# FOREIGN DIRECT INVESTMENT AND ITS DETERMINANTS IN MEXICO FROM 1992 TO 2003. A SPECIAL APPROACH IN THE EXCHANGE RATES

Milton Hugo Salas Martínez *

## RESUMEN

En años recientes (de 1990 a la fecha) ha habido un incremento considerable en los flujos de Inversión Extranjera Directa (IED) y de empresas multinacionales en todas las economías del mundo. En este artículo, hacemos un análisis econométrico de los principales determinantes de la Inversión Extranjera Directa de once países en el período 1992-2003 en México, haciendo énfasis en los tipos de cambio. Para ello utilizaremos un panel de datos y se demostrará empíricamente que el salario del país receptor de IED, el PIB del país receptor de IED, el PIB del país que hace IED, el grado de apertura del país receptor de IED, el tipo de cambio del país receptor de IED y su volatilidad son variables determinantes que explican el comportamiento de la IED en México.

*Clasificación JEL:* F21, F31

*Palabras clave:* Inversión Extranjera Directa, tipo de cambio

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# ABSTRACT

In recent years (from 1990 to nowadays) there has been a significant increase in Foreign Direct Investment (FDI) flows and multinational enterprises in all the economies. The aim of this paper is to analyse the determinants of FDI from eleven countries in the mexican economy in the period 1992-2003, with a special emphasis on the exchange rates. To do so, we use a panel data technique and we demonstrate empirically that the FDI host country's (in this case Mexico's) wage, the FDI host country's GDP, the FDI investor country's GDP, the host country's foreign trade (trade openness), the host country's foreign exchange rate and its volatility are variables that determine the behaviour of the FDI in Mexico.

*JEL classification:* F21, F31

*Keywords:* Foreign Direct Investment, exchange rate

# I. INTRODUCTION

In recent years (from 1990 to nowadays) there has been a significant increase in foreign direct investment flows and multinational enterprises in all the economies. According to the UNCTAD's World Investment Report (2003, p. 231), Foreign Direct Investment (FDI) is defined as "investment involving a long-term relationship and lasting interest in and control by a resident entity in one economy (foreign direct investor or parent enterprise) in an enterprise resident in another economy other than that of the foreign direct investor (FDI enterprise or affiliate enterprise or foreign affiliate). FDI implies that the investor exerts significant influence on the management of the enterprise resident in the other economy. Such investment involves both the initial transaction between the two entities and all subsequent transactions between them and among foreign affiliates, both incorporated and unincorporated. FDI may be undertaken by individuals or by business entities".

In fact the UNCTAD's World Investment Report (2002) described Mexico as one of the winners in 2001 in FDI. This can also be seen in the graph. In 2001, Mexico reached historical levels of FDI. It had 26775.70 millions of dollars. In this year Mexico became the country with the highest FDI flows in Latin America. However, in the following 2 years things have changed. Even though the mexican economy has not suffered a high volatility in its exchange rate, FDI flows have decreased in 2002 and 2003. This indicates that there are other factors that seem to explain FDI.

Because the mexican economy has many commercial partners in the economic world, I am going to analyse the behaviour of FDI from eleven countries in Mexico. Most of empirical work has studied FDI in Mexico only from US. It is known that Mexico has had a very forceful relationship with the United States. For instance, mexican exports to the United States increased by 70% from 1982 to 1990, excluding exports by the Maquila Industry. By 1990, 71% percent of Mexico's exports were destined to the United States (compared to 53% in 1982) (UNCTAD, 1993). Finally, the United States is by far the largest foreign direct investor in the world, with a share of global direct investment stocks in 1998 of 24 percent (UNCTAD, 1999).

In fact, the US has been the main source of FDI in the mexican economy, followed by countries of the European Union. Graph 2 displays the percentage of FDI made by the US, European Union, and other countries.

As we can see in graph 2, the American FDI in Mexico constitutes a great percentage of totals FDI. However, there are some periods in which the FDI from European Union and the rest of the countries have increased considerably. For example in 1999 we can see a 46% of FDI from other countries. This figure decreased in the following 2 years. However, the participation of the European Union and the rest of the countries have increased in 2003 and 2004. In 2001, the participation was only 24%. However, in 2003 this figure increased to 45%.

This motivates me to analyse the behaviour of FDI with respect to eleven countries, which have the most significant amounts of FDI. These countries are: US, Canada, France, Germany, Italy, Japan, Netherlands, Spain, Sweden, Switzerland and United Kingdom.

