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Examining the relationship between the exchange rate, foreign direct investment and trade

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EXAMINING THE RELATIONSHIP BETWEEN THE EXCHANGE RATE, FOREIGN DIRECT INVESTMENT AND TRADE

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Dedication

I dedicate this dissertation to the almighty God for giving me the strength and courage to continue. To my parents for giving me strength.

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Abstract

Extensive research has been carried out on the relationships among foreign direct investment (FDI), exports, the exchange rate, and economic growth. However, these research findings are mixed and inconclusive. Therefore, further research and discussion are needed on this topic. This study focused on Mexico, since it is one of the major FDI recipient countries in Latin America and much of its trade is a result of its free trade agreements. This study examines the relationship between FDI, exports, and economic growth in the context of FDI from developed to developing countries (Mexico).

The second chapter analyzes the relationship of FDI with the level of the exchange rate, exchange rate volatility, and exchange rate expectations during the period from 1994 to 2008. The analysis revealed a significant impact of level of exchange rates and exchange rate expectations on FDI flows. Regional trade agreements, such as the European Union (EU) and the North American Free Trade Agreement (NAFTA), were important factors to attract FDI.

The third chapter examines the long-run relationship between U.S. FDI and U.S exports to Mexico from 1988Q1 to 2008Q4. This analysis found a complementary (positive) relationship between FDI and exports. However, the strength of the relationship differs with different types of FDI. The analysis further revealed a weak complementary relationship with exports of processed food and a strong positive relationship with manufacturing exports. The study also showed a significant impact of NAFTA on manufacturing and total FDI and an insignificant impact on processed food FDI.

Chapter four examined Granger causality among GDP, exports, and FDI in Mexico for the period of 1970 to 2008. The causality was tested from the bivariate to the multivariate framework using Toda and Yamamoto (1995) and Doland and Lutkepohl (1996) (TYDL) methodologies. An important finding in this study is the Ganger causality from gross fixed capital formation and labor force to imports. The results suggest that the Granger causality between GDP and exports; FDI and GDP; exports and FDI observed in two, three or four variable frameworks are through a channel of imports.

Chapter 1: Introduction

1.1 Introduction

Over the last three decades, Foreign Direct Investment (FDI) has emerged as one of the most important sources of globalization and an important catalyst for economic growth, transferring technology and knowledge between participating countries. FDI also provides opportunities and financial challenges around the world. There exists extensive literature related to FDI inflows and outflows (Barrell and Pain, 1996; Blonigen, 1997; Coughlin, et al., 1991; Cushman, 1988; Pain, 1993). The theories related to the types of FDI suggest two types of FDI: horizontal (market-seeking) and vertical. The international market searching for the lowest cost of production is called vertical FDI, which is mainly export oriented (Shatz and Venables, 2000). Horizontal FDI refers to the establishment of homogenous plants in foreign locations as a means of supplying certain goods in a foreign country. This type of FDI replaces exports from the home country to the host country.

The exchange rate is a crucial factor of FDI flows and some studies on FDI determinants have integrated the exchange rate (Amuedo-Dorantes and Pozo, 2001; Barrel and Pain, 1998; Blonigen, 1997; Buch and Kleinert, 2008; Campa, 1993; Crowley and Lee, 2003; Goldberg and Kolstad, 1995; Guo and Trividi 2002; 1994; Schmidt and Broll, 2009; Steveen 1998; Russ, 2007; Waldkirch, 2003). Previous studies (Barrel and Pain 1998; Klein and Rosengren, 1994; Guo and Trividi, 2002; Buch and Kleinert, 2008) suggest that a depreciation of the host country's currency attracts FDI. In the meantime, other research (Waldkirch, 2003; Campa; Schmidt and Broll, 2009; Amuedo-Dorantes and Pozo, 2001) argues that the appreciation of the host currency attracts FDI.

Mexico is one of the most open market countries in the world (Villarreal, 2010). It joined the OECD in 1994 and is one of the few developing members of the OECD. In the same year, Mexico, the United States and Canada implemented the North American Free Trade Agreement (NAFTA) to reduce trade barriers among Canada, the United States, and Mexico and encourage FDI among the three countries. Previously, under the General Agreement on Tariffs and Trade (GATT), Mexico imposed tariffs of 90%-100% on imported goods and often required import licenses. After NAFTA, the Mexican tariff rates were reduced dramatically, averaging 20% and the requirement for import licensing was largely eliminated (Qasmi and Fausti, 2001).

1.1 Problem Statement of the Study

Trade and FDI are two channels where the firm gains access to the intended market. Fluctuations of the exchange rate generate complications in the international market and affect economies. Appreciation of the home currency may have positive or negative impacts on trade/FDI. The relationship between the exchange rate and FDI has long been discussed in literature, but there still exists controversy on the direction in which the effect will occur.

Complementary and substitutionary relationships between FDI and exports are both reported in previous literature (Alguacila and Ortsa, 2003; Bajo-Rubio and Montero-Munoz, 2001; Head and Ries, 2001; Marchant et al., 2002; Ning and Reed, 1995; Pfaffermayer, 1996), but the literature on the relationship between processed food and manufacturing FDI with exports is sparse. Some literature has reported a complementary relationship (Bolling and Somwaru, 2001; Kim and Kang, 1996; Marchant et al., 2002), while most of studies focused on developing countries where raw inputs are imported by foreign affiliates in the host country. Others studies revealed substitutionary relationships (Blonigen, 1997; Malanoski et al., 1997), therefore the issue has still not been resolved. The strength of the relationship may also be weak or strong depending on the exchange rate. Furthermore, regional trade agreements and exports-oriented policies of countries have treated exports as the principal channel through which openness can promote economic growth (Export-led growth). In addition to this, a stronger impact of FDI on economic growth is found for export oriented policies than for import oriented policies. Results are mixed with respect to FDI-led growth as well as export-led growth. The results differ according to the country examined, time of study, and econometric method used. The majority of studies testing these relationships were conducted based on a two variable context. This study will test the direction of causality using five variables.

1.2 Research Objectives

The overall objective of this study was to test the effect of the exchange rate on FDI and the effect of FDI and exports on economic growth in Mexico. Specific objectives of this study are:

1) To determine the relationship between the exchange rate and FDI inflows into Mexico from OECD countries;
2) To determine the long- run relationship between FDI and exports in Mexican processed food and manufacturing industry types of FDI; and,
3) To test the direction of causality among FDI, exports, and growth in Mexico.

1.3 Justification of the Study

Mexico is the largest FDI recipient in Latin America (UNCTAD, 2002) and among developing countries, the second largest trading country in terms of trade (WTO, 2001). One of the main factors is Mexico's location. Mexico offers its services to the entire North American market, rather than just its domestic market (Graham and Wada, 2000). The successful increase in trade has been accompanied by United States foreign direct investment (FDI) in Mexico following the implementation of NAFTA.

Mexican trade policies of 1980 and NAFTA effectively linked the Mexican economy with the global economy and that of the United States. The growth rate of real gross domestic product (GDP) averaged 2.29% per year during 1981-2009. The growth rate after NAFTA and the peso crisis (1996-2009) averaged 2.84%. This growth rate is lower compared to the import substitution trade policy of Mexico. Therefore, this analysis will determine the effect of the exchange rate on FDI inflows into Mexico as well as the direction of causalities among FDI, exports, and growth. This will shed light on the inflows of FDI to a developing country from developed countries, the relationship between FDI and exports and the direction of causalities among FDI, exports, and growth.

1.4 Outline of the Dissertation

This dissertation is formatted in three "journal-article style" chapters. The second chapter analyzes the relationship between FDI and the exchange rate, exchange rate volatility, and exchange rate expectations. This analysis uses FDI outflows from OECD countries to Mexico using data from 1994 to 2008. All variables are measured on the 2005 price basis (in U.S. dollars). The PPML method (Santos and Tenreyo, 2006) was used to estimate the gravity model.

The third chapter determines the long-run relationship between FDI and exports. This relationship is examined under three different types of FDI (processed food, manufacturing, and total). This analysis utilized quarterly data from 1988Q1 to 2008Q4. The autoregressive distributed lag model (ARDL) developed by Pesaran et al. (2001) was used to test the relationship. The impact of NAFTA on the relationship between FDI and exports was also determined.

Chapter four tested the direction of casualties among FDI, exports, and growth in Mexico. This analysis uses data from 1980 to 2008. The modified Wald statistic was used to test the causal relationship. Model 1 and 3 were in the bivariate framework. In Model 2 and 5, imports are integrated. Finally, the sixth model is derived from the new growth theory as employed by Sala-i-Martin (1995) and Fosu (2006) where exports and imports are used as an additional variable along with labor and capital. Finally, chapter five summarizes the research findings, discusses policy implications, and considers potential opportunities for future research.

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Chapter 2: The Exchange Rate and Inward Foreign Direct Investment in Mexico

2.1 Introduction

An important part of globalization is the increase in trade as well as foreign direct investment (FDI), which has occurred around the world. The largest amount of FDI outflows around the world are from the Organization for Economic Cooperation and Development (OECD) countries. In 2009, 81% of global outward FDI is reported from OECD countries. In the same year, 57% of global inflows of FDI were reported for OECD countries. The highest amount of FDI outflows and inflows is reported in the year 2007 (Figure 2.1 and Appendix 2.1).

For many developing countries, FDI has become an increasingly important source of external financing (UNCTAD, 2011). It brings recent technology, knowledge, employment as well as economic growth to a country. Mexico is one of the developing countries among the member of OECD countries and the largest FDI recipient in Latin America (UNCTAD, 2002). One of Mexico's most important trading partners is the United States and most of its (Mexico's) exports are targeted to the U.S. market. Therefore, it is no surprise that the economies of both Mexico and the United States are deeply intertwined. To make Mexico less dependent on the U.S. economy and to gain some economic benefits, the Mexican government has signed different trade agreements with various countries (Villarreal, 2010). In 1986, Mexico joined the General Agreement on Tariffs and Trade (GATT). Before GATT, Mexico imposed tariffs of up to 100% on imported goods and also required importers to have proper licenses (Qasmi and Fausti, 2001). Since 1990, Mexico has been one of the most open countries in the world with respect to trade

(Villarreal, 2010). It joined both the OECD and North America Free Trade Agreement (NAFTA) in 1994.

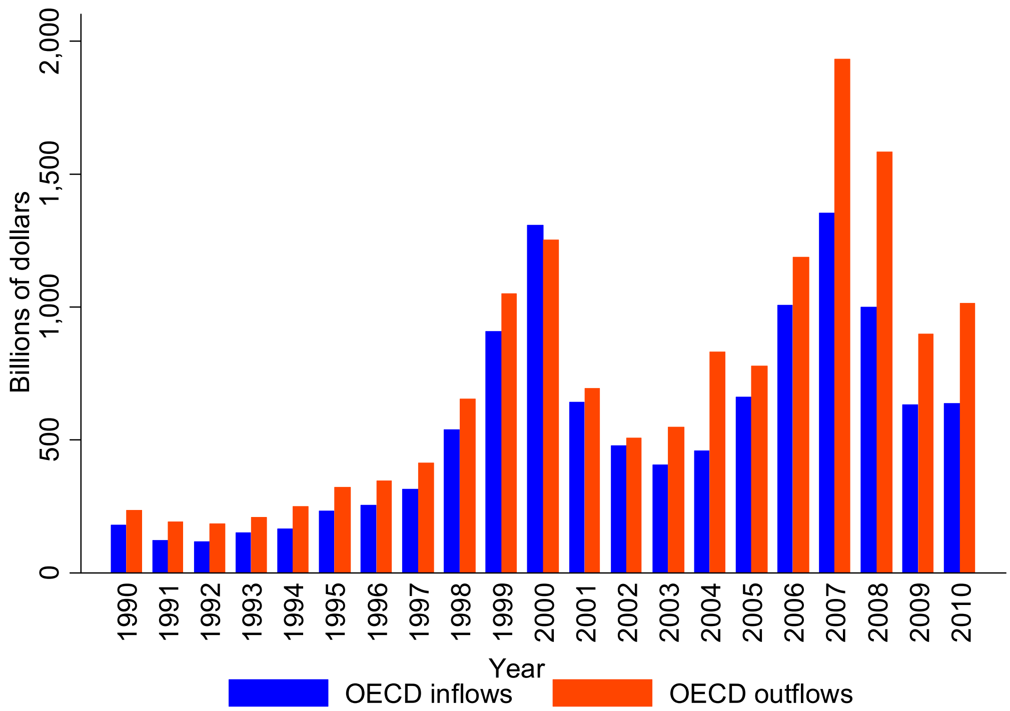

Figure 2.1 Foreign direct investment inflows and outflows in OECD countries
Source: Organization for Economic Cooperation and Development (OECD) Statistics online version.

World FDI inflow into Mexico was around U.S. $27 billion in 2007, decreasing to U.S. $14.4 billion in 2009. From OECD member countries, there was approximately U.S. $25 billion of FDI inflow to Mexico in 2007. This later decreased to U.S. $14 billion in 2009 (Table 2.1). In 2004, approximately U.S. $134 billion of total FDI was allocated to the manufacturing sector with U.S. $3 billion allocated to food industries (Figure 2.2). Total FDI inflows to Mexico decreased to U.S. $8 billion in 1995. Thereafter, FDI flows to Mexico have gradually increased. Furthermore, with Mexico having become a relatively open country (in terms of ease of trading restrictions), its export volume has also increased. Both exports and FDI are also affected by variations in the exchange rate. Under such a scenario, it is very important to study and analyze the impacts that exchange rates and fluctuations in exchange rates have on FDI flows.

Table 2.1 FDI inflows in millions of dollars to Mexico, 1985 to 2009

Year	W	OECD	SA	EU15	NAFTA	EUROPE
1985	5754	3252	-1	777	2040	895
1986	7341	4193	2	1198	2687	1293
1987	5345	2645	-1	678	1373	862
1988	4838	2509	0	616	1838	740
1989	6848	3690	9	928	2397	910
1990	5758	3286	98	825	1941	924
1991	10039	5004	384	1358	3238	1370
1992	14654	7582	66	1475	5826	1523
1993	11229	6260	360	990	4916	987
1994	22827	11326	1048	1951	8124	1898
1995	16822	8139	144	2222	5704	2232
1996	18519	7111	..	1121	5679	1280
1997	24526	11122	..	3089	7461	3155
1998	21251	7290	..	1940	5178	1981
1999	13716	13318	55	3861	8045	3987
2000	17814	17185	102	3189	13389	3343
2001	27168	26331	46	4180	22082	4010
2002	19310	18545	64	4886	12929	5362
2003	15268	14956	49	4638	9810	4980
2004	23673	23297	131	..	9137	13733
2005	21856	18726	737	..	12003	6482
2006	19195	18592	115	..	12886	7062
2007	27174	25196	89	..	12206	12443
2008	22517	20699	156	..	11674	8424
2009	14462	14090	189	..	7855	5846
Total	397905	294343	3839	39922	190418	95723
Total/W	1	0.74	0.02	10.40	4.77	0.50

Source: Organization for Economic Cooperation and Development (OECD) Statistics online version. Own calculation W: World, North American Free Trade Agreement (NAFTA) and South Asia (SA)

Fluctuations in exchange rates and exchange rate volatility in developed countries impact the economy and generate complications in the international market. The influence that exchange rates and exchange rate volatility have on FDI has been discussed previously in the literature.

However, there is still controversy over the direction in which the effect occurs. The depreciation of a host currency with respect to the home currency may have either a positive or a negative effect on FDI flows. Some researchers, such as Campa (1993); Rivoli, (1996), explain the positive relationship (home per host currency) and others, like Cushman (1985, 1988); Goldber and Kolstad (1995), suggest a negative relationship. Cushman (1985) included real exchange rate risk and expectations in their FDI model and concluded that an increase in future changes in the exchange rate reduce exports, but also attract market- seeking FDI. The negative impact of the exchange rate on export oriented FDI was reported by Lecraw (1991). In the meantime, Campa (1993) included expectations of the exchange rate and exchange rate volatility in the model, suggesting that the depreciation of the host country's currencies against that of the home country's decreases FDI due to the association of the lower level of exchange rate (with the lower level of expected profit in terms of the home currency). Froot and Stein (1991) established the capital imperfection theory of exchange rate and suggested that the depreciation of the host currency is positively related with FDI. The depreciation of the host currencies relatively increases the wealth of the investors and increases the FDI inflow.

Most of the literature related to FDI inflows/outflows along with exchange rate related variables have primarily focused on developed rather than less-developed countries. The limited research on FDI flows into developing countries is attributed to the lack of reliable FDI data, as well as the shortage of capital in developing countries (Thomas and Grosse, 2001; Majeed and Ahmad, 2007). FDI inflows into developing countries are mainly due to countries with relatively low production costs for things such as raw materials and labor (Shatz and Venables, 2000). The limited amount of research conducted on FDI flows into developing countries motivated me to study inward FDI into Mexico from developed countries (OECD).

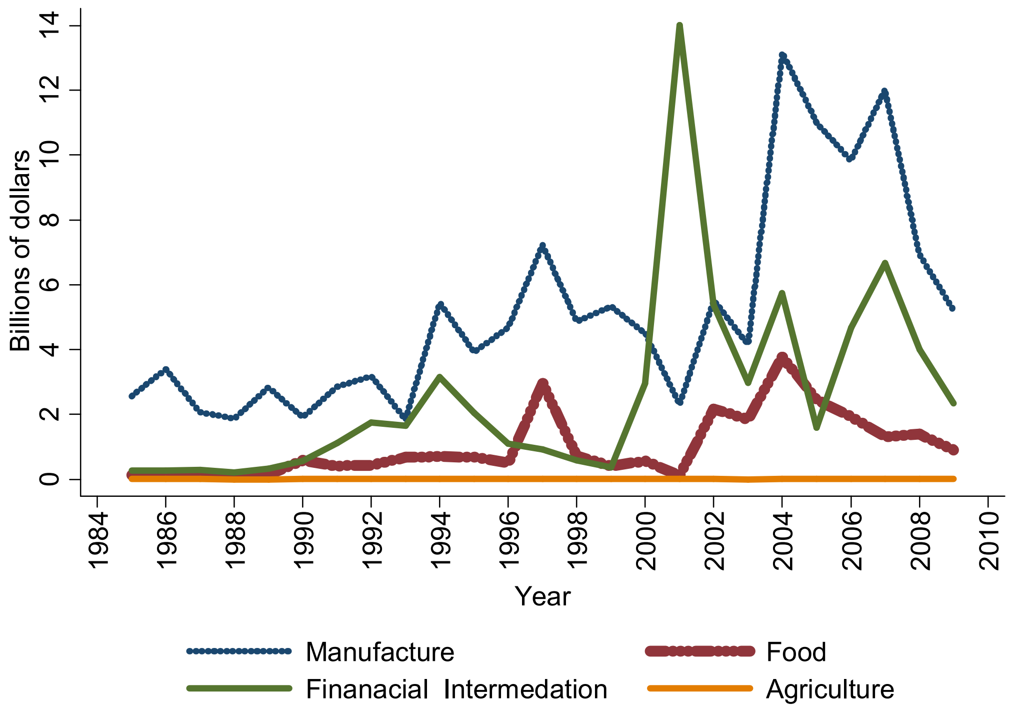

Figure 2.2 Foreign direct investment inflows allocation in Mexico
Source: Organization for Economic Cooperation and Development (OECD) Statistics online version.

The study plans to explain the relationship between exchange rates, exchange rate volatility, and expectations of exchange rates with FDI by looking at the case of developed and developing countries. The Poisson pseudo- maximum likelihood (PPML) econometric method is used to test the relationship between exchange rates and FDI. Annual FDI inflow data into Mexico from 25 OECD countries for the period 1994 to 2008 were used for the analysis. The research results suggest that exchange rates and expectations of the exchange rates are positively related with FDI. Exchange rate volatility did not show a significant impact on FDI flows. Wage, interest rate, regional trade agreements, language, the capital labor ratio, and distance variables are significant and help to explain inward FDI flows. This study differs from previous work in that the timeframe we consider allows for sufficient data post-NAFTA implementation and post-OECD creation.

2.2. Literature Review

2.2.1 Determinant of Foreign Direct Investment

There exists extensive literature related to FDI inflows and outflows (Barrell and Pain, 1996; Blecker, 2009; Blonigen, 1997; Coughlin et al., 1991; Cushman, 1988; Pain, 1993)[1]. Theories related to the types of FDI suggest that there are two types of FDI: horizontal (market-seeking) and vertical. The international market searching for the lowest cost of production is called vertical FDI, which is mainly export oriented (Shatz and Venables, 2000). Horizontal FDI involves the establishment of homogenous plants in foreign locations as a means of supplying certain goods in the foreign country. This type of FDI replaces exports to the host country from the home country. Gross Domestic Product (GDP) and Gross National Product (GNP) serve as proxies for market size. The larger the size of the home market, the larger the firm will be and the more capable it will be in expanding abroad. In this situation, the GDP of the home country is positively related to FDI. There is a host of literature that show a positive relationship between FDI and GDP (e.g., Barrel and Pain, 1996; Campa, 1993; Chakrabarti, 2001; Culem, 1988). Groose and Trevino (1996) stated that the size of the home country's market, which serves as a proxy for the number of domestic firms, is positively related to the amount of FDI in the host country. Bevan et al. (2004) examined the determinants of FDI in European transition economies using panel data from 1994 to 2000 and reported a positive relationship between GDP and FDI.

[1] See Blonigen (2005) for literature on FDI determinants.

In some cases, domestic demand deficiencies are important reasons for a home country to invest in a foreign market. In such situations the home country's GDP could be negatively related to FDI (Pitelis, 1996). Per capita GDP measures labor productivity and it is expected that high labor productivity encourages FDI. It is also assumed that higher wage rates discourage inward FDI, so the expected sign for the inward FDI coefficient could either be positive or negative. Thomas and Grosse (2001) reported the negative relationship of GDP and inward FDI for Mexico during the period of 1980-1995 using the Generalized Least Squares (GLS) method. Brozozowski (2006) studied FDI flows from the European Union (EU) into Mexico for the period from 1994 to 1997 and suggested that GDP and real per capita GDP are significant variables in explaining FDI flows. The relationship between FDI and growth in per capita GDP is negative. Pan (2003) studied inward FDI in China for the period of 1984 to 1996 and found a significant, but negative relationship. The above literature indicates that inward FDI into a developing country does not hold the same as it does for a developed country.

The cost of borrowing money is assumed to be the financing cost, which is born by the home country. Lower costs of borrowing money in the home country attract inward FDI in the host country. There is, therefore, a negative relationship between the cost of borrowing and inward FDI. Grosse and Trevino (1996) found that the cost of borrowing for the home country affects outward FDI flow from the United States. The relatively high interest rate in the host country increases inward FDI. However, if the foreign investor is using capital available in the host countries, the relationship could be negative. Ramasamy and Yeung (2010) found that the cost of borrowing was negative and significant for both the manufacturing and service sectors. There are numerous studies that show a negative relationship between FDI and the cost of borrowing (e.g., Ajami and BraNiv, 1984; Liu et al., 1997; Love and Lage-Hidalgo, 2000; Pan, 2003; Thomas and Grosse, 2001).

Whether trade and FDI can be viewed as complements or substitutes remains questionable. A complementary relationship indicates that both trade and FDI move in the same direction in the foreign market (e.g., Alguacila and Orts, 2003; Head and Ries, 2001; Lipsey and Weiss, 1981; Marchant et al., 2002). A substitutionary relationship indicates that with an increase in FDI, exports would decrease (e.g., Gopinath et al., 1999). Grosse and Trevino (1996) reported that trade's ability to determine inward FDI was negative and significant. However, the subdivision of trade flows into imports and exports showed a significant and positive relationship with the FDI determinant. Pain and Wakelin (1998) studied the relationship between FDI and manufacturing exports, taking into consideration the data of 11 OECD countries since 1971. They found that the relationship between trade and FDI varies across countries.

The home country invests in the host country in order to obtain the advantages of the lower manufacturing costs in the host country. Lower relative wage costs will encourage FDI inflows. The lower labor cost reduces total cost, especially in labor intensive manufacturing industries. As labor costs decrease for a host country, the attractiveness (to the home country) of that host country increases with respect to FDI. Thomas and Groose (2001) found a negative effect for wages in a subsample on efficiency seeking FDI into Mexico. This might not be the case if the inward FDI is in the service sectors, where wages are higher than they are in other sectors. Love and Lage-Hidalgo (2000) reported that cheap labor available in Mexico is positively related with FDI inflows to Mexico. This is supported by Ramasamy and Yeung (2010), who also reported a positive relationship between labor cost and FDI in service sectors. Geographical distance has been used to approximate transportation costs and it is widely known to have a negative impact on FDI[2]. Goldberg and Grosse (1994) reported the relationship between distance and FDI to be negative. Greater distances are considered negative transaction costs that could potentially hinder the ability of an economic agent in entering a foreign market. Increased physical distance tends to lower the amount of FDI flows into the host country from home countries. Hejazi (2005) studied the exports and outward FDI of OECD countries and reported a negative relationship between distance and FDI. The negative relationship between distance and FDI was also reported by Bergstrand and Egger (2007); Gopinath and Echeverria (2004); Mello-Sampayo (2007). However, in the study of Vita and Abbott, (2007) they reported a positive relationship between the United Kingdom inward FDI and distance.

2.2.2 Foreign Direct Investment and Exchange Rate

The literature related to the interrelationship between the exchange rate, exchange rate volatility, and exchange rate expectations with FDI is mixed. There is no clear statement as to how exchange rates affect FDI. There are several channels through which the level of the exchange rate affects FDI. Given an imperfect capital market, real exchange rate depreciation of the host country currency stimulates FDI (Froot and Stein, 1991). In this situation, we expect a negative relationship of the exchange rate (home per host currency) and FDI. The strong negative impact of the exchange rate depreciation of the host currency was also reported by Barrel and Pain (1998); Blonigen and Feenstra (1997); Blonigen (1997); Cushman (1985, 1988).

Froot and Stein (1991) reported that the depreciation of U.S currency increased foreign acquisition of U.S firms in the post-1985 time period by linking the real exchange rate and the wealth of the investor with FDI. Their results suggest that with the imperfect capital market, a depreciation of the host country's currency increases the relative wealth of foreign firms,

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[2] The role of distance on trade can be found on Anderson, 1979; Bergstrand, 1985.

allowing more foreigners to invest in the United States. Evidence of the wealth effect on FDI was also reported by Klein and Rosengren (1994). Meanwhile, Blonigen (1997) studied Japanese foreign direct investment in the United States using panel data. His findings are consistent with the findings of Froot and Stein (1991). The main assumption of his study was that firms produce and sell only in their home market. Guo and Trividi (2002) re-examined Japanese FDI in the United States and his findings corroborate those of Blonigen (1997). Cushman (1985, 1988) derived a theoretical model based on host inputs used for production processes and found that a depreciation in a host's currency increased FDI flows. This is in line with the findings of Froot and Stein. Recently, Buch and Kleinert (2008) tested the capital market (Froot and Stein, 1991) and the good market hypotheses (Blonigen, 1997). They found a positive relationship between FDI and the appreciation of the home currency. Further, they reported a weaker relationship of appreciation of the home currency and FDI for export oriented countries. Studies such as Barrel and Pain (1998) found that a depreciation in the host countries' currencies increased FDI flows.

Some of the studies (e.g. Campa, 1993; Schmidt and Broll, 2009; Steveen, 1998; Waldkirch, 2003) lend credence to the perception that a real appreciation in a host country's currency attracts FDI. In such a scenario we can expect a positive relationship between FDI and the real exchange rate. Waldkirch (2003) studied foreign direct investment flows into Mexico for the period 1980 to 1998 and reported that an appreciation of host currency increases FDI flows. However, Amuedo-Dorantes and Pozo (2001) noticed no statistically significant relationship between the level of the exchange rate and inward FDI flows into the United States. Campa (1993) suggests that capital flow increases the productivity of the firms in the host country and under such a condition, it would be reasonable to assume that a host country's currency would appreciate.

