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The effects of the Exchange Rate on Foreign Direct Investment: the links between Europe and USA

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Abstract

The impact that the exchange rate has on the Foreign Direct Investment is a topic that has attracted a lot of attention over the years. Using data of the annual outward, and inward, US Foreign direct investment flows into and from fifteen European countries, over the time horizon 1996-2006, this dissertation studies the effect that the exchange rate, the exchange rate volatility and the expectations on the exchange rate have on the Foreign Direct Investment. More specifically we test if a depreciated currency attracts FDI, if high levels of volatility discourage FDI and if a large devaluation of the local currency attracts FDI into that country. The results of the USA inward showed a negative relationship between the currency devaluation and the FDI, that the exchange rate volatility discourages the FDI, and also, a positive relation for the expectations meaning that large devaluation normally attracts FDI. For the USA outward, a positive relationship between the exchange rate level and the expectations with the FDI and a negative between the exchange rate volatility and the FDI. Taking the case of the European governments, in order to attract US investment, they should follow policies that potentiate the increasement of the real Gross Domestic Products, the level of openness or reduction of the corporate taxes.

Key-words: Foreign Direct Investment, exchange rate, exchange rate volatility

JEL-Code: F21; F31.

Resumo

O impacto que a taxa de câmbio tem no Investimento Direto Estrangeiro (IDE) é um tópico que tem atraído muita atenção ao longo dos anos. Usando dados anuais dos fluxos externos e internos do Investimento Direto Estrangeiro dos Estados Unidos da América para e de quinze países Europeus, no horizonte temporal 1996-2016, esta dissertação tem como objetivo estudar o efeito que a taxa de câmbio, que a volatilidade da taxa de câmbio e que as expectativas da taxa de câmbio têm no Investimento Direto Estrangeiro. Mais concretamente, testar se uma desvalorização de uma moeda atrai IDE, se níveis altos da volatilidade da taxa de câmbio desencorajam o IDE e se uma grande desvalorização de uma moeda local atrai IDE para esse país. Os resultados obtidos para a base de dados dos fluxos internos do Investimento Direto Estrangeiro dos USA mostram a existência de uma relação negativa entre a desvalorização da moeda e o IDE, mostram que a volatilidade da taxa de câmbio desencoraja o IDE, e ainda uma relação positiva entre as expetativas e o IDE significando que uma grande desvalorização normalmente atrai IDE. Para a base de dados dos fluxos externos do Investimento Direto Estrangeiro dos USA, os resultados mostram uma relação positiva entre o nível da taxa de câmbio, e as expectativas, com o IDE, e uma relação negativa entre a volatilidade da taxa de câmbio e o IDE. Tomando como exemplo os Governos europeus, de modo a atraírem investimento dos Estados Unidos, estes devem adotar políticas que permitam aumentar o Produto Interno Bruto, o grau de abertura ou reduzir as taxas corporativas.

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1. Introduction

The Foreign direct investment (FDI) is an interesting topic that has attracted the attention of the literature over the years. As explained by Udomkerdmongkol et al. (2009), the FDI is an important global capital flow that finances investment. The exchange rate is another attractive topic in the Economy and Finance world. Many authors have focused on understanding the role that the exchange rate has on the variations of the FDI. Authors like Froot and Stein (1991) have found through their research that the correlation between the two variables is very different from the correlation observed between the exchange rate and other forms of capital flows, with the exchange rate and FDI presenting a very strong relationship.

When the topic began to attract the authors' attention, the studies focused mainly on observing how the exchange rate affected the USA flows to other countries.

Over the years, most of the studies have studied the topic mainly in three ways. Some authors have studied the impact that changes in the exchange rate have on the FDI (Froot and Stein, 1991; Dewenter, 1995). Another branch, has focused in analyzing the effect that the volatility of the exchange rate has on the FDI (Dhakal et al., 2010; Jehan and Hamid, 2017), and others put in focus the impact that expected changes in the exchange rate have on the FDI (Chakrabarti and Scholnick, 2002; Mariel and Pankova, 2010). Some studies have also studied the three effects (Cushman, 1985, 1988; Schmidt and Broll, 2009).