## Graph 2
## Foreign Direct Investment by country of Origin
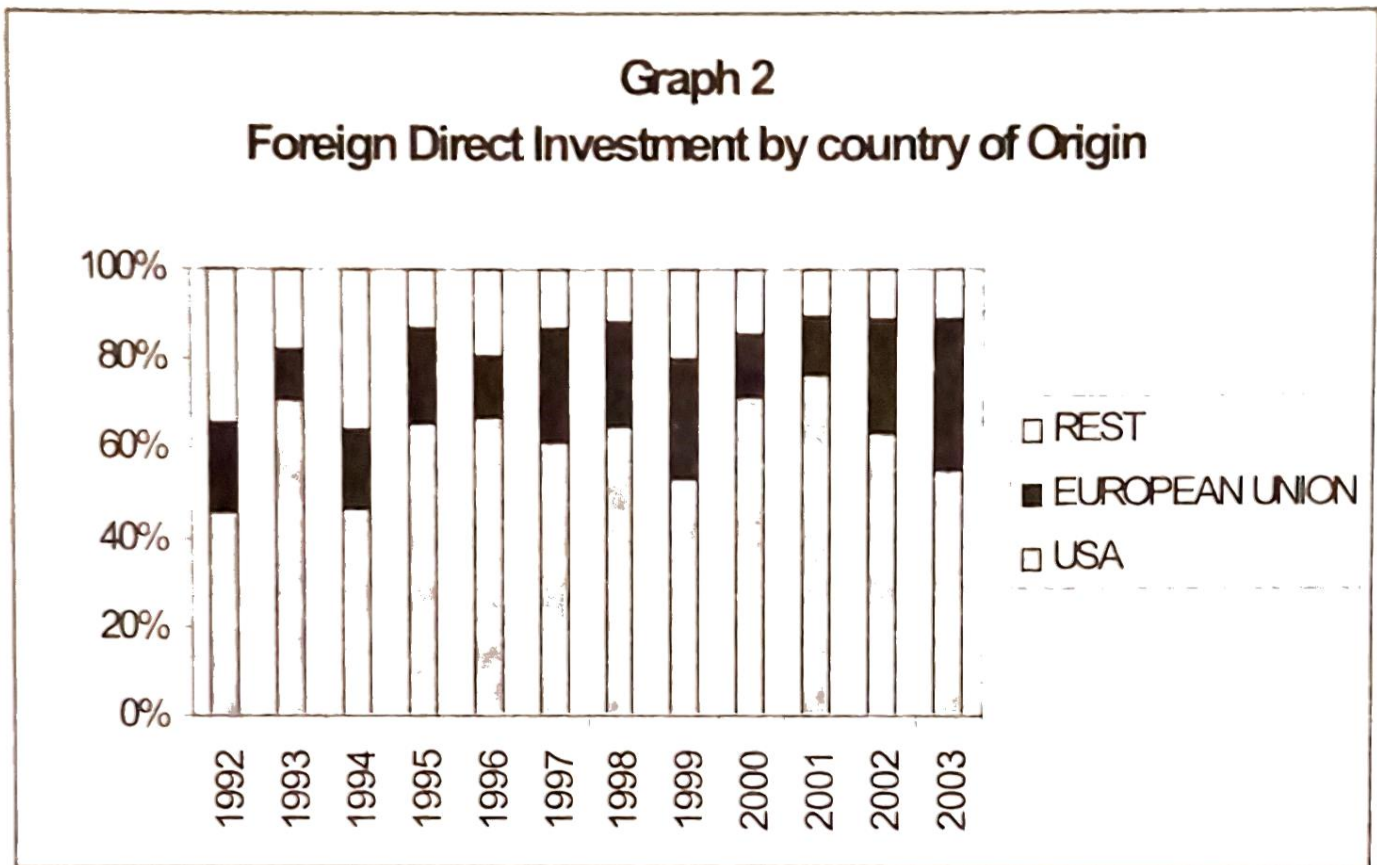


Source. Secretaria de Economia.

# II. LITERATURE REVIEW

FDI is an indicator, which has been studied by several authors. There are three schools, which studied FDI in the Economies: the dependency school, the modernization school, and the integrative school. Wilhelms and Witter (1998) and Hein (1992) give us a comprehensive review of the 3 schools above mentioned. Their relevance for this paper is that they analyze the modernization school by dividing it in two approaches: the perfect market capital approach and the imperfect market capital approach. This will lead us to the Frood and Stein's (1991) model, which is summarized later.

To explain the main determinants of FDI, Wilhelms and Witter (1998) construct a theory, which they name "the FDI fitness theory". They define the FDI fitness theory as a country's ability to attract, absorb and retain FDI. The problem with their study is that they do not justify with a theoretical

model the relevance of the variables that explain FDI. Nevertheless, they make an excellent empirical survey literature to justify the variables that determines the FDI.

Singh and Jun (1995) also make a survey of the main determinants of FDI. They argue that there are 4 vectors of explanatory variables, which explain the FDI. Risk sharing, market discipline, export orientation, and the transfer of technology and managerial expertise. They connect to the research of FDI given by Lucas (1993) to understand the link between exchange rates and FDI. In his empirical research they found a negative relationship between exchange rates and FDI. However, the most important contribution of these authors is that they demonstrated that from the 4 vectors (mentioned above) that explain FDI, the export orientation is the most important one.

Lucas (1993) also makes contribution in FDI. Although his study is strongly based on the relationship between FDI and aggregate demand in export, he recognizes a relationship between FDI and exchange rates. In his study of FDI in East Asia economies, he explains the sensitivity of FDI flows to production costs. He argues that there is a residual role of the exchange rate risk in determining the value of repatriated profits. This argument allows him to include the exchange rate as an explanatory variable of FDI.

As I had mentioned above, in the study given by Wilhelms and Witter (1998) of FDI, they mention that the imperfect market approach is a part of the Modernization School. The main argument to understand the link between FDI and Exchange Rates under imperfect markets approach is that of Froot and Stein (1991). They run a regression of FDI and exchange rates by industry in the US and they find evidence that the depreciation of the dollar was a variable, which make the FDI inflows in the US increase. To explain this phenomenon theoretically, they made an assumption that there are imperfections in the capital markets. These imperfections in the capital market are informational. When these informational imperfections arise in the capital market, they generate a wealth effect for the foreign firm.

This relative wealth is not exclusively related to the exchange rate movements. They argue that even in periods of stability of the exchange rate, an increase in

relative wealth across countries has made the FDI increase. This argument is very important because it gives us a justification to include the relative wealth as another explanatory variable of FDI. Blonigen (1997) explains an empirical example in which the relative wealth effect was not due to exchange rate movements. He studies the japanese acquisitions in US across 3-digit SIC (Standard Industrial Classification) industries from 1975-1992. He found other factors that explain the relative wealth across countries. With this argument Blonigen (1997) includes the GDP of the japanese economy as another determinant of FDI.