Gorg and Wakelin (2002) studied the effect of a leveled exchange rate, exchange volatility, and exchange rate expectations on outward U.S. FDI flows to developed countries; as well as FDI inflows to the U.S from those same developed countries for the period 1983 to 1995. They proposed that the exchange rate volatility and exchange rate expectations are closely related, as suggested in Campa (1993). The results suggest there is a positive relationship between U.S outward FDI and appreciation of host countries' currencies although, a negative relationship between host countries' currencies and inward FDI into the United States. There is no evidence of the effect of exchange rate volatility and exchange rate expectations either on outward or inward FDI. However, Schmidt and Broll (2009) found that exchange rate expectations of the host currency reduces U.S outward FDI, but the appreciation of the host currency was found to be positively related with FDI flows. Crowley and Lee (2003) studied the relationship between exchange rate volatility and foreign investment between the United States and 17 other OECD countries during the period of 1980 to 1998 under a regime of flexible exchange rates. This study reported a weak effect of exchange rate volatility on FDI. This relationship differs across countries due to differing currency valuations. Countries with a stable exchange rate were found to be the least affected by exchange rate volatility. They also emphasized that the relationship between the exchange rate and FDI is weak if exchange rate volatility is small and vice versa.

Cushman (1985) includes real exchange rate risk and expectations on FDI and concluded that an increase in future changes reduces exports, but increases market-seeking FDI. This holds as long as the foreign affiliate firms' production is not exported to the home country. Cushman (1988) found similar results between exchange rate volatility and inward U.S. FDI. Goldberg and Kolstad (1995) found that exchange rate volatility increases U.S. FDI abroad. Recent findings of Russ (2007) are consistent with those of Goldberg and Kolstad (1995). This literature shows a mixed relationship between FDI, the exchange rate, exchange rate volatility and exchange rate expectations. The relationship differs across countries as well as with the time period considered for the analysis. Therefore, this study will investigate the determinants of FDI in Mexico and the relationships between the exchange rate, exchange rate volatility, exchange rate expectations, and FDI. To test those relationships, theoretical and empirical models are developed in section 2.4. In section 2.5, the empirical results are presented. The last section summarizes and provides conclusions for the study.

2.3 Methodology and Data

2.3.1 The Model

The gravity model is based on an analogy of Newton's Law of Gravity, which has been applied most often to analyze bilateral trade (Bergstrand, 2007; Feenstra et al., 2001; Silva and Tenreyro, 2006; Siliverstovs and Schumacher, 2009). Tinbergen (1962) and Pöyhönen (1963) first employed a gravity model to study international trade. The first theoretical foundation for the gravity model to analyze trade was derived by Anderson (1979) and was based on a constant elasticity of substitution (CES) utility function. Later, Bergstrand (1985) also derived the gravity model based on CES utility. Deardorff (1995) derived a gravity model using CES utility and the Heckscher-Ohlin theory of international trade. The theoretical foundations of the gravity model explaining trade flows (e.g., Anderson, 1979; Helpman, 1987; Leamer, 1974; Deardorff, 1995; Bergstrand, 1985) have been well documented. According to the gravity model of trade, transportation costs and trade barriers tend to discourage trade flows and the market size of both the host and home country tend to encourage trade.

The use of the gravity model as an explanation of FDI has increased in recent years. It has been became the most popular and widely used method in analyzing the importance of countries' attractive location factors for FDI (Brainard, 1997; Grosse and Trevino, 1996; Lipsey and Weiss, 1981; Lipsey and Weiss, 1984). Recent work has had relatively little success in the derivation and establishment of theoretical aspects of the gravity model as it relates to FDI (Bergstrand and Egger, 2007; Helpman and Yeaple, 2004; Keller and Yeaple, 2009; Kleinert and Toubal, 2010). Helpman and Yeaple (2004) derived a theoretical foundation based on the interaction between exports and foreign affiliates' sales, in which a firm either chooses to export or stream FDI. Kleinert and Toubal (2010) extended the work of Helpman and Yeaple (2004), allowing for a fixed set up cost that increases with an increase in distance. The traditional gravity model for FDI suggests that market size (home and host country) and the corresponding distance between two countries have positive relationships with FDI. The gravity theory of international trade uses the distance decay theory. However, the FDI gravity framework uses the distance incentive theory. As the distance between two participating country increases, transportation costs also increase. Thus, it will be preferable to produce in the host country rather than export from the home country (Brainard 1993, Markusen and Venables, 2000).

In this study, the theoretical gravity model for FDI is derived by following the method outlined in Kleinert and Toubal (2010), which draws from the proximity concentration theory. First, the theoretical model is derived for foreign production with domestic inputs. The utility function for the foreign consumer is defined by the Cobb-Douglas production function,

$$U_f = X_{Af}^{\alpha} X_{Mf}^{(1-\alpha)} \qquad (2.1)$$

where $0 < \propto < 1$; A represents the agricultural sectors which produce a homogenous good, and M represents the manufacturing sectors of differentiated products. Suppose there are *j* firms in the home county that produces a differentiated product. The foreign consumer can choose a single variety from those differentiated products. The consumption of the manufacturing goods in the foreign country, X_{Mf} , is a substitubility function of CES type and is defined as

$$X_{Mf} = \left[\int_h^N \int_j^N x_{Jhf}^{(\sigma-1)/\sigma} \; djdh \right]^{\sigma/(\sigma-1)} \qquad (2.2)$$

where, x_{jhf} signifies a foreign country's (*f*) consumption of a single product produced by firm *j* in the home county (*h*); σ is the elasticity of substitution, the larger σ signifies the greater the degree of substitutability between products. For the CES utility, σ is greater than one and is the same for any pair of products. Assuming monopolistic competition among homogenous firms and homogenous products, equation (2.2) is simplified to the product $X_{Mf} = n_h x_{hf}^{(\sigma-1)/\sigma}$ where n_h signifies the number of home country's firms in equilibrium. The price of manufacturing that particular good in a foreign country for consumption in the foreign county is represented as:

$$P_{Mf} = \left[\int_h^N n_h \, p_{hj}^{1-\sigma} \, d_h \right]^{1/(1-\sigma)} \quad (2.3)$$

M is removed to simplify the equation for further derivation. Home country sales to the foreign market depend upon the prices between the countries, p_{hf}, and the market size, Ψ_f, of the foreign country. Foreign demand is given by:

$$x_{hf} = p_{hf}^{-\sigma}(1-\alpha)\Psi_f P_f^{\sigma-1} \quad (2.4)$$

where x_{hf} and p_{hf} signify the quantity and the price of that good which is produced in the home country and sold in the foreign country, respectively; P_f , Ψ_f signify the price index and market size, respectively, in the foreign country. Firms obtain access to foreign markets either through exports or by producing in the foreign country. Therefore, a firm chooses to produce abroad if it is more profitable than exporting and this condition is expressed as:

$$\pi_h^{MNE} - \pi_h^{Ex} > 0 \Leftrightarrow (1-\varphi)\left[p_{hf}^{MNE} x_{hf}^{MNE} - p_{hf}^{Ex} x_{hf}^{Ex}\right] > c_f \qquad (2.5)$$

where $\varphi = \sigma/(\sigma-1)$ and c_f signifies the fixed cost for the establishment of the said manufacturing plant in the foreign country. The entry of the firm in the foreign country is determined by the level of fixed costs and by the difference in sales in the foreign market. It could be possible that either all of the firms in the home country have affiliations in the foreign country or none of the firms of the home country have affiliations in the foreign country. Exports to the foreign country incur distance costs of the iceberg type. Iceberg types of models define price in multiplicative terms. The distance cost between the home country and the foreign country are denoted by τ_{hf}. Thus, the price of the home country goods in the foreign country is given by the following multiplicative expression:

$$p_{hf}^{Ex} = p_{hh}\tau_{hf} \qquad (2.6)$$

The above relationship suggests that with an increase in distance, the price of exports to the foreign country also increase. Further, assuming that foreign affiliate's import intermediate inputs from the home country, the variable cost incurred by the foreign affiliates in the foreign country is given by:

$$VC_f = \left(\frac{w_f}{\delta}\right)^{\delta} \left(\frac{q_{hf}}{1-\delta}\right)^{1-\delta} \quad (2.7)$$

where, VC_f is the foreign country variable cost; δ is the cost share for labor and imports; w_f *and* q_{hf} are the wage in foreign country and price for the imported goods, respectively. With an increase in distance, the price of imports of intermediate inputs by the foreign affiliates in the foreign country is also increased by the distance cost of the iceberg type. Therefore, the quantity demanded in the foreign country is denoted by $q_{hf} = q_{hh}\tau_{hf}$. The marginal cost $p_{hf} = c_{hf}/\varphi$ increases as distance costs increase. Hence, the price of the goods produced in the foreign affiliates also increases. The profits of the home country's firms may be higher by producing abroad rather than by exporting. The total foreign affiliate's production of the home countries' firms to a foreign country is given by:

$$n_h p_{hf} x_{hf} = n_h p_{hh}^{(1-\sigma)} \tau_{hf}^{(1-\sigma)(1-\delta)} (1-\alpha)\, \Psi_f P_f^{\sigma-1} \quad (2.8)$$

According to Redding and Venables (2003), the terms $n_h p_{hh}^{1-\sigma}$ and $(1-\alpha)\, \Psi_f P_f^{\sigma-1}$can be considered as the supply capacity of the home country and the demand capacity for the foreign country, respectively. The distance cost between two countries is therefore an increasing function of geographical distance, $\tau_{hf} = \tau D_{hf}^{\omega_1}$. The τ is the unit distance costs and $\omega_1 > 0$. The gravity equation is specified as:

$$ln(AS_{hf}) = \beta_0 + \gamma_1 ln(s_h) - \phi_1 ln(D_{hf}) + \omega_1(m_f) \qquad (2.9)$$

where $\beta_0 = (1-\sigma)(1-\delta)\, ln\tau$, $\phi_1 = (\sigma-1)(1-\delta)\omega_1$; the variable AS_{hf} signifies sales by foreign affiliates, s_h and m_f are the home supply capacity and foreign demand, respectively and D_{hf} is the distance between the home and foreign countries. The coefficient of the distance is negative since $\sigma > 1$.

The standard gravity model is extended to include exchange rates, interest rates, and relative imports to host countries (e.g. Goldberg and Klein, 1998; Santis et al., 2004). The process of economic integration also seems to influence the patterns of FDI dispersion (Blomstrom and Kokko, 1997). Thus, the standard gravity model is extended to include regional dummies for the North American Free Trade Agreement (NAFTA) and the European Union (EU). These dummy variables pick up persistent deviations between the model's predictions and trade with each region. Following the literature and theoretical foundation, the Gravity Model to explain FDI can be written as:

$$FDI = f\left(GDP_h, GDP_f\ , Dist,\right) \qquad (2.10)$$

$$FDI = f\left(GDP_h, GDP_f\ Dist, \sum_k DK_{hf}\right) \qquad (2.11)$$

$$DK = f(\ ER, IR, wage, EXV, IM, EU, \dots, NAFTA) \qquad (2.12)$$

The econometric model for the equations (2.10 and 2.11) can be written as:

$$FDI_{hft} = \propto_0 + \ \beta_1 GDP_{ht} + \beta_2 GDP_{ft} + \beta_3 DIST_{hf}\ + \gamma_h + T\ +\ \varepsilon_{hft} \qquad (2.13)$$

$$\begin{aligned} FDI_{hft} = \propto_0 + \ & \beta_1 GDP_{ht} + \beta_2 GDP_{ft} + \beta_3 DIST_{hf} + \beta_4 KLR_{hft} +\ \beta_5 (r_d - r_f)_{hft} \\ & + \beta_6 (w_d - w_f)_{hft} +\ \beta_7 ER_{hft} + \beta_8 ERV_{hft} + \beta_9 trend_{hft} +\ \beta_{10} IM_{ft}\ + \beta_{11} EU_h \\ & + \beta_{12} NAFTA_t\ +\ \gamma_h + T\ + \varepsilon_{hft} \qquad (2.14) \end{aligned}$$

where, FDI_{hft} is the outward FDI from OECD countries (home) to Mexico (foreign) at time *t*; γ_h and *T* are the country and time fixed effects, respectively; ε_{hft} denotes the error (white noise) term. The market size variable is a proxy by gross domestic product (GDP). GDP_{ht} and GDP_{ft}

are gross domestic product for both home and host countries, respectively. The expected sign of home country GDP is positive. The host market size variable could either be positively or negatively related to FDI. Relative difference in wages between home and host country $(w_d - w_f)_t$ is positively related with FDI. The higher the relative difference is, the higher the level of FDI will be. The relative difference in interest rate, $(r_d - r_f)_t$, is negatively related with FDI. The real exchange rate (host per home), ER_{hft}, is either positively or negatively related with FDI. Exchange rate volatility,(ERV_{hft}), and the exchange rate expectation, $(trend_{hft})$, are calculated following the method of Campa (1993). Exchange rate volatility is the annual standard deviation of the monthly change in the log of the exchange rate. Trend measures the average rate of change in the log of monthly exchange rates and is calculated on the basis of two assumptions. In the first case, trend is derived by the log of the annual mean of the monthly change for the exchange rates in years *t-1* and *t-2,* which is denoted as 'static forecast.' In the second case, it is derived by annual mean of the monthly change in the logs of exchange rates in years *t+1* and *t+2*, which is denoted as 'perfect forecast.' The association between home exports and FDI is either positive or negative. The relative factor endowment ratio, KLR_t , at time *t* is proxied by the relative capital labor ratio between home and host countries and is expected to be positively related with vertical FDI. The cost associated with importing goods to the host country from the home country is approximated by the distance ($DIST_{hf}$) between the two countries. The coefficient of distance is negatively related with FDI. The variables denoting membership in both the European Union (EU) and NAFTA are expected to be positive.

2.3.2 Data

In this study, we used the data of 25 OECD countries from 1994-2008 to analyze the effect of the exchange rate and determinants of the FDI into Mexico. The panel data utilized represents a good cross section within the time period studied in this research. The variables are measured in real terms by using the gross domestic product deflator. The dependent variable is annual FDI inflow as percent of Mexican GDP. FDI is obtained from OECD statistics. Gross Domestic Product (GDP) is extracted from Penn World Table version 7.0. The real exchange and real interest rates are constructed using data from the International Financial Statistics CD-ROM, IMF (2010) following the method of Waldkirch (2003). The data on home exports to host country and wage data were obtained from OECD statistics. The factor endowment ration is derived by using data from the World Development Indicator, World Bank (2011). The geographical distance between countries was calculated using the World Clock's (2011) distance calculator. See Appendix 2.2 for the variable definition and sources.

2.3.3 Econometric Estimation

The gravity model is a very popular empirical approach that seeks to answer numerous trade related questions and has a relatively well-documented theoretical foundation (Anderson, 1979; Bergstrand, 1985; Deardorff, 1995; Helpman, 1987; Leamer; 1974). It is also widely applied to determine the attractiveness of a particular market for FDI (Bergstrand and Egger, 2007; Helpamn and Yeaple, 2004; Keller and Yeaple, 2009; Kleinert and Toubal, 2010). The gravity model is log linearized to estimate the parameters of the model. The log linear gravity model discards zero values of the dependent variable, which tend to yield biased estimated coefficients (Martin and Phan, 2008; Silva and Tenreyo, 2006). To remedy this, some studies have added the value of one to values of the dependent variable as a means of accounting for zero values; the estimated coefficients are still biased (Baldwin and Nino, 2006). The use of the panel fixed effect controls for unobserved heterogeneity, but does not account for zero values. In addition, constant terms are lost and sample selection bias is created (Egger and Pfaffermayr, 2003).

Additionally, the recent econometric work of Silva and Tenreyo (2006) proved that estimation of the gravity model using ordinary least square (OLS) is severely biased if there are zero values in the dependent variable and the errors do not have constant variance (heteroskedasticity). He provided the comparative analysis of the OLS and Poisson pseudo-maximum likelihood (PPML) methods and concluded that the estimation of the log linear gravity equation is problematic. Meantime, some studies (e.g. Head and Ries, 2008; Siliverstovs, 2009) provided the support for the PPML method as opposed to using OLS.

However, Martin and Pham (2008) argued that the econometric findings of Silva and Tenreyo are only consistent if there is heteroskedasticity in the data, but such results could produce severely biased estimators if there are numerous zero values. Again, Silva and Tenreyo (2011) argued that the model specified in Martin and Phan (2008) was poorly specified and confirmed that PPML is still a valid estimation procedure, even if there are large zero values in the dependent variable. Therefore, in this paper we followed the PPML method in determining the determinants related to FDI and in my analysis regarding the relationship between FDI and the exchange rate.

From the Silva and Tenreyro (2006), the conditional mean for the equation (2.13 and 2.14) can be defined as:

$$E\left[FDI_{hf}/x_{hf}\right] = \mu\left(x_{hf}\beta\right) = exp\left(x_{hf}\beta\right)$$

$$= exp\left(\propto_0 + \beta_1 lnGDP_{ht} + \beta_2 lnGDP_{ft} + \beta_3 lnDIST_{hf} + \gamma_h + T + \varepsilon_{hft}\right) \quad (2.15)$$

$$E\left[FDI_{hf}/x_{hf}\right] = \mu\left(x_{hf}\beta\right) = \exp\left(x_{hf}\beta\right)$$

$$= \exp(\propto_0 + \ \beta_1 GDP_{ht} + \beta_2 GDP_{ft} + \beta_3 DIST_{hf} + \beta_4 KLR_{hft} + \ \beta_5 (r_d - r_f)_{hft}$$

$$+ \beta_6 (w_d - w_f)_{hft} + \ \beta_7 ER_{hft} + \beta_8 ERV_{hft} + \beta_9 trend_{hft} + \ \beta_{10} IM_{ft} \ + \beta_{11} EU_h$$

$$+ \beta_{12} NAFTA_t \ + \ \gamma_h + T \ \ + \varepsilon_{hft} \qquad (2.16)$$

where γ_h and T are the country and time fixed effects, respectively. Following Cameron and Trivedi (2005), the Poisson distribution function for the above equations can be written as

$$Prob\left[FDI_{hf} = FDI/x_{hf}\right] = \frac{exp\left[-\mu\left(x_{hf}\beta\right)\right]\left[\mu\left(x_{hf}\beta\right)\right]^{FDI_{hf}}}{FDI_{hf}!} \qquad (2.17)$$

where, FDI_{hf} = 0, 1, 2, . . . , ! is the factorial of FDI. In the Poisson distribution, variance and mean are the same (Equi-dispersion) since this is the property of the Poisson distribution. Therefore, the variance and mean of FDI_{hf} are equal to$\left(x_{hf}\beta\right)$. Given the Poisson distribution function, the log-likelihood function is written as:

$$lnL(\beta) = \textstyle\sum_{h=1}^{N}\sum_{f=1}^{N}\left[FDI_{hf}\left(x_{hf}\beta\right) - exp\left(x_{hf}\beta\right) - lnFDI_{hf}!\right] \qquad (2.18)$$

The Poisson maximum likelihood estimator, $\widehat{\beta_P}$, has the following first order condition:

$$\sum_{h=1}^{N}\sum_{f=1}^{N}\left[FDI_{hf} - exp\left(x_{hf}\beta\right)\right] x_{hf} = 0. \qquad (2.19)$$

Equations (2.16) imply that the expectation is zero if $E\left(FDI_{hf}/x_{hf}\right) = \ exp\left(x_{hf}\beta\right)$. Hence, the estimator that maximizes equation 2.18 is consistent, even in entries for FDI_{hf} that do not have a Poisson distribution signifying that entries for FDI_{hf} do not necessarily need to be integers. The equation weights all observations the same. According to Silva and Tenreyro, all observations provide the same information on the curvature of the conditional mean coming from observations with large $\exp(x_{hf}\beta)$, which is offset by their larger variance. The equation 2.19 is numerically equal to the Poisson pseudo- maximum likelihood (PPML). This method is the proper solution by which heteroskedasticity can be accounted for and allows for zero values in the dependent variable in the gravity model estimation. My data suggest the presence of heteroskedasticity and zero values for the dependent variable for some countries. The PPML is performed using the STATA 11 statistical software package.

2.4 Result and Discussion

The purpose of this study is to analyze the determinants that stimulate FDI flows from the OECD to Mexico and analyze the impacts of the level of exchange rates, exchange rate volatility, and exchange rate expectations have on FDI flows. This section presents the econometric estimation of the gravity model of FDI. The study is comprised of data for 25 OECD countries for the period 1994 to 2008. The data set is unbalanced. The Breusch and Pagan LM test suggested the presence of heteroskedasticity. Furthermore, some dependent variable values are zero. Given this, it was deemed that the Poisson pseudo-maximum likelihood (PPML) method was the more appropriate econometric approach.

The result (Model1) suggests that the home country GDP is positively related with FDI flows to Mexico. These findings suggest that the larger the market size is for the home country, the higher the levels of FDI. This is in line with gravity models such as Grosse and Trevino 1996; Hejazi, 2005; Kleinert and Toubal, 2010; Thomas and Grosse, 2001. The GDP coefficient for the host country is positively related with FDI flows, which is consistent with the theory related to the Gravity model (Kleinert and Toubal, 2010; Xuan and Xing, 2008). The coefficient of distance is negatively related with FDI, which is consistent with foreign production with domestic intermediate inputs. The greater the distance between countries, the higher the cost will be for the importation of those intermediate inputs into Mexico. This finding is consistent with findings of Grosse and Trevino (1996); Thomas and Grosse (2001); Hejazi (2005). Also, a greater distance between two countries will cause the goods produced by foreign affiliates in Mexico to be more expensive in the home market. This ultimately inhibits exports oriented FDI. In contrast to our findings, previous research (e.g., Vita and Abbott, 2007) has reported a positive relationship between FDI and distance. Thus, it can be assumed that the greater the distance between two markets, the greater the level of FDI (primarily market-seeking FDI). One of the important constraints in the model is that the coefficient for home GDP is one. This is not supported by the data, which is consistent with the finding of Kleinert and Toubal (2010).

This paper also tests for the impacts of exchange rates, exchange rate volatility, and exchange rate expectation on FDI. The exchange rate volatility and the exchange rate expectation variables were generated after the method of Campa (1993). In the present study, the United States is the single most important source of FDI in the Mexican economy. Likewise, the United Kingdom, Germany, and Spain are the largest European investors in Mexico. Cultural similarities such as similar languages between two countries may also impact FDI flows. Therefore, the model was extended to include a dummy variable for the United States, European countries, and those countries sharing a common language. In addition, wages, interest rates, level of exchange rates, exchange rate volatility, exchange rate expectations, and capital labor ratios were also included in the model.

In Models 2 (static forecast) and 3 (perfect forecast), the sign of the coefficient of the home country GDP did not change, however, the sign of the coefficient for host GDP changed

Table 2.2 Results of the Poisson regression

Variables	Model1	Model2[1]	Model3[2]
Constant	-0.038(0.499)	7.273(1.764)***	10.348(1.692)***
lnGDPh	0.199(0.003)***	0.110(0.007)***	1.692(0.007)***
lnGDPf	0.141(0.023)***	-0.447(0.090)***	-0.611(0.086)***
lnDIST	-0.356(0.119)***	-0.295(0.097)***	-0.320(0.097)***
$\ln(w_d - w_f)$		0.154(0.019)***	0.159(0.019)***
$(r_d - r_f)$ (10^{-3})		1.358(0.086)***	1.293(0.086)***
ln IM(10^{-3})		4.356(8.531)	1.854(8.554)
KLR		0.224(0.020)***	0.239(0.020)***
ER (10^{-3})		1.192(0.097)***	1.212(0.097)***
ERV (10^{-3})		-0.065(0.077)	0.074(0.081)
Trend		11.216(1.738)***	0.589(0.132)***
NAFTA		0.866(0.115)***	0.896(0.115)***
EU		0.077(0.025)***	0.079(0.025)***
Lag		0.729(0.031)***	0.719(0.031)***
Observations	400	374	374
Test GDPh =1 p-value	0.00	0.00	0.00
Pseudo R2	47	64	64.25

Note: *** significance at the 1% level. Figures in parenthesis are standard errors. [1] Static forecast; [2] Perfect forecasts

to negative. A negative sign for host GDP is at odds with the assumption of the theoretical model under the scenario of foreign production with intermediate domestic goods. This suggests that for developed countries, the theorized relationships in attracting FDI do not always perform similarly to those in developing countries. The main reason for flows of FDI into a developing country is the attempt at minimization of production costs and these flows are mostly export oriented either to the home country or to third party countries (Büthe and Milner, 2008). Furthermore, the FDI in Mexico is targeted to the U.S. and other North American markets. This could be a potential reason why the relationship between Mexican GDP and FDI flows are negative. Previous research (e.g., Borensztein et al., 1998) had reported a negative relationship between host GDP and FDI.

The level of the exchange rate (host/home) is found to be a positive and significant variable for predicting FDI flows into Mexico. Appreciation of the home currency increases inward FDI into Mexico from the OECD. This evidence is consistent with some of the literature (e.g., Barrel and Pain, 1998; Buch and Kleinert, 2008; Cushman, 1985; Cushman, 1988; Froot and Stein, 1991; Groose and Trevino, 1996; Klein and Rosengren, 1994), however, this finding is not consistent with other studies such as Campa (1993); Stevens (1998); Schmidt and Broll, (2009). Studies related to FDI attraction that focused expressly on Mexico also had mixed results. Thomas and Groose (2001) and Love and Lage-Hidalgo (2000) reported that depreciation of the Mexican peso will attract FDI into Mexico. In contrast to this, Waldkirch (2003) reported that appreciation of the Mexican peso would attract FDI flows into Mexico. The differences in methodology and time period used in the analyses make it very difficult to compare the results with previous findings. Waldkirck (2003) used a Tobit model on 1980-1998 data for 11 countries, whereas Love and Lage-Hidalgo (2000) examined outward U.S. FDI into Mexico for 1967- 1994 using a short-run dynamic model. Furthermore, it is reported that a relatively more open country (less trade restrictions) attracts export oriented FDI (Chen, 2009; Ekholm et al., 2007). This could be true for Mexico due to the following: 1) Mexico has been a relatively open country for trade circa 1990; 2) Mexico is a member of OECD; 3) and Mexico has also been a member of NAFTA since 1994. Under this situation, our finding of a positive relationship (i.e., a depreciation of the Mexican peso increases FDI flows into Mexico) between FDI and the exchange rate is meaningful.

The volatility of the exchange rate is not a significant variable for determining FDI flows into Mexico. The finding of a relatively weak relationship between FDI and volatility is in line with those findings in Crowely and Lee (2003) as well as Gorg and Walkelin (2002). Other studies such as Cushman, (1985, 1988); Goldberg and Kolstad (1995); Russ (2007) reported that exchange rate volatility increases outward FDI. The negative impact of volatility is an indicator of the instability of economic conditions that may impact some investor decisions. The negative relationship of volatility and FDI flows is reported by Chakrabarti and Scholnick (2002); Escaleras and Thomakos (2008); Lizardo (2009); Udomkerdmongkol et al. (2009); Vita and Abott, (2007). According to Russ (2007), growth and shrinkage in FDI flows depend upon whether the volatility originates from the home country or from the host country. Therefore, we conclude that most of the countries investing in Mexico are developed countries with stable economies and also feel that exchange rate volatility may not be an important determinant of FDI. The expectations on future changes of the real exchange rate (trend) are found to be statistically significant. This suggests that future deprecation of the host currency increases FDI flows. This finding is consistent with the finding of Cushman (1985, 1988); Schmidt and Broll (2009).

