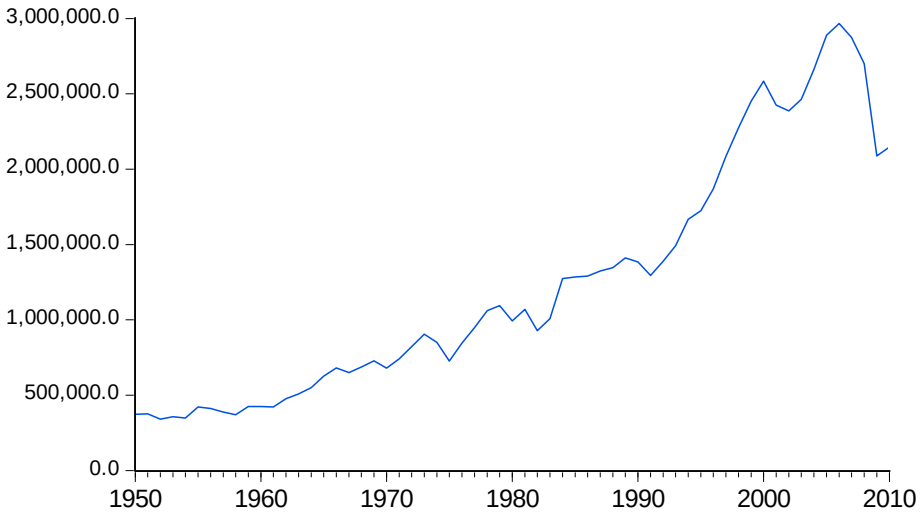
from developed countries. It may seem illogical that FDI into the US was so little on the late 1900s, but Lipsey (1993) believed that it may be due to the limited technological advances of those decades and also skills were transferred in a different form that it does today. Therefore, knowledge transfer was in the form of human relocation to either; establish a new enterprise or manage the ones already in place. Many countries did not had the capability or technology, like today, to be able to invest in a developed country like the US, but it was much easier for the US to carry out this knowledge transfer with no trouble into other countries. By the late 1980s FDI into the US rise significantly, accounting for more than half of the world's FDI (Lipsey, 1993). In the early 1990s we can see a higher growth of FDI into the US. New developments such as the computer, the internet and banking features such as electronic transfers facilitated the movement of foreign multinationals into America. The "dot com bubble" also promoted the increase of foreign investment into the US, thru confidence on future profits and a rise of the stock market equity value in the internet sector. But with the "dot com bubble" burst in 2001, along with 9/11 terrorist attacks and the slowdown of the global eoconomy contributed to a slowdown in FDI and a dip in the american economy. Since 2001 up to today, FDI distribution to the US have greatly fluctuated. However, the US still one of the top developed countries that received a significant portion of the total world foreign investments.

Figure 4.1. Real Foreign Direct Investment for United States 1950-2010 (Millions)



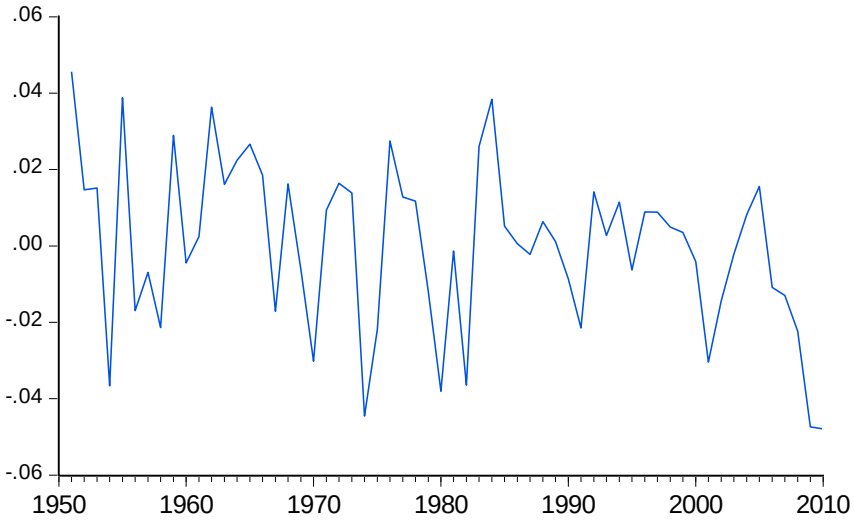
Data regarding Capital Formation for the US is presented in Figure 4.2. Capital Formation in the US has been on the rise for the last decades. From 1950 to early 1970s Capital Formation had a continuous growth. For the next two decades this amount fluctuated until early 1990s. Following the new millennium which included new technologies such as; the use of computers and the use of World Wide Web for personal and business transactions, Capital Formation experienced a rise. This period was characterized by a large economic movement enabled through the new banking technologies such as the electronic money transfer. The global economic slowdown may explain in some extent the decrease in Capital Formation in the last decade, since investors and enterprises have been more cautious on investments and prefer to save rather than to spend.

Figure 4.2. Capital Formation for United States 1950-2010 (in Billions)



As shown in Figure 4.3, Total Factor Productivity for the US has been very variable. There was a significant increase on the US productivity from 1954 to 1955 of almost 100 percent in one year. But the following year the productivity fell by 43 percent. Another significant increase occurred 20 years later, on 1975, when the country's productivity increased by almost 50 percent. However, the following year's productivity decreases considerably. By the early 1980s the US productivity increased but it soon decreased until the 1990s. Another significant decrease can be seen in the beginning of the new millennium. As previously stated, a number of economic factors may have influence the country's productivity such the "dot com bubble" burst and 9/11 terrorists attack. Even though, for the last years the US productivity weakened, the American economy is still a well-thought-of nation, attractive to foreign investment that will bring new technology and higher productivity.

Figure 4.3. Total Factor Productivity US 1950-2010



To examine the relationship between the variables a correlation matrix analysis was performed as presented in Table 4.1 The percentage change for Capital Formation and FDI was calculated since TFP is a growth rate. Capital Formation is statistically significant, with a *p*-value of .00 and a correlation of .78, this indicates that the Capital Formation and the TFP are correlated. FDI do not seem to be correlated with TFP since it has a correlation of .17 and is not statistically significant. Although, FDI did not seem to be statistically significant and have low correlation with TFP, is going to be included in the analysis given that we are examining which of these variables have a greater impact into the country's productivity.

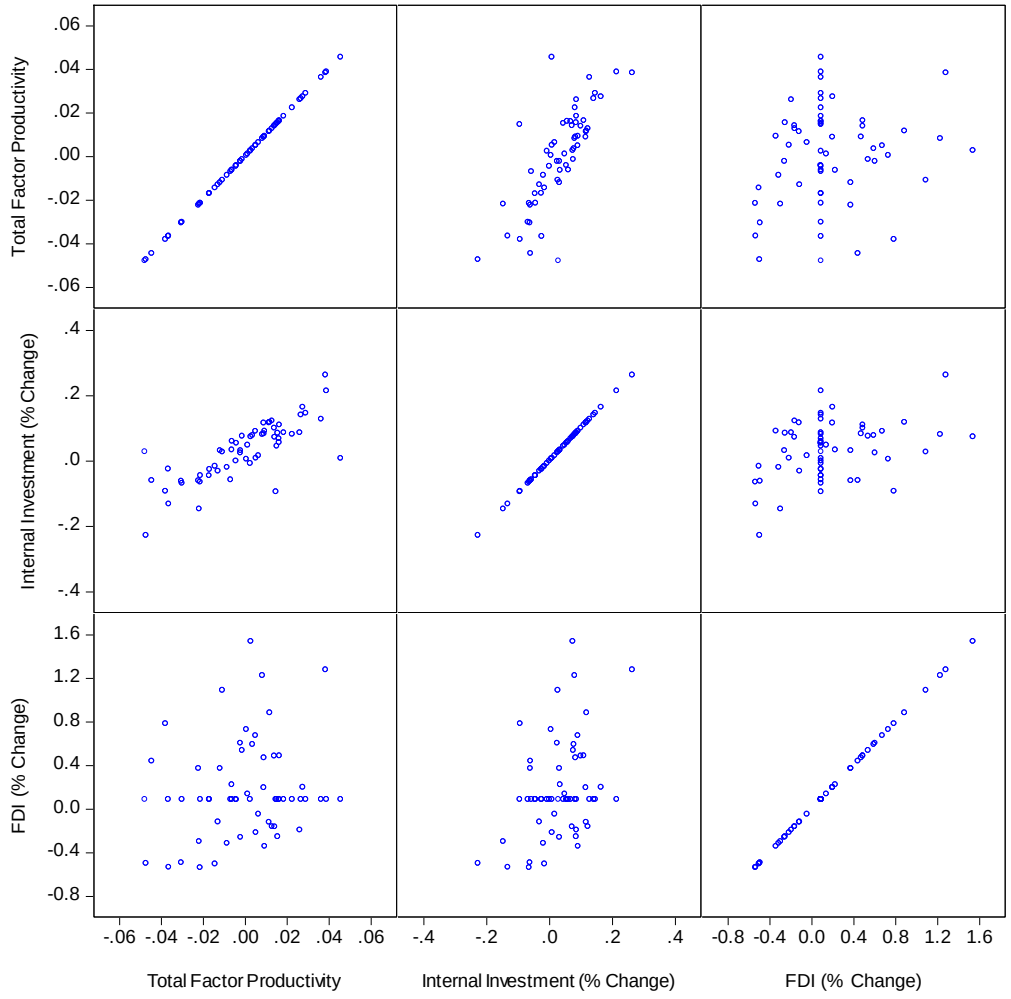
Table 4.1. Covariance Analysis USA 1950-2010

Correlation Probability	TFP	CF (% Change)	FDI (% Change)
TFP	1.000000 -----		
CF (% Change)	0.784437 0.0000	1.000000 -----	
FDI (% Change)	0.179906 0.1690	0.372920 0.0033	1.000000 -----

A scatter plot matrix was constructed to examine the variables relationship by reviewing the pair wise plots of TFP, Capital Formation and FDI. As shown in Figure 4.4, Capital Formation has a linear positive correlation with TFP, since a straight line can easily fit the data indicating the existence of a linear relationship. FDI do not appear to have a positive correlation with TFP. Furthermore, FDI scatter plot does not seem to a have a clear relationship with TFP; hence it is visually difficult to determine the type of relation between these variables.

One important detail worth mention is that scatter plot examines the relationship in the data but it does not imply causality. Likewise, this tool is also useful in the association between the variables but do not evidence for a cause and effect relation.