Görg and Wakelin (2002) studied the three effects but introduced a little twist since the authors studied the effects not only in one direction but in the two directions. The authors studied the effects that movements on the exchange rate have on the US Outward Investment and on the Investment Inward in the United States.

The majority of the recent studies have focused on studying this correlation in the emerging markets because of their particular differences and specificities. To my best knowledge, there is a scarcity of recent literature that approaches the relationship between exchange rate and FDI in developed countries, more properly, between the United States and Europe. Additionally, most of the papers focus on analyzing only one part of the flow. Few papers study the two flows, the outward and the inward Foreign Direct Investment and in this dissertation, we analyzed both cases between Europe and the United States.

Over the years, the foreign direct investment from Europe into the United States has been increasing as we can see in figure 1.1.[1]

Figure 1.1 Europe Direct Investment position in the United States from 2000 until 2016
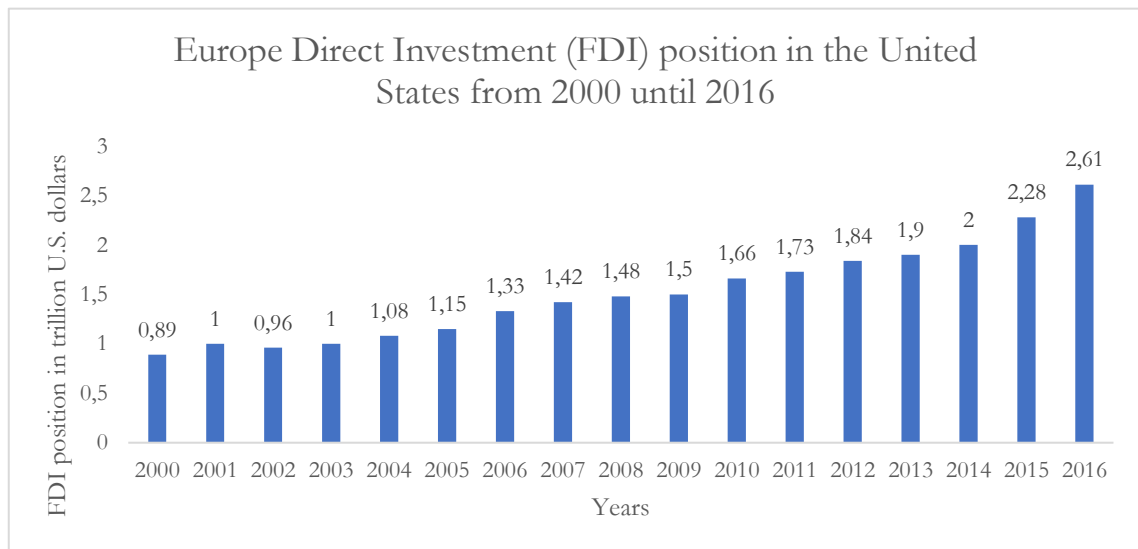
Since 2000, the FDI position has increased by more than 190%. In 2016 the total position of the European direct investment in the United States was 2,61 trillion U.S. dollars. Considering that the total FDI in the United States accounted for 3,71 trillion U.S. dollars we can understand that the European direct investment represents a huge part of the American FDI inflows, representing almost 70% as we can see in figure 1.2[2].

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[1] Data source: https://www.bea.gov/international/di1fdibal.htm
[2] Data source: https://www.bea.gov/international/di1fdibal.htm