The coefficient for the dummy variables indicating involvement in the European Union (EU) and North American Free Trade Agreement (NAFTA) are positive and significant at the 1% significance level suggesting that the regional trade agreement of Mexico with other countries attracts more FDI. This supports the finding of Buthe and Milner (2008); Chen (2009). The language dummy variable (*lag*) takes a value of 1 when any country pair shares a similar language, otherwise *lag* = 0. The positive and significant sign of the language variable suggests that cultural similarity is an important determinant in trade. The closer the cultural ties are between countries, the greater the FDI flows from one to the other. This finding is in line with the previous findings of Gorg and Wakelin (2002) and Hejazi (2005).

The coefficient of exports to Mexico is positive, but insignificant. The positive coefficient implies a complementary relationship between FDI and exports to Mexico. The finding of a complementary relationship is consistent with previous research (Alguacila and Orts; 2003; Bajo-Rubio and Montero-Munoz, 2001; Brouwer et al., 2008). Most of the research has focused primarily on developing countries. In a developing county, raw inputs required for the production of goods are imported from the home country. The findings of a positive, but insignificant relationship between FDI and exports could be due to the statistical significance of the distance variable. Any increase in the distance increases the transportation cost for imported intermediate inputs required by foreign affiliates for goods production. As stated in the theoretical model, an increase in distance also increases the price of that good produced by foreign affiliates and hence suppresses export volume to Mexico (import volume to Mexico).

The relative difference in wages between home and host countries is positively related and significant. This suggests that the higher the wage is in home countries, the higher the FDI will be in the host country. This is consistent with our hypothesis. This finding suggests that OECD FDI outflows to Mexico occur because of lower Mexican labor costs. The relative difference in interest rate is positive and significant. The higher the interest rate is in the home country, the higher the level of outward FDI. Conversely, as the interest rate goes lower in the host country, the greater the level of inward FDI will be. This result is consistent with the finding of Thomas and Grosse (2001). The estimated coefficient of the relative factor endowment ratio (KLR) is statistically significant at the 1% level. This finding could possibly suggest that OECD member countries' investment in Mexico is mainly due to the difference in the factors of production. Mexico is endowed with labor, while other OECD member countries (e.g., the United States and Canada) are capital intensive. The higher the capital labor ratio is in OECD countries, the higher FDI flows into Mexico will be. This finding is consistent with the concept of comparative advantage as outlined in international trade theory due to the flows of the capital from capital abundant countries to a capital scarce countries, like Mexico (Koo and Kennedy, 2005).

2.5 Conclusion

This paper analyzed the determinants of foreign direct investment (FDI) in the developing economy of Mexico from the OECD countries; and the impact of the exchange rates, exchange rate volatility and expectations of exchange rates on FDI flows over the period from 1994 to 2008. The theoretical gravity model of FDI is derived based on foreign production with domestic intermediate inputs, following Kleinert and Toubal (2010). The Poisson pseudo-maximum likelihood (PPML) estimation mentioned by Silva and Tenreyo (2006) was used to estimate the FDI gravity model. Silva and Tenreyo (2009, 2011) confirmed that the PPML method is superior to the Ordinary Least Square (OLS) method in the presence of zero values in the dependent variable and with evidence of heteroskedasticity being present. Tests for heteroskedasticity were positive, suggesting its presence. Furthermore, some of the observations of the dependent variable had 0 values, thus the authors concluded that the PPML method was the more appropriate method for this study.

Empirical results indicate that market size, which is measured by gross domestic product (GDP), wages, interest rates, distance, capital-labor ratio, level of exchange rates, and exchange rate expectations are critically important variables in determining the levels of FDI into Mexico. This study revealed a positive relationship of home and host country GDP with FDI in the three variable cases (Model 1). Interestingly, the coefficient of host country GDP turned to a negative value once additional variables (i.e., exchange rates, volatility, expectations, wages, interest rates, membership in the European Union (EU), membership in NAFTA, common language, and capital labor ratio) affecting FDI determination were added to the gravity equation (Models 2 and 3).

According to Chen (2009), countries that are integrated with larger markets experience a greater increase in total and export platform FDI. Low labor cost, the maquiladora program[3], and different regional trading agreements involving Mexico all serve to increase exports from Mexico either to the home country or to third party countries. The findings of the positive sign and statistical significance of wage, the European Union, and the NAFTA variables in the model support the notion that the home country chooses Mexico for its' lower labor costs and production activities are export oriented.

The positive and significant coefficient corresponding to the level exchange rate (home per host currency) variable suggests that an appreciation of the home currency encourages outward FDI from the OECD member countries to Mexico. This finding is contradictory to Campa (1993), who originally postulated that an appreciation in the host currency attracts FDI. The insignificant impact of exchange rate volatility could be due to the economic stability enjoyed by the vast majority of those countries investing in Mexico. The positive and significant impact of exchange rate expectations with FDI suggests that expected future deprecation of the host currency attracts FDI in Mexico. This study showed a complementary (though insignificant) relationship between FDI and exports to Mexico from OECD countries, suggesting that raw

[3] The maquiladora program was established in May 1965 along the U.S. -Mexican border and it was under this program that raw material inputs and machinery could be imported into Mexico without paying import taxes or duties and then re-export back (as value added goods) either to the home country or to third party countries paying only taxes on the value added portion for those products while in Mexico (Fussell,2000)

inputs required by foreign affiliates are imported into Mexico to produce the finished product. However, the appreciated home country currencies make importing into Mexico more expensive, which could in turn, weakens the relationship between FDI and exports to Mexico. The relative wage variables are positively related and significant in determining the level of FDI in Mexico, suggesting that lower labor costs available in Mexico is attracting FDI flows. The relative interest rate is also an important variable to determine FDI flows in Mexico, suggesting that the higher the interest rate in the home country, the higher the FDI outflows from that country will be.

The characteristics that attract FDI to a country depend upon the specific types of FDI in question (i.e., export oriented, market seeking, or efficiency seeking). The impact of the exchange rate, exchange rate volatility, and exchange rate expectations on FDI depend upon exactly where production takes place, the intermediate goods that are required for the production process and whether those intermediate goods need to be imported by the host counties or are available in the host county (Cushman, 1985). Given this, the level of exchange could be positively or negatively related to FDI. Manufacturing industries tend to be more labor intensive in countries receiving FDI. Most of the FDI utilized within the host countries are invested in capital items because of the relatively cheap labor rates available as compared to labor in the home economy. In the case of Mexico, most of the manufacturing FDI are exported to the home country or to the third party countries. In such a situation, a depreciation of the host country currency may attract more FDI. However, previous research (Campa, 1993; Gorg and Wakelin, 2002) suggests that the host country currency will appreciate if the flow of foreign capital increases output. Furthermore, the association of FDI and exchange rates varies at the industry level, as well as at the firm level. Therefore, it is crucial to isolate and examine the determinants of manufacturing FDI, processed food FDI, and total FDI individually. The following chapter will examine the determinants of total FDI, manufacturing FDI, and processed food FDI and determine their relationship with the exchange rate and exports.

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Chapter 3: U.S. Foreign Direct Investment and U.S. Exports to Mexico: The Case of the Processed Food and Manufacturing Sectors and NAFTA

3.1 Introduction

Mexico is the largest recipient of FDI in Latin America (UNCTAD, 2002) and the second largest trade player among developing countries in the world (WTO, 2001). Mexico's geographic location has been one of the key factors for its successful trade industry. Further, the availability of cheap labor also added to its recent boom in international trade (Goldberg and Grosse, 1994; Love and Lage-Hidalgo, 2000). Since the mid1980s and after the signing of the North American Free Trade Agreement (NAFTA) in 1994, Mexico has seen a remarkable increase in trade with the United States (U.S.). The steady increase in trade has been accompanied by U.S. foreign direct investment (FDI) in Mexico. Between 1994 and 2005, FDI flows into Mexico have been reported to be $170.00 billion and have mainly been concentrated in the areas of manufacturing and banking (Waldkirch, 2008).

The processed food industry is one of the largest manufacturing industries supporting the U.S. economy. Processed food is a "value-added" product, since raw commodities are transformed into processed products using material, labor, and technology inputs (U.S. Department of Commerce, 2010). Processed food is the most rapidly growing sector of international trade in the global food and agricultural market (Henderson et.al., 1996) and the United States is among the world leaders in processed foods trade.

However, foreign affiliated sales of processed food are actually greater than the international trade of the processed food. Processed food exports comprise 6% of total food trade in the international market in comparison to 16% for agricultural bulk products (Regmi and

Gehlhar, 2005). The smaller share for processed food exports to the international market implies that FDI is the key element in the processed food industries. There are several reasons for FDI to gain higher importance in food processing industries: 1) the perishable nature of processed food 2) transportation costs, 3) differences in phytosanitary standards across regions and 4) the additional hindrance that stems from trade barriers that still significantly hinder the international trade of processed food (Regmi and Gehlhar, 2005). Until 2000, Japan, Canada, Mexico, Thailand, South Korea, and Hong Kong were the principal importers of processed food. By 2005 and the full effect of NAFTA in force, Japan fell behind Mexico (with Mexico having become the second largest importer of processed food) and Canada, the largest importer of processed food (Wilkinson, 2008). In this research we examine the impact of key factors associated with FDI flows into Mexico. Furthermore, our study will explore the relationship between processed food exports of the U.S. and the level of U.S. FDI in Mexico's processed food industry. Furthermore, this research breaks down FDI into total FDI and FDI specifically allocated to the manufacturing sector. This study also seeks to determine the impact NAFTA has had on U.S. FDI in Mexico.

Trade and FDI are the two primary channels by which firms gain access to foreign markets. The main goal of firms is to increase sales and profits either through exports or FDI. Under this situation, it is important to understand the relationship between trade and FDI. A large amount of FDI related literature has explored the relationship between trade and FDI (Blonigen, 2001; Gopinath et al., 1999 Marchant et al., 2002; Ning and Reed, 1995; Pfaffermayer, 1996). Studies have shown complementary relationship between FDI and trade (Bajo-Rubio and Montero-Munoz, 2001; Head and Ries, 2001), as well as substitutive association (Bolling and Somwaru, 2001; Mundell, 1957) between trade and the FDI. Gopinath et al. (1999) found trade as a substitute for FDI in the processed food industry. In other studies a complementary relationship between FDI and trade is reported for developing countries (Marchant et al., 2002). The exact relationship between trade and FDI is still not clear from the literature. It appears that country or region specific factors affect the results. It might also be the case that regional trade agreements affect the trade and investment patterns among the countries involved in a particular agreement.

There is a host of literature examining the conflicting relationship between FDI and trade. However, the literature in the area of processed food and manufacturing sectors is sparse. FDI in the processed food and manufacturing sectors are normally horizontal in nature (Reed and Marchant, 1992). In horizontal FDI, the same type of capital will be established in the foreign country that is available in the home country to fulfill demand in host countries. Thus, the determinants of FDI are similar to that of developed countries (i.e., per capita gross domestic product, growth rate of GDP, and market size) (Worth, 1998). However, due to the hierarchical structure of the food (industry) system, there is a strong incentive for firms to integrate vertically. With this type of FDI, outflows tend to occur in lower wage countries. Thus, the determinants of FDI differ based on the characteristics of the country of origin. It is also noted that the determinants of FDI differ between developed and developing countries (Bolling and Somwaru, 2001; Makki et al., 2004).

This study assesses the role of product demand and relative factor prices, both at home and abroad. In addition, the relationship between processed food exports and FDI in the processed food and manufacturing sectors is evaluated to understand the effect NAFTA has had on these two sectors. It is hoped that this research will to contribute to the literature that seeks to explain the main determinants of FDI and the relationship between trade and FDI by looking at the developed-developing country case. The autoregressive lag (ARDL) bounds test approach is used to test the long- run relationship between FDI and exports. Quarterly FDI flows in Mexico from the United States for the time period 1988 through 2008 are used for this analysis. The result indicates a complementary long- run relationship between FDI and exports for all types of FDI. Per capita GDP, wages, exchange rates, and exports are important variables that are hypothesized to determine FDI inflows into Mexico. The positive impact of NAFTA on the FDI inflow to Mexico is consistent with the stated goals of NAFTA.

3.2 Literature Review

3.2.1 Total FDI

There exists extensive literature related to FDI inflows and outflows (Barrell and Pain, 1996; Barrell and Pain, 1997; Blonigen, 1997; Coughlin et al., 1991; Love and Lage-Hidalgo, 2000; Pain and Wakelin, 1998). The literature suggests that variables such as market size, interest rate, wages, and exchange rates are important variables in determining FDI. Gross Domestic Product (GDP) and Gross National Product (GNP) serve as proxies for market size. In market seeking FDI, market size variables are positively related to FDI inflows (Culem 1993; Barrel and Pain, 1996; Chakrabarti, 2001). Love and Lage-Hidalgo (2000) found that market size and relative factor costs are important variables in predicting FDI inflows into Mexico. Bevan et al. (2004) studied the determinants of FDI in European transition economies using panel data covering the period 1994 to 2000. They concluded a positive relationship between GDP and FDI. Grosse and Trevino (1996) reported a negative relationship between the interest rate and FDI inflows into the United States. Other numerous studies have shown a negative relationship between FDI and the interest rate (Ajami and BarNiv, 1984; Liu et al., 1997; Pan, 2003; Thomas and Grosse, 2001).

Thomas and Grosse (2001) examined the characteristics of the country of origin to understand the role of FDI in Mexico. Trade, wage, GDP, and exchange rate data were important in explaining inward FDI flow into Mexico. The negative relationship of wages and GDP with FDI helped them to conclude that the country of origin variables determining inward FDI in developing countries are not similar to developed countries. Barrell and Pain (1996) developed a theoretical model of U.S. originated outward bound FDI in seven OECD countries using quarterly data from 1971 to 1988. They used a dynamic ordinary least square (OLS) to solve the spurious regression and non-stationary time series data. They found relative wage and interest rate as important determinants of FDI. Love and Lage-Hidalgo (2000) also reached the conclusion that the relative wage difference between the United States and Mexico has a significant effect on the flow of FDI.

The argument that trade and FDI can be viewed as either complements or substitutes remains questionable. A complementary (positive) relationship indicates that both trade and FDI move in the same direction in foreign markets (Alguacil and Orts, 2002; Bajo-Rubio and Montero-Munoz, 2001; Head and Ries, 2001; Pfaffermayer, 1996). A substitutionary (negative) relationship indicates that an increase in FDI decreases exports (Gopinath et al., 1999; Mundell, 1957). Pfarrermayer (1996) found a positive and significant relationship between outward FDI and exports. Bajo-Rubio and Monter-Munoz (2001) used cointegration analysis and found a positive and significant relationship between FDI and exports. Amiti and Wakelin (2003) stated that the relationship between exports and FDI depends upon the characteristics of the individual country and trade costs.

3.2.2 FDI in Processed Food and Manufacturing Sectors

There exists significant presence of literature related to total FDI determinants (Barrell and Pain, 1996; Barrell and Pain, 1997; Blonigen, 1997; Coughlin et al., 1991; Daniels et al., 2007; Love and Lage-Hidalgo, 2000). However, there are limited studies that focused on FDI determinants for the processed food and manufacturing sectors. Studies have shown that FDI in processed food industries may be horizontal in nature (Bolling et al., 1999; Reed and Marchant, 1992; Handy and Henderson, 1996). In horizontal FDI, the same type of capital will be established in the foreign country as it is in the home county. Determinants of FDI are similar to total FDI for the developed country (i.e., per capita GDP, growth rate of GDP, and market size). In the case of vertical FDI for the U.S., the outflows will be to lower wages than in the home country (Amiti and Wakelin, 2003; Reed and Marchant, 1992; Worth, 1998). Ning and Reed (1995) studied the determinants of FDI in food and kindred products for six industrialized countries from 1983 to 1989. They found that the exchange rate difference, host market size, cultural linkage, and trading blocs as significant determinants of FDI in food manufacturing. Marchant et al. (2002) found that the interest rate, exchange rate, and GDP as important variables that influence FDI in the processed food sector. Gopinath et al. (1999) found that the market size variable is positively related to FDI. Mattson and Koo (2002) also found that real host GDP has a positive and significant effect on FDI. They stated that the U.S. food processing industry is not labor intensive and, therefore, labor cost may not be a significant factor for FDI. In contrast to this finding, Skripnitchenko and Koo (2005) found that flows of FDI will decreases as the factor cost (labor cost and interest rate) in the host country increases.

There are limited studies that show the relationship between FDI and trade in processed food industries (Gopinath et al., 1999; Marchant et al., 2002; Ning and Reed, 1995). Mattson and

Koo (2002) studied the relationship between exports and FDI for processed food in the Western Hemisphere sourced from the United States. Their results suggested the positive relationship between U.S. exports and FDI. The positive relationship between food processing FDI and host GDP tends to hold for the foreign investor in the host country, where greater market opportunities exist. Marchant et al. (2002) studied the relationship between trade and U.S. FDI in East Asian countries in the processed food industry from 1989 to 1998. Their findings suggested that the exchange rate, interest rates, and compensation rates are important determinants of FDI. They also found a complementary relationship between FDI and exports for developing countries. A strong complementary relationship between outward FDI and trade of U.S. processed food in China was also reported by Marchant et al. (1999).

United States outward FDI to OECD countries are good examples of investment from developed to developing countries. Malanoski et al. (1997) examined the relationship of trade and FDI for U.S. processed food in OECD countries. They stated that the substitutionary relationship between FDI and exports could possibly be because of cost effectiveness to build a similar plant in the host country rather than export. Afterwards, Gopinath et al. (1999) studied U.S. foreign direct investment and U.S. export of processed food to 10 countries (OECD) form 1982-1994. Their study is based on the profit maximization theory of economics. Their results indicated the small substitutionary effect between FDI and exports. Bolling and Somwaru, (2001) have studied the relationship between U.S. FDI and exports to developed and developing countries using panel data from 1984-1994. They found a complementary relationship between trade and FDI for developing countries and a substitutionary relationship between trade and FDI for developed countries. GDP is negatively related with FDI for developing countries and is positively related with FDI for developed countries. Depreciation of the U.S. currency is positively related to the FDI and exports for this country grouping (except for Australia and Canada).

Makki et al. (2004) analyzed the determinant of foreign direct investment by the U.S. food processed industry in developed and developing countries using panel data from 1989 to 2000. They reported that market size, per capita income, and openness to trade have significant relationships with U.S. food processing sourced FDI. Their influences differ with developed and developing countries. GDP and openness to trade are positively related with FDI in food processing for developed countries. However, GDP is not a significant variable to determine the level of FDI for developing countries. Per capita income is the major determinant of U.S. FDI in developing countries. The relationship between the exchange rate and FDI in processed food was also examined by Bolling et al. (2007) using data from 1983 to 2002. They reported that the exchange rate, the level of fixed capital in the U.S. food industry, and the cost of materials in both the U.S. and abroad are important determinants of FDI in the food industry. They also found that an appreciation of the U.S. dollar encourages outward FDI and concluded that the opposite would happen in the case of dollar depreciation.

Pain and Wakelin (1998) studied the relationship between FDI and manufacturing exports, analyzing the data of 11 OECD countries since 1971. They found that the relationship between trade and FDI varies across countries. The substitutionary relationship was observed between outward FDI except for Japan, Italy, Denmark, and Finland. For the U.S., the complementary relationship between trade and FDI was found with majority owned firms and a substitutionary relationship was observed in minority owned firms. Blonigen (1997) found both substitutionary and complementary relationships between U.S. automobile parts trade and U.S. FDI into Japan using data from 1978-1991. Lipsey and Weiss (1981) studied U.S. manufacturing exports to 44 countries. They also included 13 other major exporting countries exports to the same destinations. The regression was performed separately for developed and less-developed countries. They found a complementary relationship between U.S. overseas production and U.S. exports for developing countries. The negative relationship was found for developed countries. Kim and Rang (1996) also supported the complimentary relationship between FDI and trade for developing countries. Head and Ries (2001) also discovered the complementary relationship between FDI and exports using panel data of 932 Japanese manufacturing firms over a 25 year period. A substitutionary relationship between FDI and exports was also reported for auto and electronics firms. They stated that the relationship between FDI and exports varies across firms.

3.3 Methodology and Data

3.3.1 The Model

Multinational enterprises (MNEs) can function in a foreign market either by exporting their products or through FDI. Different approaches have been used to model FDI (i.e., cost minimization (Bajo-Rubio and Sosvilla-Rivero, 1994) or profit maximization (Barrel and Pain, 1996). These models allow for the derivation of the optimal foreign capital stock. The theoretical model used in this chapter is a derivation of that developed by Barrel and Pain (1996). The model begins with the profit function for a firm that sells a product to domestic and foreign markets.

$$\Pi = P_d(V_d)V_d + P_f(V_f)V_f - TC(X) \qquad (1)$$

where P and V denote price and sales. The subscripts d and f are for domestic and foreign markets, respectively. X represents total output and TC is the total cost. The above profit function has the following assumptions:

$$V_f > 0 \;;\; V_d + V_f = X(K, L)$$

$$X_f = f(L_f, K_f)$$

where, K and L are capital and labor inputs. The total cost function has two components: one is associated with domestic production and another is associated with foreign production.

Following Barrel and Pain (1996), sales revenues will be positively related to the level of foreign direct investment if production in the foreign market of host country (X_f) includes consumer-oriented service facilities. With foreign price $P_f(V_{f,}\ X_f)$, the profit maximization problem for the Multinational enterprises can be written as:

$$\Pi = P_d(V_d)V_d + P_f(V_{f,}\ X_f)V_f - TC_d(X_d) - TC_f(X_f) - \lambda\,(V_d + V_f - X_d - X_f) \qquad (2)$$

The Lagrangian yields the marginal conditions:

$$\Pi_{Vd} = MR_d - \lambda = 0 \qquad (3a)$$

$$\Pi_{Vf} = MR_f - \lambda = 0 \qquad (3b)$$

$$\Pi_{Xd} = -MC_d + \lambda = 0 \qquad (3c)$$

$$\Pi_{Xf} = V_f(\delta P_f/\delta X_f) - MC_f + \lambda = 0. \qquad (3d)$$

Equating conditions (3a) and (3b) state that marginal revenue in the two markets is identical, i.e $MR_d = MR_f$. Equating equations (3c) and (3d) indicate that marginal cost is different in two markets.

$$MC_d = MC_f - V_f(\delta P_f/\delta X_f). \qquad (4)$$

Applying the implicit function theorem, we can solve for the unknown variablesV_d, V_f, X_d, and X_f since the marginal conditions described in the first-order conditions are invertible. The cost minimization of production in each location can be used to solve the problem as an alternative. This approach produces four additional endogenous variables K_d, K_f, L_d, and L_f. The total cost of production in both domestic and foreign markets is given by:

$$TC_d = w_d L_d + r_d K_d \qquad (5a)$$

$$TC_f = w_f L_f + r_f K_f \qquad (5c)$$

where w_d and w_f denote wages and r_d and r_f denote the cost of capital in the domestic and foreign market, respectively. To maximize the profit in each market, marginal revenue should equal marginal cost. This condition is expressed as:

$$MR_d(\overline{D}_d) = MC_d(w_d\,,\,r_d) \qquad (6a)$$

$$MR_f(\overline{D}_f) = MC_f(w_f\,,\,r_f) - V_f(\overline{D}_f)(\delta P_f/\delta X_f) \qquad (6b)$$

with $\overline{D}_d$ and $\overline{D}_f$ signifying the aggregate level of demand in the domestic and foreign markets, respectively. Applying the marginal conditions from the profit maximization and cost minimization, we can solve for eight endogenous variables, V_d, V_f, X_d, X_f, K_d, K_f, L_d, and L_f, in terms of exogenous variables. Therefore, the optimal foreign capital stock can be written as:

$$K^{*}{}_{f} = f(\bar{D}_f, r_q, r_f, w_d, w_f) \qquad (7)$$

Equation (7) indicates the optimal level of foreign capital stock. Thus, with foreign output, optimal foreign capital stock is positively related to host country demand ($\bar{D}_f$) and to the relative unit costs between the home and host countries. The host country's per capita GDP is used as a proxy for its demand. In the case of the cost minimization problem, capital and wage costs entered in equation (7) depend on the quantities of available labor and capital. Assuming substitutions between capital and labor, the capital and labor cost entered in equation (7) are presented as ratios so that the rate of substitution between labor and capital used must be equal their price ratios.

As noted in Bajo-Rubio and Sosvilla-Rivero (1994), equation (7) can be further augmented with the addition of a trade barrier variable. With trade barriers, firms are likely to invest more in foreign plants and optimal foreign capital, $K^{*}{}_{f}$, is thus positively related to the level of trade barriers. Therefore, the capital stock in the foreign plant is a function of total demand, unit production costs, and the level of any extant trade barriers. Optimal capital stock in equation 7 is extended to include the effects of the exchange rate and exports. Thus, the desired model using the relative costs is as follows:

$$FDI = f(\bar{D}_f, r_d/r_f,\ w_d/w_f,\ ER, EXP, NAFTA) \qquad (8)$$

where *ER* is real exchange rate, *EXP* is U.S. exports to Mexico and *NAFTA* is dummy variable for the trade barriers (*NAFTA* =1 from the year 1994 to 2008 and *NAFTA* =0 otherwise). According to Barrel and Pain, exports are endogenous so that its lag value is used to estimate the FDI equation. The empirical specification of equation (8) is expressed as:

$$FDI_t = \beta_0 + \beta_1 lnGDPPC_t + \beta_2 ln(w_d - w_f)_t + \beta_3 (r_d - r_f)_t + \beta_4\, ER_t + \beta_5 \ln(EXP)_{t-1} + \beta_6 NAFTA_t + \varepsilon_t \qquad (9)$$

In equation (9), ln represents the natural logarithms of the variables, ε_t is the error term representing variables not included in the model and is assumed to be white-noise and follows a normal distribution. FDI is the outward foreign direct investment flow from the U.S to the Mexico (host). $GDPPC_t$, per capital GDP at time *t* should be positively related to FDI. Relative differences in wages between the United States and Mexico $(w_d - w_f)_t$ are positively related, which intimates that the higher the relative difference between the two wage rates, the higher the level of FDI. The relative difference in the interest rate, $(r_d - r_f)_t$, is negatively related to FDI. The real exchange rate (US$ per peso) ER_t , is negatively related to FDI. The association between U.S exports and U.S. FDI can either be positive or negative. The dummy variable, *NAFTA,* is expected to be positively correlated to FDI.