Another important argument that Froot and Stein (1991) give us is that the movements of the exchange rates generates more than proportional movements in the FDI inflows. In his regression of FDI against the exchange rate he found such argument. Blonigen (1997) and Chakabrarti and Scholnik (2001) also find that the deviations of the exchange rate create a more than proportional change in the FDI flows.

The study of Wheller and Moody (1992) is not particularly for the purpose of this paper. They explore the FDI as a location tournament in which the developing nations compete against each other in a theoretical game to be the main host of FDI. However, their study makes a connection with the imperfect market capital approach by Froot and Stein (1991). They explain that if imperfections arise in the capital market, the investment of the firm in high return assets can be discouraged. The assets become risky, which means that the firm is going to decrease the FDI in the host country. In other words, uncertainty in the assets in which the foreign firm is going to invest appears when the capital markets are imperfect.

The drawback of their study for the purpose of this paper is that they do not include the exchange rate as an explanatory variable of FDI. They use other variables to explain the behaviour of FDI.

Blonigen (1997) also finds a negative correlation between the exchange rate appreciation and FDI. He applied his econometric model for japanese and german acquisitions via FDI in US.

He argues that if the exchange rate is a random walk there is no connection between exchange rates and FDI. This argument is also explained by Chakabrarti and Scholnik (2001).

The study of Blonigen (1997) is strongly based on the model of imperfect capital market approach of Froot and Stein (1991). But Blonigen (1997) argues that the wealth effect explained by Frood and Stein (1991) is difficult to measure in an empirical way. He demonstrated that the increase in the Japan's firms' wealth in the late 80's was not due to the exchange rate movements but due to the speculative bubble in the japanese Stock market. That is why he introduces the Japan stock market as an independent variable of FDI flows. He also incorporates the japanese GDP growth because he argues that it is a way to measure the relative wealth across countries.

This is another reason that explains why we must incorporate the relative wealth as an explanatory variable of FDI. It means that the relative wealth effect given by Froot and Stein (1991) is going to be included as another explanatory variable of FDI in this paper.

Nevertheless, his study has some limitations. He does not study the volatility of the exchange rate or uncertainty in the exchange rate. Another limitation of his study is that he included other variables to explain FDI without a theoretical justification, such as the domestic acquisitions in the US.

Klein and Rosengreen (1994) also find a significant relationship between real exchange rate and FDI. They analyse such relationship in 7 US industries in the period 1979-1991. They have the same conclusions as the authors mentioned above: FDI in the US has tended to decrease with a strong dollar and increase with a weak dollar.

They also include relative labour costs and relative wealth to test the main ideas the imperfect market capital approach, given by Froot and Stein (1991).

However, the authors do not give a theoretical model in which they can explain the introduction of the relative labour costs and relative wages as independent variables. They only mention that they include these variables because of the relationship of FDI with the relative labour cost theory and the imperfect market capital approach.

Swenson (1992) also finds in her empirical study of Foreign Direct Investment in US industries that the relation of the domestic exchange rate and FDI is positive. Even tough her study is basically with tax rates in US.

Edwards (1990) studies the FDI for the OECD countries and he finds a positive relationship between the depreciation of the exchange rate and FDI flows.

Goldberg and Kolstald (1995) make also a study of short-term exchange rates and FDI. However, they analyse specifically the short term exchange rate variability for FDI flows. This variability of the exchange rate is taken as the standard deviation of the exchange rate. This standard deviation is also taken as an explanatory variable by Chakabrarti and Scholnik (2001).

In their two-period model they divide the analysis of a firm that wants to make FDI. The first analysis is when the firm is risk neutral. They demonstrate that if the firm is risk neutral exchange rate movements do not affect its decisions of FDI. The second analysis is when the firm is risk averse; they mention that the decision of the firm of making FDI is very sensitive to exchange rate movements.

Campa (1993) explains a relationship between exchange rate fluctuations and FDI. In his empirical model of the US industries he finds a negative relationship between such variables. His most important contribution to the FDI is to demonstrate that it does not matter if a firm is risk averse or risk neutral. Both firms are discouraged to make FDI in the host economy if there is a high level of uncertainty. This argument contradicts the study made by Goldberg and Kostald (1995).

Campa's (1993) empirical study is very interesting. However, he is defining as a dependent variable the number of entry firms in the US and not the total FDI. Then his analysis is limited because it is better to introduce the total FDI in the period as an economic indicator of the capital account of the balance of payments. To analyse the behaviour of FDI we have to take into account other factors of FDI and not only the number of entry firms in the host economy such as equity capital, reinvested earnings, and intra company loans. All these factors are included in the FDI indicator of the capital account of the balance of payments.

For the purpose of this paper the theoretical model of Chakabrarti and Scholnik is the most suitable to explain the relationship between exchange rates and FDI.

They don't find empirical relationship between the exchange rates and FDI. However, the most important contribution that they do to the FDI literature is that they introduce the skewness of the exchange rate as an independent variable. The skewness of the exchange rate is the most important variable for them to explain FDI.

# III. A THEORETICAL MODEL OF EXCHANGE RATES AND FDI AND EMPIRICAL SPECIFICATION

## III.1 THE THEORETICAL FRAMEWORK

The following theoretical is based on Chakabrarti and Scholnik's (2001), this model is very important for our paper because it analyses exclusively the exchange rates and FDI.

Suppose that there is a foreign firm that wants to make a project of foreign direct investment in the mexican economy. The foreign firm has diminishing returns to scale. Also the foreign firm has inelastic expectations of the exchanges rates (this concept is explained later).