Figure 4.4. Scatter Plot Matrix for FDI, Capital Formation & TFP USA 1950-2010

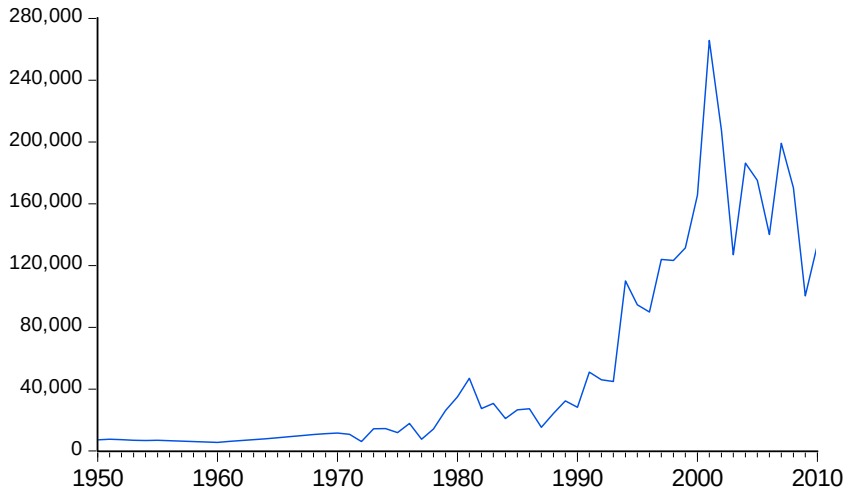


4.2.2 Mexico Variable Behavior

For Mexico being a developing country, FDI inflows are significantly low compared to the US. As shown in Figure 4.5, for the period of 1950-1970 FDI inflows for Mexico were very small. Even though Mexico's GDP grew fast and the economy seems to be promising, FDI into this country was small. One reason could be that Mexico focused on infrastructure improvement, education and industrialization (Kehoe & Meza, 2011). This time period is also referred as the *Desarollo Estabilizador* period. This economic policy was based in the Import Substitution

Industrialization (ISI), which relies on the idea that domestic production should be the replacement of foreign imports. The government also pushed this economic model and adopted monetary policies to increase the private sector credit capacity (Garrido, 2002). Foreign investment became a second priority; this ought to explain the low FDI inflow into Mexico from 1950 to almost 1980. In these decades, a country based on agriculture and export economy started shifting towards a more manufacture oriented economy. Industrialization drove the growth in the agricultural sector (Kehoe & Meza, 2011). These structural changes in the Mexican economy positioned the country among the developing countries capable of maintain an adequate economic growth (SAT, 2010). There was an FDI increase by the end of 1970s until 1980s. This coincides with the so called *Desarrollo Compartido*, where economic policies focus on economic growth (Kehoe & Meza, 2011) with a high growth of real GDP per worker and an increasing inflation under a fixed exchange rate government. Oil fields discoveries in Mexico boots the oil industry and public investment programs were developed to expand this industry. This could explain the increase of FDI into the country since foreign investors that wanted to have a presence in the country invest in this profitable market. However, as oil prices drop and exports decline in 1981s and the peso devaluation in 1982 the Mexican economy struggle and there was an evident decrease in FDI for this period. Some important changes help the Mexican economy recover such as; NAFTA, the privatization of government owned companies, and the banking liberalization (Kehoe & Meza, 2011). In the 1990s Mexico was one of the highest FDI receivers among Latin American countries, and its total net FDI was significantly more than in 1990.

Figure 4.5. Real Foreign Direct Investment for Mexico 1950-2010 (in Millions)

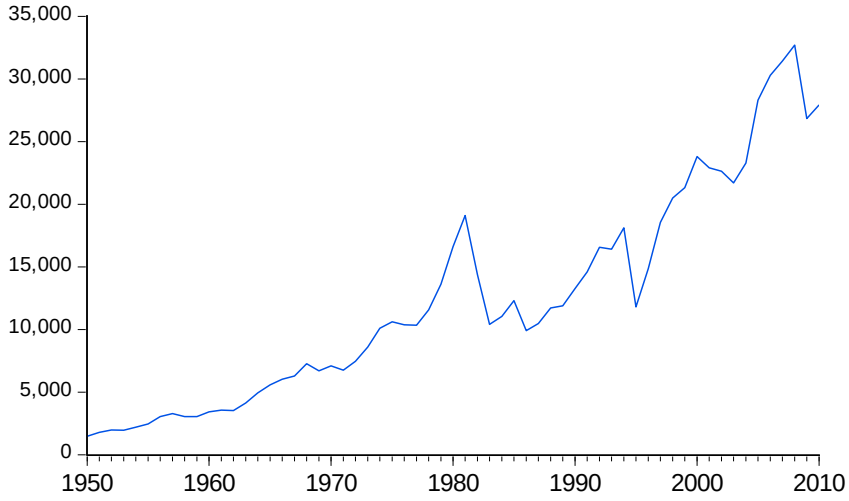


As demonstrated in Figure 4.6, Mexico's Capital Formation has been on the rise for the last five decades, since their focus was the urbanization, a higher industrialization and a better education for the country. The import substitution model of the 1950s enabled the country to obtained high economic growth rates and low inflation rates that promote the investments on infrastructure. These investments served as an engine for the country to smooth the progress of industrialization and consequently attract foreign investment into the country. The major increases in FDI into the country occurred on early 1990s. One important factor of this decade was the creation and implementation of the NAFTA. This RTA made possible a non-tariff barrier on agricultural trade between these countries, with immediate tariff elimination and agricultural provisions to be implemented by 2008[9]. Even though, economic conditions after 2000 for the US economy were challenging and the terrorists attack in 2001 greatly affected the

[9] According to the USDA restrictions on Canada-Mexico and US-Mexico trade were removed in 2008. This include duty free quote on US exports to Mexico on; Nonfat dry milk, corn and sugar high fructose corn syrup. And tariff implementation on US imports from Mexico on; Sprouting broccoli, cucumbers, asparagus, cantaloupe and sugar.

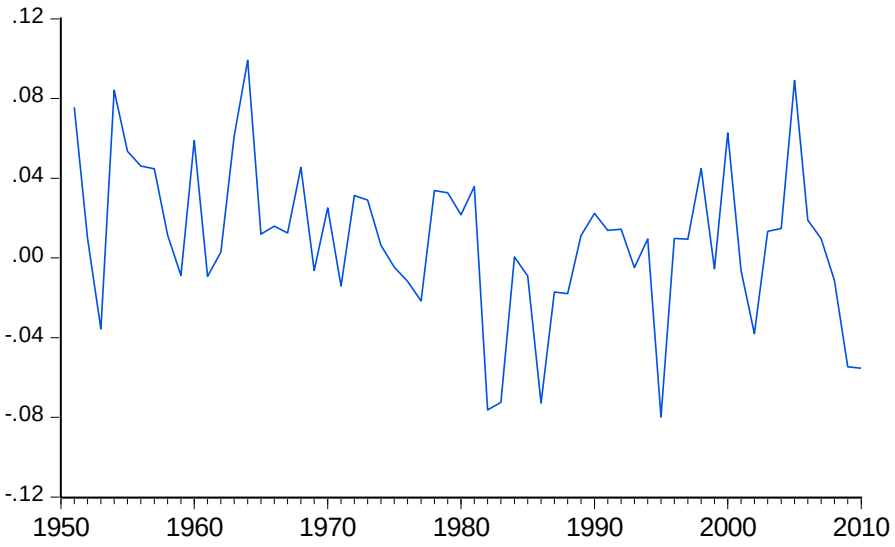
American economy, due to the close relation of the two countries, these factors could in some way or another affect Mexico's economy, the country continues a constant growth pattern in Capital Formation which has positioned them in one of the top developing countries for foreign investment in Latin America.

Figure 4.6. Capital Formation for Mexico 1950-2010 (in Billions)



With a similar pattern as the US, TFP for Mexico has been very variable. There was a lot of variation on the country's productivity in the 1950s. As shown in Figure 4.7, the annual increases and decreases were very significant. These TFP variations continued throughout the 1960s. Even though 1970s and 1980s show fluctuations we can see a clear reduction on Mexico's TFP for these two decades. For the next two decades we still see variation on the country's TFP but a noticeable increase in mid-1980 through 1990. Mexico's productivity in the last two decades continued to be very volatile. For the last five years, productivity has declined considerably but as the global economic situation improve Mexico's productivity might also pick up.

Figure 4.7. Total Factor Productivity Mexico 1950-2010



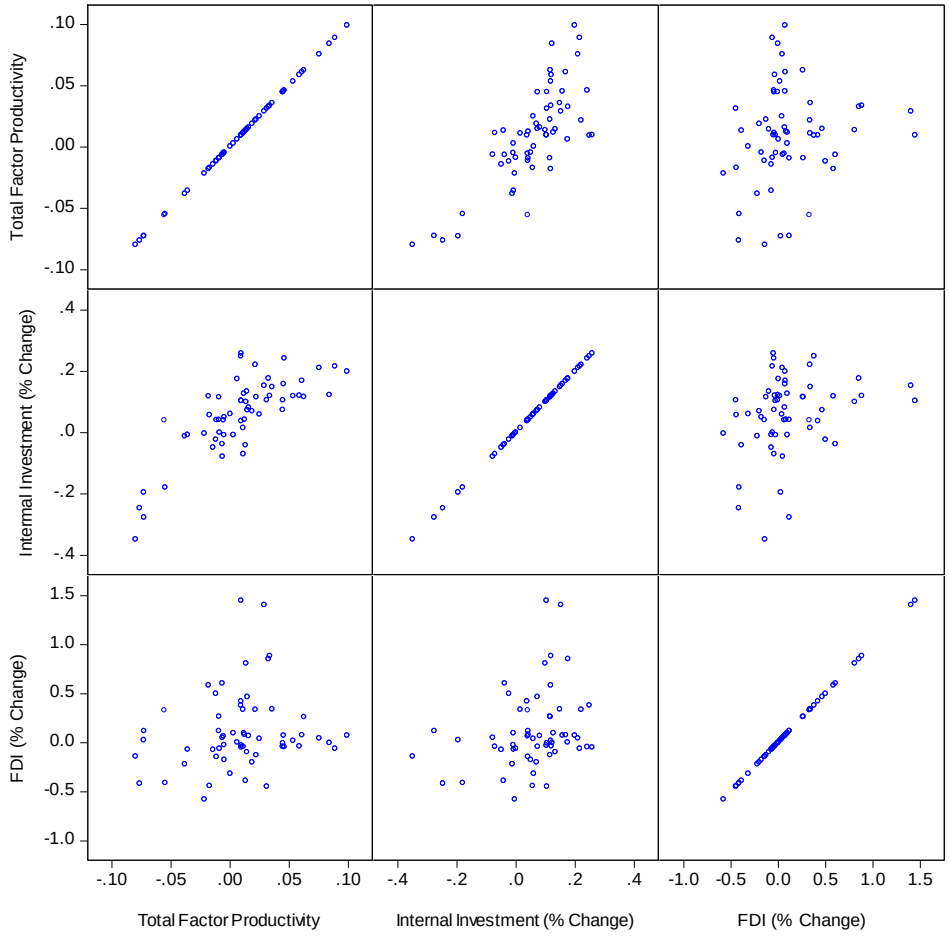
A correlation matrix for Mexico's variables is presented in Table 4.2. The percentage change was also calculated for Capital Formation and FDI is calculated since TFP is a growth rate to preserve homogeneity between the variables. Capital Formation is statistically significant, with a *p*-value of .00 and a correlation of .78, this indicates that Capital Formation and the TFP are highly correlated. FDI do not seem to be correlated with TFP since it has a low correlation of .16 and a statistically insignificant *p*-value of .21. Even though FDI did not seem to be statistically significant and have low correlation with TFP, is going to be included in the analysis given that we are examining which of these variables have a greater impact into the country's productivity.