Figure 1.2 Foreign Direct Investment position in the USA in the year 2016
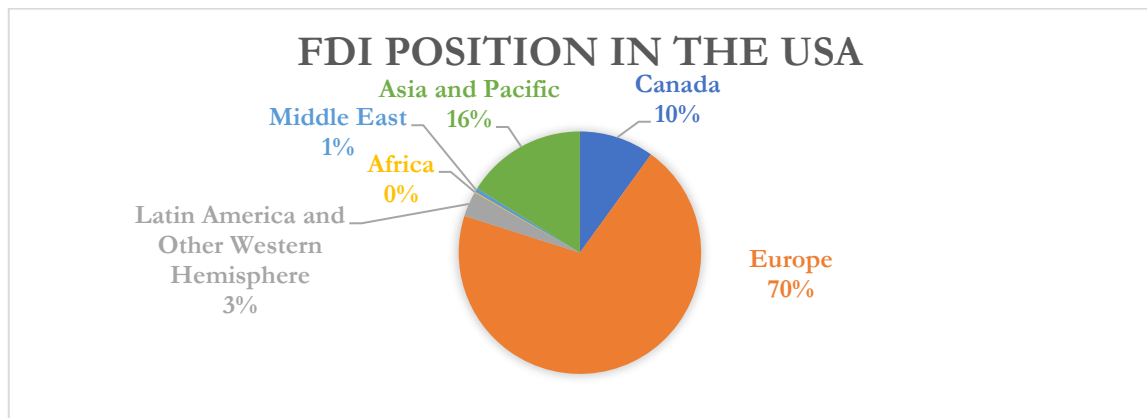
In table 1.1[3], we can observe the FDI position of the fifteen European countries of the sample, and we can see that those fifteen countries represent more than 98% of the European Direct Investment in the United States and more than 69% of the total USA FDI inflows.

Table 1.1 European countries FDI position in the USA in the year 2016, in millions

Countries	FDI position
Austria	10 611
Belgium	79 854
Denmark	18 233
Finland	5 874
France	252 864
Germany	291 697
Ireland	85 460
Italy	30 010
Luxembourg	417 386
Netherlands	355 242
Norway	25 548
Spain	68 169
Sweden	46 933
Switzerland	310 759
United Kingdom	555 687
Total	2 554 327

[3] Data source: https://www.bea.gov/international/di1fdibal.htm

In the other way, we can observe that the United States also plays a big role in the Europe Foreign Direct Investment Inflow representing 59% of the total, as represented in the figure 1.3[4] and with an increase of 360% in the American position since 2000 (figure 1.4[5]), which demonstrates the huge relationship between the United States and the European countries when talking about Foreign Direct Investment.

Figure 1.3 US direct investment position abroad in the year 2016
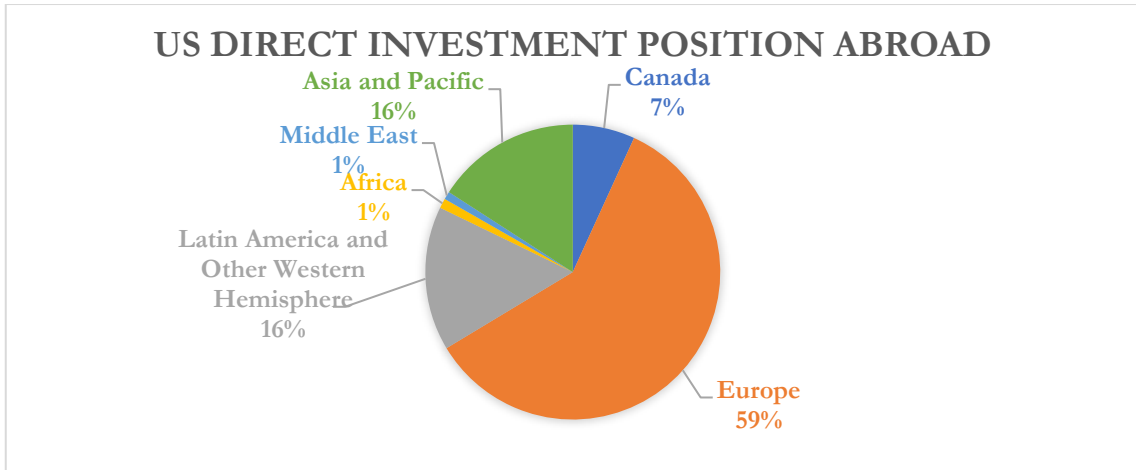
Figure 1.4 US Direct Investment position in Europe from 2000 until 2016