The foreign firm's revenues of the foreign firm for making FDI are given by:

$$R = \frac{Qf}{1+r} \tag{1}$$

Where $Q$ is a measure of the scale project FDI, $R$ is the revenue in mexican pesos at a future point in time for unit $Q$, $f$ is the expected exchange rate Mexican peso/foreign currency at the time when the projects pays back and $r$ is the opportunity cost of capital over the project's life.

The foreign firm's total costs of making the project of FDI are given by:

$$C = \left(\frac{1}{2}\right)Q^2 g \tag{2}$$

Where $C$ is the cost of the project in the foreign currency for unit $Q$ and $g$ is the current exchange rate (mexican peso per foreign currency) at the time of making the investment.

Then the expected net payoff of making the project of FDI in the host economy is given by:

$$\prod = \frac{Qf}{1+r} - \frac{1}{2}Q^2g \tag{3}$$

In equation (3), $\prod$ is the expected net payoff for the foreign firm. If the firm has diminishing returns to scale, it means that if the firm increases all its inputs in the same proportion $x$ then the output will have a proportion of less than $x$. For our example this increase in all its inputs is given by $Q$ (the measure of the scale of the project). The US firm makes the project by choosing the adequate optimal quantity of $Q$. However for one additional quantity of $Q$, it generates a cost, which is higher than the revenues that the firm can have. Because we have diminishing returns to scale, the marginal revenue is less than the marginal cost with respect to $Q$. In other words, $R'(Q) < C'(Q)$;

From equation (1) and (2) we can say that:

$$R'(Q) = \frac{f}{1+r} \tag{4}$$

$$C'(Q) = Qg \tag{5}$$

And, according to diminishing returns to scale above mentioned we have:

$$Qg > \frac{f}{1+r} \tag{6}$$

Then, what the firm has to do is to find the optimal choice of $Q$ ($Q^*$) to maximize its expected net profits.

In the model we do not specify whether the firm is risk averse or not. This model applies for both risk averse and risk neutral firms. Goldberg and Kostald (1995) argue in their model of exchange rate variability that it is important to know if the foreign firm is risk averse or not. When the firm is risk neutral there is no relationship between exchange rates and FDI. With a small degree of risk aversion they comment that exchange rate movements affect FDI. The limitation of the Goldberg and Kostald (1995) model is that they analyse the exchange rate variability, in other words, the standard deviation of the exchange rate. They do not analyse the exchange rate uncertainty.

Because in the model we are introducing expectations of the exchange rate at the time when the project pays back ($f$) and relative shocks of the exchange rates, we must analyse the exchange rate under uncertainty. That is why we can apply this model for both risk averse and risk neutral firms.

Campa (1993) explains why exchange rate uncertainty can discourage FDI for both risk averse and risk neutral firms. His main argument is that under an environment of exchange rate uncertainty the firm faces a dynamic problem of efficient decisions of the level of $Q$ (the scale of the project of making FDI). He introduces the option pricing theory and states that what the firm (in this case the US firm) is not concerned about is not the capital and foreign exchange markets today but the future expected profits.

It means that the firm has to compute its profits in the period $t_0$, given the optimal choice of $Q$, but the firm has the revenues until the period $t_1$. That is because we are including the actual exchange rate and the expected exchange rate in the following period. The firm does not know exactly how much it will get in the following period. The only thing that the firm knows is the cost of the project of the FDI that it is going to make.

Another important argument that must be included in the Chakabrarti's model is the relative wealth. In equation (1) the term $r$ (the relative cost of capital) is related to relative wealth. Froot and Stein (1991) argue that "the more net wealth an entrepreneur can bring to such an investment 'information-

sensitive' investment, the lower will be the capital costs for the foreign firm" (Froot and Stein, 1991, p. 1194). It implies that the relative wealth is a function, which depends on the expected exchange rate in the following period. Thus:

$$r = r(g) \tag{7}$$

(In this case $g$ is the exchange rate of mexican pesos expressed in another currency).

What equation (7) implies is that if the mexican peso/foreign currency exchange rate increases, the foreign currency gains "strength" and then the relative cost of capital for the foreign firm decreases, the foreign firm is encouraged to run the project of FDI in the mexican economy.

Cushman (1985) argues that an expected higher level of the domestic exchange rate reduces the capital cost for the foreign firm. This reduction of the domestic capital cost encourages the foreign firm to increase FDI in the host economy.

In this theoretical model, the role of the expectations of the exchange rate plays a very important role. Suppose that the current exchange rate $g$ (mexican peso/foreign currency) appreciates. According to equation (2) the cost $C$ increases. This increase of the cost reduces the expected net profit of the foreign firm. In other words, from equation (2):

$$C'(g) = \frac{1}{2}Q^2 \tag{8}$$

The expression in equation (8) is positive. Then, in this simple model it is demonstrated that the appreciation of the exchange rate (of the mexican economy in this case) yields a reduction in the FDI inflows.