Table 4.2. Covariance Analysis Mexico 1950-2010

Correlation Probability	TFP	CF (% Change)	FDI (% Change)
TFP	1.000000 -----		
CF (% Change)	0.776920 0.0000	1.000000 -----	
FDI (% Change)	0.161022 0.2190	0.274209 0.0340	1.000000 -----

Similar to US, Capital Formation for Mexico has a linear positive correlation with TFP, since a straight line can easily fit the data indicating the existence of a linear relationship. As shown in Figure 4.8, FDI does not appear to have a positive correlation with TFP. Furthermore, FDI scatter plot does not seem to a have a clear relationship with TFP; hence it is visually difficult to determine the type of relation between these variables.

Figure 4.8. Scatter Plot Matrix for FDI, Capital Formation & TFP Mexico 1950-2010



Although US and Mexico are two countries economically different, there are some similarities in their variables behavior. For both countries, FDI was very low in the 1950s and slowly increased in the next decades. Capital Formation has also been increasing for the las five decades and for both countries there has been a decrease in the last years. TFP have also been very erratic on both countries. Furthermore, Capital Formation in both counties have a positive correlation with TFP, while FDI did not seem to be statistically significant for either if the countries productivity.

4.3 OLS Analysis

A regression analysis was performed to examine the effects of FDI and Capital Formation into each country's TFP. Since TFP is a residual calculation, and to maintain variable unit homogeneity, this analysis will be carry out using the FDI and Capital Formation growth rates as well. Dummy variables were used in the regression for any extreme value observed on the regression model residuals.

4.3.1 OLS Assumptions Results

This section will present the results for the various OLS assumptions examined for our models. With this assumption analysis it will be possible to determine if the model follows the appropriate trail for accurate estimation.

4.3.1.1 Linearity Assumption

To analyze whether the relationship between TFP, FDI and Capital Formation follows a straight line the Variance Inflation Factor (VIF) calculation will be carry out for each country. VIF shows the amount of inflation of the variance of the coefficient due to collinearity. Two VIF calculations were estimated: centered VIF and uncentered VIF. The difference between these two VIF's is that the centered include the constant in the calculation and the uncentered do not. The VIF test results for each country are presented in the next sections. The existence of linearity between the variables could also be visually analyzed thru the use of a scatterplot, as shown on Figures 4.4 and 4.8, for US and Mexico, respectively. Both figures showed that there is a linear relationship between TFP and capital formation, not a clear relationship is found between TFP and FDI.

4.3.1.1.1 US Results

As shown in Table 4.3, the centered VIF for the Capital Formation variable is 1.50 and the uncentered VIF is 1.49. For the FDI variable, the centered VIF is 1.34 and the uncentered VIF is 1.69. According to Greene (2002), as a rule of thumb if the VIF calculation is less than 20 there is low collinearity between the variables. Since both our VIF calculations were less than 20, we can conclude that there is low collinearity between these variables.

Table 4.3. Variance Inflation Factors US

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	2.36E-06	2.705698	NA
Capital Formation	0.000136	1.501289	1.497298
FDI	6.19E-06	1.690462	1.339989

4.3.1.1.2 Mexico Results

Table 4.4 shows a similar behavior for the Mexican variables. The centered VIF for the Capital Formation variable is 2.11 and the uncentered VIF is 4.96. For the FDI variable, the centered VIF is 1.44 and the uncentered VIF is 1.69. Although the centered and uncentered VIF's for Mexico are higher than for the US., but less than 20, we can conclude that there is low collinearity between these variables.

Table 4.4. Variance Inflation Factors Mexico

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	1.03E-05	6.002395	NA
Capital Formation	0.000291	4.956481	2.113897
FDI	1.81E-05	1.685229	1.438294

4.3.1.2 Homoscedasticity Assumption

To test if the variance of the errors (ϵ_i) is constant (Homoscedastic) the presence of heteroscedasticity in the residuals was examined using the White test. The results for the examination of the homoscedasticity assumption and the hypothesis testing results for each country are presented below.

4.3.1.2.1 US Results

The results for the White heteroscedasticity test are presented in Table 4.5. As presented in Chapter 3, the null hypothesis states that there is no existence of heteroscedasticity. The null hypothesis is rejected if the calculated *p*-value is lower than the significance level of 5%. The calculated *p*-value for US is .72, which is higher than our significance level, therefore we fail to reject the null hypothesis and conclude that there is no existence of heteroscedasticity in the model.

Table 4.5. Heteroskedasticity Test (White) US

F-statistic	0.673154	Prob. F(9,50)	0.7290
NR-squared	6.484365	Prob. Chi-Square(9)	0.6906
Scaled explained SS	4.350875	Prob. Chi-Square(9)	0.8868

4.3.1.2.2 Mexico Results

Table 4.6 presents the results for the White heteroscedasticity test for Mexico's data. The calculated *p*-value for Mexico is .40, which is higher than our significance level of 5%, therefore we fail to reject the null hypothesis and conclude that there is no existence of heteroscedasticity in the model.

Table 4.6. Heteroscedasticity Test (White) Mexico

F-statistic	1.064573	Prob. F(10,49)	0.4068
NR-squared	10.70896	Prob. Chi-Square(10)	0.3806
Scaled explained SS	7.226126	Prob. Chi-Square(10)	0.7039

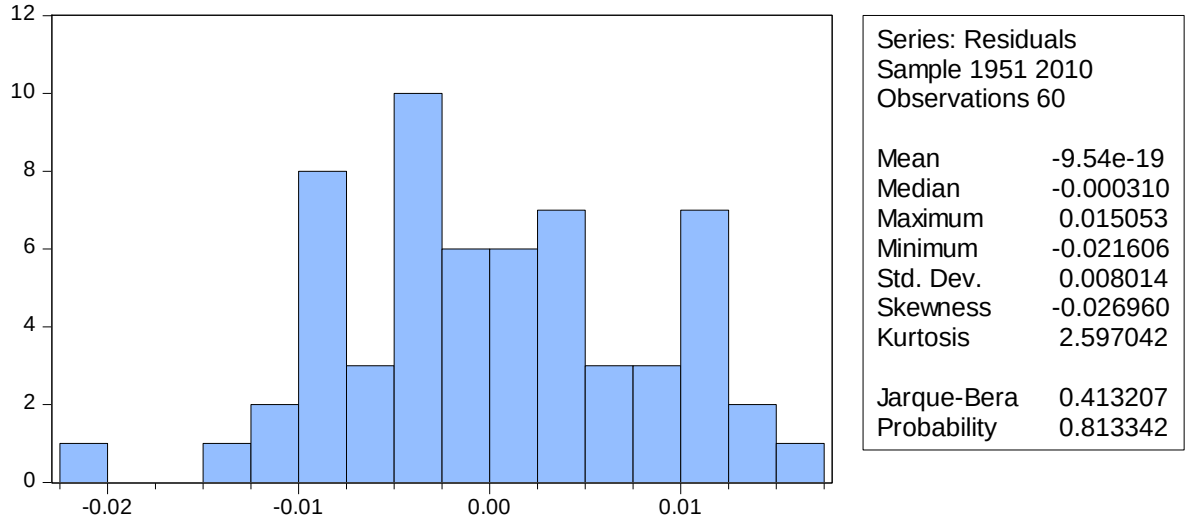
4.3.1.3 Normal Distribution Assumption

The normality of the data was analyzed through a histogram analysis and the Jarque-Bera statistic test to examine the normal distribution of the standardized residuals. The results for the examination of the normal distribution of the variables and the hypothesis testing results for each country are presented below.

4.3.1.3.1 US Results

The results of the Jarque-Bera statistic test and histogram for US are presented in Figure 4.9. We can see that the histogram followed a bell shape form which implies that the data is normally distributed. The null hypothesis for the normality test is that the data is normally distributed. We will reject the null hypothesis if the calculated *p*-value is lower than our significance level of 5%. The calculated *p*-value for the Jarque-Bera test is .81; therefore we fail to reject the null hypothesis and concluded that the data is in fact normally distributed.

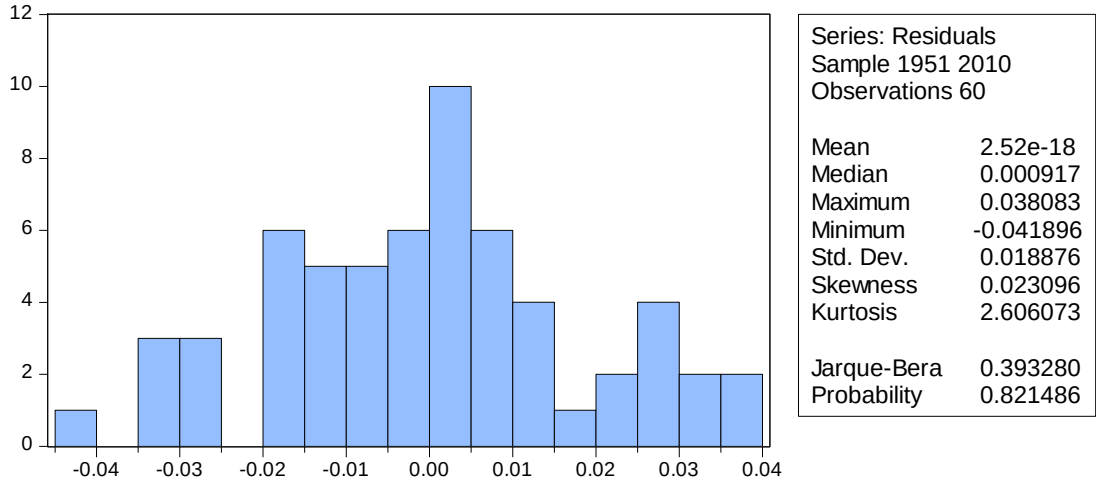
Figure 4.9. Normality Test US



4.3.1.3.2 Mexico Results

The histogram showed in Figure 4.10 seemed to follow a bell shape form which implies that the data is normally distributed. The null hypothesis for the normality test is that the data is normally distributed. We will reject the null hypothesis if the calculated *p*-value is lower than our significance level of 5%. The calculated *p*-value for the Jarque-Bera test is .82, as with US, we fail to reject the null hypothesis and concluded that the data is in fact normally distributed

Figure 4.10. Normality Test Mexico



4.3.1.4 Independence Assumption

To examine for the presence of serial correlation the Breusch-Godfrey Lagrange Multiplier test was performed. This test allowed us to determine if there is autocorrelation in the errors of the OLS residuals. Breusch-Godfrey test for autocorrelation was performed using one and two lags. The results for the analysis of this assumption for each country are presented below.

4.3.1.4.1 US Results

The results for the LM autocorrelation test are presented in Table 4.7. As previously stated in Chapter 3, the null hypothesis for this test is that there is no serial correlation for the residual errors. We will reject the null hypothesis if the calculated *p*-value is lower than our significance level of 5%. The LM test results show that the calculated *p*-value for 1 and 2 lags are .29 and .22 respectively. Since the calculated values are higher than our significance level we

fail to reject the null hypothesis of no serial correlation and conclude that the residual errors are independent from each other.

Table 4.7. Breusch-Godfrey Lagrange Multiplier Test US

	1 lag	*2 lags*
F-statistic	1.112604	1.538394
NR-squared	1.211270	3.292044
Prob. F(1,54)	0.2962	0.2242
Prob. Chi-Square(1)	0.2711	0.1928

4.3.1.4.2 Mexico Results

Table 4.8 shows the results for the LM autocorrelation test for Mexico The LM test results show that the calculated *p*-value for 1 and 2 lags are .57 and .56 respectively. Since the calculated *p*-values are higher than our significance level of 5% we fail to reject the null hypothesis of no serial correlation and conclude that the residual errors are independent from each other.