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[4] Data source: https://www.bea.gov/international/di1fdibal.htm

[5] Data source: https://www.bea.gov/international/di1fdibal.htm
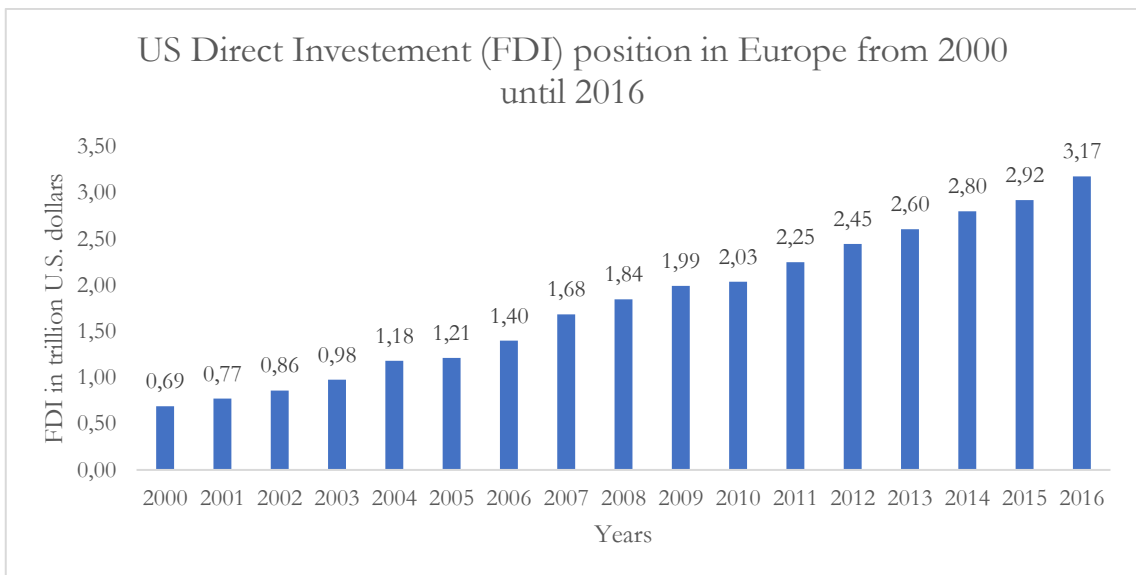
This dissertation investigates the effects that the exchange rate could have in the FDI. Analyzing data of the annual outward US Foreign Direct Investment flows to fifteen European countries (Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Norway, Spain, Sweden, Switzerland and United Kingdom) and data of the outward European Foreign Direct Investment flows to the USA, over the time horizon 1996-2016, this dissertation will analyze the effects that the value of the local currency, the volatility of the exchange rate and the expectations of changes in the exchange rate have on the Foreign Direct Investment.

To do so, I will follow Chakrabarti and Scholnick (2002), and use the mean, standard deviation and the skewness of monthly exchange rate devaluations of the currency of that country in the preceding year, to measure the average level of the Exchange Rate, Exchange rate volatility and the Expectations on the Exchange Rate, respectively.

The aim of this dissertation is to test three main hypotheses: (i) If when a depreciation of a country's currency occurs, the inward FDI rises; (ii) If FDI is discouraged by high levels of exchange rate volatility; (iii) if a large devaluation of the local currency attracts FDI into that country.

The two databases presented mixed results concerning the mean devaluation and volatility variables, but they are in agreement concerning the expectations variable. The results of the USA outward confirmed the hypothesis tested (however with the mean devaluation variable not being statistically significant) confirming that a depreciation of a European country's currency (in this case) raises the USA direct investment into Europe and that a high exchange rate volatility diminishes the USA direct investment into the UE. The results of the USA Inward, on the other hand, confirmed only the hypothesis of the expectations variable, rejecting the other two hypotheses. Both database results showed that a large devaluation of a European country currency attracts USA direct investment.