To find the optimal quantity of $Q$ ($Q^*$) we take the first order conditions in equation (3). Taking the first derivative of $\Pi$ with respect to $Q$ we have:

$$\prod{}'(Q) = \left(\frac{f}{1+r}\right) - Qg \qquad (9)$$

According to first order conditions we have:

$$\left(\frac{f}{1+r}\right) - Qg = 0 \qquad (10)$$

$$\left(\frac{f}{1+r}\right) = Qg \qquad (11)$$

$$f = (Qg)(1+r) \qquad (12)$$

$$\frac{f}{g} = Q(1+r) \qquad (13)$$

$$Q = \left(\frac{f}{g}\right)/(1+r) \qquad (14)$$

If we take logs (ln) in equation (14), it will be easier to get the optimal value of $Q$ $(Q^*)$. Then

$$\ln Q = \ln f - \ln g - \ln 1 - \ln r \qquad (15)$$
$$\ln Q = \ln f - \ln g - \ln r \qquad (16)$$

If we change this expression in logs to natural exponential functions, we have:

$$e^{\ln Q} = e^{\ln f - \ln g - \ln r} \qquad (17)$$

Then from this equation, we can find the optimal quantity $Q^*$:

$$Q^* = f - g - r \tag{18}$$

Finally, the expression $f$-$g$ can be expressed in logs to get:

$$Q^* = \ln\left(\frac{f}{g}\right) - r \tag{19}$$

The first right hand side term of the last equation can be expressed as the expected level of depreciation of the exchange rate. In other words:

$$D = \ln\left(\frac{f}{g}\right) \tag{20}$$

Where $D$ is the expected level of depreciation. Then:

$$Q^* = D - r \tag{21}$$

The optimal choice $Q^*$ is going to be a function of $r$ (the opportunity cost of capital), and the expected level of the depreciation of the exchange rate mexican peso/foreign currency. Then $Q^*$ can be expressed as:

$$Q^* = Q^*(r, D) \tag{22}$$

$$\,-\quad+$$

Now, I will proceed analyse the comparative statistics. According to equation (21), if the opportunity cost of capital $r$ increases, the foreign firm is going to reduce the measure of the scale project ($Q^*$) because now the project is more expensive. It implies that the profits are reducing and the foreign firm decides to decrease its FDI in Mexico. In other words:

$$Q^{*\prime}(r) = -1 < 0 \tag{23}$$

The contrary happens with the expected level of depreciation of the exchange rate $(D)$. Suppose that there is a depreciation of the mexican peso/foreign currency exchange rate. Then the firm thinks that there will be further depreciation of this exchange rate. It means that the project of FDI in Mexico becomes cheaper. Then the US firm decides to increase the optimal level of the scale project $(Q^*)$. This extends the FDI capital flows.

$$Q^{*\prime}(D) = 1 > 0 \tag{24}$$

As we have said at the beginning of the explanation of the theoretical model, the foreign firm's expectations of the exchange rates are inelastic. If there is inelasticity in the expectations we can say that the change of the expected exchange rate must be higher than the changes of the current level of the exchange rate. If the foreign firm sees that today the mexican peso appreciates then the inelastic expectations make the firm to form expectations about the future level by less than the amount of the current appreciation.

With these expectations the firm thinks that its currency is going to devaluate by more than the current value. Then the firm decides to reduce FDI by more than the real shock of the mexican peso/foreign currency exchange rate.

Then

$$\frac{df}{dg} = G \neq 1 \tag{25}$$

In equation (25), $G$ is the derivative of the expected exchange rate with respect to the current exchange rate. The value of $G$ must be different from 1. If it were equal to 1, we would talk about perfect elasticity of exchange rate expectations.

In equation (25) we can see that the domestic country (Mexico) must have a non-volatile exchange rate to maintain high levels of FDI. If the domestic country has a high volatility of the exchange rate at time $t_0$, then the firms think that at time $t_1$ the domestic exchange rate will be more volatile. In an environment of uncertainty of the exchange rate, the firm decides to reduce FDI flows to the domestic country.

Now, that inelasticity in exchange rate expectations is more marked in large exchange rate shocks. Then, the derivative of $G$ with respect to the current exchange rate is given by:

$$\frac{dG}{dg} > 0 \tag{26}$$

Given that the derivatives in equations (23) and (25) are positive, then the current exchange rate has a positive relationship with the optimal choice of $Q^*$. Therefore we state that:

$$\frac{dQ^*}{dg} > 0 \tag{27}$$

Equation (27) gives the main conclusion of this model. A depreciation of the mexican peso/foreign currency exchange rate (an increase in the current exchange rate) makes the project of FDI cheaper for the foreign firm. Then the foreign firm increases FDI in Mexico.

However, Chakabrarti and Scholnik (2001) extend this model by introducing large shocks in the economy. These larger shocks in exchange rates are taken as the second derivative of $Q^*$ with respect to the current exchange rate. Then he argues that:

$$\frac{d^2Q^*}{dg^2} > 0 \tag{28}$$

What equation (28) denotes is that a relatively large depreciation of the mexican peso leads a more than proportional increase in FDI inflows. This argument is also supported by the empirical work of Blonigen (1997). In his econometric study of japanese acquisitions in the US, he found that for the manufacturing sample a 10% of real exchange rate depreciation of the dollar generated a 10-16% increase in total japanese acquisitions via foreign direct investment.

Given that the foreign firm is concerned about the value of the exchange rate in the following period what this model suggests is that if the exchange rate is very stable and does not fluctuate widely, the host economy (Mexico) will gain FDI inflows.

To measure this relative shocks, Chakabrarti and Scholnik (2001) introduce the skewness of the exchange rate.

As we know in descriptive statistics, there are four moments that a variable has: the mean, the standard deviation, the skewness and the kurtosis. In this theoretical model we can add the mean of the exchange rate, the standard deviation (because we are including volatility of the exchange rates), and the skewness because we are including relative shocks of the exchange rates in the theoretical model.

Even though this model helps us to understand the behaviour of the FDI in an economy in relation with the exchange rates, we must include other explanatory variables of FDI to have a better approach. Analysing exclusively the relationship between FDI and exchange rate expectations is limited.

However, if we are including the variable $r$, the relative cost of capital that the foreign firm faces to make FDI projects in Mexico, we can extend the theoretical model to have more determinants of FDI.

Then I augment the model by introducing in explicit form 4 variables: the mexican (domestic) wage, the domestic $GDP$, the $GDP$ of the foreign country $(FGDP)$ and the foreign trade of the domestic country.