3.3.2 Data

We selected the United States and Mexico to analyze foreign direct investment (FDI) and the relationship between exports and FDI in the processed food sector, the manufacturing sector, and in total. The annual data, spanning from 1988 and 2008, were converted to quarterly data for the purposes of analysis. The variables are measured in real terms by using the gross domestic product deflator. The dependent variable is outward FDI flow from the United States to Mexico and expressed as a share of Mexican GDP. Consistent with other literature such as Marchant et. al. (2002), foreign affiliate sales were used to capture FDI. The data on annual U.S. foreign affiliate sales in Mexico is extracted from U.S. Direct Investment Abroad: *Operations of U.S. Parent Companies and Their Affiliates* (U.S. Department of Commerce, Bureau of Economic Analysis). The data for processed food FDI are obtained by using Standard

Industrial Classification level (SIC 20) of aggregation for food and kindred products. The food and kindred products grouping includes meat, fish and dairy products, processed fruits and vegetables, grains (milled and bakery products), sugar and confectionary products, fats and oils, beverages, and others processed foods. From 1998, data is available on the basis of the North American International Classification System (NAICS). NAICS classes 31 to 33 represent the manufacturing industry and NAICS 311 represents the food manufacturing sector. Manufacturing and food manufacturing FDI from 1998 were converted into SIC format using

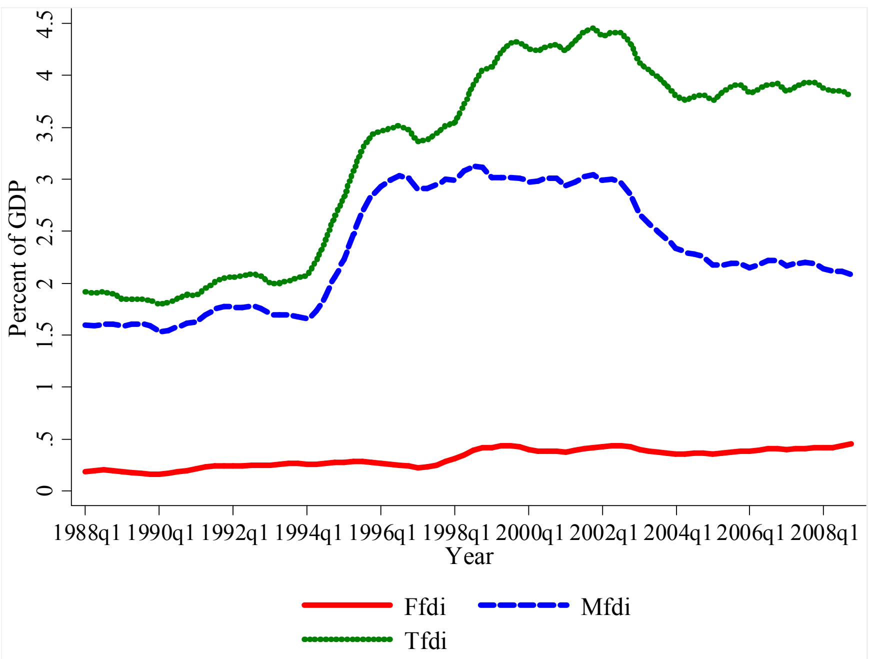

Figure 3.1 Total sales (TFDI), manufacturing sales (MFDI) and processed food sales (FFDI) as percent of Mexico GDP by U.S. affiliates in Mexico
Source: Own calculations using data from the U.S. Department of Commerce, Bureau of Economic Analysis

the method of Blecker (2007). Per capita GDP is extracted from Penn World Table version 7.0. The real exchange rate and real interest are constructed using data from the International

Financial Statistics CD-ROM, IMF (2010) following the method of Waldkirch (2003). The data on U.S exports to Mexico is obtained from the United Nation's COMTRADE database. Wage data were constructed using information compiled from the United States Bureau of Labor Statistics and the U.S. Bureau of Economic Analysis.

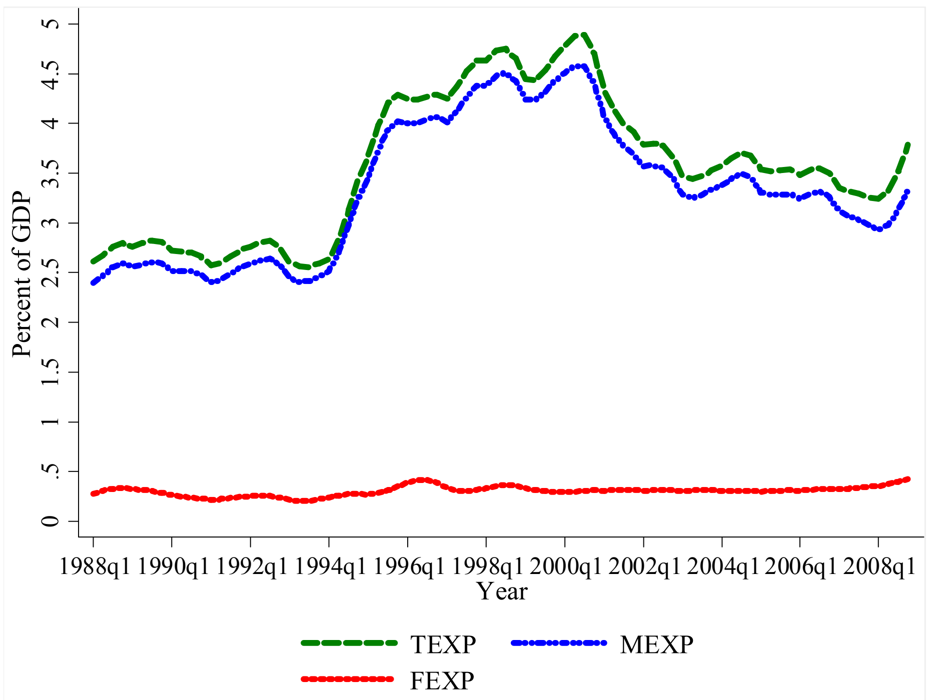

Figure 3.2 U.S. total exports (TEXP), manufacturing export (MEXP), and processed food export (FEXP) as percent of Mexico GDP
Source: Own calculations using data from the UNCOMTRADE

The average U.S. affiliates sales (FDI) are 11.72, 8.72 and 0.88 percent of GDP, respectively in total, manufacturing and processed food (Appendix 3.1 and 3.2). The majority of the U.S. affiliates sales and U.S. exports to Mexico are in the manufacturing sectors (Figure

3.1 and 3.2). Variable descriptions, data sources and summary statistics are listed in Appendices 3.3, and 3.5.

3.3.3 Econometric Estimation

3.3.3.1 Unit Root Tests

Time series data tend to exhibit either a deterministic or stochastic trend and are therefore non-stationary. When non-stationary time series data are used in a regression model, the results may spuriously indicate significant relationships when they really do not exist. In these cases, the least square regression is biased and *t*-statistics are not reliable (Lukepohl and Kratzig, 2004). In this study, the Augmented Dickey-Fuller test (ADF) and Phillips-Perron test (PP) are used to examine the null hypothesis of non-stationary against stationary of the data. The number of lag selections is an important part of the ADF test, since inappropriate selections of the lag yield biased estimates. The number of lags included in the ADF test is determined by Akaike Information (AIC) and Schwarz Criteria (SC) in a simple autoregressive (AR) regression model with a constant and a trend, and without a trend (constant only). The lag length for the PP test is determined according to a Newey and West (1994) bandwidth using a Bartlett kernel. The ADF and PP tests do not account for structural breaks and do not reject the null hypothesis of non-stationary of the data, when in fact data series are stationary around the structural breaks. Thus, the results from the ADF and PP tests are not conclusive in determining the order of integration. To deal with these problems, a number of tests have been developed to allow for structural breaks in the series. In this study, the Zivot and Andrews (1992) and Perron and Vogelsang (1992) unit root tests were used. These methods allow for a single structural break and do not require prior knowledge as to the specific break year. Once the unit roots in the series are determined, we further refine our econometric approach with the adoption of the autoregressive distributed lag (ARDL) bounds testing approach, testing for both the long-run and short-run relationships.

3.3.3.2 ARDL Bounds Testing Approach

ARDL bounds testing approach was first developed by Pesaran and Shin (1999) and later extended by Pesaran et al. (2001). This method has several advantages over other cointegration techniques such as Johansen and Juselius (1990) and Enger and Granger (1987). These cointegration techniques rely on the assumption of strictly I(1) variables (integrated order one). The requirement of the I(1) variables makes the estimate of the cointegration test subject to biases, since the order of integration of the variable depends upon the type of the unit root test and lag length selection. The ARDL bound testing approach does not impose the restriction that all variables under the study must be integrated in the same order. That means the ARDL approach can be applied regardless if the order of integration is one, zero or even if it is fractionally integrated (mixed). Other cointegration techniques are sensitive to sample size, but the ARDL bound testing approach is relatively more efficient in either small or finite sample sizes. The ARDL methodology yields estimates in the long- run and valid *t*-statistics, even in the presence of endogeneity (Harris and Sollis 2003). Moreover, a simple dynamic error correction (ECM) model provides short-run coefficients along with long-run equilibrium without losing valid long-run coefficients. The ARDL model can be regarded as the equal number of lag length for all variables or different orders of lag without affecting the asymptotic distribution of the test statistic (Pesaran et al., 2001). In the present study, FDI and exports are jointly endogenous variables and our variables are a mixture of I(0) and I(1) with respect to their order of integration; the ARDL bounds testing approach fits very well.

ARDL bounds testing approach (Pesaran et al., 2001) involves estimating the unrestricted error correction model (URECM) for equation (3.9) which is specified as:

$$\Delta FFDI_t = \alpha_0 + \beta_1 FFDI_{t-1} + \beta_2 lnGDPPC_{t-1} + \beta_3 \ln(w_d - w_f)_{t-1} + \beta_4 (r_d - r_f)_{t-1} + \beta_5 ER_{t-1} + \beta_6 ln\, FEXP_{t-1} + \sum_{i=1}^{p} \emptyset_i \Delta FFDI_{t-i} + \sum_{i=0}^{q} \vartheta_i \Delta lnGDPPC_{t-i} + \sum_{i=0}^{q} \omega_i \Delta ln(w_d - w_f)_{t-i} + \sum_{i=0}^{q} \lambda_i \Delta (r_d - r_f)_{t-i} + \sum_{i=0}^{q} \gamma_i \Delta ER_{t-i} + \sum_{i=0}^{q} \varphi_i \Delta lnFEXP_{t-i} + \eta\, NAFTA + \varepsilon_t \quad (3.10a)$$

$$\Delta MFDI_t = \alpha_0 + \beta_1 MFDI_{t-1} + \beta_2 lnGDPPC_{t-1} + \beta_3 \ln(w_d - w_f)_{t-1} + \beta_4 (r_d - r_f)_{t-1} + \beta_5 ER_{t-1} + \beta_6 ln\, MEXP_{t-1} + \sum_{i=1}^{p} \emptyset_i \Delta MFDI_{t-i} + \sum_{i=0}^{q} \vartheta_i \Delta lnGDPPC_{t-i} + \sum_{i=0}^{q} \omega_i \Delta ln(w_d - w_f)_{t-i} + \sum_{i=0}^{q} \lambda_i \Delta (r_d - r_f)_{t-i} + \sum_{i=0}^{q} \gamma_i \Delta ER_{t-i} + \sum_{i=0}^{q} \varphi_i \Delta lnMEXP_{t-i} + \eta\, NAFTA + \varepsilon_t \quad (3.10b)$$

$$\Delta TFDI_t = \alpha_0 + \beta_1 TFDI_{t-1} + \beta_2 lnGDPPC_{t-1} + \beta_3 \ln(w_d - w_f)_{t-1} + \beta_4 (r_d - r_f)_{t-1}$$

$$+ \beta_5 ER_{t-1} + \beta_6 ln\, TEXP_{t-1} + \sum_{i=1}^{p} \emptyset_i \,\Delta TFDI_{t-i} + \sum_{i=0}^{q} \vartheta_i \,\Delta lnGDPPC_{t-i}$$

$$+ \sum_{i=0}^{q} \omega_i \,\Delta ln(w_d - w_f)_{t-i} + \sum_{i=0}^{q} \lambda_i \,\Delta (r_d - r_f)_{t-i} + \sum_{i=0}^{q} \gamma_i \,\Delta ER_{t-i}$$

$$+ \sum_{i=0}^{q} \varphi_i \,\Delta lnTEXP_{t-i} + \eta\, NAFTA + \varepsilon_t \quad (3.10c)$$

where, α_0 is drift, ε_t is the white noise error term, β_i are the long- run coefficients, Δ is the first difference operator and p and q are optimal lag lengths (these could be either the same or different). $FFDI$, $MFDI$, $TFDI$ are processed food FDI, manufacturing FDI, and total FDI, respectively. $FEXP$, $MEXP$, $TEXP$ are processed food exports, manufacturing exports and total exports, respectively. The optimal lag selection in the unrestricted ARDL model is based on the AIC and SC criterion.

The ARDL bounds testing procedure is based on the joint F-statistics of the coefficients of the lagged levels of variables used to examine for the existence of cointegration. Therefore, in the first steps of the ARDL bounds testing approach, we estimate the unrestricted ARDL model of equation (3.10) by using ordinary least square (OLS) to test the Null hypothesis $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$ against the alternative hypothesis $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq 0$. Pesaran et al. (2001) reported two sets of critical bound values to test the cointegration at different levels of significance and are generated based on sets of 500 and 1,000 observations and 20,000 and 40,000 replications. Narayan (2005) argued that critical values generated based on the larger sample sizes could not be used for smaller sample sizes. Narayan (2005) reported a new set of critical values for sample sizes ranging from 30 to 80. For the present study, we use critical values from Narayan (2005). If the computed F-statistics are higher than the upper bound critical values, then the null hypothesis of no cointegration is rejected and is classified as a long-run relationship. Conversely, if the F-statistics are lower than the lower bound critical values, then the null of no cointegration is not rejected. The results are inconclusive if the computed F-statistics fall within the bounds for the critical values.

Once the long-run relationship was established in equation (3.10), we moved on to the second step where the long- run coefficient based on the ARDL (p_1, q_1 q_2 q_3 q_4) is estimated. The lag length of the ARDL (p_1, q_1 q_2 q_3 q_4 q_5) can be selected based on AIC and SC criteria.

$$FFDI_t = \alpha_0 + \sum_{i=1}^{i=p_1} \beta_1\, FFDI_{t-i} + \sum_{i=0}^{i=q_1} \beta_2\, lnGDPPC_{t-i} + \sum_{i=0}^{i=q_2} \beta_3\, ln\left(w_d - w_f\right)_{t-i} + \sum_{i=0}^{i=q_3} \beta_4 \left(r_d - r_f\right)_{t-i} + \sum_{i=0}^{i=q_4} \beta_5\, ER_{t-i} + \sum_{i=0}^{i=q_5} \beta_6\, lnFEXP_{t-i} + \eta\, NAFTA_t + \varepsilon_t \quad (3.11a)$$

$$MFDI_t = \alpha_0 + \sum_{i=1}^{i=p_1} \beta_1\, MFDI_{t-i} + \sum_{i=0}^{i=q_1} \beta_2\, lnGDPPC_{t-i} + \sum_{i=0}^{i=q_2} \beta_3\, ln\left(w_d - w_f\right)_{t-i} + \sum_{i=0}^{i=q_3} \beta_4 \left(r_d - r_f\right)_{t-i} + \sum_{i=0}^{i=q_4} \beta_5\, ER_{t-i} + \sum_{i=0}^{i=q_5} \beta_6\, lnMEXP_{t-i} + \eta\, NAFTA_t + \varepsilon_t \quad (3.11b)$$

$$TFDI_t = \alpha_0 + \sum_{i=1}^{i=p_1} \beta_1 \, TFDI_{t-i} + \sum_{i=0}^{i=q_1} \beta_2 \, lnGDPPC_{t-i} + \sum_{i=0}^{i=q_2} \beta_3 \, ln\left(w_d - w_f\right)_{t-i}$$

$$+ \sum_{i=0}^{i=q_3} \beta_4 \left(r_d - r_f\right)_{t-i} + \sum_{i=0}^{i=q_4} \beta_5 \, ER_{t-i} + \sum_{i=0}^{i=q_5} \beta_6 \, lnTEXP_{t-i} + \eta \, NAFTA_t$$

$$+ \quad \varepsilon_t \qquad (3.11b)$$

In the third step, we obtained short-run coefficients by estimating an error correction model associated with the long- run estimates. The model is specified as follows:

$$\Delta FFDI_t = \mu + \sum_{i=1}^{i=p_1} \emptyset_i \Delta \, FFDI_{t-i} + \sum_{i=0}^{i=q_1} \vartheta_i \Delta \, lnGDPPC_{t-i} + \sum_{i=0}^{i=q_2} \omega_i \, \Delta \ln\left(w_d - w_f\right)_{t-i}$$

$$+ \sum_{i=0}^{i=q_3} \lambda_i \, \Delta \left(r_d - r_f\right)_{t-i} + \sum_{i=0}^{i=q_4} \gamma_i \Delta \, ER_{t-i} + \sum_{i=0}^{i=q_5} \varphi_i \, \Delta \, lnFEXP_{t-i} + \psi ECM_{t-1}$$

$$+ \quad \varepsilon_t \qquad (3.12a)$$

$$\Delta MFDI_t = \mu + \sum_{i=1}^{i=p_1} \emptyset_i \Delta \, MFDI_{t-i} + \sum_{i=0}^{i=q_1} \vartheta_i \Delta \, lnGDPPC_{t-i} + \sum_{i=0}^{i=q_2} \omega_i \, \Delta \ln\left(w_d - w_f\right)_{t-i}$$

$$+ \sum_{i=0}^{i=q_3} \lambda_i \, \Delta \left(r_d - r_f\right)_{t-i} + \sum_{i=0}^{i=q_4} \gamma_i \Delta \, ER_{t-i} + \sum_{i=0}^{i=q_5} \varphi_i \, \Delta \, lnMEXP_{t-i} + \psi ECM_{t-1}$$

$$+ \quad \varepsilon_t \qquad (3.12b)$$

$$\Delta TFDI_t = \mu + \sum_{i=1}^{i=p_1} \emptyset_i \Delta TFDI_{t-i} + \sum_{i=0}^{i=q_1} \vartheta_i \Delta\, lnGDPPC_{t-i} + \sum_{i=0}^{i=q_2} \omega_i\, \Delta \ln\left(w_d - w_f\right)_{t-i} + \sum_{i=0}^{i=q_3} \lambda_i\, \Delta \left(r_d - r_f\right)_{t-i} + \sum_{i=0}^{i=q_4} \gamma_i \Delta\, ER_{t-i} + \sum_{i=0}^{i=q_5} \varphi_i\, \Delta\, lnTEXP_{t-i} + \psi ECM_{t-1} + \varepsilon_t \qquad (3.12c)$$

where ECM, the error term which is obtained from the equation (3.11) $ECM_t = FFDI_t - \alpha_0 - \sum_{i=1}^{i=p_1} \beta_1\, FFDI_{t-i} - \sum_{i=0}^{i=q_1} \beta_2\, lnGDPPC_{t-i} - \sum_{i=0}^{i=q_2} \beta_3\, \ln\left(w_d - w_f\right)_{t-i} - \sum_{i=0}^{i=q_3} \beta_4 \left(r_d - r_f\right)_{t-i} - \sum_{i=0}^{i=q_4} \beta_5\, ER_{t-i} - \sum_{i=0}^{i=q_5} \beta_6\, lnFEXP_{t-i} - \eta\, NAFTA$ and ECM_{t-1} is the one lagged of the error correction terms. Here $\emptyset_i$, ϑ_i, ω_i, λ_i, γ_i, and $\varphi_i$are the short- run coefficients of the model and coefficient (ψ) associated with ECM allows for adjustment back to the long- run equilibrium, given a deviation in the last quarter (after a short-run shock).

3.4 Result and Discussion

3.4.1 Unit Roots Test

For ARDL bounds testing, pre-testing of the series for the order of integration is not required but a unit root test was run to eliminate the possibility of I(2) or higher order of integration. In the presence of I(2) variables, the computed F-statistics by Pesaran et al. (2001) and Narayan (2005) are not valid. Therefore, to ascertain the order of integration, we applied ADF and PP unit root tests in the level and the first differences of the series (Table 3.1). The results from the ADF test do not reject the null hypothesis of non-stationary for all variables. At the same time, PP tests also do not reject the null of non-stationary for all variables except, for the *wage* and *exchange rate* (without trend). Once the tests are performed for the variables in their first differences, the

Table 3.1 ADF and PP unit root tests

	Constant with trend		Constant without trend	
Variables	ADF	PP	ADF	PP
FFDI	-2.44(3)	-1.81(3)	-2.41(3)	-1.97(3)
MFDI	-3.11(3)	-2.83(3)	-0.99(3)	-1.47(3)
TFDI	-2.78(3)	-2.80(3)	-2.40(3)	-2.78(3)
lnGDPPC	-1.95(2)	-2.01(3)	-0.28(2)	-0.30(3)
$\ln(w_d-w_f)$	-1.70(3)	-4.40(3)***	-2.55(3)	-4.46(3)***
(r_d-r_f)	-1.67(4)	-2.20(3)	-1.10(4)	-1.72(3)
ER	-2.79(1)	-2.75(3)	-2.80(1)*	-2.86(3)**
lnFEXP	-0.14(3)	-1.41(3)	-2.59(3)	-2.06(3)
lnMEXP	-2.53(3)	-2.72(3)	-1.49(3)	-1.49(3)
lnTEXP	-2.20(3)	-2.53(3)	-1.66(3)	-1.64(3)
difference				
ΔFFDI	-3.83(2)***	-3.12(3)	-3.83(2)***	-3.09(3)**
ΔMFDI	-4.90(2)***	-4.48(3)***	-4.94(2)***	-4.56(3)***
ΔTFDI	-4.81(2)***	-4.23(3)***	-4.85(2)***	-4.34(3)***
ΔlnGDPPC	-6.34(2)***	-5.96(3)***	-6.36(1)***	-6.01(3)***
$\Delta \ln(w_d-w_f)$	-5.49(2)***		-5.03(2)***	
$\Delta (r_d-r_f)$	-5.00(2)***	-6.98(3)***	-5.15(4)***	-7.01(3)***
Δ ER	-7.85(1)***	-7.74(3)***	-7.83(0)***	-7.73(3)***
Δ lnFEXP	-7.34(2)***	-4.22(3)***	-6.39(2)***	-4.07(3)***
Δ lnMEXP	-5.50(2)***	-4.01(3)***	-5.47(2)***	-4.02(3)***
Δ lnTEXP	-5.45(2)***	-4.03(3)***	-5.36(2)***	-4.03(3)***

Note: Asterisks indicate significance at the 10 percent (*), 5 percent (**) and 1 percent (***) levels, respectively. The critical values for ADF and PP tests with a constant and a trend are -4.032, -3.45, -3.147 whereas with a constant but no trend are -3.4386, -2.856, and -2.568 for 1, 5, 10, percent significance levels, respectively. Figures in parenthesis are standard errors

null hypothesis is strongly rejected by both tests except for *FFDI* (The PP test with trend does not reject the null of non-stationary for *FFD*I in first differences). A main problem associated with the ADF and PP tests is that they do not allow for the possibility of structural breaks in the series. The Zivot and Andrews and Perron and Vogelsang unit root tests allow for a single structural break. The null hypothesis is that the time series are non-stationary with a single break. The results are reported in table (3.2). The Zivot and Andrews test suggest that *wage* and *FFDI* are I(0) in levels and all others are I(0) in their first difference, except *per capita GDP*. The results of the Perron and Vogelsang test suggest that *FFDI, TFDI, MEXP,* and *TEXP* are I(0) in levels and others are I(0) in their first difference. The Zivot and Andrews and Perron and Vogelsang tests suggest that results obtained from ADF and PP tests are doubtful.

Table 3.2 Zivot and Andrews and Perron and Vogelsang tests for unit roots

	Zivot -Andrews			Perron-Vogelsang		
Varaible	Break year	t-statistics	Result	Break year	t-statistics	Result
FFDI	1994q3	-5.447***	I(0)	1996q2	5.21***	I(0)
MFDI	1994q4	-3.634	I(1)	1995q4	-2.383	I(1)
TFDI	1994q3	-4.642	I(1)	1996q1	-4.719**	I(0)
lnGDPPC	1994q3	-4.331	I(1)	2006q1	-2.989	I(1)
$\ln(w_d-w_f)$	1994q4	-5.01***	I(0)	1995q3	-3.921	I(1)
(r_d-r_f)	2000q4	-3.785	I(1)	2001q2	-3.837	I(1)
ER	1994q4	-3.568	I(1)	1998q1	-3.302	I(1)
lnFEXP	1994q4	-2.846	I(1)	1996q1	-2.753	I(1)
lnMEXP	1995q1	-4.121	I(1)	1996q2	-4.595**	I(0)
lnTEXP	1995q1	-3.938	I(1)	1996q2	-4.582**	I(0)
differences						
ΔMFDI	1994q4	-5.714	I(0)	1994q3	-6.235***	I(0)
ΔlnGDPPC	1996q2	-3.073		1994q3	-7.301***	I(0)
$\Delta \ln(w_d-w_f)$				1989q2	-7.126***	I(0)
$\Delta (r_d-r_f)$	1998q2	-5.43	I(0)	1997q3	-8.018***	I(0)
Δ ER	1996q1	-4.912	I(0)	1994q2	-10.64***	I(0)
Δ lnFEXP	1994q4	-10.242	I(0)	2005q2	-9.65***	I(0)

Note: Asterisks indicate at the 10 percent (*), 5 percent (**) and 1 percent (***) significance level respectively. The critical values for The Zivot – Andrews are -5.34, -4.80, -4.58 for 1, 5, 10, % significance level (Zivot and Andrews, 1992, table 2a , P 256). Critical values for Perron-Vogeslang test are -5.07, -4.41, -4.07 for 1, 5, 10 % significance (Perron and Vogeslang, 1992 table 2a, P. 256)

Therefore, considering one structural break in the series, we concluded that variables *FFDI, TFDI, MEXP,* and *TEXP* are I(0) and others are I(1).

3.4.2 ARDL Bounds Test Results

This section discusses the findings obtained from the ARDL bounds testing approach of Pesaran et al. (2001). The analysis uses the outflows of FDI from the United States to Mexico for the period 1988Q1 to 2008Q4. The first step in the ARDL bounds testing approach is to estimate equation 3.10 using OLS regression. The optimal lag length in equation 3.10 is determined using AIC and SC criteria. In order to select the optimal lag length, we set the maximum lag length of 4. The optimal lag of 2 is selected for total FDI. In selecting lag length for processed food and manufacturing FDI, both AIC and SC criteria fail to provide conclusive results as to lag length. For processed food FDI, the lag lengths of 2 and 1 are selected by AIC and SC criteria, respectively. Similarly, for manufacturing FDI, lag lengths of 3 and 2 are selected by AIC and SC criteria, respectively. To come up with the best fit for the model, the Ramsey RESET test for the misspecification of the model was used. Therefore, we selected an optimal lag length of 2 for both processed food and manufacturing FDI.

The misspecifications tests of equations 3.10 with or without NAFTA are reported in Table (3.3). The regression for the ARDL equation fits the data very well explaining 96% of variability in the dependent variable across the models' independent variables (R^2 = 96%). The Breusch-Godfrey test (BG) results suggest the presence of serial correlation only in the total FDI equation for the second lag, but the correlogram doesn't indicate the presence of serial correlation. All the equations pass the diagnostic tests of functional form misspecification, normality, heteroscedasticitity, and autoregressive conditional heteroscedasticity. The cumulative sum (CUSUM) and cumulative sum of squares (CUSUMQ) tests suggest that all the equations satisfied the stability condition. We were then safe to test the existence of the long-run relationship.

Table 3.3 Diagnostic tests for the ARDL equation

	Without NAFTA			With NAFTA		
Tests	FFDI	MFDI	TFDI	FFDI	MFDI	TFDI
R2	0.97	0.97	0.96	0.97	0.97	0.96
BG1	1.52(0.21)	0.25(0.62)	2.28(0.13)	2.16(0.14)	2.06(0.15)	0.93(0.33)
BG2	3.438(0.18)	0.27(0.87)	2.50(0.29)	4.42(0.11)	4.03(0.13)	18.09(0.00)***
ARCH1	0.04(0.85)	0.06(0.81)	0.48(0.49)	0.07(0.79)	0.01(0.91)	0.28(0.56)
ARCH2	0.03(0.98)	0.07(0.96)	1.092(0.58)	0.08(0.96)	0.05(0.98)	0.38(0.83)
DW	2.13	2.05	2.08	2.17	2.17	2.07
WHITE	80(0.45)	80(0.45)	79(0.45)	80(0.45)	80(0.45)	79(0.45)
JB	3.50(0.17)	2.56(0.28)	5.66(0.06)*	5.05(0.08)*	1.25(0.53)	4.93(0.85)
RSEET	1.13(0.34)	1.66(0.19)	1.26(0.30)	0.74(0.53)	0.72(0.55)	1.17(0.33)
CUSUM	satisfied	satisfied	satisfied	Satisfied	satisfied	satisfied
CUSUMSQ	satisfied	satisfied	satisfied	Satisfied	satisfied	satisfied

Note: Asterisks indicate at the 10 percent (*), 5 percent (**) and 1 percent (***) significance level respectively. Figures in parenthesis are probabilities. JB test is the Jarque-Bera test for normality; BG is the Breusch-Goldfrey test for autocorrelation based on lag 1 and 2. ARCH is test for autoregressive conditional heteroscedasticity of order 1 and 2.White is the White test for heteroscedasticity of the errors. RESET is the Ramsey RESET test, null is no specification problem. CUSUM, CUSUMSQ the cumulative sum of the recursive residual and the cumulative sum of squares of the recursive residual explains parameter instability if the cumulative sum or the cumulative sum of square are not within the band of two critical lines at 5% significance level.