Besides this chapter, this dissertation is organized as follows: in chapter 2, is made a literature review of the theme. Chapter 3 describes the model and data. Chapter 4 presents the empirical results. Chapter 5 presents the robustness tests. Chapter 6 concludes.

2. Literature review

2.1   Main Theories

The main literature has analyzed the Foreign Direct Investment and perceived that changes in the exchange rate have an important impact on the FDI flows. However, the theory, as explained by Dewenter (1995), states that should not exist any relationship between FDI and exchange rates if purchasing power parity (PPP) always holds, because exchange rate changes offset differences in relative inflation, keeping earnings, as measured in the home currency, constant. The truth is that many empirical studies like Cushman (1985, 1988) or Froot and Stein (1991) have found a relationship between the two variables.

First, there is some theoretical background that we should take a closer look. One important hypothesis is the Market Size hypothesis. As Dhakal et al. (2010) explained, the investment will go first to markets that are large enough to provide scale economies that are necessary for the production. Another theory is the Aliber's hypothesis given by Aliber (1970). According to Buckley and Casson (1981) and Jehan and Hamid (2017), the hypothesis explains that differences in the relative strength of the currencies have an important role, that is, countries with weaker currencies cannot influence FDI inflows as much as countries with strong currencies.

A different theory is the Wealth theory proposed by Froot and Stein (1991). They approached the relation between wealth position and investment and consequently the relation between exchange rate and FDI. They explain that foreigners hold most of their wealth in nondollar-denominated form and therefore a depreciation of the dollar rises their relative wealth position and consequently decreases their relative cost of capital which allows them to be more aggressive bidding for assets. Their results confirmed that relative wealth and therefore the exchange rate have an important impact on FDI.

Differently, Cushman (1987) evidenced the importance of the labor costs in both source and host countries, since they are an important determinant of FDI. The author estimated equations for FDI flows between the USA and five other industrialized countries and his results demonstrated that a rise in host country wages discourages FDI into that country. Therefore, a depreciation of a country currency weakens the currency and consequently make the wages and labor costs cheaper. Those cheaper costs will encourage FDI flows into that country.

Later, Klein and Rosengren (1994) elaborated a study where they try to understand if the exchange rate affects U.S. FDI through the relative wage effect, or through the relative wealth effect. In their study, they confirmed that a depreciation (appreciation) of the bilateral real exchange rate is correlated with a rise (drop) in the FDI inflow into the USA. Their findings consistently support the significance of the relative wealth hypothesis but failed to support the relative labor hypothesis which demonstrates, according to the authors, that previous studies where the effect of real wage movements on FDI was significant, may have been collecting relative wealth effects instead.

Some literature has approached the subject differently. Some have looked to the fact that the exchange rate also has an impact on the timing of investment decisions. According to Kohlhagen (1977), anticipated changes in the exchange rate will surely affect the timing of direct foreign investment. Love and Lage-Hidalgo (2000) studied the investment flows from the USA to Mexico and also concluded that the timing of the investment decision is affected by the exchange rate. Additionally, they found support for the hypothesis of the real labor cost. They found that the labor costs differences between the USA and Mexico have a significant influence on the flow of FDI.

2.2   How Foreign Direct Investment affects the Exchange Rates

Although the major part of the studies reports the effects that the exchange rate has on the FDI, others have studied the contrary. They analyzed how the FDI affects the exchange rate because they believe that different types of flows affect the exchange rate differently. Athukorala and Rajapatirana (2003) with a mixed sample of Asian and Latin American countries, showed that FDI is associated with the depreciation of the real exchange rate and that the composition of capital inflows is important to determine their impact on the real exchange rate. Jongwanich and Kohpaiboon (2013) also found importance in the composition of the capital flows and through their results, they concluded that FDI generates a slower speed of real exchange rate appreciation than the other forms of capital flows (portfolio investments and bank loans). However, despite the lower speed, the magnitude of appreciation of the FDI is really close to the magnitude of the other two forms. Al-Abri and Baghestani (2015) on the other hand, has analyzed if a greater foreign investment is able to reduce real exchange rate volatility and found that it was more effective in reducing in China, India, Malaysia, Singapore, and South Korea, but conversely, greater FDI increased real exchange rate volatility in Indonesia, the Philippines, and Thailand.