Table 4.8. Breusch-Godfrey Lagrange Multiplier Test Mexico

	1 lag	*2 lags*
F-statistic	0.311589	0.576141
NR-squared	0.344224	1.276714
Prob. F(1,54)	0.5790	0.5655
Prob. Chi-Square(1)	0.5574	0.5285

This section presented the results for the four assumptions examine that indicate that the MRM is adequate. The results of the assumptions indicate that for US and Mexico there is no collinearity between the variables, the variances of the errors are constant (Homoscedastic), also that data is normally distributed and there is no autocorrelation. The assumptions analyzed

indicate that there have not been any violations of these assumptions; therefore we can conclude that the multiple regression models are unbiased.

4.3.2 OLS Results: United States

A summary of the OLS regression results for U.S. are presented in Table 4.9. The residuals of the initial OLS regression indicate that there were extreme values for the years; 1951, 1952, 1954 and 2010; therefore two dummy variables were created for these years to diminish their impact on the regression. After the inclusion of the dummy variables, *t*-Statistic for FDI is -2.76 and for Capital Formation is 16.46. According to the regression model, an increase in FDI reduces significantly the Total Factor Productivity Growth for the US, while an increase in Capital Formation increases significantly the TFP growth for the country.. These results are dissimilar to the ones obtained by Kuo *et al.* (1992) and Zhou, where they found a significant positive impact from FDI and capital formation on China's TFP. We reject the FDI null hypothesis stated in Chapter 3, and conclude the FDI does affect the country's TFP. However, we reject the Capital Formation null hypothesis stated in Chapter 3 and conclude that Capital Formation does affect the country's FDI. The percentage of the variance of the dependent variable explained by the regression is calculated by the r-squared. The r-squared for this regression is .86. The closer the R squared value is to 1, the better the model. The high value in the Durbin-Watson statistic reported does not indicate serial correlation in the residuals. Even though, the Breusch-Godfrey Serial Correlation LM Test will also be conducted to validate this assumption.

Table 4.9. OLS Results Summary US

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.006451	0.001234	-5.228126	0.0000
Capital Formation	0.221540	0.013456	16.46389	**0.0000**
FDI	-0.007216	0.002611	-2.763447	0.0078
R-squared	0.868277	Adjusted R-squared		0.858697
S.E. of regression	0.008301	Durbin- Watson stat		1.708182

To "correct" the standard error of the regression coefficients for serial correlation a Heteroscedasticity and Autocorrelation Consistent (HAC) covariance matrix method was estimated. This approach will correct the coefficient standard errors but not their estimates. Results of the regression model using HAC method are presented in Table 4.10. As in the case of the US regression, the HAC model presents a lower standard error for both explanatory variables, with a reduction of .002 for Capital Formation and of .0002 for FDI.

Table 4.10. OLS Results Summary (HAC) US

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.006451	0.001537	-4.197421	0.0001
Capital Formation	0.221540	0.011672	18.97994	**0.0000**
FDI	-0.007216	0.002488	-2.900708	0.0053
R-squared	0.868277	Adjusted R-squared		0.858697
S.E. of regression	0.008301	Durbin-Watson stat		1.708182

The changes observed under the HAC method are the ones on the variables standard errors. Even though this change is no significant the HAC model is the one selected as our OLS model. The use of this method is considered by Greene (2002) to be a standard for econometrics analysis.

4.3.3 Mexico OLS Results

A summary of the results from the OLS regression for Mexico are presented in Table 4.11. The residuals of the initial OLS regression indicate that there were extreme values for the years; 1954, 1964, 1996, 1997 and 2010, therefore two dummy variables were created for these years to diminish its impact on the regression. After the inclusion of the dummy variables, *t*-Statistic for FDI is -.511 and for Capital Formation, 11.58. This model showed that for Mexico, only Capital Formation has a significant and a positive impact in the TFP growth. These results differ from the results obtained by Kuo *et al*. (1992) and Zhou, where they found a significant impact on both, FDI and Capital Formation on the country's TFP. We fail to reject the FDI null hypothesis stated in Chapter 3, and conclude the FDI does not affect the country's TFP. However, we reject the Capital Formation null hypothesis stated in Chapter 3 and conclude that Capital Formation does affect the country's FDI. The percentage of the variance of the dependent variable explained by the regression is calculated by the *r*-squared. The *r*-squared for this regression is .76; we can conclude that the regression model does fit the data by .76. The high value in the Durbin-Watson statistics reported does not indicate serial correlation in the residuals. Even though, the Breusch-Godfrey Serial Correlation LM Test will also be conducted to validate this assumption.

Table 4.11. OLS Results Summary Mexico

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.004436	0.002859	-1.551559	0.1265
Capital Formation	0.256787	0.022176	11.57929	**0.0000**
FDI	-0.003440	0.006725	-0.511488	0.6111
R-squared	0.767442	Adjusted R-squared		0.750528
S.E. of regression	0.019550	Durbin-Watson stat		1.816364

The HAC covariance matrix method was also conducted for Mexico to "correct" the standard error of the regression coefficients for serial correlation. As previously stated, with the use of this approach the standard errors coefficients will be corrected but not their estimates. Results of the regression model using HAC method are presented in table 4. As in the case of the US regression, the HAC model presents a lower standard error for both explanatory variables, with a reduction of.003 for Capital Formation and of .002 for FDI.

Table 4.12. OLS Results Summary (HAC) Mexico

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.004436	0.003217	-1.378840	0.1735
Capital Formation	0.256787	0.017069	15.04378	**0.0000**
FDI	-0.003440	0.004249	-0.809579	0.4217
R-squared	0.767442	Adjusted R-squared		0.750528
S.E. of regression	0.019550	Durbin-Watson stat		1.816364

Under the HAC method the changes observed only occurred on the variables standard errors. Since the use of HAC is considered to be a standard for econometrics analysis (Greene, 2002), this model is the one selected for the OLS analysis.

4.4 Panel Data Results

This section present the results for the FE and RE models estimated for both US and Mexico. After the presentation of the results of these two models, two more tests will be presented to examine which of the models including the MRM is preferred. After the presentation of the two panel data models, we are going to analyze whether of these two are preferred using the Hausman Specification test. Subsequently, with the Breusch-Pagan LM Test we will determine if panel data model or OLS is favored.

4.4.1 The Fixed Effects Model

This section will present the regression analysis results performed in panel datasets for the FE model. The FE model allows to consistent estimate any correlation with the regressors that have been overlooked from the individual heterogeneity of the country. The main estimator feature on the FE model yields consistent estimates of β and remove any time-invariant elements to determine the unbiased effect of the explanatory variables. The FE model results for US and Mexico are presented in Table 4.13.

The F-test for the FE model is equal to .0006 which is less than the significance level of 5%, indicating that the coefficients in the model are different than zero. In the FE model the errors are correlated with the regressors by .13. The null hypothesis for the *t*-values of the variables states that each coefficient will be different from zero. We reject the null hypothesis if the t value is higher than 1.96 for a 95% confidence level. The t-value for the Capital Formation

variable is 13.13 since this value is higher than 1.96 we reject the null hypothesis and conclude that Capital Formation has a significant influence on TFP. The *t*-value for the FDI variable is -1.46, since this value is lower than 1.96, we cannot reject the null hypothesis and conclude that FDI does not significantly influence TFP. The *p*-values test also confirms these conclusions for both variables. The Capital Formation *p*-value is .0000, lower than our significance level of 5%, therefore with reject the null hypothesis and confirms that Capital Formation is statistically significant to TFP. On the contrary, the *p*-value for FDI is .014; we cannot reject the null hypothesis and conclude that FDI is not statistically significant to TFP. The F test is also performed to check for country effects. The null hypothesis of this test is that all the country dummy coefficients are the same. We will reject the null hypothesis if the calculated *p*-value is lower than the significance level of 5%. Since the F-test results for the FE model have a calculated *p*-value of .43 we fail to reject the null hypothesis and conclude that country effects are not significant. This also is an indication that the MRM may not contain any omission variable problems due to county dummies oversight (Balgati, 2005).

Table 4.13. Panel Data Fixed Effects Model Results

R-sq: within =0.6080						
Between = 1.0000						F(2,16) = 89.9
Overall = 0.6142						Prob > F = 0.000
Variable	Coef.	Std. Error	t-Stat	P > t	95% Conf. Interval	
C	-0.0052124	0.0020319	-2.57	0.012	-0.0092368	-0.0011879
Capital Formation	0.2366711	0.0180243	13.13	0.000	0.2009171	0.2723705
FDI	-0.0067355	0.0046108	-1.46	0.147	-0.0158678	0.0023968
F test that all u_i=0						
F(1,116) = 0.61						Prob > F = 0.4346

4.4.2 The Random Effects Model

This section will present the regression analysis results performed in panel datasets for the RE model. Under this model, each country's error is not correlated with the explanatory variables allowing them to be explicative variables. Since we are comparing two economically different countries it can be logical to suppose that the difference across them can influence our dependent variable. The RE model results for US and Mexico are presented in Table 4.14.

The F test for the RE model is .16, this is higher than the significance level of 5%, indicating that the coefficients in the model are not different than zero. One difference from the FE model is that the FE assumes that the differences across countries are not correlated with the regressor; therefore its assumed that differences are uncorrelated. Instead of the *t*-statistic calculated for the FE model, RE model calculates a *z*-value for each variable. However, as in the FE model these values are going to be compared with the significance level of 5%. The calculated *z*-values are also similar to the FE results. The *z*-value for the Capital Formation variable is 13.41, since this value is higher than 1.96 we reject the null hypothesis and conclude that capital formation has a significant influence on TFP. The *z*-value for the FDI variable is -1.56, since this value is lower than 1.96, we cannot reject the null hypothesis and conclude that FDI does not significantly influence TFP. The Capital Formation calculated *p*-value is .0000, lower than our significance level of 5%, therefore with reject the null hypothesis and confirms that Capital Formation is statistically significant to TFP, this is similar to the results obtain in the FE model. In contrast, the calculated *p*-value for FDI is 0.118; we cannot reject the null hypothesis and conclude that FDI is not statistically significant to TFP.

Table 4.14. Panel Data Random Effects Model Results

R-sq: within =0.6080						
Between = 1.0000					Wald Chi2(2)= 186.25	
Overall = 0.6142					Prob > Chi = 0.000	
Variable	Coef.	Std. Error	z	P > z	95% Conf. Interval	
C	-0.0052486	0.002028	-2.59	0.010	-0.0092235	-0.0012737
Capital Formation	0.2387115	0.0178061	13.41	0.000	0.2038123	0.2736107
FDI	-0.0071417	0.0045741	-1.56	0.118	-0.0161067	0.0018233

This section presented the results of the FE and RE models. As we can see the FE and RE models have generated similar results. We can see that the most significant variable in the regression model is Capital Formation and that FDI is not statistically significant. We can also take into account that the FE results may suggest that the OLS regression is adequate for our analysis. Since the results of the FE and RE models are very similar we performed the Hausman Specification Test and determine which of these two models is appropriate. Following this test, the panel data model preferred is going to be compared against the OLS regression to determine which of these two better suits our analysis.