The results of the existence of long-run relationships are presented in Table (3.4). Regression of the processed food FDI equation (3.10a) suggests that the F-statistics with or without NAFTA (4.48 and 4.89) are higher than the upper bound critical value (3.864) at the 5% significance level. The null hypothesis (i.e., no long-run relationship) is rejected for the processed food FDI equation at the 5% level of significance. Regression of the manufacturing FDI equation (3.10b) rejects the null hypothesis at the 1% level of significance in the presence of NAFTA. The calculated F-statistics for the total FDI equation (3.10c) are higher than the upper bound critical value at the 1% significance level. The existence of a long-run relationship is also tested for export equations. The results suggest the existence of a long-run relationship for processed food, manufacturing, and total export equations at the 1%, 10%, and 5% significance levels, respectively.

Table 3.4 Results from bounds tests on equations 3.10 for the existence of a long-run relationship

Dependent variables	Lags	Without NAFTA	With NAFTA
FFDI	2	4.48**	4.89**
FEXP	2	6.21***	5.49***
MFDI	2	4.65**	6.22**
MEXP	2	3.49*	3.42*
TFDI	2	4.95***	6.22***
TEXP	2	4.22**	4.45**

Note: Asterisks indicate at the 10 percent (*), 5 percent (**) and 1 percent (***) significance level respectively. Asymptotic critical value bounds are obtained from Narayan (2005, p. 1989), Appendix: case III: unrestricted intercept and no trend for k=6. Lower and upper bounds are 3.457- 4.943, 2.627-3.864, 2.236- 3.381 at 1%, 5%, and 10 % significance level respectively.

After the establishment of the existence of a long-run relationship, we estimated long-run coefficients by applying OLS regression on equations (3.11 a, b, c). The appropriate lag length for each variable on the ARDL is selected by AIC and SC criteria. Therefore, we estimated an ARDL (2, 2, 2, 0, 0, 2) long–run model. The results are presented in table (3.5). The empirical results on long-run coefficient estimations show that variables such as per capita GDP of Mexico, real exchange rate, and lagged exports are very important variables to explain the U.S. FDI inflows into Mexico. In our study, per capita GDP is a positive and highly significant variable that explains FDI inflows into Mexico. This result is consistent with economic theory. The U.S. company will normally invest in a country with greater market opportunities, which is known as market-seeking FDI. With market-seeking FDI, the same type of capital will be established in the foreign country. Many studies reported a positive relationship between market-seeking FDI and GDP (Barrell and Pain, 1996; Barrell and Pain, 1997). Literature focusing on Mexico (Love and Lage-Hidalogo, 2000; Thomas and Grosse, 2001) also supported the positive relationship. The positive and statistically significant impact of per capita GDP on

U.S. FDI in the Mexican processed food sector is not surprising. For every 10 unit increase in Mexican per capita GDP, FDI in the Mexican food sector increases by 0.011 % of GDP. According to Regmi (2001), consumers in developing countries with higher income demand more processed food. This demand for processed food increases with increases in income. The positive relationship between *market size* and *FDI* in processed food is also found by Gopinath et al. (1999); Mattson and Koo, (2002); Marchant et al. (2002); Makki et al. (2004).

There is a positive relationship between FDI and lagged exports (imports to Mexico). This suggests complementary association between U.S FDI and U.S exports to Mexico. The parameter estimate indicates that a 10 unit increase in U.S. exports to Mexico increases U.S. FDI of processed food by 0.0020% of GDP (though the coefficient of U.S. exports is insignificant). The complementary relationship could be due to the fact that FDI may cause producers to import intermediate inputs from the home country. Therefore with an increase in outward FDI, exports of the intermediate good increase (Banerjee 1997). The weak complementary relationship between U.S. FDI and U.S. exports of processed food in Mexico could be due to a strong dollar (Jerardo and Bolling, 2001; Bolling et al., 2007). The complementary relationship between exports and FDI in the processed food sector is consistent with Merchant et al. (1999); Bolling and Somwaru 2001; Mattson and Koo, (2002); Marchant et al. (2002). Studies such as Gopinath et al. (1999) and Malanoski et al. (1997) dealt with the developed country cases and reported the substitutionary relationship. The substitutionary relationship could possibly be because firms may find it more cost effective to build a similar plant in the host countries rather than to export (Malanoski et al., 1997).

There is a positive and highly significant relationship between FDI and U.S. manufacturing exports to Mexico (imports to Mexico). This suggests a strong complementary relationship between FDI and U.S exports of manufactured goods to Mexico. The parameter estimates indicate that a 10 unit increase in U.S. exports of manufacturing leads to increased inflows of FDI into Mexico by 0.051% of GDP. This finding is consistent with Lipsey and Weiss (1981) who found a complementary relationship between U.S. exports of manufacturing and FDI. In this study, we utilized majority U.S. controlled FDI (more than 50% of U.S. ownership),

Table 3.5 Estimated long- run coefficients using the ARDL (2,2,2,0,0,2) approach

	Without NAFTA			With NAFTA		
Dependent	FFDI	MFDI	TFDI	FFDI	MFDI	TFDI
constant	-0.29***	-4.94***	-4.90***	-0.30**	-5.73***	-6.89***
	(0.14)	(1.37)	(1.82)	(0.15)	(1.19)	(1.68)
lnGDPPC	0.11***	1.58***	2.47***	0.11***	1.82***	2.78***
	(0.04)	(0.29)	(0.39)	(0.04)	(0.25)	(0.35)
$\ln(w_d\text{-}w_f)$	0.18***	0.68***	0.82***	0.17***	0.35*	0.42
	(0.03)	(0.21)	(0.28)	(0.04)	(0.19)	(0.27)
$r_d\text{-}r_f$ (10^{-3})	0.10	-1.20	-2.36	0.09	1.02	-2.10
	(0.60)	(42.30)	(5.56)	(0.61)	(3.66)	(4.94)
ER	0.25***	-0.62	-0.29	0.25***	-0.46	-0.17
	(0.07)	(0.51)	(0.62)	(0.07)	(0.44)	(0.55)
lnFEXP	0.020			0.02		
	(0.017)			(0.02)		
lnMEXP		0.51***			0.39**	
		(0.18)			0.15	
lnTEXP			0.21			0.08
			(0.22)			(0.20)
NAFTA(10^{-3})				0.04	6.40***	8.11***
				(0.25)	(1.29)	(1.86)

Note: Asterisks indicate at the 10 percent (*), 5 percent (**) and 1 percent (***) significance level respectively. Figures in parenthesis are standard errors.

therefore our finding is also consistent with the Pain and Wakelin (1998) who reported a complementary relationship between majority U.S. owned FDI and exports of manufacturing for OECD countries. There is a positive and insignificant relationship between FDI and total U.S.

exports suggesting a complementary association exists between total exports and total FDI. The parameter estimates indicate that a 10 unit increase in total FDI exports leads to increased total FDI investment in Mexico by 0.021% of GDP. Studies of Bajo-Rubio and Monter-Munoz, 2001; Alguacil and Orts, 2002 indicate a complementary relationship between total FDI and U.S total exports. Our finding is consistent with the literature.

The *real exchange rate* (home currency per host currency) is positive and statistically significant for processed food FDI. An appreciation in the Mexican peso, relative to the U.S. dollar, increases inflows of FDI into Mexico, which is not consistent with our hypothesis. According to Waldkirch (2003), the positive association is also consistent with the argument that the peso should appreciate if firm productivity increases as a result of capital inflows. Makki et al. (2004) reported a negative relationship between real exchange rate and FDI in processed food for developing countries. Other studies such as Bolling et al. (2007); Gopinath et al. (1998) found that an appreciation of the U.S. dollar (depreciation of peso) increases outward FDI in processed food indicating that countries with an undervalued exchange rate will experience an increase in FDI. In other words, an undervalued Mexican peso will increase FDI inflows.

The real exchange rate is negative and insignificant for manufacturing and total FDI inflows to Mexico. The result is consistent with our hypothesis, implying that appreciation of peso (depreciation of U.S. dollar) decreases U.S. FDI to Mexico. As the U.S. dollar depreciates, it will be more expensive for U.S. firms to invest in Mexico. Research findings regarding the relationship between FDI and exchange rates are controversial. Some studies such as Froot and Stein (1991); Görg and Wakelin (2002) suggested a negative relationship between host country exchange rates and FDI. However, other studies (Blonigen, 1997; Campa, 1993; Waldkirch, 2003) reported a positive relationship between host country exchange rates and FDI.

The relative difference in wages between the U.S. and Mexico is positive and highly significant in determining the level of FDI. Therefore, the result is consistent with our hypothesis. This implies that an increase in U.S. wages increases FDI inflows into Mexico. For every 10 dollar increase in the relative difference in wages, FDI in the Mexican processed food sector increases by 0.018% of GDP, holding other factors constant. The finding is consistent with literature (Love and Lage-Hidalgo, 2000; Skripnitchenko and Koo, 2005; Thomas and Grosse, 2001). Some of the studies (Ning and Reed 1995; Matton and Koo, 2002) found a negative impact of wages on FDI, suggesting that cheap labor may not be an important variable in attracting FDI. The coefficient of interest rate is very small and insignificant for all types of FDI, suggesting that user cost of capital is not an important variable to determine inflows of FDI into Mexico, which is consistent with study of Love and Lage-Hidalgo (2000); Barrell and Pain (1996).

The effect of NAFTA on the U.S FDI and U.S. exports to Mexico is another an important part of this study. The effect of NAFTA was positive for all types of FDI suggesting that after the implementation of NAFTA, FDI inflows into Mexico have increased. This finding is consistent with our hypothesis. Interestingly, the lower impact of wages on FDI was observed, even accounting for the effect of NAFTA. For manufacturing FDI, *wage* is significant only at the 10% level (it was significant at 1% before NAFTA) and even insignificant for total FDI. The highly significant complementary relationship between FDI and exports of manufacturing is now only significant at the 10% level. It seems that NAFTA had a devastating impact on the real wage rate and on U.S exports to Mexico. Literature (Burfisher et al., 2001; Hoyos and Iacovone, 2011) suggests that it is very hard to disentangle the effect of NAFTA because at the same time of NAFTA's implementation (January, 1994), there was a Mexican financial crisis (December, 1994). Janvry (1996) argued that NAFTA greatly reduced the negative impact of the peso crisis on U.S. trade with Mexico, which would have been extant in the absence of NAFTA. Audley et al. (2004) stated that the lower impact of the wage variable was due to the pesos crisis and not to NAFTA. This study's finding of a weaker complementary relationship between FDI and U.S. exports of manufacturing while taking into account NAFTA's effect on U.S./Mexican trade is in line with the above stated literature. A devaluation of the Mexican peso renders imports into Mexico more expensive and thus brings about a weaker complementary relationship.

The results of short-run coefficients with long- run coefficients obtained from ECM are given in table (3.6). However this time, the exchange rate is not significant for the processed food FDI, intimating that exchange rates do not have significant short-run effects. The food export, which is not significant in long-run coefficient estimation is now significant, suggesting that a food export has a short run impact on processed food FDI. For manufacturing FDI, variables such as *exports, wage*, and *per capital GDP* have short run effects. The error correction term (equilibrium correction) coefficient is highly significant with the correct sign (negative), implying a high speed of adjustment back to long-run relationship given a deviation in the previous quarter (after a short-run shock). Approximately 51% of disequilibrium or shock from the previous quarter converges back to the long- run equilibrium in the current quarter for the processed food FDI. Higher speed of adjustment 77% and 89% were found for the manufacturing and total FDI, respectively.

Some misspecification tests of the ARDL error correction model have been carried out (table 3.7). The Breusch-Godfrey (BG) test results suggest serial correlation problem only in total FDI equation. But the correlogram shows no problem of serial correlation. In addition, all models satisfied the normality assumption. The Ramsey RESET tests show that there is not a

Table 3.6 Error correction representation for the selected ARDL (2,2,2,0,0,2) model

	Without NAFTA			With NAFTA		
Dependent	FFDI	MFDI	TFDI	FFDI	MFDI	TFDI
constant	-0.03	-0.56*	-0.43	-0.03	-0.27	-0.06
	(0.05)	(0.28)	(0.43)	(0.05)	(0.26)	(0.41)
Ecm_{t-1}	-0.51***	-0.77***	-0.89***	-0.50***	-0.84***	0.81***
	(0.14)	(0.18)	(0.25)	(0.14)	(0.14)	(0.18)
ΔFDI_{t-1}	1.84***	1.94***	2.01***	1.84***	1.84***	1.83***
	(0.09)	(0.14)	(0.21)	(0.09)	(0.10)	(0.14)
ΔFDI_{t-2}	0.99***	-1.00***	-1.07***	-0.99***	-0.92***	0.90***
	(0.08)	(0.13)	(0.19)	(0.08)	(0.09)	(0.13)
$\Delta lnGDPPC_{t}$	0.15***	0.99***	1.74***	0.15***	1.42***	2.33***
	(0.05)	(0.31)	(0.45)	(0.05)	(0.26)	(0.42)
Δ $lnGDPPC_{t-1}$	-0.34***	-2.88***	-4.09***	-0.35***	-3.50***	-4.61***
	(0.08)	(0.49)	(0.80)	(0.08)	(0.46)	(0.79)
Δ $lnGDPPC_{t-2}$	0.27***	2.47***	2.94***	0.27***	2.49***	2.69***
	(0.05)	(0.39)	(0.65)	(0.05)	(0.33)	(0.57)
Δ $ln(w_d-w_f)_t$	0.17***	1.35***	1.59***	0.17***	0.78***	0.84**
	(0.05)	(0.28)	(0.42)	(0.05)	(0.24)	(0.38)
Δ $ln(w_d-w_f)_{t-1}$	-0.24***	-1.93***	-2.51***	-0.24***	-1.07***	-1.32**
	(0.08)	(0.47)	(0.71)	(0.08)	(0.36)	(0.58)
Δ $ln(w_d-w_f)_{t-2}$	0.11***	0.80***	1.04***	0.10***	0.46**	0.56*
	(0.04)	(0.22)	(0.34)	(0.04)	(0.18)	(0.29)
Δ r_d-r_f $(10^{-3})_t$	-1.17	7.38*	3.49	-1.18	8.58**	3.25
	(0.76)	(4.38)	(6.54)	(0.76)	(3.95)	(6.26)
Δ ER_t	0.02	-0.64*	-0.92	0.02	-0.55	-0.75
	(0.06)	(0.38)	(0.56)	(0.06)	(0.34)	(0.54)
$\Delta lnEXP_t$	0.04*	0.57***	0.30	0.04*	0.58***	0.25
	(0.02)	(0.19)	(0.27)	(0.02)	(0.17)	(0.26)
$\Delta lnEXP_{t-1}$	-0.06*	-0.89***	-0.47	-0.06*	-0.81***	-0.29
	(0.03)	(0.26)	(0.38)	(0.03)	(0.23)	(0.36)
$\Delta lnEXP_{t-2}$	0.03	0.33***	0.11	0.03	0.34***	0.13
	(0.02)	(0.13)	(0.22)	(0.02)	(0.12)	(0.20)

Note: Note: Asterisks indicate at the 10 percent (*), 5 percent (**) and 1 percent (***) significance level respectively. Figures in parenthesis are standard errors specification problem. Further CUSUM and CUSUMSQ tests do not show any evidence of instability in each equation.

Table 3.7 Diagnostic tests for the error correction for the ARDL (2,2,2,0,0,2) model

	Without NAFTA			With NAFTA		
Tests	FFDI	MFDI	TFDI	FFDI	MFDI	TFDI
R2	0.96	0.96	0.93	0.96	0.97	0.94
BG1	0.35(0.56)	1.40(0.24)	1.42(0.23)	0.36(0.55)	1.51(0.22)	7.89(0.01)***
BG2	0.36(0.84)	5.17(0.08)	1.45(0.49)	0.37(0.83)	1.56(0.46)	10.70(0.00)***
ARCH1	1.08(0.30)	0.01(0.94)	0.31(0.58)	0.05(0.28)	0.45(0.50)	0.80(0.37)
ARCH2	1.21(0.55)	0.11(0.95)	1.63(0.44)	1.30(0.52)	0.39(0.82)	1.84(0.40)
DW	2.07	1.80	2.08	2.07	2.17	2.31
WHITE	80.00(0.45)	80.00(0.45)	80.00(0.45)	80.00(0.45)	80.00(0.45)	80.00(0.45)
JB	0.06(0.97)	2.23(0.33)	4.94(0.08)*	0.03(0.98)	0.07(0.97)	0.97(0.62)
RSEET	1.86(0.15)	1.69(0.18)	1.52(0.22)	1.47(0.14)	1.06(0.37)	0.52(0.67)

Note: Asterisks indicate at the 10 percent (*), 5 percent (**) and 1 percent (***) significance level respectively. Figures in parenthesis are probabilities. JB test is the Jarque-Bera test for normality; BG is the Breusch-Godfrey test for autocorrelation based on lag 1 and 2. ARCH is test for autoregressive conditional heteroscedasticity of order 1 and 2.White is the White test for heteroscedasticity of errors.

3.5 Conclusion

This study examines the relationship between U.S. FDI and U.S exports to Mexico from 1988Q1 to 2008Q4. Three different types of FDI were used (processed food, manufacturing, and total FDI) in examining the relationship between FDI and U.S exports. The analysis is based on the profit maximization theory of Barrell and Pain (1996). Statistical procedures were used to test for a unit root to remove the possibility of having I(2) or higher order of integration. The results indicate that the variables such as *per capita GDP*, *wage*, *interest rate*, *exchange rate*, *manufacturing FDI,* and *food export* are integrated of order one I (1) and variables such as *food FDI*, *total FDI*, *manufacturing export,* and *total export* are integrated of order zero I(0). The

ARDL bounds testing approach of Pesaran et al. (2001) was used to determine the relationship between FDI and exports. This method is efficient in relatively small samples and our estimates are also valid, even if some of the explanatory variables are endogenous. This procedure allows for the inclusion of both I(0), I(1) or mixed variables. The order of lag is selected based on Akaike Information Criteria (AIC) and Schwarz Criteria (SC). The bounds testing approach suggests that variables in the profit maximization framework are bound together in the long-run. The error correction terms have the expected signs (negative) and are highly significant, thus suggesting a high speed of adjustment to the long-run equilibrium from short run shocks.

Empirical results indicate that *per capita GDP, wage, and lag of exports* measure *market size* and are the most important variables in determining inflows of FDI into Mexico in the long-run. The positive sign for *per capita GDP* is in line with market-seeking FDI literature (Barrell and Pain 1996; Gopinath et.al., 1999; Matton and Koo, 2002). Results indicating that the *real exchange rate* is both positive and significant with regard to processed food FDI are consistent with the literature, suggesting that the host country's currency should appreciate if a firm's productivity increases as a result of capital inflows (Waldkirch, 2003). The positive coefficient of *relative wage* with *FDI* suggests that investment in Mexico is primarily due to lower labor costs.

The most important finding of this research is the complementary relationship between FDI and exports. The weak complementary relationship between FDI and exports of processed food could be due to appreciation in the U.S. dollar. The appreciation of the dollar makes U.S. exports more expensive for Mexican consumers. The highly significant and positive relationship for manufacturing exports suggest that FDI in the manufacturing sector import raw inputs by foreign affiliates to assemble final products. Most manufacturing products are re-imported into the United States or exported to other countries.

The positive impact of NAFTA on all three types of FDI is another significant finding. The impact of NAFTA is weak for processed food FDI. This could be due to the fact that there is less volume in the international trade of the processed food than for FDI. The occurrence of the pesos crisis with the implementation of NAFTA in the mid-1990s could be another factor. The strong positive relationship of NAFTA with manufacturing FDI and total FDI suggest that after the implementation of NAFTA, U.S foreign direct investment has been increasing to Mexico, which is consistent with the goals of NAFTA. However, when accounting for the effect of NAFTA on each of the FDI equations, the effect of wages on FDI decreases. The peso crisis can be blamed for this finding too.

It is felt that further research with a larger sample size would improve the reliability of the findings. It was also determined from the results of this study that the relationship between FDI and their determinants vary with the level of aggregation of the firms, so firm level data would be appropriate for the research to see the exact relationship. The research would also be more informative if a Granger causality test of the relationship between FDI and trade could be conducted.

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Chapter 4: Relationship among Foreign Direct Investment, Economic Growth and Exports in Mexico

4.1 Introduction

In developing countries, foreign direct investment (FDI) is a main channel through which capital, knowledge, and technologies are transferred between countries. The benefits from FDI on economic growth depend upon the ability of the host countries to access, learn, and implement new technologies (Borensztein et al., 1998; Waldkirch, 2010; Xu, 2000). According to Bhagwati (1978), the benefits from FDI are likely to be less if FDI is a substitute for imports in comparison to countries with export promotion policies. Thus, the growth enhancing effect of FDI and trade interaction depends upon the specific policies and factor endowments of various countries.

The relationships among FDI, exports, and economic growth have been explored quite extensively in economic literature. The majority of research has used a bivariate framework. Studies that used bivariate framework include: Baliamoune-Lutz (2004); Sharma and Panagiotidis (2005); Xu (1996). Meanwhile, other researchers such as Balassa (1978); Balasubramanyam et al. (1996); Feder (1983); Fosu (1990); Tsai, (1994) used a multivariate framework derived from the production function, in which the growth variable is regressed against exports or FDI along with other endogenous variables such as labor and capital. The growth hypothesis is supported if the coefficient on export/ FDI is significantly positive. Most cross-country studies assume a positive relationship between FDI and economic growth (FDI-led growth) (Balasubramanyam et al., 1996; Borensztein et al., 1998). According to Balasubramanyam et al. (1996), there is a strong role of FDI on economic growth in export promoting countries in comparison to the countries with import-substitution policies. Similarly, most of the research shows a positive relationship between economic growth and exports (export-led growth) in cross-country studies (Balssa, 1984; Feder 1983; Fosu 1996). However, the major problem or limitation of cross-country data analysis is the assumption of common production technologies across countries, which is not always true[4]. The host countries' domestic policy such as monetary, fiscal, production technology, financial structures, and external shocks may differ across countries. Therefore, the effect of FDI and exports on growth varies across countries. Further, provision for the case of reverse causality was not allowed in past research, which has led to inconsistent conclusions.

There is ample research literature (Apergis et al., 2008; Choe, 2003; Liu et al., 2001) on panel and time series data for individual countries, using methods that allow reverse causality between a pair of variables in a bivariate or in a multivariate framework. Some empirical studies (Basu et al., 2003; Choe 2003; Karikari 1992; Liu et al., 2002; Pradhan, 2009) show a bidirectional causality between FDI and growth. In a relatively open economy, Apergis et al. (2008) found a two-way causal relationship between FDI and economic growth. Some studies (Chakraborty and Basu, 2002) reported a one-way causality from GDP to FDI. In a closed economy, Basu et al. (2003) reported a one-way causality flow from GDP to FDI. Research studies (Awokuse, 2005; Awokuse, 2006; Maneschiold 2008) reported the two-way causality between exports and growth. However, studies such as Awokuse (2003) suggested a one-way causality running from exports to growth. Meanwhile, Sharma and Panagiotidis (2005) reported a no causal relationship between exports and growth.

Research results on causal relationships among exports, FDI, and GDP are contradictory with results ranging from unidirectional causality, bidirectional causality or no causality at all. In this study, we explore in depth the issue of exports, FDI, and GDP. The main purpose of this

[4]In other words, these studies do not take into account the level of technology.

research is to examine the direction of causality among FDI, exports, and growth using time series data from the Mexican economy. Toda and Yamamoto (1995) and Dolado and Lukepohl (1996) -TYDL- methodology is used to test the direction of causality between a pair of variables. We also investigated the impact of NAFTA and United States GDP on causality among variables. This study aims to shed light on the mixed results of Granger causality among FDI-led growth, export-led growth, and FDI-led exports by constructing a five variable vector auto regressions (VAR) model for Mexican economic growth. Annual time series data from 1970 to 2008 were used for the analysis.

4.1.1 Economic Growth in Mexico

Mexico is the largest FDI recipient in Latin America (UNCTAD, 2002) and, among developing countries, is the second largest trading country (by volume) in the world (WTO, 2001). The economic growth of Mexico was interrupted by several economic factors such as oil shocks, fiscal and monetary policies, debt crisis, and devaluation of the Mexican peso. The annual economic growth rate of Mexico was 4.1 % from 1961 to 2009 and 6.7% per year for the years 1961 to 1970. The economic growth rate in the Mexican economy began to slow down in the 1970s, primarily due to crude oil price shocks and a slowdown in overall productivity. The macroeconomic changes that occurred during the mid-1970s led to a debt crisis in the early 1980s and a sharp recession in GDP growth. From 1981 to 2009, annual average GDP growth slumped to 2.29 %. Implementation of NAFTA in 1994 seems to have had a positive impact on the economic growth of Mexico, but the economic crisis resulting from the devaluation of the peso at the same time led to decreased output and a significant rise in inflation. After recovery from the peso crisis, the annual growth rate increased by 2.84% from 1996 to 2009 (Figure 4.1).

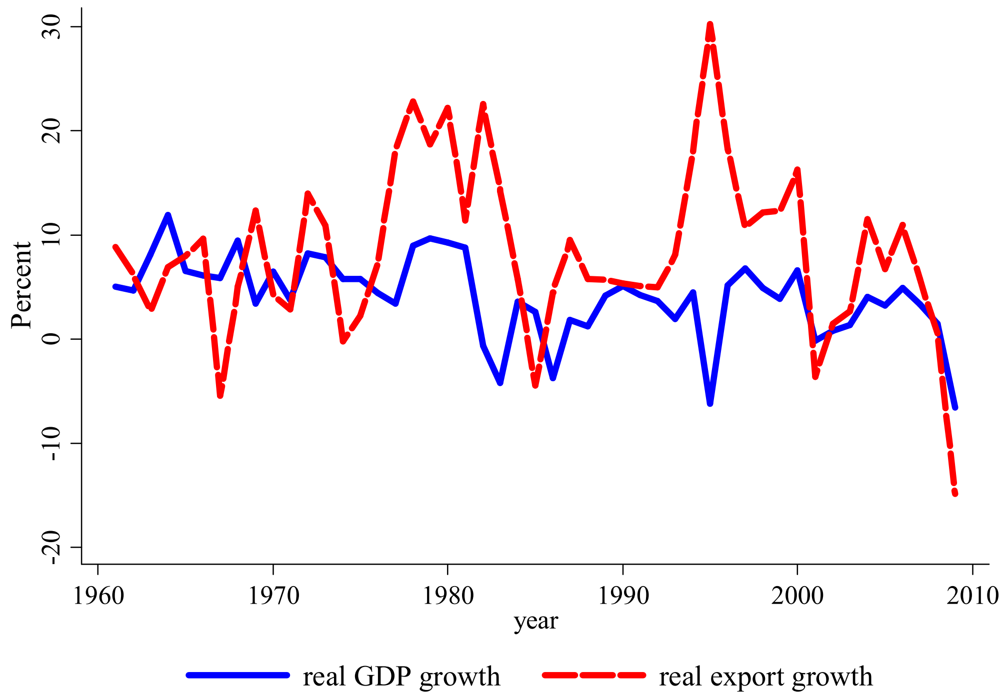

Figure 4.1 GDP and Exports growth rates (percent), 1960 to 2009
Source: World Develoment Indicator online version, World Bank (2011).