2.3 How Exchange Rates affect the Foreign Direct Investment

Usually, the main literature tests the relationship between the exchange rate and the Foreign Direct Investment by examining how the movements of the exchange rate affect the FDI, how the exchange rate uncertainty affects the FDI and how the expectations of a rise or a drop in the exchange rate affect the FDI. Overall, the empirical research found that changes in the exchange rate have a negative impact on the FDI, but on the other hand, there is not much consensus on how the uncertainty and the expectations affect the Foreign Direct Investment with the majority defending that the exchange rate uncertainty discourage FDI flows indeed but having researches that prove the contrary.

2.3.1 The impact of movements of the Exchange Rate on the FDI

Almost all literature agrees that an appreciation of the exchange rate diminishes the Foreign Direct Investment. Something supported by Froot and Stein (1991), with the authors finding that the FDI was the only type of capital inflow that was statistically negatively correlated with the value of the dollar. Dewenter (1995) followed Froot and Stein (1991) and also found a higher level of foreign acquisitions into the United States is correlated with a depreciating U.S. dollar. Cushman (1985, 1988) analyzing the bilateral FDI flows into the United States from five developed countries, Liu and Deseatnicov (2016) focused on the Chinese outward FDI and Udomkerdmongkol et al. (2009) with a sample of sixteen emerging market countries, also found the same results as the two previous studies, a negative correlation between the variables. On the other hand, Schmidt and Broll (2009), in contrast with the theoretical predictions, have found that an appreciation of the home-country currency is linked with higher levels of FDI into that country, in other words, a positive correlation between the exchange rate and the FDI.

2.3.2 The impact of the Exchange Rate volatility on the FDI

The impact of the volatility of the exchange rate on the Foreign Direct Investment has had more ambiguous results. Despite the theory claim that high volatility has a discouraging effect on the FDI, some empirical studies have found the opposite relation. For example, Cushman (1985, 1988), reported that rises in the volatility lead to increases in FDI flows. Dhakal et al. (2010) with a sample of East Asian countries showed also a favorable effect of the exchange rate volatility on the FDI. More recently, Liu and Deseatnicov (2016) have found that Chinese Multinational companies have the tendency to invest in locations with a higher level of financial uncertainty.

On the other hand, Campa (1993), Chakrabarti and Scholnick (2002), Udomkerdmongkol et al. (2009) and Mariel and Pankova (2010) found results more in line with the theoretical predictions. Campa (1993) focused on the FDI flows into the United States and confirmed a negative impact of the exchange uncertainty on the entry of investment. Udomkerdmongkol et al. (2009) also found a negative effect studying the US FDI flows to emerging economies. Chakrabarti and Scholnick (2002) with a simple model studied the FDI flows from the United States to twenty OECD countries and found that a rise in exchange rate volatility diminishes FDI, however, the results are not significant. Mariel and Pankova (2010) followed Chakrabarti and Scholnick (2002) and used their simple model for central European economies. They found the same results, but also the same insignificance. However, they also ran a dynamic model and detected a significant improvement compared with the simple model. This new model produced significant negative results for the volatility of the exchange rate.

Furceri and Borelli (2008) tested the importance of the exchange rate volatility in analyzing the FDI inflows in the EMU (Economic and the Monetary Union) neighborhood countries. They found that the effect of the exchange rate volatility depends on the level of openness of the country. A lower level of openness turns the results positive, and a higher level of openness negative. However, after a robustness check, the results do not hold when are controlled by country groups, that is, the effect of exchange rate volatility on FDI is different across the several country groups.