4.5.3 Hausman Specification Test

The Hausman Specification Test was conducted for comparison of the FE and RE models. Hausman (1978) suggests the comparison of these two models, since both are consistent under the null hypothesis, as mention in Chapter 3, states that individual effects are not correlated with the regressors, but the probability limits if the null hypothesis is rejected are different. We will reject the null hypothesis if the calculated *p*-values are lower than our significance level of 5%. The calculated *p*-value of the HST is .7607, since this number is higher

than the stated significance level, we fail to reject the null hypothesis and conclude that the RE is preferred over the FE model.

4.5.4 Breusch-Pagan Lagrange Multiplier (LM) Test

Since the HST indicates that the preferred model was the RE model, we examined if RE are present in the model. For this examination the Breusch-Pagan Lagrange Multiplier (BPLM) Test was applied. As stated in Chapter 3, BPLM null hypothesis states that there are no variance and no significant difference across countries. We will reject the null hypothesis if the calculated *p*-values are less than the significance level of 5%. The results for the BPLM test stated that calculated *p*-value is .49. Since this amount is higher than the significance level of 5 %, we fail to reject the null hypothesis of no variance across countries and conclude that the RE model is not appropriate, since there is no evidence of difference across countries. Under this statement we can conclude that the OLS regression is preferred rather than the RE model.

Chapter 5: Conclusions and Recommendations

5.1 Conclusions

The main objective of this study was to analyze the effects of FDIs and internal investments (capital formation) on a host country's productivity – specifically United States and Mexico. The results obtained from our MRM model were quite different from the expected.

As the empirical literature suggests we expected the FDI had a significant positive impact in the country's productivity (Palmade & Anayiotas, 2004), (Yao & Wei, 2007), since investment inflows are getting into the country. We also expected that Capital Formation to have a positive impact in the country's TFP, since these investments will improve different areas of the country such as their infrastructure and education, making this country more productive.

The three models included in this study to analyze whether FDI and Capital Formation have a significant impact on the country's productivity yield very similar results, even though US and Mexico are two countries with different economic structures. Since TFP estimation was expressed as a percentage growth rate, and to maintain uniformity in the variable units, the explanatory variables were also expressed as growth rate percentages.

We observe that Capital Formation for US and Mexico has a positive impact on the country's productivity. One significant observation worth mention is that the TFP growth rates for both countries are very similar. One can expected that a developed country productivity growth to be higher than the growth rate of a developing country, but in the case of US and Mexico both TFP growth rates for the time period analyzed were very alike. Even though their Capital Formation growth rates had a significant effect on the TFP variable, the economic differences between the two countries are significant. Because the US is a developed country the

amount of internal investment available is higher than of Mexico. In contrast, the FDI growth rate appears to have a negative significant effect in US TFP, while it does not show any impact on Mexico's productivity. These results are different to the conclusions obtained by Aitken & Harrison, (1999), where they found that FDI had a positive impact in a country's productivity at the industry level. Also, our results seemed to be opposite Alfaro (2009), who concluded that FDI will contribute to productivity improvement in countries with well developed financial markets. This is a very interesting finding from our analysis, since in recent decades there has been a great increase for FDI inflows into the US and Mexico.

This study was aimed to contribute to the limited empirical literature of the effects of FDI and Capital Formation into a country's total productivity. The comparative analysis performed on the behavior of these variables for a developed and a developing country suggest that their growth rate are very similar and that the country's productivity seems to be more influenced for the Capital Formation variable rather than for FDI inflows into the country. We believe the contributions made by this research can promote further TFP empirical analysis.

5.2 Future Research

A natural extension to this research might be decomposing the time period into fractional periods to evaluate if current findings hold. An analysis of a larger group of developed and developing countries could be conducted to study the behavior of these variables across different countries with different economic structures. The inclusion of other macroeconomic variables such as government spending can also be added into the model to see how this variable affects the country's productivity. Another interesting analysis could be to study the effects of FDI outflows into the country's TFP, for a developed and developing country.

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Appendixes

Appendix A: PWT 7.0 Data US

country	isocode	year	POP	rgdpl	rgdpch	ki	rgdpwok
United States	USA	1950	152271	13118.76	13183.49	18.59565	31450.27429
United States	USA	1951	154878	14130.98	14138.6	17.18432	33907.18279
United States	USA	1952	157553	14599.65	14546.3	14.87607	35080.04773
United States	USA	1953	160184	14973.68	14916.08	14.90887	36168.62481
United States	USA	1954	163026	14413.35	14383.6	14.82487	35066.68448
United States	USA	1955	165931	15153.98	15148.09	16.79581	37134.26848
United States	USA	1956	168903	15175.98	15168.68	16.05542	37392.71185
United States	USA	1957	171984	15163.35	15141.16	14.89436	37807.09111
United States	USA	1958	174882	14792.2	14761.36	14.35964	37151.29098
United States	USA	1959	177830	15353.1	15334.08	15.58162	38867.86985
United States	USA	1960	180671	15458.29	15437.69	15.23224	39015.04111
United States	USA	1961	183691	15550.76	15525.79	14.7848	39413.98116
United States	USA	1962	186538	16264.22	16242.8	15.69866	41691.01856
United States	USA	1963	189242	16750.42	16729.69	16.04631	42876.47445
United States	USA	1964	191889	17463.41	17443.32	16.42077	44564.27811
United States	USA	1965	194303	18363.77	18350.65	17.58156	46669.35758
United States	USA	1966	196560	19277.57	19268.37	17.97957	48623.7039
United States	USA	1967	198712	19522.06	19514.14	16.76745	48736.18354
United States	USA	1968	200706	20322.92	20310.77	16.85361	50333.29252
United States	USA	1969	202677	20763.54	20746.03	17.32446	50676.62827
United States	USA	1970	205052	20508.48	20479.55	16.16388	49469.01813
United States	USA	1971	207661	20937.65	20912.49	17.06217	50288.94922
United States	USA	1972	209896	21847.16	21823.9	17.95462	51557.72574
United States	USA	1973	211909	22835.31	22817.43	18.71702	53015.95808
United States	USA	1974	213854	22486.35	22458.98	17.71216	51275.13065
United States	USA	1975	215973	22261.5	22219.19	15.12641	50273.43567
United States	USA	1976	218035	23262.04	23231.36	16.68628	51778.20322
United States	USA	1977	220239	24107.96	24090.75	17.88286	52706.82339
United States	USA	1978	222585	25128.49	25118.7	18.97971	53821.01005
United States	USA	1979	225055	25571.92	25563.55	19.03152	53990.90802
United States	USA	1980	227726.5	25114.21	25090.21	17.38315	52523.46613
United States	USA	1981	229966.2	25467.84	25454.43	18.26023	52946.17302
United States	USA	1982	232187.8	24887.15	24852.08	16.08066	51463.0676
United States	USA	1983	234307.2	25871.77	25839.5	16.65158	53345.03569
United States	USA	1984	236348.3	27513.81	27497.94	19.59734	56261.85335
United States	USA	1985	238466.3	28427.27	28403.89	18.96106	57678.72526
United States	USA	1986	240650.8	29155.74	29124.81	18.41888	58498.67355
United States	USA	1987	242803.5	29846.23	29813.57	18.28405	59401.68521

country	isocode	year	POP	rgdpl	rgdpch	ki	rgdpwok
United States	USA	1988	245021.4	30738.38	30701.1	17.88928	60853.93899
United States	USA	1989	247341.7	31480.85	31450.44	18.14596	61825.19099
United States	USA	1990	250131.9	31679.65	31636.85	17.49362	61949.04062
United States	USA	1991	253492.5	31153.23	31091.49	16.43495	61470.34564
United States	USA	1992	256894.2	31780.93	31730.19	17.0437	62759.30143
United States	USA	1993	260255.4	32264.48	32227.2	17.79247	64102.54503
United States	USA	1994	263435.7	33218.26	33203.38	19.05473	65952.88458
United States	USA	1995	266278	33700.82	33689.53	19.21887	67118.88131
United States	USA	1996	269394	34592.01	34596.44	20.04388	68920.77066
United States	USA	1997	272647	35789.93	35804.41	21.36107	70970.53248
United States	USA	1998	275854	36923.94	36940.14	22.32159	73365.72898
United States	USA	1999	279040	38174.55	38189.59	23.01186	75810.16658
United States	USA	2000	282172	39159.75	39174.89	23.38175	76867.45649
United States	USA	2001	285082	38960.44	38959.34	21.83495	76624.10936
United States	USA	2002	287804	39154.04	39149.18	21.18689	77115.63787
United States	USA	2003	290326	39793.02	39788.67	21.32392	78178.28843
United States	USA	2004	293046	40910.01	40907.97	22.20794	80649.46474
United States	USA	2005	295753	42534.82	42534.82	22.96674	83541.79014
United States	USA	2006	298593	43258.39	43258.39	22.97479	84597.90266
United States	USA	2007	301580	43697.46	43691.53	21.81771	85350.43096
United States	USA	2008	304375	43340.71	43326.03	20.48233	84771.23305
United States	USA	2009	307007	41146.93	41101.86	16.54479	81172.19372

Appendix B: PWT 7.0 Data Mexico

Country	isocode	year	POP	rgdpl	rgdpch	ki	rgdpwok
Mexico	MEX	1950	28485.18	3413.99	3399.497	15.23918	12268.19011
Mexico	MEX	1951	29296.24	3641.332	3629.028	16.80294	13199.76701
Mexico	MEX	1952	30144.32	3665.084	3655.951	17.88513	13392.99806
Mexico	MEX	1953	31031.28	3530.282	3521.827	17.9085	13004.14276
Mexico	MEX	1954	31959.11	3801.847	3793.309	18.12128	14109.12263
Mexico	MEX	1955	32929.91	3987.518	3979.045	18.75671	14918.8487
Mexico	MEX	1956	33945.89	4164.498	4158.097	21.62014	15713.08178
Mexico	MEX	1957	35015.55	4364.048	4356.665	21.48286	16593.52928
Mexico	MEX	1958	36141.96	4427.246	4413.333	19.1013	16943.50567
Mexico	MEX	1959	37328.47	4376.732	4362.506	18.7076	16883.36984
Mexico	MEX	1960	38578.51	4602.493	4588.981	19.28552	17900.47452
Mexico	MEX	1961	39836.23	4577.321	4565.119	19.55534	17835.94436
Mexico	MEX	1962	41121.49	4604.016	4590.738	18.68482	17964.83728
Mexico	MEX	1963	42434.26	4881.731	4870.046	19.94559	19088.49708
Mexico	MEX	1964	43774.58	5373.883	5363.526	21.05292	21056.59017
Mexico	MEX	1965	45142.4	5492.783	5486.6	22.48401	21574.51632
Mexico	MEX	1966	46537.83	5651.385	5645.974	22.91939	22237.09196
Mexico	MEX	1967	47995.56	5792.495	5786.524	22.59804	22827.54768
Mexico	MEX	1968	49518.8	6110.44	6106.823	24.03671	24130.17091
Mexico	MEX	1969	51110.93	6153.857	6146.579	21.32415	24326.70021
Mexico	MEX	1970	52775.16	6353.079	6345.571	21.18578	25155.11345
Mexico	MEX	1971	54406.9	6429.532	6420.809	19.31754	22170.65438
Mexico	MEX	1972	55984.29	6778.64	6769.714	19.68011	23134.13995
Mexico	MEX	1973	57557.3	7148.166	7140.741	20.91955	24152.7639
Mexico	MEX	1974	59122.84	7406.868	7404.705	23.07528	24792.31719
Mexico	MEX	1975	60678.05	7665.812	7662.655	22.81834	25399.13487
Mexico	MEX	1976	62219.96	7779.497	7772.844	21.42559	25508.99404
Mexico	MEX	1977	63759.98	7798.681	7791.165	20.79169	25318.16611
Mexico	MEX	1978	65295.99	8257.106	8250.128	21.46367	26549.03975
Mexico	MEX	1979	66825.88	8827.015	8824.18	23.07092	28123.01261
Mexico	MEX	1980	68347.48	9393.005	9398.502	25.86208	29667.82366
Mexico	MEX	1981	69969.26	9981.473	9993.394	27.29736	38108.42086
Mexico	MEX	1982	71640.9	9533.436	9526.854	21.06519	35973.8288
Mexico	MEX	1983	73362.88	8813.503	8794.681	16.1258	33195.62206
Mexico	MEX	1984	75080.14	8926.814	8907.994	16.49977	33239.21359
Mexico	MEX	1985	76767.23	9016.015	9000.169	17.8119	33225.38872
Mexico	MEX	1986	78442.43	8460.471	8437.401	14.96478	30945.1637
Mexico	MEX	1987	80122.49	8378.957	8359.406	15.63804	30283.43284