In several studies, researchers argued that exports are the main channel through which the trade liberalization can effect economic growth (Balassubramanyam et al., 1996). It was observed that the effect of export substitution policies on economic growth had less impact than import substitution policies. The average growth rate of exports before 1980 was 8.169% per year. The average export growth rate changed to 8.64% after the shift from an import substitution policy to an export promotion policy. In 1986, Mexico joined the GATT which reduces tariffs and relaxes restrictions on foreign investments in an economy. The annual export growth rate was 8.6% from 1980-1993. Exports increased dramatically after 1994. Between 1994 and 2008, the export growth rate was 10.24%. Export growth slumped dramatically in 2009 due to the economic crisis in the United States (Figure 4.2).

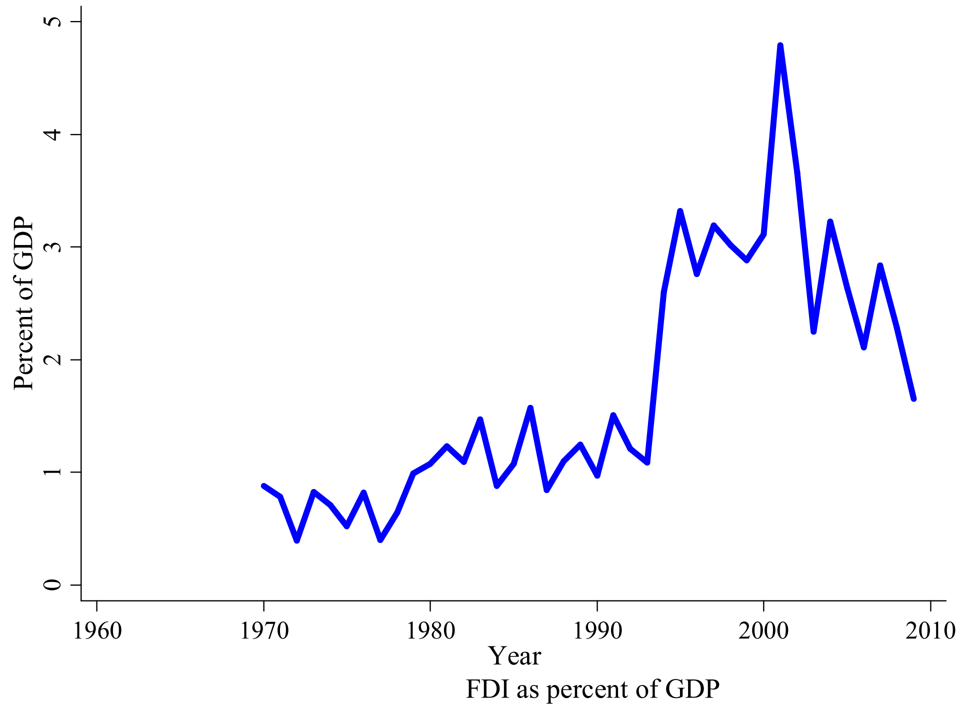

Figure 4.2 FDI inflows into Mexico (percent of GDP), 1970 to 2009
Source: World Develoment Indicator online version, World Bank(2011)

The foreign investment law (FIL) in Mexico was first introduced in 1973 and FDI was ratified only for a specific proportion of a firm's total capital such as mining (only 49%), petrochemical (40%), and fabrication of automobile components (40%) (UNCTAD, 1992). After the debt crisis, the FIL was modified in 1989, allowing for 100% ownership of a firm's capital in many sectors. The changes were also made in 1993 to make FIL compatible with NAFTA. Another policy change was made in 1999, allowing for the liberalization of a majority of financial services. The inflow of FDI in Mexico during 1980 and 1990 was 1.14% of GDP. One of the principal aims of NAFTA was to increase U.S. FDI inflows in Mexico and the results thereafter have been 2.89% of average GDP (Figure 4.2).

4.2 Literature Review

The causality relationship in the cross-country study assumes a positive relationship between FDI and growth as well as exports and growth (Balasubramanyam et al*.,* 1996; Balssa, 1985; Borensztein et al., 1998; Feder 1983; Fosu, 1996). The major limitation of the cross-country study is the assumption of a similar production function across all countries. Recent developments in econometric analysis of panel and time series data and the more sophisticated econometric methods resulting from extended research allowed researchers to examine the reverse causality test among different economic variables. The following research articles provide causality in Panel and individual country cases using time series data.

4.2.1 Granger Causality Studies on Panel Data

Choe (2003) examined Granger causality between FDI and economic growth for 80 countries from 1971-95 by using a panel VAR model. The research results suggest a bidirectional causality between FDI and economic growth. Using panel cointegration and the panel causality test, Apergis et al*.* (2008) report a positive impact of FDI on economic growth for high income countries that have successfully implemented privatization programs. Basu et al. (2003) examined the relationship between FDI and GDP using cointegration and causality over the period 1978-1996. Results suggest a two-way causality between FDI and growth for relatively open economies and a one-way causality for closed economies. Using panel cointegration analysis, Pradhan (2009) explored the relationship between FDI and economic growth of ASEAN countries from 1970-2007. Except for Malaysia, the study shows a bidirectional causality between FDI and economic growth, suggesting that a high level of FDI can generate a corresponding high level of economic growth. High levels of economic growth can, in turn, generate high levels of FDI. Using multivariate Granger causality in a VAR format, Liu et al. (2001) examined the causal relationship among FDI, exports, and imports in China using panel data over the period of 1984-1998. Researchers suggested a positive causal relationship from imports to FDI, FDI to exports, and exports to imports.

4.2.2 Granger Causality Studies on Individual Countries

Several studies examine the Granger causality effect on individual countries. While analyzing the causality effect, some studies used bivariate while others have used multivariate frameworks. Karikari (1992) examined bivariate causality between FDI and growth in Ghana for the period from 1961 to1988, without considering integration and cointegration. The research results do not support the hypothesis of causality between FDI and growth. Using the technique of cointegration and error correction modeling (VECM), Chakraborty and Basu (2002) explored the link between FDI flows and economic growth in India under a multivariate framework. Results suggest that the direction of causality runs from GDP to FDI.

Sharma and Panagiotidis (2005) formulated the model based on Feder's (1983) to test the Granger causality effect on multiple economic variables. The results do not support causality between a pair of variables such as export and growth; export and investment; export and gross fixed capital formation; and so on. Alguacil and Orts (2002) explored VECM in Spain using quarterly data for the period 1970-1992 and reported a one-way causality running from FDI to exports. Baliamoune-Lutz (2004) examined the relationship between exports, FDI, and growth in Morocco using data from 1973 to 1999. The research results suggest two-way causal relationships between FDI and exports, a one-way causal relationship running from FDI to growth, and a one-way causality running from exports to growth.

Based on the new growth theory, Shan and Sun (1998) applied Toda and Yamamoto (1995) and Doland and Lukepohl (1996) (TYDL) methodologies to test the export- led growth hypothesis in China since 1987 to 1996. The results indicate a two-way causality between exports and growth. A bidirectional causal relationship among FDI, growth, and exports in China is also reported by Liu et al. (2002) using quarterly data from 1981 to 1997. Dritsaki et al. (2004) examined the relationship between exports, economic growth, and foreign direct investment for Greece using annual data for the period 1960-2002 and the VAR error correction method. The study suggested two-way causal relationships between exports and economic growth. The study also shows a unidirectional causal relationship of FDI on GDP. Awokuse (2003) tested the export-led growth hypothesis based on the augmented production function for Canada using VECM and TYDL causality testing methods. Quarterly data from 1961 to 2000 were used. In this study, a one-way causality running from exports to growth was observed. Using similar method and quarterly data from 1963 to 2001, Awokuse (2005) also examined the export-led growth for Korea. The research findings show a two-way causality between exports and growth.

Using quarterly data from 1990 to 2002 and TYDL methodology, Duasa (2007) tested the causal relationship between FDI and growth in Malaysia. The study does not support the causal link between FDI and economic growth. Omisakin (2009) used data from 1970-2006 and TYDL and autoregressive distributed lag (ARDL) models to examine the causal relationship among FDI, growth, and trade openness in Nigeria. The results reveal unidirectional causality running from FDI to growth. Ericsson and Irandoust (2001) examined the causal relationship between FDI and growth for four OECD countries: Denmark, Finland, Norway, and Sweden. This study was based on a production function framework for the period of 1970 to 1997. The results supported bidirectional causality between FDI and growth for Sweden and unidirectional causality running from FDI to growth for Norway. Using the neoclassical growth theory and multivariate cointegration VAR, Awokuse (2006) tested the export-led growth and import-led growth separately for Bulgaria, the Czech Republic, and Poland. The researcher found evidence of a two-way causality between exports and growth. The research findings also indicate a one-way causality running from exports and imports to growth for the Czech Republic and imports to exports for Poland.

4.2.3 Granger Causality Studies in Mexico

Numerous studies also examined the relationship between FDI, exports, economic growth, and other major economic variables for Mexico. Thornton (1996) carried out the bivariate causality test using cointegration over 1895-1992. The study found a positive relationship flowing from exports to economic growth. This research result is also supported by Abdulnasser and Manuchehr (2000). Alguacil et al. (2002) analyzed the causality between exports, FDI, and domestic performance using time series data from 1980.I to 1999.IV in Mexico. The results support both the export-led growth and FDI-led growth hypothesis. Cuadros et al. (2004) found a positive FDI-led growth in Mexico using the TYDL procedure for the period 1980.I to 2000.IV. Maneschiold (2008) analyzed the export-led growth hypothesis for Argentina, Brazil, and Mexico using a VAR error correction framework. The study showed a two-way causality between exports and growth after the inception of NAFTA and a one-way causal relationship flowing from exports to GDP before the inception of NAFTA.

The above literature review shows three different frameworks (cross country, panel, and time series) to study growth nexus. Panel cointegration is the most recent technique to have been developed that deals with the country specific cointegration relationship. According to Banerjee et al. (2004), the cointegration test in panel data may be falsely rejected (null of no cointegration) due to few cointegrated relationships. Thus, the causality literature using panel data may be misleading. He suggested looking at the relationships on a country by country case. Further, the past literature also shows that the causality relations differ with the period of study, country, and methods of econometric analysis. Empirical evidence is mixed and inconclusive.

Therefore, this study will investigate the long-run relationship among FDI, growth, and exports. In this analysis, we attempt to test first the hypothesis that FDI improves the economic growth of the host country (FDI-led growth) ; secondly, the hypothesis that exports improve economic growth of the host country (export-led growth); thirdly, the hypothesis that the economic growth of the host country improves the growth of FDI (export-led FDI); fourthly, the hypothesis that FDI improves the growth of exports (FDI-led export); fifthly, the hypothesis that exports improve growth in FDI (export-led FDI); sixthly, the hypothesis of bidirectional causality or possibly the case of no causality at all. Theoretical and empirical models to test these hypotheses are developed in section 4.4. Empirical results are presented in the section 4.5. The last section summarizes the conclusions of the chapter.

4.3 Methodology and Data

4.3.1 The Model

The model to investigate interrelationships among FDI, economic growth, and exports is derived from a production function in which FDI is introduced as an input, in addition to labor and capital. Suppose the level of output in an economy is determined by the production factors and the production technology as shown below:

$$Y_t = A_t K_t^{\propto} L_t^{\beta} \qquad (4.1)$$

where, Y_t stands for gross domestic product (GDP), *K* and *L* for the inputs of capital stock and labor stock, respectively, all in year *t*. The variable *A* is used to denote total factor productivity (TFP). TFP is the amount of output that is not explained by increasing labor or capital inputs. We assume that the coefficients of *K*, *L*, and *A* are positive. Thus, assuming constant technology, any rise in the amount of labor or capital will increase the output level in that economy. The production function described in equation 4.1 is expanded according to a new growth theory mentioned by Barro and Sala-i-Martin (1995) and Fosu (2006).

Improvements in technology (e.g. improved capital stock) makes labor more productive and increases per worker output with fixed supplies of both labor and capital. Chen (1992) and Borensztein et al. (1998) argue that foreign direct investment (FDI) is a major source of human capital and new technology in developing countries. According to Lipsey (2001), the impact of FDI on economic growth is through TFP. The inclusion of FDI in a production function will capture externalities such as learning by watching and spill-over effects. The impact of FDI and other relevant variables can be captured through *A*. Equation 4.1 can be written as follows:

$$Y_t = E_t K_t^{\propto} L_t^{\beta} FDI_t^{\gamma} \qquad (4.2)$$

where *E* represents exogenous factor of growth. The importance of exports for economic growth has been well documented in economic literature and several researchers have counted exports in their production functions. Several examples of literature explaining the export–led growth hypothesis (Abu-Quarn and Abu Bader, 2004; Ericcson and Irandoust, 2001; Thornton, 1996) showed the importance of exports in economic growth. According to Fosu (1990), exports are viewed as the systematic error term affecting output. This will secure the effect of the international factors influencing the output that is not secured by either labor or capital. Riezman et al. (1996) have pointed out that Granger causality tests may be misleading if imports are not counted in the production function. We included a dummy variable *NAFTA* to take into account the effect of trade liberalization (NAFTA = 1 from 1994 to 2008 and zero otherwise). In Mexico, a majority share of FDI flows from the United States. In addition, the geographic proximity of Mexico to the United States combined with the existence of several other trade agreements between Mexico and the United States serve to interconnect the Mexican economy with that of the United States. Hence, the GDP of the United States has been included in the growth equation to secure against foreign economic shocks. To investigate the causal relationship among FDI, exports, and growth along with the capital and labor, equation (4.2) can be written as follows:

$$Y_t = E_t K_t^{\propto} L_t^{\beta} FDI_t^{\gamma} Import_t^{\theta} Export_t^{\delta} Trend_t^{\omega} NAFTA_t^{\emptyset} \qquad (4.3)$$

From equation (4.2) it can be written as follows:

$$lnY_t = C + \propto lnK_t + \beta lnL_t + \gamma\, lnFDI_t + \theta lnImport_t + \delta lnExport_t + \emptyset\, NAFTA_t + e_t \qquad (4.4)$$

$$lnY_t = C + \propto lnK_t + \beta lnL_t + \gamma\, lnFDI_t + \theta lnImport_t + \delta lnExport_t + \omega Trend + \varphi\, lnUSGDP_t + e_t \qquad (4.5)$$

where *ln* represents the natural logarithm of the variables and e_t is white noise and is assumed to be normally and identically distributed, *C* is the constant term. The log linear specification implies that the parameters $\propto, \beta, \gamma,\ \theta, \delta$, and φ are elasticities of capital, labor, FDI, imports, exports, and GDP of the United States, respectively. The sign of the parameters are all expected to be positive.

4.3.2 Data

This research uses annual time series data for Mexico from 1970 to 2008. Aggregate output (Y_t) is measured by real GDP of Mexico and Mexican capital stock (K_t) is proxied by the real value of gross fixed capital formation (GFCF). This proxy for capital stock has been used in several studies such as Balsubramanyam et al. (1996) and Borensztein et al. (1998). The data on labor (L_t) corresponds to the number of economically active citizens in the Mexican population. Foreign direct investment was converted to real FDI using the GDP deflator for Mexico (in 2000 constant prices). All data were converted into natural logarithms before analysis. The data sources for all variables were the World Development Indicator (WDI, 2011) and the Penn World Tables (Appendix 4.1). The summary statistics is provided in Appendix 4.2

4.4.3 Econometric Methods

The majority of time series studies have used the Granger causality test to examine the causality between economic variables. The concept of causality was initially defined by Granger (1969) in a bivariate framework. A time series *X* is said to be the 'Granger cause' of a series *Y*. If the connection can be made that shows through a series of t-tests and F- tests on the values of *X* that have been lagged, than those lagged *X* values furnish information about future values of *Y* that are statistically significant.

The standard Granger causality tests are sensitive to the model selection and functional form. As far as the model specification is concerned, most of these studies have used simple two variable relationships (Gujaratio, 1995 Gujaratio, 1995; Xu, 1996). Sims (1972) argued that Granger causality in a bivariate model is mainly due to the omitted variable. In such cases the causal inferences are invalid, the Granger causality test requires that the underlying variables must be stationary (Granger, 1988).

The Engle and Granger correction model (ECM) as developed by Engle and Granger (1987) and the vector autoregressive error correction model (VECM) as developed by Johansen and Juselius (1990) are just two examples of recent developments in time series analysis that consider the issue of integration and cointegration in time series analysis. In these models, the error correction term describes the long-run equilibrium relationship and the lagged difference terms indicate the short-run relationship. Both ECM and VECM specifications are cumbersome and sensitive to values of nuisance parameters, especially in the case of small sample size (Rambaldi and Doran, 1996). To determine the extent of cointegration, the Engle and Granger method uses the Augmented Dickey-Fuller (ADF) test on the residuals obtained from the regression on the level variables. This may give inefficient and misleading results if more than two I(1) variables are used in the regression and the nature of the variables are endogenous[5]. The VECM process allows for a multivariate format and also allows for more than one cointegrating vectors. However, these methods are complicated if there are more than two cointegrating vectors. This also requires a pretest for unit roots and cointegration. According to Bewley and Yang (1996) and Toda (1994), the power of the LR test is high only when the correlation between the shocks that generate the stationary and non-stationary components is sufficiently large and the specific lag length is small. The power of the LR test deteriorates if the specification of lag length is large. Further, use of F–statistics for the causality test in VAR and ECM is not valid if variables are integrated and cointegrated and the test statistic does not have asymptotic properties (Toda and Yamamoto 1995; Zapata and Rambaldi, 1997; Gujarati, 1995).

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[5] May be more than one cointegrating vectors

Therefore, in this analysis, we apply the Granger causality test as developed by Toda and Yamamoto (1995) and Doland and Lutkepohl (1996), hereafter referred to as TYDL. The method utilizes a modified Wald statistic in testing for the significance of the parameters of a VAR model. According to Toda and Yamamoto, the modified Wald statistic is valid even if the series are a mixture of I(0), I (1) or I(2) and cointegrated or noncointegrated of any order. The procedure will be valid as long as the order of integration (d_{max}) does not exceed the true lag length (k) of the VAR model.

Implementation of the TYDL method involves two steps. The first step involves the determination of the maximum order of integration (d_{max}) of the variables in the system and the lag length (k) of the VAR model. Unit root tests are used to determine d_{max}. The lag length of the variables in the VAR (k) model can be selected according to the Sequential Modified LR test, Akaike Information Criterion (AIC), Schwartz Information Criterion (SIC), and Hannan-Quinn Information Criterion (HQIC). Once the optimal lag length (k) and d_{max} are determined, the diagnostic checking of the VAR model can be done by applying a normality test, autocorrelation, heteroskedasticity, and VAR stability tests. In the step second, the Granger causality inferences are made by applying the Wald tests to the first k VAR coefficient matrices (but not all lagged coefficients) on the equations (4.5 to 4.10). The estimation of the VAR (k+d_{max}) guarantees the asymptotic χ^2 distribution for the Wald statistic. Therefore, the TYDL causality procedure has been labeled as the long- run causality tests.

$$lnGDP_t = \theta_1 + \sum_{i=1}^{p} \varphi_{1i} lnGDP_{t-i} + \sum_{i=1}^{p} \eta_{1i} lnGFCF_{t-i} + \sum_{i=1}^{p} \lambda_{1i} ln\, LFT_{t-i} + \sum_{i=1}^{p} \Omega_{1i} ln\, FDI_{t-i}$$

$$+ \sum_{i=1}^{p} \varpi_{1i} ln\, Import_{t-i} + \sum_{i=1}^{p} \psi_{1i} ln\, Export_{t-i} + u_{1t} \qquad (4.5)$$

$$lnGFCF_t = \theta_2 + \sum_{i=1}^{p} \varphi_{2i} lnGDP_{t-i} + \sum_{i=1}^{p} \eta_{2i} lnGFCF_{t-i} + \sum_{i=1}^{p} \lambda_{2i} ln\, LFT_{t-i} + \sum_{i=1}^{p} \Omega_{2i} ln\, FDI_{t-i}$$

$$+ \sum_{i=1}^{p} \varpi_{2i} ln\, Import_{t-i} + \sum_{i=1}^{p} \psi_{2i} ln\, Export_{t-i} + u_{2t} \quad (4.6)$$

$$\boldsymbol{l}\mathrm{nLFT_t} = \theta_3 + \sum_{i=1}^{p} \varphi_{3i} lnGDP_{t-i} + \sum_{i=1}^{p} \eta_{3i} lnGFCF_{t-i} + \sum_{i=1}^{p} \lambda_{3i} ln\, LFT_{t-i} + \sum_{i=1}^{p} \Omega_{3i} ln\, FDI_{t-i}$$

$$+ \sum_{i=1}^{p} \varpi_{3i} ln\, Import_{t-i} + \sum_{i=1}^{p} \psi_{3i} ln\, Export_{t-i} + \mathrm{u_{3t}} \quad (4.7)$$

$$lnFDI_t = \theta_4 + \sum_{i=1}^{p} \varphi_{4i} lnGDP_{t-i} + \sum_{i=1}^{p} \eta_{4i} lnGFCF_{t-i} + \sum_{i=1}^{p} \lambda_{4i} ln\, LFT_{t-i} + \sum_{i=1}^{p} \Omega_{4i} ln\, FDI_{t-i}$$

$$+ \sum_{i=1}^{p} \varpi_{4i} ln\, Import_{t-i} + \sum_{i=1}^{p} \psi_{4i} ln\, Export_{t-i} + u_{4t} \quad (4.8)$$

$$lnImport_t = \theta_5 + \sum_{i=1}^{p} \varphi_{5i} lnGDP_{t-i} + \sum_{i=1}^{p} \eta_{5i} lnGFCF_{t-i} + \sum_{i=1}^{p} \lambda_{5i} ln\, LFT_{t-i}$$

$$+ \sum_{i=1}^{p} \Omega_{5i} ln\, FDI_{t-i} + \sum_{i=1}^{p} \varpi_{5i} ln\, Import_{t-i} + \sum_{i=1}^{p} \psi_{5i} ln\, Export_{t-i} + u_{5t} \quad (4.9)$$

$$lnExport_t = \theta_6 + \sum_{i=1}^{p} \varphi_{6i} lnGDP_{t-i} + \sum_{i=1}^{p} \eta_{6i} lnGFCF_{t-i} + \sum_{i=1}^{p} \lambda_{6i} ln\, LFT_{t-i} + \sum_{i=1}^{p} \Omega_{6i} ln\, FDI_{t-i}$$

$$+ \sum_{i=1}^{p} \varpi_{6i} ln\, Import_{t-i} + \sum_{i=1}^{p} \psi_{6i} ln\, Export_{t-i} + u_{6t} \quad (4.10)$$

In the above equations, u_1 to u_6 are white noise error terms; p signifies lag length of k+d_{max}. Now, to test the hypothesis that exports does not Granger-cause GDP (exports $\nrightarrow$ GDP), we tested the significance of k^{th} coefficient by testing the null hypothesis $\boldsymbol{\psi}_{1i} = 0, i = 1,2 \ldots \ldots., k$ in equation 4.5. Rejection of the null hypothesis concludes that exports Granger-cause GDP growth, establishing the conclusion that there is a long-run relationship between exports and GDP.

4.4 Result and Discussion

This study analyses the impact of FDI and exports on economic growth based on the endogenous growth theory. From the visual inspection of the Autocorrelation function (ACF) and partial autocorrelation function (PCF), it can be inferred that all series have a linear trend and are non-stationary. Non-stationary time series may contain a unit root. So prior to testing for a causality relationship between the time series, it is necessary to test the order of integration of the series.

4.4.1. Unit root test

Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were carried out on the time series in level and first differences to identify the existence of unit roots. The number of lags included in the ADF test were determined using AIC and SIC in a simple autoregressive (AR) regression model with a constant and a trend variable and in a regression model without a trend variable (constant only). We selected lag length for the PP test according to a selection process as specified by the Newey and West (1994) bandwidth using a Bartlett kernel. The results of the ADF and PP tests are presented in Table (4.1). The ADF test indicates that all series are non-stationary at their levels, but become stationary after taking the first difference. The PP test rejects the null of non-stationary of FDI in level with the trend but does not reject non-stationary without the trend. In first differences, both PP tests (with and without trend) rejected the null hypothesis of non-stationary of the series. Therefore, we concluded that the series along with FDI are integrated order one, i.e, I(1).

4.4.2 The VAR Model and Granger Causality Test

To select the lag length of the VAR models, all criteria (LR, FE, AIC, SIC and HQIC) have been checked. According to Lutkepohl (2005), SIC and HQIC provide consistent estimates of the true lag selection in VAR. In the present study, amongst all the criteria, SIC constantly showed the optimal lag of one regardless of different maximum lag lengths in the system. Therefore, lag length (*k*) of one is selected. With the maximum order of integration expected in the system and the optimal VAR lag length, augmented VAR (2) level was selected to test the direction of causality in the system. Once the lag length of the augmented VAR was specified, some misspecification tests of error of the VAR were carried out. The Lagrange multiplier test (LM) was used to check the residual serial correlation. We do not reject the null hypothesis of no autocorrelation for all models except for the new growth model (model 6). The results are likely due to the relatively small sample size. In addition to this, all models satisfied the normality assumption.

Furthermore, the stability condition of the VAR was satisfied and there are no roots outside of the unit circle (Table 4.2). The misspecification test was also carried out for all equations of endogenous variables in VAR (2). The results in table (4.3) show mixed results of normality. The LM test suggests that there is no autocorrelation problem, except for the LFT equation. Similarly, Ramsey RESET tests stated that there is no specification problem, except for exports and FDI equations. However, CUSUM and CUSUMSQ tests do not show any evidence of instability in each equation.

Table 4. 1Tests of the unit root hypothesis with trend and constant and constant only

Variables	Trend		No Trend	
	ADF	PP	ADF	PP
Levels	Tau	Tau	Tau	Tau
GDP	-3.01(1)	-2.39(3)	-2.00(1)	-2.07(3)
Exports	-2.29(2)	-1.85(3)	-0.93(2)	-0.86(1)
Imports	-2.03(2)	-2.09(3)	-0.02(2)	-0.09(3)
GFCF	-2.69(2)	-2.54(3)	-1.28(1)	-0.90(3)
FDI	-2.94(3)	-3.87(3)**	-0.95(3)	-0.91(3)
LFT	-1.99(2)	-2.34(3)	-0.34(2)	-1.17(3)
First difference				
ΔGDP	-4.52(0)***	-4.52(3)***	-4.25(0)***	-7.25(3)
ΔExports	-3.17(1)*	-3.36(3)*	-3.14(1)**	-3.30(3)**
ΔImports	-4.32(2)***	-4.31(3)***	-4.52(0)***	-4.40(3)***
ΔGFCF	-5.05(0)***	-5.02(3)***	-5.14(0)***	-5.09(3)***
ΔFDI	-4.35(3)***	-8.58(3)***	-4.43(3)***	-8.72(3)***
ΔLFT	-3.98(1)**	-6.30(3)***	-4.06(1)***	-6.44(3)***

Note: Asterisks indicate at the 10 percent (*), 5 percent (**) and 1 percent (***) level respectively. The critical values for ADF and PP tests with constant and trend are -4.032, -3.45, -3.147 whereas with constant notrend are -3.4386, -2.856, and -2.568 for 1, 5 , 10 , percent significance level, respectively. Figures in parenthesis show the maximum lag length

After the diagnostic test of the augmented VAR (2), a Granger causality test was performed (Table 4.4, 4.5, and 4.6). The results from the bivariate (Model 1) Granger causality test using GDP and exports suggest that the null hypothesis of no Granger causality from exports to growth can be rejected at the 5% significance level (Table 4.4). The sum of lagged coefficients for exports is 0.07. This suggests that there is a long- run positive relationship between economic growth and exports and the direction is from exports to economic growth. This result is consistent with the findings of Cuardros et al. (2002), Thornton (1996); Abdulnasser and Manuchehr (2000); Awokuse (2003).