Schmidt and Broll (2009) presented mixed results. The authors analyzed the impact of the exchange rate uncertainty by looking to the US outward FDI. They examined two measures for the volatility, the standard deviation (most used by the empirical studies) and an alternative measure of uncertainty. This alternative measure is a specification that only captures the part of real exchange rate volatility that is not explained by failures of the law of one price. The results show that the first measures of the exchange rate risk (standard deviation) have a negative effect on the US outward FDI flows for most of the industries. The second measure presented a different result with the manufacturing industries having a negative effect and the nonmanufacturing sectors having a positive relationship between the exchange risk and the US FDI outflows.

More recently Jehan and Hamid (2017) had a different and new approach. They added the role of financial development while they examined the effect of the exchange

volatility on the capital flows. They studied the effect by analyzing the capital flows toward developing markets, dividing those capital flows into two pieces, Foreign Direct Investment as the physical capital inflows and remittance inflows as financial inflows. Their results showed a negative impact of the exchange rate volatility on the FDI, but that negative impact is actually reduced with the addition of the role of financial development.

2.3.3 The impact of expected changes in the Exchange Rate on the FDI

How the Foreign Direct Investment reacts to an expected depreciation of a currency is something that has attracted much interest by some recent literature. Let's take as example the dollar. As explained by Cushman (1985, 1988) and Schmidt and Broll (2009), the idea behind the expectations is that if an appreciation of the dollar occurs and the dollar is above its long-run trend (overvalued dollar), the value of the dollar is expected to decrease (the value of the exchange rate moves toward the Purchasing Power Parity value – Mean Reversion process), which means that a depreciation will occur in the near future. Therefore, if a depreciation is expected in the next period, the investor will postpone their decision of investment in order to not lose wealth with the devaluation.

Another important study was the study elaborated by Chakrabarti and Scholnick (2002). The authors approached the difference in the type of shocks, since agents may react differently in the presence of small shock than in the presence of large shocks. They explained that large shocks may indicate deviations from the PPP, and consequently, the expectations of mean reversion will be much present. Therefore, after a large depreciation, we should expect large FDI flows since is expected a reversion and consequently an appreciation of the local currency. Chakrabarti and Scholnick (2002) also state that the investors could see small shocks as offsetting inflation differences and not as changes in the real exchange rate. Using the Skewness of exchange rate movements as a variable that distinguishes large than small shocks, their results showed a robust positive impact of the skewness of devaluations on FDI inflows indicating that a large devaluation of a country currency will raise the FDI flows to that country in the year after.

Other papers that approached the subject were Cushman (1985) that found that an expected appreciation of real foreign currency is associated with significant reductions of the FDI. Later, Cushman (1988) with an improved variable for the expectations have found

particularly the same results. Udomkerdmongkol et al. (2009) also concluded that foreign investors will delay the FDI decision if they expect local currency depreciation. Schmidt and Broll (2009) and Liu and Deseatnicov (2016) results are in line with the results of the previous studies. On the other hand, Mariel and Pankova (2010), contrary to what the authors expected they found the reverse correlation, that is, a depreciation of the local currency would lead to an increase of the Foreign Direct Investment.

Differently, Görg and Wakelin (2002) followed a different path. The majority of the studies analyses the impact that movements on the exchange rate has on the outward flow of the United States Foreign Direct Investment and few studies the impact on the inward flow. Görg and Wakelin (2002) studied the impact on both flows, they analyzed the impact of the level and the volatility of the exchange rate and the exchange rate expectations on the outward, and inward US Foreign Direct Investment from 1983 to 1995. Their results showed no evidence of an effect of the volatility and the expectations on the FDI for the Outward US investment and Inward investment in the USA. For the level of the exchange rate their results showed a strong relationship with the FDI, however, both databases present contradictory results. For the US outward it was found a positive relationship with an appreciation in the host country currency, and for the US inward, was found a negative relationship with an appreciation in the dollar.

In the next chapter, it will be explained in more detail the data and the model that will be applied to test the hypotheses.

3 Data and Methodology

3.1   Description of the Data

The data regarding the Foreign Direct Investment was obtained from the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce. From the BEA was collected the country's Foreign Direct Investment positions and from there the FDI flows were deduced. The difference between the position of the country in year t and year t-1 was assumed as the FDI flow of the year t. In table 3.1.1 and 3.1.2 are presented the descriptive statistics of the FDI data for both cases.