Country	isocode	year	POP	rgdpl	rgdpch	ki	rgdpwok
Mexico	MEX	1988	81781.82	8303.642	8291.35	17.27195	29714.63141
Mexico	MEX	1989	83366.84	8505.641	8490.048	16.80173	30011.14838
Mexico	MEX	1990	84913.65	8800.97	8788.964	17.78361	30669.895
Mexico	MEX	1991	86488.03	9037.119	9028.512	18.69452	25633.32961
Mexico	MEX	1992	88111.03	9231.364	9229.294	20.35597	25764.60585
Mexico	MEX	1993	89749.14	9226.707	9222.991	19.82876	25278.85072
Mexico	MEX	1994	91337.9	9487.552	9487.964	20.9044	25484.68742
Mexico	MEX	1995	92880.35	8631.385	8618.649	14.73785	22889.03475
Mexico	MEX	1996	94398.58	8923.246	8922.184	17.62672	23508.97738
Mexico	MEX	1997	95895.15	9416.423	9419.482	20.52681	24105.92662
Mexico	MEX	1998	97325.06	9761.946	9765.533	21.55986	24810.98745
Mexico	MEX	1999	98616.91	10016.5	10020.25	21.57248	25804.48185
Mexico	MEX	2000	99926.62	10566.13	10570.11	22.53385	26970.57671
Mexico	MEX	2001	101247	10428.91	10430.24	21.683	26900.86734
Mexico	MEX	2002	102479.9	10380.54	10381.5	21.2752	26391.24993
Mexico	MEX	2003	103718.1	10384	10382.62	20.14556	26434.88754
Mexico	MEX	2004	104959.6	10682.73	10681.82	20.76219	26360.78839
Mexico	MEX	2005	106202.9	11964.79	11964.79	22.27491	29665.02974
Mexico	MEX	2006	107449.5	12418.47	12418.47	22.69057	30136.46785
Mexico	MEX	2007	108700.9	12696.95	12696.88	22.76699	30494.58634
Mexico	MEX	2008	109955	12750.42	12751.51	23.32033	30156.01553
Mexico	MEX	2009	111212	11633.92	11629.61	20.74654	27550.39321

Appendix C: TED Data US & Mexico

	Total annual hours worked (in thousands)	Total annual hours worked (in thousands)
	Mexico	United States
1950	18,693,100	115,993,525
1951	18,905,793	121,262,732
1952	19,120,905	122,455,183
1953	19,338,465	123,875,771
1954	19,558,501	120,403,203
1955	19,787,606	124,421,776
1956	20,064,122	126,479,965
1957	20,344,502	125,401,416
1958	20,628,801	122,111,780
1959	20,917,072	125,921,725
1960	21,219,910	127,627,170
1961	21,717,859	127,161,719
1962	22,227,493	129,885,544
1963	22,749,085	131,643,160
1964	23,282,918	135,230,427
1965	23,873,732	139,293,783
1966	24,512,865	143,103,925
1967	25,169,109	144,647,298
1968	25,842,922	146,792,272
1969	26,534,773	149,865,857
1970	27,308,831	148,310,792
1971	28,760,674	148,005,093
1972	30,289,703	152,862,553
1973	31,900,022	157,315,776
1974	33,599,743	158,458,995
1975	35,640,110	154,808,083
1976	37,128,495	160,155,773
1977	38,679,038	165,380,687
1978	40,513,087	172,242,188
1979	42,949,411	176,208,037
1980	45,639,292	175,568,204
1981	47,208,299	176,490,204
1982	48,831,127	174,637,844
1983	49,064,985	178,597,198
1984	51,160,616	187,502,077
1985	53,702,073	190,892,028

	Total annual hours worked (in thousands)	Total annual hours worked (in thousands)
	Mexico	United States
1986	55,440,172	194,048,152
1987	57,413,693	199,122,217
1988	59,456,436	203,459,350
1989	61,697,882	208,581,542
1990	63,911,396	208,858,469
1991	66,072,657	205,713,125
1992	67,596,678	207,418,523
1993	68,600,535	211,649,250
1994	71,121,464	217,728,646
1995	70,316,420	221,337,518
1996	74,187,185	223,505,847
1997	80,114,810	230,184,131
1998	79,637,293	234,002,206
1999	83,273,655	238,369,676
2000	82,448,837	240,753,802
2001	81,435,752	238,545,439
2002	85,270,430	237,533,619
2003	83,798,325	238,184,109
2004	85,854,129	240,793,181
2005	90,035,665	244,802,660
2006	92,163,850	249,823,773
2007	93,419,570	252,228,942
2008	95,050,354	250,251,113
2009	90,017,043	237,711,196
2010	90,994,018	238,409,309
2011	95,395,279	241,205,686

Appendix D: Real FDI Calculation US

	Foreign direct investment, net inflows (BoP, current US$) (World Bank Data) & Estimates	GDP deflator (base year varies by country) (World Bank Data) & Estimates	Calculated GDP deflator 2005 Base Year	Calculated Real FDI
1950	*98086889*	*14.53825796*	*0.145382580*	*817153641*
1951	*111442011*	*15.042587*	*0.150425870*	*890651771*
1952	*126615513*	*15.5644111*	*0.155644111*	*970760624*
1953	*143854979*	*16.10433717*	*0.161043372*	*1058074793*
1954	*163441702*	*16.66299316*	*0.166629932*	*1153242355*
1955	*185695276*	*17.24102881*	*0.172410288*	*1256969676*
1956	*210978808*	*17.83911639*	*0.178391164*	*1370026654*
1957	*239704846*	*18.4579515*	*0.184579515*	*1493252439*
1958	*272342107*	*19.09825387*	*0.190982539*	*1627561653*
1959	*309423129*	*19.76076818*	*0.197607682*	*1773951185*
1960	*351552955*	20.44626498	0.20446265	*1933507589*
1961	*399419011*	20.62440128	0.206244013	*2107415147*
1962	*453802319*	21.08414573	0.210841457	*2296964659*
1963	*515590243*	21.37543952	0.213754395	*2503563028*
1964	*585790965*	21.74884609	0.217488461	*2728743697*
1965	*665549940*	22.32351443	0.223235144	*2974178033*
1966	*756168580*	23.10243861	0.231024386	*3241687734*
1967	*859125495*	23.76596441	0.237659644	*3533258349*
1968	*976100615*	24.92190302	0.24921903	*3851054014*
1969	*1109002604*	26.21098682	0.262109868	*4197433517*

	Foreign direct investment, net inflows (BoP, current US$) (World Bank Data) & Estimates	GDP deflator (base year varies by country) (World Bank Data) & Estimates	Calculated GDP deflator 2005 Base Year	Calculated Real FDI
1970	1260000000	27.54117742	0.275411774	457496780487.81
1971	870000000	28.91572523	0.289157252	300874348841.39
1972	1350000000	30.13921	0.3013921	447921495022.03
1973	2120000000	31.82029363	0.318202936	666241495108.78
1974	3330000000	34.69330595	0.346933059	959839343379.98
1975	2560000000	37.9714279	0.379714279	674191133004.93
1976	3250000000	40.15531396	0.40155314	809357387556.64
1977	2900000000	42.70298919	0.427029892	679109368018.67
1978	5850000000	45.70344648	0.457034465	1279990996530.37
1979	8700000000	49.50003891	0.495000389	1757574376105.33
1980	16930000000	53.99570983	0.539957098	3135434287984.40
1981	25190000000	52.21999764	0.522199976	4823822507893.55
1982	12474000000	55.40164779	0.554016478	2251557579700.72
1983	10470000000	57.59307615	0.575930762	1817926858479.00
1984	24760000000	59.75609756	0.597560976	4143510204081.63
1985	20010000000	61.58102301	0.61581023	3249377652456.51
1986	35419000000	62.95795689	0.629579569	5625817887005.65
1987	58471000000	64.80258168	0.648025817	9022942988784.61
1988	57736000000	67.05924434	0.670592443	8609700357573.24

	Foreign direct investment, net inflows (BoP, current US$) (World Bank Data) & Estimates	GDP deflator (base year varies by country) (World Bank Data) & Estimates	Calculated GDP deflator 2005 Base Year	Calculated Real FDI
1989	68250000000	69.58362648	0.695836265	9808341912237.81
1990	48490000000	72.22264085	0.722226408	6713961083675.31
1991	23180000000	74.67702536	0.746770254	3104033655386.38
1992	19810000000	76.24996956	0.762499696	2598033824140.02
1993	51380000000	77.92166286	0.779216629	6593801789484.88
1994	46130000000	79.50816876	0.795081688	5801919565870.19
1995	57800000000	81.35788645	0.813578865	7104412678513.03
1996	86520000000	82.79851304	0.82798513	10449463018152.30
1997	1.0559E+11	84.39467659	0.843946766	12511452649427.70
1998	1.7903E+11	85.50745904	0.85507459	20937354707699.30
1999	2.89443E+11	86.7606317	0.867606317	33361098730244.10
2000	3.21274E+11	88.63776785	0.886377678	36245723216955.60
2001	1.6702E+11	90.64730996	0.9064731	18425257194227.00
2002	84370000000	92.11993633	0.921199363	9158712366149.84
2003	63750000000	94.10546683	0.941054668	6774314197597.66
2004	1.45966E+11	96.77215864	0.967721586	15083470499394.70
2005	1.12638E+11	100	1	11263800000000.00
2006	2.43151E+11	103.2525298	1.032525298	23549156664567.10
2007	2.21166E+11	106.2892556	1.062892556	20807935729903.50

	Foreign direct investment, net inflows (BoP, current US$) (World Bank Data) & Estimates	GDP deflator (base year varies by country) (World Bank Data) & Estimates	Calculated GDP deflator 2005 Base Year	Calculated Real FDI
2008	3.10093E+11	108.6043968	1.086043968	28552527265351.20
2009	1.58581E+11	110.5845526	1.105845526	14340248815084.20
2010	2.36226E+11	111.4805551	1.114805551	21189883731584.40