As I had explained before, Blonigen (1997) demonstrates via his econometric model of japanese acquisitions in US via FDI that the relative wealth across countries is not only due to exchange rate movements as Froot and Stein (1991) had argued. He argues that there are other factors that can increase the relative

wealth of the country, which makes the investment. In his econometric study he explores the japanese FDI in US and he founds that the japanese economy experienced a very high wealth increase, which was not due to exchange rate movements.

If the *GDP* of the foreign country increases, then the foreign firm decides to increase FDI flows into Mexico. So we have the following equation:

$$Q^* = Q^*(FGDP) \tag{29}$$
$$+$$

The cost of the project implies that the firm is also analysing the behaviour of the wages in the domestic country. If there is an increase in wages in the mexican labour sector, then the foreign firm is discouraged to implement FDI in Mexico because the cost of making the project of FDI becomes more expensive. Several authors include the wage of the host economy as an explanatory variable of FDI such as Lucas (1993), Wheeler and Moody (1992) and Klein and Rosengreen (1994).

Cushman (1985) also includes the domestic wage as an explanatory variable of FDI in his model of real exchange rate risk and expectations. However, he excludes such variable in his econometric specification. He excludes it under the assumption that the wage is constant in all the countries. Then:

$$Q^* = Q(w) \tag{30}$$
$$-$$

Another way to see the relationship between FDI and mexican wages is in the term *r* (the relative cost of capital). As part of the capital, the firm has also to take into account the human capital to determine the actual cost of making FDI. If the firm sees that the wage increases, then the relative cost of capital becomes larger which means that the foreign firm decides to decrease FDI flows into the economy.

The variable "foreign trade" of the domestic country as a determinant of FDI has been used to explain FDI. Edwards (1990) incorporated the foreign trade as an explanatory variable in his study of FDI in the OECD countries from the most advanced nations. He argues that the degree of foreign trade is a very important factor that the firm takes into account to make FDI in the host economy.

From 1992 to the present the mexican economy has experienced a considerable increase of degree of foreign trade. To express the foreign trade in numerical terms, we have the following equation:

$$\frac{IMPORTS + EXPORTS}{GDP} * 100 = FOREIGNTRADE \qquad (31)$$

He argues that the multinational firms that invest in the domestic economy prefer to locate in tradable sectors. The following graph displays the grade of the foreign trade of the mexican economy in the period 1992-2003.

Graph 3. foreign Trade in Mexico (%)
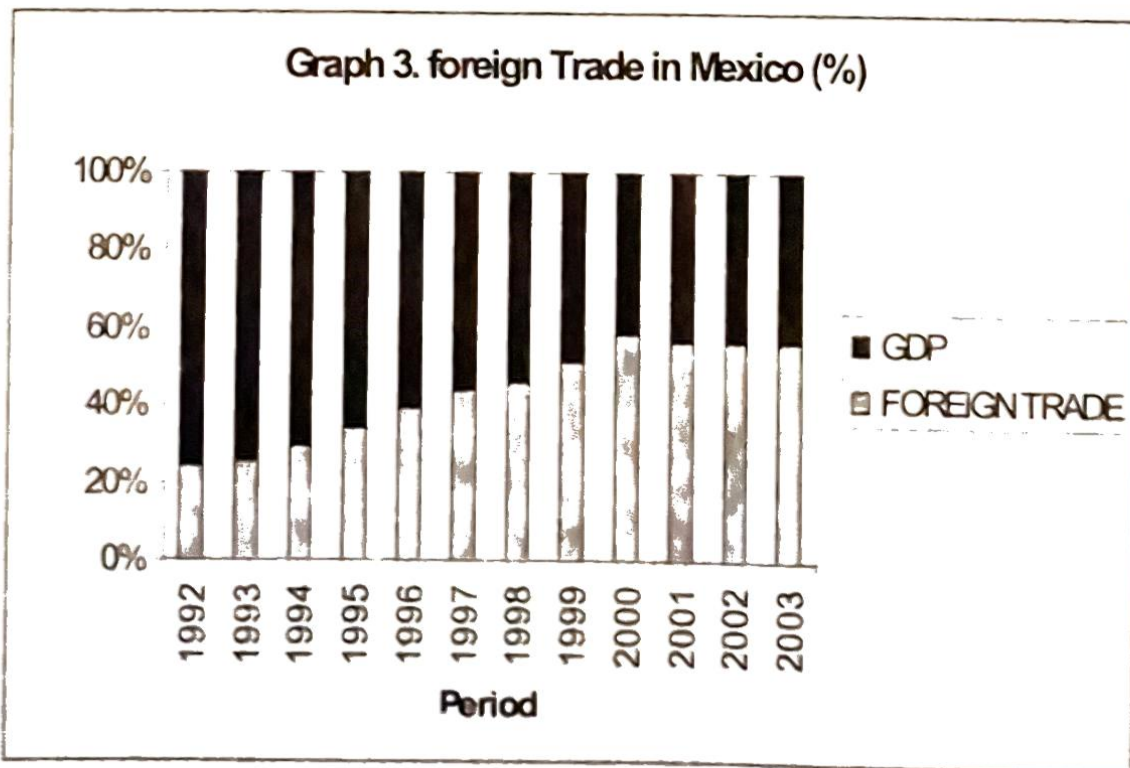
Source. Banco de Mexico.

As can be seen in graph 3, the foreign trade has dramatically increased in the mexican economy. The foreign trade of the mexican economy has increased from 24% in 1992 to 56% in 2003.