Table 4.2 Misspecification tests for augmented VAR (2)

	Model1	Model2	Model3	Model4	Model5	Model6
JB	2.75(0.60)	2.51(0.87)	2.15(0.71	3.14(0.79)	3.75(0.88)	4.70(0.97)
LM	5.44(0.24)	10.26(0.33)	0.57(0.97)	12.91(0.17)	32.63(0.04)	58.24(0.03)
VAR STABILITY	No root lies outside the unit circle					

Note: See Appendix 1 for Models. Asterisks indicate significance at the 10 percent (*), 5 percent (**) and 1 percent (***) levels, respectively. Figures in parenthesis are probabilities. The JB test signifies the Jarque-Bera test for normality, the LM test for autocorrelation is based on lag 2. VAR stability reveals that all roots have a modulus of less than one and lie inside the unit circle.

With the inclusion of *NAFTA* as an exogenous variable in the equation, Granger causality between GDP and exports is positive and significant only at the 5% level (sum of lagged coefficients for exports were 0.08). Isolation of the NAFTA effect is very difficult because of other free trade agreements joined by the NAFTA partners, the peso crisis that happened during the same period of NAFTA implementation, as well as the other shocks that occurred in the past. Janvry (1996) argued that NAFTA greatly reduced the negative impact of the peso crisis on U.S. trade with Mexico. Furthermore, Arora and Vamvakids (2003) reported the small impacts of NAFTA on the economic growth of Mexico because of the long and inherently powerful trade partnership between the United States and Mexico. Some articles (Hufbauer and Schott, 2005) argue that the lack of fiscal reform and lack of rule of law might have resulted in slow economic growth in Mexico. The effects of U.S. GDP and trend on Mexican growth were positive, but no evidence was found to support Granger causality between GDP and exports.

The inclusion of imports along with GDP and exports (Model 2) (Table 4.4) supports the export-led growth hypothesis as in the bivariate framework (Model1) at the 5% significance level. Granger causality from exports to imports is supported at the 1% significance level without the exogenous variable in the system. This finding suggests the existence of the long-run

Table 4. 3 Misspecification tests for estimated endogenous equations

VAR(2)	LM	ARCH	JB	White	Ramsey	CUSUM
Model 1						
GDP	0.18(0.92)	0.44(0.80)	14.16(0.00)***	11.60(0.17)	0.72(0.55)	within
Exports	2.84(0.24)	1.54(0.46)	0.28(0.87)	6.53(0.59)	3.61(0.02)**	within
Model 2						
GDP	0.00(1.00)	0.51(0.78)	21.06(0.00)	15.52(0.34)	1.67(0.20)	within
Exports	0.00(1.00)	0.18(0.92)	0.59(0.00)	21.77(0.08)	2.87(0.06)	within
Imports	0.81(0.67)	3.74(0.15)	1.32(0.52)	25.90(0.03)	0.61(0.61)	within
Model 3						
GDP	0.37(0.83)	0.89(0.64)	9.26(0.01)	16.61(0.12)	0.25(0.86)	within
FDI	0.18(0.91)	1.82(0.40)	0.15(0.93)	6.98(0.83)	1.06(0.38)	
Model 4						
GDP	0.68(0.71)	0.18(0.91)	10.28(0.01)	33.39(0.18)	0.56(0.65)	within
Exports	2.28(0.32)	1.08(0.58)	0.83(0.66)	14.18(0.77)	2.67(0.07)*	within
FDI	1.94(0.38)	1.42(0.49)	3.90(0.00)***	10.05(0.93)	0.78(0.52)	within
Model5						
GDP	0.34(0.85)	0.30(0.86)	10.85(0.00)	32.32(0.12)	1.31(0.29)	within
Exports	0.54(0.76)	0.28(0.87)	0.67(0.72)	28.93(0.22)	2.09(0.13)	within
Imports	1.84(0.40)	6.20(0.05)**	0.09(0.96)	29.88(0.19)	0.59(0.63)	within
FDI	1.22(0.54)	1.56(0.46)	0.87(0.65)	28.73(0.42)	2.18(0.12)	within
Model 6						
GDP	0.32(0.85)	0.56(0.75)	25.98(0.00)***	33.03(0.27)	3.43(0.04)	within
Exports	2.87(0.24)	4.77(0.09)*	0.11(0.95)	33.03(0.28)	1.63(0.21)	within
Imports	1.63(0.44)	1.54(0.46)	1.16(0.56)	29.57(0.44)	1.35(0.29)	within
FDI	3.98(0.14)	1.99(0.37)	0.02(0.99)	34.530.22)	2.73(0.07*)	within
GFCF	0.36(0.84)	0.40(0.82)	44.60(0.00)	33.59(0.25)	0.28(0.84)	within
LFT	8.36(0.02)**	4.64(0.10)	18.79(0.00)***	35.43(0.19)	0.86(0.48)	within

Note: See Appendix 3.3 for Models. Asterisks indicate significance at the 10 percent (*), 5 percent (**) and 1 percent (***) level respectively. Figures in parenthesis are probabilities. JB test is the Jarque-Bera test for normality, LM test for autocorrelation based on lag 2. ARCH is an LM test for autoregressive conditional heteroskedasticity of order 2. White is the White test for heteroskedasticity of the errors. Ramsey is the Ramsey RESET test null is no specification problem. CUSUM test is based on the cumulative sum of the recursive residuals that explains parameter instability if the cumulative sum is not within the band of two critical lines at 5%

positive relationship between export and GDP is through a channel of imports. In the presence of NAFTA and U.S. GDP along with trend, Granger causality is significant at the 5% and 10%

significance levels, respectively. The weaker power of causality with NAFTA is due to a devaluation in the Mexican peso, which in turn, makes Mexican imports more expensive (Janvry, 1996). The main objective of NAFTA was to reduce the trade barriers faced by Canada and the United States while importing goods from Mexico. After implementation of NAFTA, the tariff rates have fallen significantly and the requirement for import licensing has largely been eliminated (Qasmi and Fausti, 2001).

Table 4.4 Granger causality results using MWALD test (TYDL method) for Model 1 and 2

Null hypothesis [1]	Without exogenous	NAFTA	Trend USGDP
Model1			
Exports ↛ GDP	4.56(0.04)**	4.33(0.05)**	1.91(0.18)
GDP ↛ Exports	0.24(0.63)	0.49(0.49)	0.07(0.79)
Model 2			
Exports ↛ GDP	4.45(0.04)**	5.4(0.03)**	1.82(0.19)
Imports ↛ GDP	0.96(0.33)	1.42(0.24)	0.41(0.53)
GDP ↛ Exports	0.27(0.61)	0.11(0.74)	0.04(0.85)
Imports ↛ Exports	0.58(0.45)	0.02(0.90)	0.12(0.73)
GDP ↛ Imports	1.14(0.29)	1.06(0.31)	0.17(0.68)
Exports ↛ Imports	6.8(0.01)**	5.1(0.03)**	3.35(0.08)**

Note: See Appendix 1 for Models. Asterisks indicate significance at the 10 percent (*), 5 percent (**) and 1 percent (***) respectively. Figures in parenthesis are probabilities. [1] Null Hypothesis is the null hypothesis of Granger no causality. Rejecting the null hypothesis suggests Granger causality

FDI -led growth was analyzed in three different models (Models 3, 4, and 5). We first examined FDI-led economic growth in the bivariate framework (Model3). Results suggest FDI-led economic growth, with or without the presence of the exogenous variable, at the 1% level of significance. The sums of the lagged coefficients 1) without the exogenous variable, 2) with NAFTA and 3) U.S. GDP and trend variables are 1.56, 2.16, and 1.10, respectively. These results suggest that there is a positive long- run relationship running from economic growth to FDI. This finding is in line with Galan and Olandipo (2009); Chakraborty and Basu (2002); Choe (2003).

Studies such as Baliamoune-Lutz (2004) and Omisakin (2009) reported a one- way causality running from FDI to GDP. Other studies such as Basu et al. (2003); Liu et al. (2002); Pradhan (2009) reported bidirectional causality.

Table 4.5 Granger causality results using MWALD test (TYDL method) for Model 3, 4 and 5

Null hypothesis	Without exogenous	NAFTA	Trend USGDP
Model 3			
FDI ↛ GDP	0.20(0.66)	0.94(0.34)	0.21(0.65)
GDP ↛ FDI	15.24(0.00)***	23.03(0.00)***	12.54(0.00)***
Model4			
Exports ↛ GDP	4.54(0.04)**	3.67(0.07)*	1.48(0.23)
FDI ↛ GDP	0.80(0.38)	0.57(0.46)	0.20(0.66)
GDP ↛ Exports	0.11(0.74)	0.55(0.46)	0.04(0.85)
FDI ↛ Exports	0.87(0.36)	0.13(0.72)	2.72(0.11)
GDP ↛ FDI	12.76(0.00)***	19.61(0.00)***	11.39(0.00)***
Exports ↛ FDI	9.41(0.00)***	3.04(0.09)*	5.66(0.02)**
Model5			
Export ↛ GDP	5.20(0.03)**	5.39(0.03)**	1.74(0.20)
Imports ↛ GDP	2.27(0.14)	2.54(0.12)	0.95(0.34)
FDI↛ GDP	2.84(0.10)	2.31(0.14)	0.56(0.46)
GDP ↛ Exports	0.19(0.67)	0.08(0.78)	1.28(0.27)
Imports ↛ Exports	0.46(0.51)	0.07(0.79)	1.10(0.30)
FDI ↛ Exports	0.05(0.82)	0.05(0.82)	5.63(0.03)**
GDP↛ FDI	0.55(0.46)	2.07(0.16)	0.01(0.91)
Exports↛ FDI	11.05(0.00)***	3.75(0.06)*	9.70(0.00)***
Imports ↛ FDI	2.23(0.15)	1.39(0.25)	4.40(0.05)**
GDP ↛ Imports	2.56(0.12)	2.03(0.17)	0.35(0.56)
Export ↛ Imports	10.01(0.00)***	6.45(0.02)**	3.28(0.08)*
FDI↛ Imports	4.59(0.04)**	4.57(0.04)**	0.22(0.64)

Note: Asterisks indicate significance at the 10 percent (*), 5 percent (**) and 1 percent (***) significance levels, respectively. Figures in parenthesis are probabilities. [1] Null hypothesis is the null hypothesis of no Granger causality. Rejecting the null hypothesis suggests Granger causality

The inclusion of exports in the analysis (Model 4) also supported export-led FDI at the 1% significance level, which is consistent with the findings of Hsiao and Hsiao (2006). In the meantime, Granger causality running from GDP to FDI is also supported. The effect of NAFTA was positive and significant. This might have resulted from NAFTA's goal of increasing U.S. FDI in Mexico. The results are consistent with Galan and Olandipo (2009), who studied the causality amongst FDI, growth, and exports by dividing their sample into pre and post-NAFTA periods. In the presence of imports in the system, causality between FDI and GDP disappeared (Model 5). The causality from GDP to FDI could be a reason for the exclusion of imports in the system. This finding is consistent with Riezman et al. (1996), who pointed out that the Granger causality test may yield misleading results if imports are not included in the equation. The result supports Granger causality from FDI to exports in the presence of U.S. GDP and trend. This suggests that the long-run relationship between FDI and exports is through the channel of imports. At the same time, a positive and significant relationship between imports and FDI was also found in the presence of U.S. GDP and trend. This could suggest that U.S. affiliates in Mexico import intermediate inputs that are required in production processes from the United States and re-export the final products to the United States. The causality from imports to FDI, from FDI to exports, and from exports to imports are also reported by Liu et al. (2001).

The new growth theory (Model 6) did not directly support the export-led economic growth and FDI-led growth and vice versa with or without exogenous variables (Table 4.6). This is not in line with Shan and Sun (1998) who found bidirectional causality between GDP and exports based on the endogenous growth model in China. Our finding supports Granger causality of GFCF and labor force on the growth of imports with or without exogenous variables in the system. Therefore, we can conclude that labor and capital are the indirect channel through which the export-led growth, FDI- led growth, and export-led FDI are supported in the bivariate (Model 1 and Model 3) and multivariate (Model 4) frameworks.

Table 4.6 Granger causality results using MWALD test (TYDL method) for Model 6

Null Hypotesis[1]	Without exogenous	NAFTA	Trend USGDP
Exports ↛ GDP	0.16(0.69)	0.48(0.50)	0.09(0.77)
Import ↛ GDP	1.56(0.22)	0.67(0.42)	1.63(0.22)
GFCF ↛ GDP	1.44(0.24)	1.81(0.91)	1.22(0.28)
FDI ↛ GDP	2.82(0.11)	1.07(0.31)	1.04(0.32)
LFT ↛ GDP	1.15(0.29)	1.26(0.27)	0.67(0.42)
GDP ↛ Exports	0.01(0.94)	0.02(0.90)	0.13(0.73)
Import ↛Exports	1.30(0.26)	0.59(0.45)	2.53(0.13)
GFCF ↛ Exports	0.11(0.75)	0.17(0.68)	0.89(0.36)
FDI ↛ Exports	1.10(0.30)	0.26(0.62)	6.30(0.02)**
LFT ↛ Exports	0.16(0.68)	0.26(0.62)	2.46(0.13)**
GDP ↛FDI	0.67(0.42)	0.64(0.43)	1.49(0.23)
Exports ↛ FDI	2.27(0.15)	1.56(0.22)	2.82(0.11)
Imports ↛ FDI	0.66(0.42)	2.00(0.17)	7.15(0.01)***
GFCF ↛ FDI	0.23(0.63)	0.16(0.70)	2.60(0.12)**
LFT ↛ FDI	0.20(0.66)	0.22(0.64)	5.37(0.03)**
GDP ↛ Imports	2.38(0.14)	2.58(0.12)	2.07(0.16)
Exports ↛Imports	0.16(0.69)	0.35(0.56)	0.12(0.74)
GFCF ↛ Imports	3.93(0.06)*	4.27(0.05)**	3.37(0.08)*
FDI ↛ Imports	6.29(0.02)**	3.82(0.06)*	2.64(0.12)
LFT ↛ Imports	9.80(0.00)***	10.03(0.00)***	6.74(0.02)**
GDP ↛GFCF	1.88(0.18)	2.26(0.15)	1.73(0.20)
Exports ↛GFCF	0.03(0.87)	0.01(0.91)	0.03(0.86)
import ↛GFCF	2.52(0.13)	1.34(0.26)	2.05(0.17)
FDI ↛GFCF	3.80(0.06)*	1.66(0.21)	2.04(0.17)
LFT ↛GFCF	1.86(0.19)	2.05(0.17)	1.53(0.23)
GDP ↛LFT	0.77(0.39)	0.75(0.40)	1.16(0.29)
Exports ↛LFT	1.45(0.24)	1.31(0.26)	1.09(0.31)
Imports ↛LFT	0.36(0.55)	0.36(0.55)	0.81(0.38)
GFCF ↛LFT	0.76(0.39)	0.74(0.40)	0.92(0.35)
FDI ↛LFT	0.60(0.45)	0.45(0.51)	0.84(0.37)

Note: Asterisks indicate significance at the 10 percent (*), 5 percent (**) and 1 percent (***) significance levels, respectively. Figures in parenthesis are probabilities.[1] Null hypothesis is the null hypothesis of no Granger causality. Rejecting the null hypothesis suggests Granger causality

4.5 Conclusions

This study examines Granger causality among GDP, exports, and FDI in Mexico during the period from 1970 to 2008. Six different types of models were used to examine Granger causality among the variables. The analysis was initially conducted under a bivariate contest, GDP and exports; FDI and GDP. The bivariate model was then extended to include variables such as imports, gross fixed capital formation (GFCF), and labor force. The theoretical model is derived according to new growth theory suggested by Barro and Salai-i- Martin (1995) and Fosu (2006). The Toda and Yamamoto (1995) and Doland and Lutkepohl (1996), TYDL, methodology was used to test Granger causality, because this method utilizes a modified Wald statistic for testing Granger causality and is valid whether the series are I(0), I(1) or I(2), cointegrated or noncointegrated. Further, this procedure is valid as long as the maximum order of expected integration in the system does not exceed the optimal lag length (k) of the VAR model. The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were used to check if the series are stationary. All the series are stationary in the first differences I(1). The optimal lag length of the vector autoregressive regression (VAR) model was selected based on Schwarz's Information Criterion (SIC) and a lag of one was subsequently chosen. With the order of integration in the system and optimal lag length of the VAR established, the augmented VAR (2) model was selected for the Granger causality study. The augmented VAR (2) satisfied the stability condition as well as other residual diagnostic tests.

The empirical results of this study indicates a unidirectional Granger causality between GDP and exports, which suggests that there is a significant and positive Granger causal relationship running from exports to GDP. These findings are consistent with the finding of Alguacil et al. (2002); Awokuse (2003); Baluamoune-Lutz (2004). The similar causal relationship held with the inclusion of the *NAFTA* trade agreement variable which is consistent with the finding of Galan and Olasdipo and (2009). These results suggest that exports are a main channel through which trade liberalization can affect economic growth (Balassubramanyan et al., 1996). There is a positive impact of FDI on economic growth of Mexico. Under the causality test, a unidirectional Granger causality between FDI and GDP running from GDP to FDI was observed. This finding is in line with Galan and Olasdipo (2009). The larger the host country means the larger the magnitude of inward flowing FDI. Surprisingly, no Granger causality was found from FDI to GDP, which is consistent with Galan and Olasdipo (2009), but inconsistent with the finding of Cuadros et al. (2002). This could be due to the fact that most of the manufacturing FDI is concentrated on the 'maquiladora' program, which may not provide spillover effects to the Mexican economy. However, the causality relationship from GDP to FDI has disappeared in the presence of imports; just then export-led FDI hypothesis is supported, suggesting that imports are the channel through which the growth in exports spurs growth in FDI.

An important finding of this study is the Ganger causality from GFCF and labor force to imports in the endogenous growth model. That is, there is a positive long-run relationship between a pair of variables from GFCF to imports and labor force to imports. This suggests that Granger causality between GDP and exports, FDI and GDP, exports to FDI derived from bivariate (model 1 and 3) and multivariate (model 4) frameworks are through a channel of imports, GFCF, and the labor force. The demand for intermediate inputs such as capital and technology that is required for foreign firms are imported into Mexico. Therefore, capital formation in Mexico is driven through imports. Accordingly, importing goods are productive in Mexico since exports are driven through imports. With the presence of NAFTA, the causality of

GFCF and imports; labor force and imports are stronger. This could be due to the dramatic reduction in tariff rates after the implementation of the NAFTA. In addition to this, the requirement of import licensing has also been largely eliminated. The Granger causality running from FDI to exports and imports to FDI in the presence of U.S. GDP and trend suggests efficiency in U.S. FDI flowing to Mexico, which causes the importation of capital and intermediate goods from the United States.

For policy- makers an important question pertains to how a country achieves sustained economic growth. Many believe that FDI boosts the productivity of host countries and promotes economic growth. This is not true for all countries since benefits from FDI depend upon a country's specific characteristics. The technological gap between foreign firms and domestic firms is an important factor in determining whether domestic firms can benefit from interaction with foreign firms. The larger the technological gap between the countries, the lower the spillover effect on domestic firms (Koko, 1996). This may be the cause for the finding of the insignificant impact of FDI on growth. According to Alfaro et al. (2004); Borensztein et al. (1998); Ford, (2008); Xu, (2000) the relationship between FDI and economic growth depends upon the absorptive capacity of the host country (i.e., infrastructure, political situation, and quality of human capital, and financial markets). The present analysis is limited by excluding some of the variables that may affect FDI-led growth, such as the supply of skilled and unskilled labor. Therefore, policy makers should put increased weight on infrastructure improvements, training productive workers, and encouraging domestic firms to invest in technology in order to achieve sustained benefits from FDI.

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Chapter 5: Summary and Conclusion

Most research on foreign direct investment (FDI) for the developing country assumes that FDI is the main channel through which technology and knowledge are transferred between participating countries to promote economic growth in the host country. Further, various regional trade agreements between developing countries and developed countries are important factors that affect FDI flows. This study explores the relationship between FDI and the exchange rate, FDI and exports, as well as the economic growth of Mexico.

Of the three studies presented in this dissertation, chapter 2 analyzed the interaction of FDI with the exchange rate, exchange rate volatility, and exchange rate expectations over the period from 1994 to 2008. The theoretical model incorporated FDI within a traditional gravity model framework and was derived following the method of Kleinert and Toubal, (2010). The Poisson pseudo-maximum likelihood (PPML) estimation of Santos and Tenreyo (2006) was used to estimate the FDI-modified gravity model. This method is superior to the Ordinary Least Squares (OLS) method in the presence of heteroskedasticity and the zero values in the dependent variable. The results suggest that the level of the exchange rate and exchange rate expectations are positively related with FDI. The deprecation of the host country currency increases FDI flows into the Mexico. Though insignificant, a positive coefficient of exchange rate volatility suggests that lower exchange rate volatility would enhance the ability of home countries to invest abroad. This finding indicates increased FDI for the country that has a smaller level of volatility (e.g., Canada, New Zealand, the United States) and lower levels of FDI for the country which has a higher level of volatility (i.e., Korea).

Chapter 3 focused on the relationship between U.S. FDI and U.S. exports to Mexico. Three different types of FDI were used, consisting of total, processed food, and manufactured

FDI. The theoretical framework is based on Barrel and Pain (1996). This analysis uses data from the period 1988Q1 to 2008Q4. Augmented Dickey Fuller (ADF), Philips Perron (PP), Zivot and Andrews (1992), and Perron and Vogelsang (1992) unit root test were used. Variables such as *per capita* GDP, wages, interest rate, exchange rate, manufacturing exports, and total export are integrated of order one I(1) and other variables are integrated of order zero I(0). The autoregressive distributed lags (ARDL) bound testing approach of Pesaran et al. (2001) was used to determine the relationship between FDI and exports. This method is efficient in a relatively small sample and estimates are also valid if some of the explanatory variables are endogenous. This procedure allows for consistent estimates in the long run, even if the series are integrated of order one I(1), of order zero I(0) or a mixture of both. The most important finding of this chapter is the complementary relationships between FDI and exports. The findings lend support to the previous literature that focused on inflows of FDI to the developing countries. An interesting finding is the weak complementary relationship for the processed food FDI and exports. The appreciation of the U.S dollar could be to blame for the weaker relationship. Another finding of this chapter is the positive relationship between NAFTA and FDI. The impact of NAFTA is weaker for the processed food FDI. The peso crisis corresponding with the implementation of NAFTA could be a reason for this. The strong complementary relationship between manufacturing FDI and exports after accounting for the effect of NAFTA is consistent with the goal of the NAFTA.

The objective of chapter 4 was to determine the relationships among economic growth, FDI, and exports in Mexico during the period 1970-2008. These relationships were tested using a bivariate and multivariate framework. The multivariate model, which incorporates imports, the labor force and gross fixed capital formation, in addition to other variables, was based on a new growth theory as suggested by Barro and Salai-i-Martin (1995) and Fosu (2006). The causal relationship among the variables is tested for by using a modified Wald test as suggested by Toda and Yamamoto (1995) and Donald and Lutkepohl (1996). Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP) tests were used to determine the stationary of the series. The unidirectional causal relationship flowing from exports to GDP exists even in the presence of NAFTA. The positive relationship between FDI and GDP flowing from GDP to FDI could be a result of the maquiladora program that may not have significant spillover effects flowing to Mexican economic growth. Meanwhile, the inclusion of imports in the equation supports the export-led FDI, suggesting that imports are the channel through which growth in exports spurs growth in FDI.

Another important finding is the causal relationship of GFCF and the labor force with imports in an endogenous growth model. The growth of GFCF and the labor force leads to growth in imports. This could indicate that growth nexus, such as export-led growth, and export-led FDI in the bivariate or multivariate models are through the channel of imports.

Overall the findings of this study are consistent with literature that suggests a complementary relationship between FDI and the appreciation of the home currencies, exports, and GDP. This study contributes to literature by emphasizing the importance of the exchange rate expectations in making FDI decisions. Lowering the exchange rate expectations (expected depreciation of the Mexican currency), foreigners are more capable to buy assets in the host country. In addition to this, depreciation of the host country currency makes consumers of the importing countries more capable to buy imported goods. In this situation, we expect higher demand for exported goods. Therefore, foreign firms in Mexico will produce more. This finding provides important implications for policy makers in the developing country, such as Mexico.

Another important addition to the literature is the relationship between the appreciation of the host currency and the attraction of processed food FDI in Mexico. An appreciation in the host currency enables consumers of the host country to buy more processed food items, which leads to an increase in the demand for processed food. To fulfill the demand, foreign affiliates will produce more. Further, the finding suggests the existence of a positive long-run relationship between exports and FDI and these relationships get weaker with the inclusion of the NAFTA effect. Therefore, the policy maker should use caution while making strategic decisions regarding FDI in Mexico. The policy maker should consider both exports and FDI together, separate from NAFTA, but for the NAFTA oriented policies they should consider the exchange rate as an additional variable along with exports and FDI.

Most developing countries rely on FDI inflows as a catalyst for their economic growth. However, there is no evidence of the long-run causal relationship flowing from FDI to growth. One of the reasons for this could be that most manufacturing FDI is concentrated in the 'maquiladora' program, which may not provide spillover effects for Mexican economic growth. Another important factor is the large technological gap between domestic and foreign firms in Mexico, which may not lead to spillover effects. Decreasing the technological gap will lead to a greater level of transfer of the advanced technology to the host country. Therefore, the quality of the technology transfer depends upon the ability of the host firms to mimic the innovate technology that are provided to the host country through the foreign firms. The findings suggested that, in the case of Mexico, policies aimed solely at attracting FDI are not sufficient to achieve economic growth. Along with FDI policies, host country absorptive capacity must be improved. Therefore, Mexican policy makers should put more weight on infrastructure development, manpower training and investment in technology.