Appendix E: Real FDI Calculation Mexico

	Foreign direct investment, net inflows (BoP, current US$) (World Bank Data) & Estimates	GDP deflator (base year varies by country) (World Bank Data) & Estimates	Calculated GDP deflator 2005 Base Year	Calculated Real FDI
1950	*42407893*	*0.002193387*	*0.000019237*	22609928172237
1951	*46858624*	*0.002632047*	*0.000023084*	19947922595400
1952	*51776463*	*0.003158436*	*0.000027701*	17599331269026
1953	*57210431*	*0.003790098*	*0.000033240*	15527254010316
1954	*63214697*	*0.004548088*	*0.000039888*	13699135121413
1955	*69849114*	*0.005457669*	*0.000047866*	12086251886524
1956	*77179816*	*0.006549161*	*0.000057438*	10663263291430
1957	*85279880*	*0.007858941*	*0.000068926*	9407811875007
1958	*94230050*	*0.009430668*	*0.000082710*	8300172457211
1959	*104119545*	*0.011316727*	*0.000099252*	7322942224479
1960	*115046948*	0.013579984	0.000119101	6460767303271
1961	*127121188*	0.014020388	0.000122964	5700101525789
1962	*140462626*	0.014405485	0.000126341	5028993597688
1963	*155204255*	0.014826865	0.000130037	4436899323839
1964	*171493027*	0.015701052	0.000137704	3914515941903
1965	*189491313*	0.016025324	0.000140547	3453635960836
1966	*209378530*	0.016839546	0.000147688	3047018207870
1967	*231352921*	0.017358686	0.000152242	2688274057942
1968	*255633536*	0.01754075	0.000153838	2371767058018
1969	*282462415*	0.018781638	0.000164721	2092524369261
1970	312107000	0.019276058	0.000169058	1846158635668
1971	307000000	0.020489691	0.000179701	1708388742647
1972	178385000	0.021818499	0.000191356	932217373466
1973	457000000	0.02474751	0.000217044	2105563912654
1974	508756000	0.03046718	0.000267207	1903974071758
1975	458411000	0.035227828	0.00030896	1483723240224
1976	731451000	0.042046309	0.00036876	1983540621397
1977	327102000	0.054855206	0.000481099	679906332256
1978	658163000	0.063635137	0.000558102	1179288919062
1979	1332000000	0.076129376	0.00066768	1994966895848
1980	2090000000	0.101563515	0.000890746	2346347332860
1981	3078000000	0.127979635	0.001122424	2742278043229
1982	1901000000	0.205947807	0.001806232	1052467473899
1983	2192000000	0.392269918	0.003440339	637146471293

	Foreign direct investment, net inflows (BoP, current US$) (World Bank Data) & Estimates	GDP deflator (base year varies by country) (World Bank Data) & Estimates	Calculated GDP deflator 2005 Base Year	Calculated Real FDI
1984	1542000000	0.624075857	0.005473355	281728465050
1985	1984000000	0.978180945	0.008578976	231263027230
1986	2036000000	1.698312525	0.014894773	136692251920
1987	1184000000	4.070154711	0.035696627	33168399973
1988	2011000000	8.657447252	0.075928727	26485364458
1989	2785000000	10.95411646	0.096071289	28988889768
1990	2549000000	14.03556341	0.123096616	20707311753
1991	4742000000	17.29891885	0.151717342	31255490980
1992	4393000000	19.79187186	0.173581379	25308014215
1993	4389000000	21.67071549	0.19005947	23092771985
1994	10972500000	23.50656139	0.206160456	53223106869
1995	9526290000	32.40955144	0.284242676	33514636625
1996	9185600000	42.3731823	0.371627073	24717251986
1997	12829800000	49.86793925	0.437358614	29334737185
1998	12707000000	57.54023684	0.504647247	25179964984
1999	13869200000	66.22349243	0.580802321	23879381152
2000	18109779299	74.23808453	0.651092992	27814428244
2001	29848454770	78.60209312	0.689366816	43298363179
2002	23782995655	84.07023566	0.737324267	32255815684
2003	16242553245	100.0000066	0.877033721	18519873139
2004	24800226639	109.065694	0.956542851	25926937432
2005	24121689927	114.020709	1	24121689927
2006	20052002334	121.6493654	1.066905885	18794537192
2007	29734289650	128.497857	1.126969461	26384290495
2008	26295379217	136.6372946	1.198355069	21942894804
2009	15333812446	142.0447547	1.245780314	12308600697
2010	18679273363	148.2510387	1.300211515	10983083057

Appendix F: TFP Calculation US

	K	H	Y	k	h	y	Kw	lw	TheoreticalY	A
	3662670729	115993524.6	1997607289							
1950	3852838139	121262731.9	2188577341	0.05192	0.045427	0.095599	0.036344	0.013628	0.049972	0.045627
1951	4036491273	122455183.5	2300219016	0.047667	0.009834	0.051011	0.033367	0.00295	0.036317	0.014694
1952	4175598472	123875771	2398544258	0.034462	0.011601	0.042746	0.024124	0.00348	0.027604	0.015142
1953	4323038804	120403202.8	2349751607	0.03531	-0.02803	-0.02034	0.024717	-0.00841	0.016307	-0.03665
1954	4454515393	124421776.4	2514514470	0.030413	0.033376	0.070119	0.021289	0.010013	0.031302	0.038817
1955	4653958536	126479965.4	2563269009	0.044773	0.016542	0.019389	0.031341	0.004963	0.036304	-0.01691
1956	4832606122	125401416.1	2607852929	0.038386	-0.00853	0.017393	0.02687	-0.00256	0.024312	-0.00692
1957	4978830495	122111780.2	2586890283	0.030258	-0.02623	-0.00804	0.021181	-0.00787	0.013311	-0.02135
1958	5100582466	125921725.1	2730241467	0.024454	0.0312	0.055414	0.017118	0.00936	0.026478	0.028937
1959	5270442047	127627169.6	2792864077	0.033302	0.013544	0.022937	0.023311	0.004063	0.027375	-0.00444
1960	5431768960	127161718.8	2856534277	0.03061	-0.00365	0.022797	0.021427	-0.00109	0.020333	0.002465
1961	5581835535	129885543.9	3033894229	0.027628	0.02142	0.062089	0.019339	0.006426	0.025765	0.036324
1962	5778397280	131643159.5	3169883315	0.035215	0.013532	0.044823	0.02465	0.00406	0.02871	0.016113
1963	5997497066	135230427	3351036107	0.037917	0.02725	0.057148	0.026542	0.008175	0.034717	0.022431
1964	6247255304	139293783.5	3568136442	0.041644	0.030048	0.064786	0.029151	0.009014	0.038165	0.026621
1965	6561778191	143103924.7	3789198772	0.050346	0.027353	0.061955	0.035242	0.008206	0.043448	0.018507

	K	H	Y	k	h	y	Kw	lw	TheoreticalY	A
1966	6914646028	144647297.8	3879267980	0.053776	0.010785	0.02377	0.037643	0.003235	0.040879	-0.01711
1967	7219104207	146792271.7	4078931568	0.044031	0.014829	0.051469	0.030822	0.004449	0.03527	0.016199
1968	7545185134	149865856.7	4208292039	0.045169	0.020938	0.031714	0.031618	0.006281	0.0379	-0.00619
1969	7896374906	148310791.9	4205304209	0.046545	-0.01038	-0.00071	0.032581	-0.00311	0.029469	-0.03018
1970	8180337588	148005093.1	4347933985	0.035961	-0.00206	0.033917	0.025173	-0.00062	0.024554	0.009362
1971	8512281152	152862553.1	4585632091	0.040578	0.03282	0.054669	0.028405	0.009846	0.038251	0.016419
1972	8909123350	157315776.1	4839007601	0.04662	0.029132	0.055254	0.032634	0.00874	0.041374	0.013881
1973	9368675973	158458995.2	4808796229	0.051582	0.007267	-0.00624	0.036108	0.00218	0.038288	-0.04453
1974	9750947061	154808083.4	4807882218	0.040803	-0.02304	-0.00019	0.028562	-0.00691	0.02165	-0.02184
1975	9989277932	160155772.7	5071938508	0.024442	0.034544	0.054922	0.017109	0.010363	0.027472	0.027449
1976	10335016056	165380686.9	5309512450	0.034611	0.032624	0.046841	0.024228	0.009787	0.034015	0.012826
1977	10767080464	172242188.5	5593225732	0.041806	0.041489	0.053435	0.029264	0.012447	0.041711	0.011724
1978	11289890536	176208037.2	5755087603	0.048556	0.023025	0.028939	0.033989	0.006907	0.040897	-0.01196
1979	11820318395	175568204.5	5719170784	0.046983	-0.00363	-0.00624	0.032888	-0.00109	0.031798	-0.03804
1980	12222524132	176490204.5	5856743893	0.034027	0.005252	0.024055	0.023819	0.001575	0.025394	-0.00134
1981	12680289353	174637844	5778492519	0.037453	-0.0105	-0.01336	0.026217	-0.00315	0.023068	-0.03643
1982	12974185001	178597198.2	6061941384	0.023177	0.022672	0.049052	0.016224	0.006802	0.023026	0.026027
1983	13333626215	187502076.8	6502840821	0.027704	0.04986	0.072732	0.019393	0.014958	0.034351	0.038381

	K	H	Y	k	h	y	Kw	lw	TheoreticalY	A
1984	13940593899	190892027.8	6778945863	0.045522	0.01808	0.042459	0.031865	0.005424	0.037289	0.00517
1985	14527867232	194048151.8	7016351330	0.042127	0.016534	0.035021	0.029489	0.00496	0.034449	0.000572
1986	15092435928	199122216.9	7246769306	0.038861	0.026148	0.03284	0.027203	0.007845	0.035047	-0.00221
1987	15661367308	203459350.3	7531562001	0.037696	0.021781	0.039299	0.026388	0.006534	0.032922	0.006377
1988	16224007145	208581542.3	7786527470	0.035925	0.025176	0.033853	0.025148	0.007553	0.0327	0.001153
1989	16824382489	208858468.5	7924091281	0.037005	0.001328	0.017667	0.025904	0.000398	0.026302	-0.00864
1990	17367501028	205713125	7897109177	0.032282	-0.01506	-0.00341	0.022597	-0.00452	0.018079	-0.02148
1991	17794439742	207418522.6	8164335131	0.024583	0.00829	0.033838	0.017208	0.002487	0.019695	0.014144
1992	18294001391	211649250.1	8397004713	0.028074	0.020397	0.028498	0.019652	0.006119	0.025771	0.002727
1993	18871608799	217728645.8	8750874426	0.031574	0.028724	0.042142	0.022102	0.008617	0.030719	0.011424
1994	19594737218	221337518.2	8973787872	0.038318	0.016575	0.025473	0.026823	0.004973	0.031795	-0.00632
1995	20339082785	223505846.8	9318879915	0.037987	0.009796	0.038456	0.026591	0.002939	0.02953	0.008926
1996	21190233487	230184131.1	9758016848	0.041848	0.02988	0.047123	0.029294	0.008964	0.038258	0.008866
1997	22215981522	234002206.1	10185616423	0.048407	0.016587	0.04382	0.033885	0.004976	0.038861	0.00496
1998	23379771756	238369676.5	10652225165	0.052385	0.018664	0.045811	0.03667	0.005599	0.042269	0.003542
1999	24663024189	240753801.7	11049784133	0.054887	0.010002	0.037322	0.038421	0.003001	0.041422	-0.0041
2000	26014505345	238545438.9	11106921003	0.054798	-0.00917	0.005171	0.038359	-0.00275	0.035607	-0.03044
2001	27138902337	237533618.8	11268689196	0.043222	-0.00424	0.014565	0.030255	-0.00127	0.028983	-0.01442