When there is a high degree of foreign of the host economy, it means that there are fewer restrictions for the foreign firm to make FDI. Having high trade barriers for the external sector discourages FDI in the economy. When the trade barriers to the foreign country are eliminated, the relative cost of capital for the foreign country increases. Then this encourages the foreign firm to invest in the domestic economy, so we have the following equation:

$$Q^* = Q^*(FOREIGNTRADE) \tag{32}$$
$$+$$

Several authors have claimed that in order to have a better approach for FDI we must include the domestic market size. The market size is usually measures as the $GDP$ of the domestic economy.

Wheller and Moody (1992) incorporate the market size as an important determinant for FDI in developing countries. Lunn (1980) argues that if the domestic markets increase (in other words, the domestic $GDP$), then "economies of scale can be exploited and large scale production can begin" (Lunn, 1980 p. 95). With this argument he justifies the inclusion of the domestic GDP as an explanatory variable of FDI. A similar argument is given by Lim (2001).

The arguments given by Lunn (1980) and Lim (2001) allow us to introduce the GDP in the extended theoretical model given by Chakabrarti and Scholnik (2001). If the size of the domestic market is small then for the foreign country is more costly to make FDI in the host economy. This increasing of the cost for the foreign country reduces the amount of FDI in the domestic economy.

Then an increase in the domestic $GDP$ will encourage the foreign firm to invest:

$$Q^* = Q^*(GDP) \tag{33}$$

## III.2 EMPIRICAL SPECIFICATION

Given the theoretical model I analyse the relationship between FDI in Mexico from eleven countries with the exchange rate, the standard deviation of the exchange rate, the skewness of the exchange rate, the GDP of the foreign country, the mexican wage, the foreign trade and the GDP of Mexico.

Because the data differ so much in absolute quantities, I expressed all the variables in logs. This is to have smoother data in our model.

Our econometric equation becomes as follows:

$$\ln(FDI_{it}) = \beta_1 + \beta_2 \ln(MER_{it}) + \beta_3 \ln(SDER_{it}) + \beta_4 \ln(SER_{it}) + \beta_5 \ln(FGDP_{it}) + \beta_6 \ln(w_{it}) + \beta_7 \ln(FT_{it}) + \beta_8 \ln(GDP_{it}) + U_{it}$$

(34)

Where $FDI_{it}$ is foreign direct investment in Mexico from country $i$ in year $t$, $MER_{it}$ is the mean of the exchange rate mexican peso/country's $i$ currency in year $t$; $SDER_{it}$ is the standard deviation of the mexican peso/country's $i$ exchange rate in year $t$; $SER_{it}$ is the skewness of the mexican peso/country's $i$ exchange rate, $FGDP_{it}$ is the gross domestic product in foreign country $i$, $w$ is the wage in Mexico, $FT_{it}$ is the level of foreign trade of Mexico, $GDP$ is the gross domestic product of the mexican economy, and $U_{it}$ is the error term. The error term is distributed i.i.d. N $(0, \sigma^2_{it})$.

Given the explanation of each variable, the expected signs of the estimated coefficients are:

$$FDI = FDI\ (MER,\ SDER,\ SER,\ GDP^*,\ w,\ FT,\ GDP)$$  (35)
$$+ \qquad - \qquad + \qquad + \qquad - \qquad + \qquad +$$

According to our theoretical model the relationship between the mean of the exchange rate and foreign direct investment must be positive.

If the mexican peso/foreign currency exchange rate has suffered devaluation (it increases), then the foreign currency becomes stronger and it encourages the foreign country to increase FDI flows to Mexico. Then the sign of the estimated coefficient in our regression is expected to be positive.

We take the standard deviation (known also as the second moment of a variable in descriptive statistics) as an explanatory variable as the variability of the exchange rate that the economy experienced during a specific period.

As the econometric study of Chakabrarti and Scholnik (2001), the sign of this coefficient is expected to be negative. In the Goldberg and Kostald's (1995) study they mention that if the exchange rate of the FDI host economy is very volatile (it has a high standard deviation value) then the FDI host economy will have a smaller amount of foreign direct investment. The same argument is given by Campa (1993); in his econometric model he finds a negative relationship between the standard deviation of the exchange rate and the FDI indicator. Then the expected sign of the estimated coefficient of the standard deviation of the exchange rate is negative.

According to our theoretical model the skewness of the devaluation of the real exchange rate and FDI inflows in the mexican economy must have positive sign.

The skewness of the exchange rate characterizes the degrees of the asymmetry of the distribution around its mean. If the value of the skewness is zero, then the distribution of the devaluation of the exchange rate is normal. If the skewness takes a positive value it means that we have relative few large devaluations, the contrary happens if the value of the skewness is negative. Then for example if the skewness of the real exchange rate in 1992 is about 10%, then it will generate a significant positive impact on FDI in more than 10%.

The term wealth (measured as the *GDP* of each foreign country) is expected to have a positive relationship with FDI.

The term *w* (the mexican real wage) is expected to have a negative relationship. If the mexican wage increases then it means an increase in the cost of making investment for the foreign country. This increase of the cost for the foreign country discourages FDI flows to the domestic economy.

The term *GDP* is also expected to have a positive estimated coefficient. Bigger size of markets facilitates the FDI.

## IV. THE DATA AND THE RESULTS

According to Hallwood and MacDonald (2000) the foreign direct investment is an indicator of the private foreign assets of the capital account of the balance of payments.

Annual data of foreign direct investment indicator were taken from the statistics of the "Direccion General de Inversion Extranjera of the Secretaria de Economia" (2004). The data are given in millions of dollars. We take the statistics of FDI made by eleven countries in the period 1992-2003. The list of the countries is: US, Canada, France, Germany, Italy, Japan, Netherlands, Spain, Sweden, Switzerland and United Kingdom.