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Appendix 2.1 Inflows and outflows of foreign direct investment (U.S. $ Billions)

Year	Inflows OECD	Outflows OECD	Outflows world	Inflows world
1990	180	237	242	203
1991	123	192	195	150
1992	118	187	196	152
1993	153	211	221	208
1994	167	252	262	243
1995	235	324	339	324
1996	256	347	365	372
1997	315	414	440	470
1998	540	655	687	702
1999	910	1052	1093	1094
2000	1309	1253	1330	1513
2001	643	696	734	805
2002	478	509	544	619
2003	406	548	574	560
2004	460	831	930	688
2005	661	779	874	1002
2006	1008	1188	1376	1453
2007	1354	1932	2165	1960
2008	1000	1584	1844	1692
2009	632	900	1111	1104
2010	637	1016	1269	1134

Source: Organization for Economic Cooperation and Development (OECD) Statistics online

Appendix 2.2 Variable definitions and data sources

Variables	Variables description	Source
FDI	Foreign direct investment inflow to Mexico	Organization for Economic Co-operation and Development (OECD), online
GDPh	Real Gross domestic product for home countries	Penn World Table 7.0, 2011
GDPf	Real Gross domestic product for host	Penn World Table 7.0, 2011
GFCF	Gross fixed capital formation	World Development Indicator, Word Bank, online, 2011
Labor	Economically active population	World Development Indicator, Word Bank, online, 2011
Wageh	Production worker in manufacturing for home countries	World Development Indicator, Word Bank, online, 2011
Wagef	Production worker in manufacturing for host countries	World Development Indicator, Word Bank, online, 2011
(wageh-wagef)	Own calculation	World Development Indicator, Word Bank, online, 2011
Nominal interest rate Mexico	Long term government bond yield greater than 6 to 2 years	Organization for Economic Co-operation and Development (OECD), online
Nominal interest rate home	Long term government bond yield average mostly 10 years	Organization for Economic Co-operation and Development (OECD), online
real interest rate (int.)	Calculated based on Waldrick (2003): (l+ nominal interest rate)/(Inflation plus l)	
GDP deflator	Gross domestic product deflator at 2005 =100	International Financial Statistics CD-ROM, IMF, 2010
Inflation	Percent change in gross domestic product deflator	International Financial Statistics CD-ROM, IMF, 2010
Nominal exchange rate for home	Nominal exchange rate national currency per U.S. dollar at the end of the period	
Nominal exchange rate for Mexico	Nominal exchange rate national currency per U.S. dollar at the end of the period	
Real exchange e rate	Peso per U.S dollar divided by home national currency per dollar. The real exchange rate value is calculated by multiplying the ration of GDP deflator of home to host	Own calculation
Monthly exchange rate	National currency per U.S dollar	International Financial Statistics CD-ROM, IMF, 2010
Monthly real exchange rate	Own calculation	International Financial Statistics CD-ROM, IMF, 2010

Appendix 3.1 Plots of the Variables

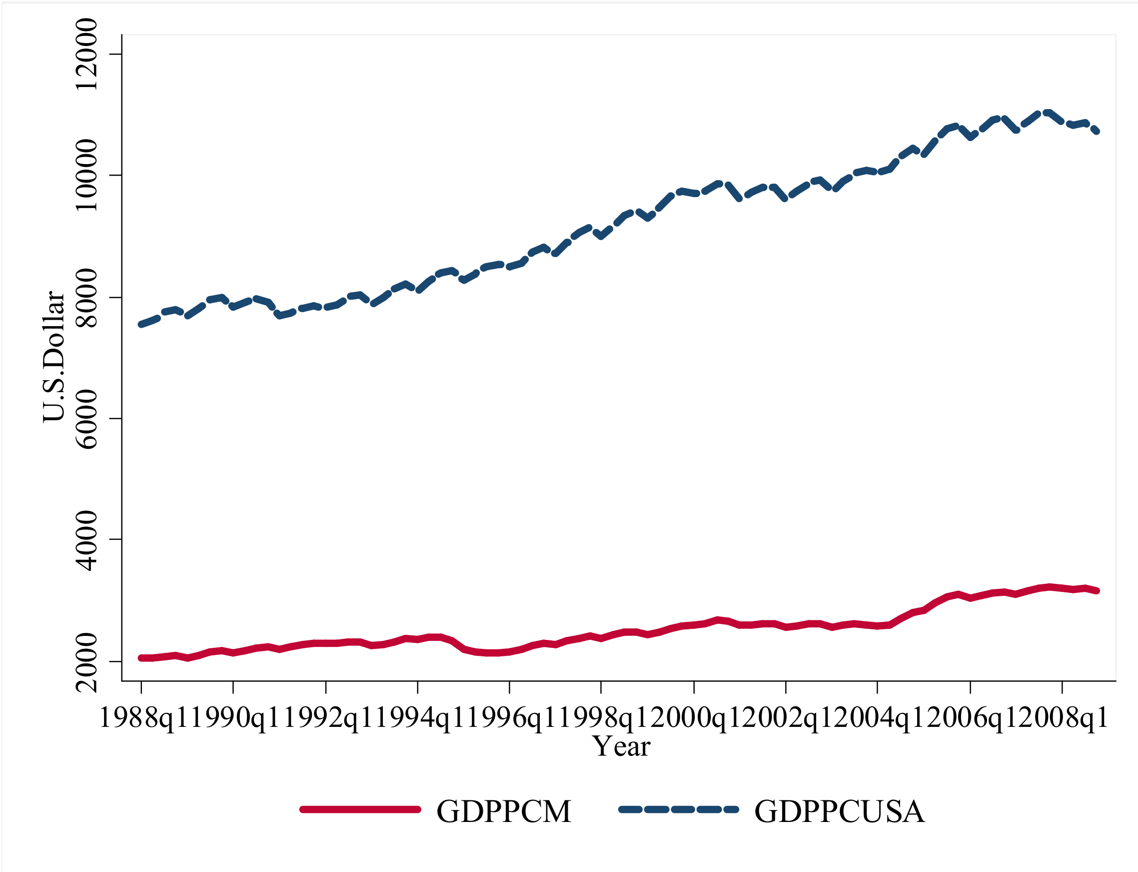

Figure 3.3 Real per capital GDP for Mexico (GDPPC) and real per capital GDP for U.S. (GDPPCUSA) in U.S. dollar.
Source: Penn World Table version 7.0, 2011

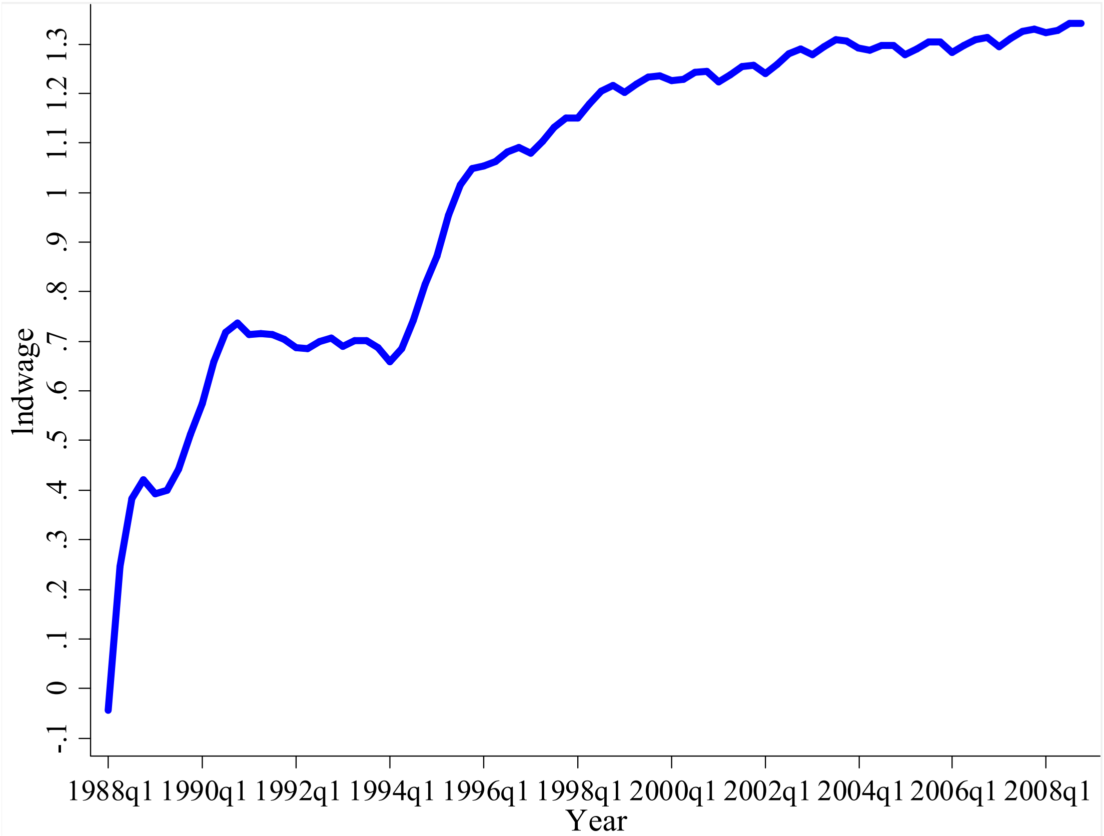

Figure 3.3 Log of relative wage difference between U.S and Mexico.
Source: Own calculation using data from United States Bureau of Labor Statistics and U.S. Bureau of Economic analysis.

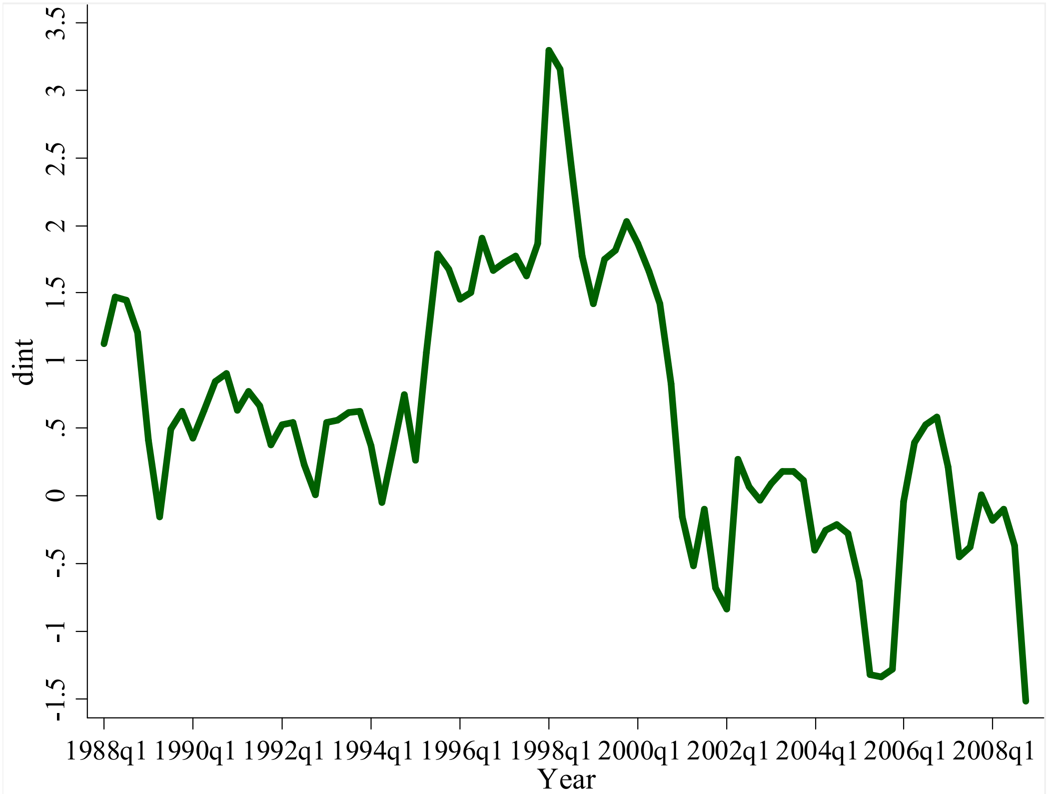

Figure 3.3 Relative interest rates difference between U.S and Mexico.
Source: Author derived calculations using data from International Financial Statistics CD-ROM, IMF (2010)

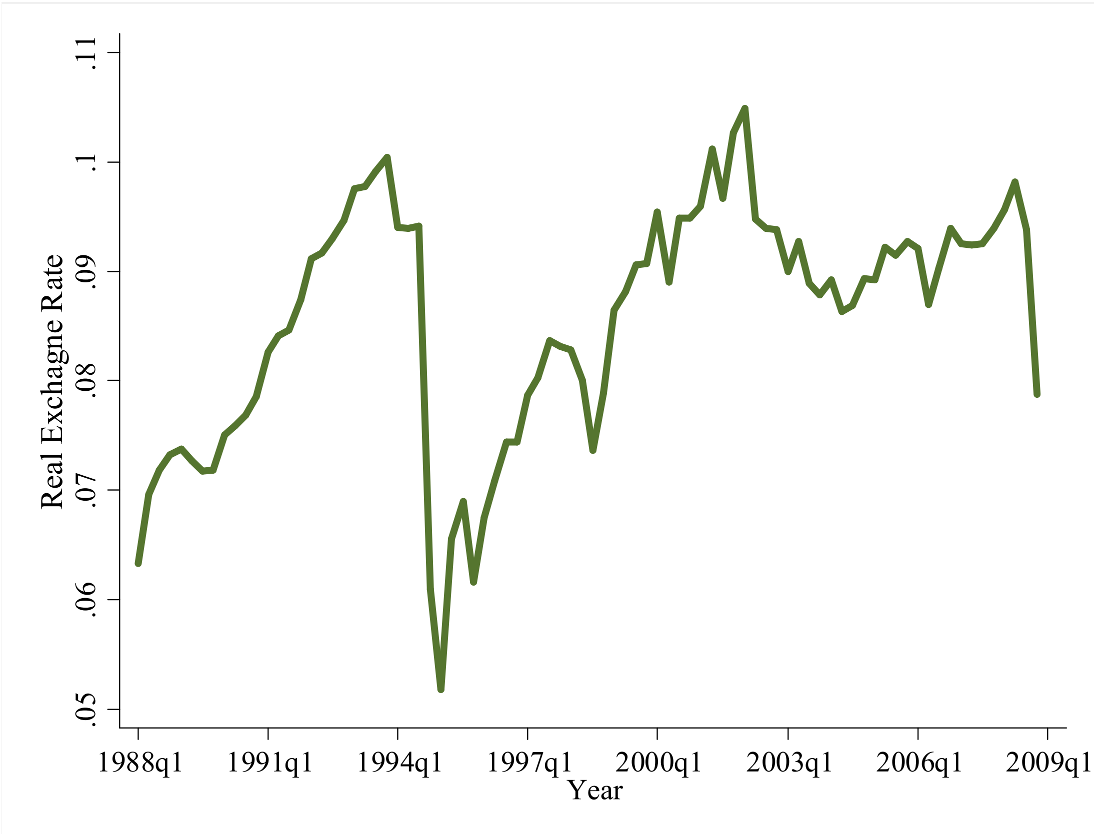

Figure 3.3 Real exchange rates U.S. dollar per Mexican peso.
Source: Author derived calculations using data from International Financial Statistics CD-ROM, IMF (2010)

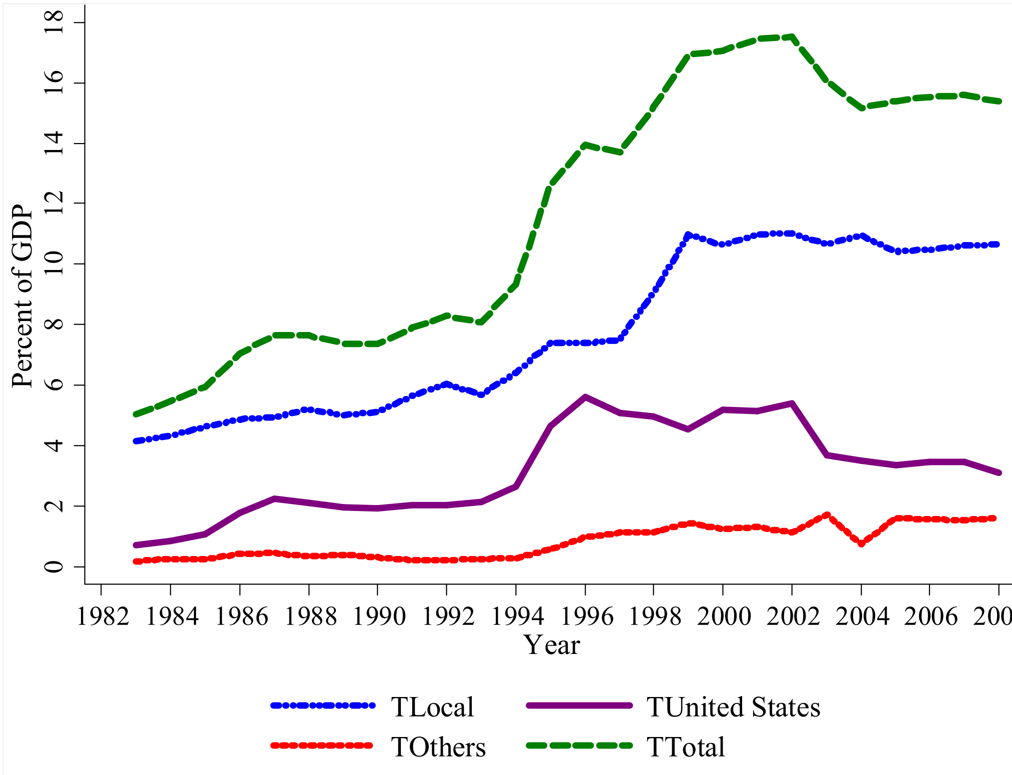

Figure 3.3 Total U.S affiliates sales to local market (Mexico) (TLocal), sales to United States (TUnited States), sales to others countries (TOthers) and the sum of all sales (TTotal) as a percent of Mexico GDP.
Source: Author derived calculations using data from the U.S. Department of Commerce, Bureau of Economic Analysis

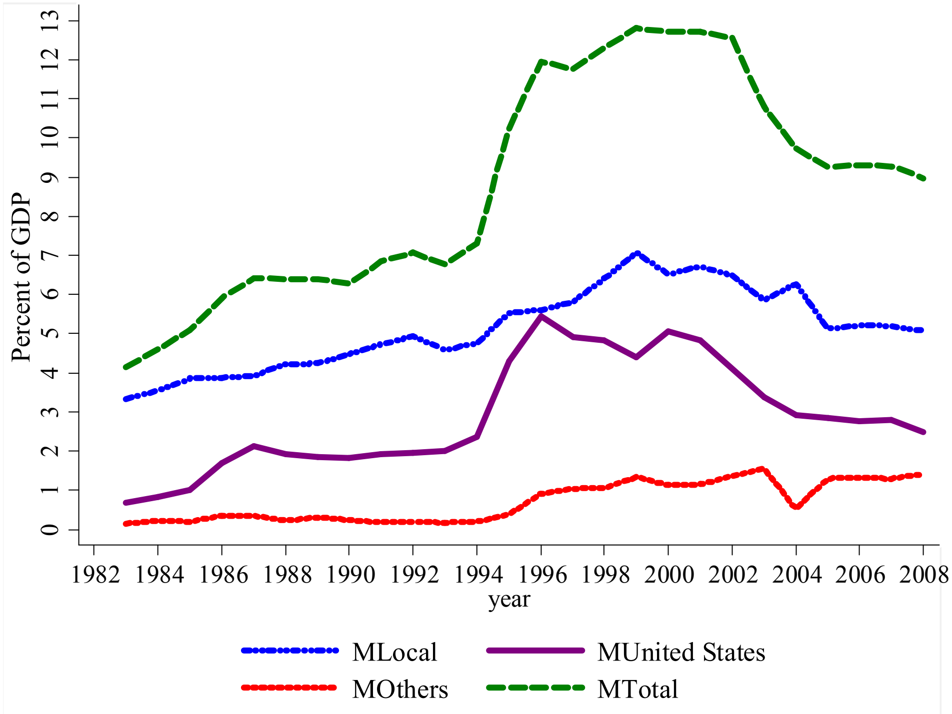

Figure 3.3 U.S affiliates sales of manufacturing goods to local market (Mexico) (MLocal), sales to United States (MUnited States) , sales to others countries (MOthers) and the sum of all sales(MTotal) as a percent of Mexico GDP.
Source: Author derived calculations using data from the U.S. Department of Commerce, Bureau of Economic Analysis

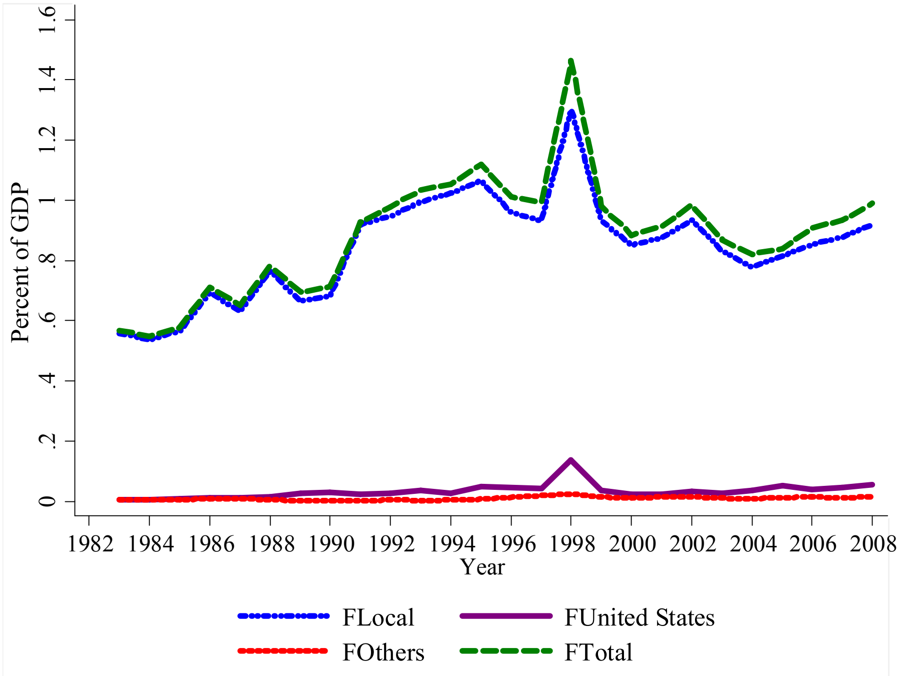

Figure 3.3 U.S affiliates sales of processed food to local market (Mexico) (MLocal), sales to United States (FUnited States) , sales to others countries (FOthers) and the sum of all sales(FTotal) as a percentage of Mexican GDP.
Source: Author derived calculations using data from the U.S. Department of Commerce, Bureau of Economic Analysis

Appendix 3.2 Summary of statistics of U.S. affiliates sales to local market (Mexico), United States and others countries

Food	Mean	Std. Dev.	Max	Min
Local	0.84	0.18	1.30	0.54
U.S.	0.03	0.03	0.14	0.00
Others	0.01	0.01	0.02	0.00
all	0.88	0.20	1.46	0.55
Manufacturing				
Local	5.16	1.06	7.07	3.34
U.S.	2.85	1.42	5.44	0.67
Others	0.71	0.51	1.56	0.15
all	8.75	2.81	12.80	4.16
Total				
Local	7.72	2.66	11.00	4.13
U.S.	3.18	1.51	5.60	0.72
Others	0.82	0.56	1.73	0.17
all	11.72	4.41	17.52	5.02

Note: std is the standard deviation, Max is the maximum, and Min is the minimum affiliate sales

Appendix 3.3 Variables definitions and source of data

Variable name	Variable definition	Source
FDI inflows in processed food	Processed food FDI as a percentage of GDP. Standard Industrial classification (SIC 20). NAICS value after 1998 is converted to SIC 20 by following Blecker (2002)	U.S. Direct Investment Abroad: operations of U.S. Parent Companies and Their Affiliates (U.S. Department of Commerce, Bureau of Economic Analysis).Data on majority owned nonbank foreign affiliates of nonbank parents.
FDI inflows in manufacturing	Manufacturing FDI percentage of GDP of Mexico. Converted to SIC 2 by following Blecker (2002)	Same as above
FDI inflows total	Total FDI inflows as percentage of GDP	Same as above
Per capital GDP	Real per capita GDP	Penn World Tables Version 7.0, 2011
Lag of processed food exports	First lag of U.S exports to Mexico in real terms. The nominal valued is divided by the GDP deflator for Mexico. SITC (0 + 11+4+22)	United Nations Commodity trade Statistics Database, 2011. SITC revision 2
Lag of manufacturing exports	First lag of U.S exports to Mexico in real terms. The nominal valued is divided by the GDP deflator for Mexico. SITC (0 +1+4+5+6+7+8+22)	United Nations Commodity trade Statistics Database, 2011. SITC revision 2
Lag of total exports	First lag of U.S export to Mexico in real term. The nominal valued is divided by GDP deflator of Mexico.	United Nations Commodity trade Statistics Database, 2011. SITC revision 2
Interest rate	Real interest rate difference between U.S. and Mexico. Calculated using Waldrick (2003). (U.S. Treasury Bill Rates/(inflation)	International Financial Statistics CD-ROM, IMF (2010)
log of Real wage	Natural log of the difference between U.S and Mexican Wages	Own calculation

Appendix 3.3, continued

Variable name	Variable definition	Source
U.S Wage	Real average weekly hour time Average hourly earnings times 48. Converted to real value by using GDP deflator of U.S	
Weekly hours	Average hours worked per week in a year	U.S. Bureaus of Labor Statistics
Hourly earning	Average earning per hour in a year	U.S. Bureaus of Labor Statistics
Mexican wage	Real Mexican wage calculated as compensation of employees divided by total employees and converted to real by multiplying the results by GDP deflator of Mexico	Own calculation
Compensation of employees	Dollars paid to employees per year	U.S. Direct Investment Abroad: operations of U.S. Parent Companies and Their Affiliates (U.S. Department of Commerce, Bureau of Economic Analysis).Data on majority owned nonbank foreign affiliates of nonbank parents.
Total employees	Total number of employees per year	Same as above.
Exchange rate	Real exchange rate calculated following Waldrick (2003). (U.S dollar/peso)*(Mexico GDP deflator/ U.S. GDP deflator)	Own calculation
U.S dollar per peso	The nominal value of exchange rate	International Financial Statistics CD-ROM, IMF (2010)
Treasury bill rates	rate at which short-term securities are issued or traded in the market	International Financial Statistics CD-ROM, IMF (2010)
Inflation	Percentage of GDP deflator	International Financial Statistics CD-ROM, IMF (2010)
GDP deflator	GDP deflator of Mexico and Untied States	International Financial Statistics CD-ROM, IMF (2010)
Nominal GDP	Mexican nominal GDP	World Development Indicators World bank

Appendix 3.4 Summary of statistics of the variables

Variable	Obs.	Mean	Std. Dev.	Min	Max
FFDI/GDP	84	0.31806	0.08846	0.16184	0.45588
MFDI/GDP	84	2.32309	0.55649	1.53628	3.13025
TFDI/GDP	84	3.25572	0.94732	1.79154	4.45471
log GDPPC	84	7.82275	0.13128	7.62891	8.07926
log (wd-wf)	84	1.01630	0.32772	-0.04540	1.34247
rd-rf	84	0.59995	0.96281	-1.51246	3.29363
Ex1	84	0.08558	0.01098	0.05182	0.10485
Log of lag FEXP	83	21.99678	0.35026	21.60075	22.77435
Log of lag MEXP	83	24.38205	0.28542	23.96885	24.86735
Log of lag TEXP	83	24.44690	0.28579	24.02383	24.95839

Note: FDI/GDP is the foreign direct investment a percentage of GDP, (wd-wf) is wage difference between U.S and Mexico. FEXP, MEXP, and TEXP are food, manufacturing and total exports. Lag means the first lag of the variable

Appendix 4.1 Variable descriptions and source of data

Variable name	Variable description	Source
GDP	Log of gross domestic product	World Development Indicators online version, World Bank 2011
Exports	Log of real exports	World Development Indicators online version, World Bank 2011
Imports	Log of real imports	World Development Indicators online version, World Bank 2011
FDI	Log of real foreign direct investment which is calculated by deflating with Mexican GDP deflator	
GFCF	Log of real gross fixed capital formation	
LFT	Economically active population. Derived by dividing the GDP of Mexico by GDP per worker	Own calculation
GDP deflator	Gross domestic product deflator	International Financial Statistics CD-ROM, IMF, 2010
GDP per worker	Gross domestic product per worker	Penn World Table 7.0, 2011

Note: all variables are in U.S dollars (2000)

Appendix 4.2 Summary Statistics of the Variables

Variable	Obs	Mean	Std. Dev	Min	Max
Log of GDP	40	26.7171	0.3783901	25.92151	27.27588
Log of Exports	40	24.67728	1.11464	22.81193	26.25833
Log of Imports	40	24.87174	0.9240423	23.58061	26.38091
Log of FDI	40	22.32472	1.111539	20.20276	24.09562
Log of GFCF	40	25.0803	0.4193365	24.27473	25.83744
Log of LFT	40	17.10974	0.3742294	16.40425	17.66449

Appendix 4.3 List of the variables that are in each model

Model 1	GDP and Exports
Model2	GDP, Exports and Imports
Model 3	FDI and GDP
Model 4	FDI , GDP, and Exports
Model 5	FDI, GDP, Exports, and Imports
Model 6	FDI, GDP, Exports, Imports, GFCFF, LFT

Vita

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