	K	H	Y	k	h	y	Kw	lw	TheoreticalY	A
2002	28169145586	238184108.7	11552949628	0.037962	0.002739	0.025226	0.026573	0.000822	0.027395	-0.00217
2003	29223960842	240793181.2	11988514313	0.037446	0.010954	0.037702	0.026212	0.003286	0.029498	0.008203
2004	30425032805	244802659.6	12579800001	0.041099	0.016651	0.049321	0.028769	0.004995	0.033765	0.015556
2005	31792951351	249823772.8	12916653362	0.04496	0.020511	0.026777	0.031472	0.006153	0.037625	-0.01085
2006	33170877973	252228942.2	13178279540	0.043341	0.009627	0.020255	0.030338	0.002888	0.033227	-0.01297
2007	34387142049	250251113.2	13191828107	0.036667	-0.00784	0.001028	0.025667	-0.00235	0.023314	-0.02229
2008	35368863235	237711196.1	12632395766	0.028549	-0.05011	-0.04241	0.019984	-0.01503	0.004952	-0.04736
2009	38550083032	259091910.5	13768604957	0.031117	-0.05462	-0.04622	0.021782	-0.01638	0.005397	-0.05162

Appendix G: TFP Calculation Mexico

	K	H	Y	K	h	y	kw	lw	Theoretical Y	A
	155898488.12	18693100.32	97248106.02							
1950	162860471.06	18905792.78	106677311.5	0.044657155	0.011378126	0.096960299	0.013397146	0.007964689	0.021361835	0.075598
1951	172581799.91	19120905.3	110481453.1	0.05969115	0.011378127	0.035660269	0.017907345	0.007964689	0.025872034	0.009788
1952	183663226.44	19338465.38	109549166.7	0.064209705	0.011378127	-0.008438397	0.019262912	0.007964689	0.0272276	-0.03567
1953	194051694.18	19558500.9	121503663.9	0.05656259	0.011378127	0.109124493	0.016968777	0.007964689	0.024933466	0.084191
1954	206317674.38	19787606.07	131308616.4	0.063209859	0.011713841	0.080696764	0.018962958	0.008199689	0.027162646	0.053534
1955	220578631.70	20064122.14	141367576.7	0.069121356	0.013974205	0.076605485	0.020736407	0.009781944	0.03051835	0.046087
1956	240066584.57	20344502.32	152809523.2	0.088349233	0.013974206	0.080937558	0.02650477	0.009781944	0.036286714	0.044651
1957	260835574.59	20628800.58	160009313.9	0.086513457	0.013974206	0.047116113	0.025954037	0.009781944	0.035735981	0.01138
1958	278261611.81	20917071.69	163376697.7	0.066808514	0.013974206	0.021044924	0.020042554	0.009781944	0.029824499	-0.00878
1959	294813051.41	21219909.95	177557315.7	0.059481577	0.014478043	0.086797066	0.017844473	0.01013463	0.027979103	0.058818
1960	314214712.95	21717858.77	182343219.2	0.06581005	0.023466114	0.026954133	0.019743015	0.01642628	0.036169294	-0.00922
1961	334066767.21	22227492.52	189323974.8	0.0631799	0.023466114	0.038283604	0.01895397	0.01642628	0.03538025	0.002903
1962	352636255.00	22749085.41	207152675.3	0.055586157	0.023466115	0.094170327	0.016675847	0.01642628	0.033102127	0.061068
1963	376223361.91	23282918.03	235239462	0.066887924	0.023466113	0.135584958	0.020066377	0.016426279	0.036492657	0.099092
1964	406841523.42	23873731.57	247957380.6	0.081382935	0.025375408	0.054063712	0.024414881	0.017762785	0.042177666	0.011886
1965	442187445.92	24512865.07	263003183.7	0.086878847	0.026771412	0.060678989	0.026063654	0.018739988	0.044803642	0.015875
1966	480299103.98	25169109.12	278014048.3	0.086188919	0.026771414	0.05707484	0.025856676	0.01873999	0.044596665	0.012478

	K	H	Y	K	h	y	kw	lw	Theoretical Y	A
1967	519045109.00	25842921.76	302581689.7	0.080670575	0.026771414	0.088368345	0.024201173	0.01873999	0.042941162	0.045427
1968	565780482.30	26534773.28	314529337.6	0.090041063	0.026771413	0.039485694	0.027012319	0.018739989	0.045752308	-0.00627
1969	604482842.29	27308830.56	335284726.1	0.068405258	0.02917143	0.06598872	0.020521577	0.020420001	0.040941578	0.025047
1970	645207447.97	28760674.18	349810900.9	0.067370987	0.053163888	0.043324893	0.020211296	0.037214722	0.057426018	-0.0141
1971	680430238.48	30289703.46	379497373.1	0.05459142	0.053163889	0.084864343	0.016377426	0.037214722	0.053592148	0.031272
1972	720995884.45	31900021.85	411429176.8	0.059617641	0.053163888	0.084142358	0.017885292	0.037214721	0.055100014	0.029042
1973	770925809.57	33599742.83	437915060.6	0.069251332	0.053282753	0.064375317	0.020775399	0.037297927	0.058073326	0.006302
1974	833400119.97	35640109.99	465146460.4	0.081038032	0.060725678	0.062184205	0.02431141	0.042507975	0.066819384	-0.00464
1975	897825107.20	37128495.32	484040041.8	0.077303789	0.041761525	0.040618564	0.023191137	0.029233067	0.052424204	-0.01181
1976	956553606.51	38679037.92	497243699.6	0.065411959	0.041761525	0.027278028	0.019623588	0.029233068	0.048856656	-0.02158
1977	1012011649.92	40513086.69	539155878.4	0.057976932	0.047417125	0.084289009	0.01739308	0.033191987	0.050585067	0.033704
1978	1077035918.38	42949411.19	589873004.1	0.06425249	0.060136729	0.094067649	0.019275747	0.04209571	0.061371457	0.032696
1979	1159229558.94	45639292.02	641988232.6	0.07631467	0.06262905	0.088349913	0.022894401	0.043840335	0.066734736	0.021615
1980	1267396735.19	47208299.42	698396286.5	0.093309539	0.034378434	0.087864623	0.027992862	0.024064904	0.052057766	0.035807
1981	1394898319.47	48831127.27	682983944.7	0.100601162	0.034375901	-0.02206819	0.030180349	0.024063131	0.05424348	-0.07631
1982	1468925945.10	49064985.1	646583946.9	0.053070267	0.004789114	-0.053295539	0.01592108	0.00335238	0.01927346	-0.07257
1983	1499523802.70	51160616.08	670226420.8	0.020830089	0.042711334	0.036565204	0.006249027	0.029897934	0.036146961	0.000418
1984	1534900287.14	53702073.33	692134455.5	0.023591813	0.049676049	0.032687513	0.007077544	0.034773234	0.041850778	-0.00916

	K	H	Y	K	h	y	kw	lw	Theoretical Y	A
1985	1581220930.79	55440171.53	663659888.9	0.030178275	0.03236557	-0.041140224	0.009053483	0.022655899	0.031709381	-0.07285
1986	1601204293.69	57413692.84	671342885.3	0.012637932	0.035597316	0.011576708	0.00379138	0.024918121	0.028709501	-0.01713
1987	1625883964.57	59456436.1	679086917.6	0.015413193	0.035579374	0.011535137	0.004623958	0.024905562	0.02952952	-0.01799
1988	1661707707.81	61697882.12	709088414.4	0.022033395	0.037698964	0.044179171	0.006610018	0.026389275	0.032999293	0.01118
1989	1697543012.84	63911396.09	747322510.6	0.021565348	0.03587666	0.053920069	0.006469604	0.025113662	0.031583267	0.022337
1990	1745385478.77	66072657.46	781602634.7	0.02818336	0.033816526	0.045870589	0.008455008	0.023671568	0.032126576	0.013744
1991	1804093934.33	67596678.34	813384951	0.033636384	0.023065833	0.040663011	0.010090915	0.016146083	0.026236998	0.014426
1992	1879424496.41	68600534.82	828089008.4	0.041755344	0.014850678	0.018077612	0.012526603	0.010395474	0.022922077	-0.00484
1993	1949586925.44	71121463.78	866573050.3	0.037331869	0.036747949	0.046473316	0.011199561	0.025723564	0.036923125	0.00955
1994	2033267311.28	70316420.45	801686116.4	0.042922111	-0.011319274	-0.074877627	0.012876633	-0.007923492	0.004953141	-0.07983
1995	2049580887.29	74187185.38	842341767.2	0.008023331	0.05504781	0.050712679	0.002406999	0.038533467	0.040940466	0.009772
1996	2095561392.08	80114809.93	902989291.4	0.022434101	0.079900923	0.071998714	0.00673023	0.055930646	0.062660876	0.009338
1997	2176198410.18	79637292.54	950082054	0.038479912	-0.005960413	0.052152072	0.011543974	-0.004172289	0.007371684	0.04478
1998	2272300073.82	83273655.39	987796644.1	0.044160341	0.045661558	0.03969614	0.013248102	0.031963091	0.045211193	-0.00552
1999	2371857058.57	82448837.17	1055837861	0.043813309	-0.009904912	0.068881806	0.013143993	-0.006933438	0.006210554	0.062671
2000	2491274667.01	81435751.89	1055895691	0.050347726	-0.012287442	5.47715E-05	0.015104318	-0.008601209	0.006503109	-0.00645
2001	2595689811.05	85270429.88	1063796827	0.041912337	0.047088384	0.007482875	0.012573701	0.032961869	0.04553557	-0.03805
2002	2692251100.31	83798324.51	1077007945	0.037200627	-0.017263961	0.012418836	0.011160188	-0.012084773	-0.000924584	0.013343

	K	H	Y	K	h	y	kw	lw	Theoretical Y	A
2003	2774579139.41	85854128.79	1121255048	0.030579629	0.024532761	0.041083358	0.009173889	0.017172933	0.026346821	0.014737
2004	2868627343.25	90035665.1	1270695172	0.033896385	0.048705128	0.133279332	0.010168916	0.034093589	0.044262505	0.089017
2005	3008242221.96	92163850.31	1334358694	0.048669577	0.023637135	0.050101333	0.014600873	0.016545995	0.031146868	0.018954
2006	3160603710.41	93419569.62	1380169417	0.050648012	0.013624857	0.03433164	0.015194404	0.0095374	0.024731804	0.0096
2007	3316795008.36	95050354.35	1401972561	0.049418185	0.017456564	0.01579744	0.014825455	0.012219595	0.02704505	-0.01125
2008	3477927865.59	90017042.55	1293831522	0.048580891	-0.052954161	-0.077134918	0.014574267	-0.037067913	-0.022493646	-0.05464
2009	3635150006	92934763.77	1343088674	0.047857679	-0.052391072	-0.07538843	0.014357304	-0.03667375	-0.022199936	-0.05545