Given that there are no historical daily data available of foreign exchange rates for the mexican peso for each of the 11 countries, I took the historical daily spot exchange rates US dollar per each of the other currencies from 1992 to 2003. This statistics were taken from the IMF's International Financial Statistics (2004). After that, with these data, I computed the spot exchange rate of the other countries per US dollar.

Then, I took the daily spot mexican peso/US dollar exchange rate from the Banco de Mexico (2004) statistics and I converted this spot exchange rate for each country to get the mexican peso/foreign currency exchange rate.

Because the data are expressed in different days from the IMF's International Financial Statistics (2004) and Banco de Mexico (2004), I use the mean of the exchange rate in each month for each country.

According to the IMF's International Financial Statistics (2004) methodology, due to the introduction of the euro on January 1, 1999, exchange rate for European Union are given only from 1992-1998. From 1999 to 2003 we take the euro currency for the following countries: France, Germany, Italy, Netherlands and Spain.

The OLS estimators of our regression suppose the prediction of heteroscedasticity. Given the large differences between inflows from the 11 countries above mentioned, heteroscedasticity across countries (panels in our case) may exist in our data. The Breusch Pagan's test indicates the presence of heteroscedasticity.

Then according to Greene (2003) we have to use the Generalized Least Squares (GLS) estimation to correct the heteroscedasticity of our variables. Also the Wooldridge (2002, p. 282-283) test detects no serial correlation of our variables. Given that our model has heteroscedasticity and no serial correlation in the panels I use the technique of Feasible Generalised Least Squares (FGLS) with heteroscedastic errors without cross sectional correlation.

I run 2 regressions of FDI. The first regression only analyses the relationship between FDI and exchange rate expectations as the empirical work by Chakabrarti and Scholnik (2001). In the second regression I include all the variables that extend the theoretical model.

Table 1 displays the results of regressing FDI, the mean of the exchange rate, the standard deviation of the exchange rate and the skewness of the exchange rate.

As we can see in the first regression, the results are satisfactory and consistent according to our theoretical model. The estimated coefficients have the right sign. Also all the coefficients are statistically significant at the 95% and at the 99% significance level. Then according to this simple model the foreign firm is very concerned about the exchange rate movements to invest in the domestic economy.

Chakabrarti and Scholnik (2001) find no significance in the mean of the exchange rate and the standard deviation of the exchange rate. They only find the skewness of the exchange rate significant. By contrast, in my model I find that the exchange rate devaluations are important for foreign investors as well as the volatility of the exchange rate.

As I had mentioned before, there are another factors that explain the behaviour of FDI. Taking exchange rates as the only explanatory variable of FDI is very limited. Then, using the same technique I analyse FDI with respect

to all the variables that extended the simple model. Table 2 displays the results of regressing equation (34).

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### Table 1. Effect of Exchange Rate Movements on FDI Flows
### (Original model)

| FDI | Coefficient |
|---|---|
| MER | 0.6998* |
| | (0.1414) |
| SDER | -0.4908* |
| | (0.1385) |
| SER | 0.4687* |
| | (0.1043) |
| Cons | 4.1695* |
| | (0.4193) |

Notes: Dependent variable: FDI. Standard Error in parentheses. The symbol * denotes significance at 95%.

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Given the results of table 2 we can see that the results are consistent. All the coefficients have the expected sign. Also we can see that even though we added more variable in the theoretical model, the main idea of the model does not lose strength. The coefficients of the exchange rate, the standard deviation of the exchange rate and the skewness of the exchange rate are still statistically significant. All the other coefficients are statistically significant at 95% level and 99% significance level.

Also all the coefficients have the expected sign according to the theory. Then for the mexican economy our econometric model predicts what the theory says.

**Table 2. Effect of Exchange Rate Movements on FDI Flows**
**(Augmented model)**

| FDI | Coefficient |
| --- | --- |
| ER | 0 7665* |
| | (0.1406) |
| SDER | -0.4200* |
| | (0.1340) |
| SER | 0.3988* |
| | (0 1065) |
| w | -5.9416* |
| | (1 5945) |
| FOREIGN TRADE | 5 3822* |
| | (1.9239) |
| FGDP | 0.6245* |
| | (0.1026) |
| GDP | 8.1408* |
| | (2 6403) |
| Cons | -112 6080* |
| | (33 7250) |

Notes. Dependent variable FDI. Standard Error in parentheses.
The symbol * denotes significance at 95%

# V. CONCLUSIONS

Foreign Direct Investment has become an important indicator to study in the last years. We have examined the FDI flows from eleven countries in Mexico and its determinants in the period 1992-2003. The exchange rate plays a very important role to determine the amount of FDI.

Cross sectional Time Series FGLS panel data estimation was used to understand the relationship between FDI, the mean, the standard deviation and

the skewness of the exchange rate, the foreign country's GDP, the domestic wages, the foreign trade and the gross domestic product of the host economy.

According to our estimation results, the theoretical model of exchange rates expectations and FDI given by Chakabrarti and Scholnik (2001) has empirical evidence for the mexican economy. Even though Chakabrarti and Scholnik (2001) do not find a significant relationship among the exchange rate, the standard deviation of the exchange rate and FDI, I found that for the mexican economy, all the variables that these authors are including are significant. However, to analyse specifically exchange rates expectations and FDI can give us wrong conclusions. There are other factors that explain FDI.

Because we have the relative cost of capital in our theoretical model, we can incorporate other variables such as the foreign and domestic GDP, the domestic wages and the foreign trade of the domestic economy. All the variables that I include have empirical justification for the mexican economy in the period 1992-2003. The econometric results of the second regression imply significance in all the variables of the augmented model of exchange rates expectations and FDI.

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