We can see that on average the United States outward flow is bigger in Netherlands, Luxembourg and United Kingdom, respectively, while the United States inward is bigger from the United Kingdom, Luxembourg, and Germany, respectively. Another curious fact is that in the USA outward flow case, the countries with bigger mean are the countries with a bigger standard deviation.

Table 3.1.1 Summary statistics of the Foreign Direct Investment flows from the USA to the European countries in millions of dollars

Countries	Mean	Max	Min	Std. Dev.	Med.
Austria	622,0	4 077,0	-5 512,0	2 131,9	1 071,0
Belgium	1 767,4	14 425,0	-18 669,0	6 779,4	2 556,0
Denmark	546,8	3 140,0	-1 251,0	1 286,6	379,0
Finland	115,7	2 156,0	-1 514,0	654,0	36,0
France	2 128,8	12 130,0	-12 559,0	5 621,7	1 430,0
Germany	3 022,3	21 006,0	-9 348,0	7 825,1	2 316,0
Ireland	18 052,2	58 313,0	-20 302,0	21 350,7	12 057,0
Italy	361,4	5 595,0	-2 807,0	1 908,8	-241,0
Luxembourg	28 662,9	85 692,0	-3 697,0	26 333,5	19 034,0
Netherlands	38 346,6	132 749,0	-5 886,0	34 399,8	31 337,0
Norway	1 313,2	12 518,0	-3 003,0	3 988,6	742,0
Spain	1 263,4	11 737,0	-17 373,0	6 521,3	1 396,0
Sweden	968,0	15 335,0	-13 427,0	5 527,4	423,0
Switzerland	6 737,3	38 547,0	-21 098,0	13 979,2	7 591,0
United Kingdom	27 430,0	83 949,0	-16 218,0	23 981,6	22 055,0

source: Author's calculation

For the three independent variables of the bilateral exchange rate, monthly data was obtained from the Datastream (when monthly data of some exchange rates were not

available, was collected the daily data and then converted to monthly data using the average method – the monthly data is the average of the daily data of that month). Since all the data for the remaining variables were in dollars, all the exchange rates are denoted as the amount of dollars needed to purchase one unit of local currency.

However, since the period studied goes from 1996 to 2016, it contemplates the introduction of the Euro (in 2002) in some countries[6] of the sample, so a special care has been taken. Therefore, to correct the introduction of the Euro was collected the local currency to euro fixed rate denoted as the amount of local currency needed to purchase one Euro. The local currency to dollar exchange rates were then multiplied by the fixed rate in order to have all period euros to dollar exchange rates for the countries that adopted the euro.

Table 3.1.2 Summary statistics of the Foreign Direct Investment flows from the European countries to the USA in millions of dollars

Countries	*Mean*	*Max*	*Min*	*Std. Dev.*	*Med.*
Austria	300,9	2 105,0	-1 147,0	634,5	255,0
Belgium	4 042,9	33 273,0	-11 292,0	10 067,5	1 462,0
Denmark	571,6	3 409,0	-2 168,0	1 296,3	533,0
Finland	212,7	4 059,0	-2 568,0	1 586,5	299,0
France	9 499,1	35 795,0	-23 667,0	17 791,1	7 086,0
Germany	11 433,6	39 902,0	-24 013,0	17 569,5	12 255,0
Ireland	1 563,8	10 565,0	-6 900,0	4 620,1	1 670,0
Italy	1 180,3	5 704,0	-1 391,0	1 799,5	836,0
Luxembourg	16 455,4	115 576,0	-36 799,0	27 649,3	8 949,0
Netherlands	11 103,8	41 603,0	-11 943,0	14 337,1	9 566,0
Norway	909,0	6 948,0	-3 125,0	2 364,8	612,0
Spain	3 074,0	13 234,0	-1 230,0	3 974,2	2 305,0
Sweden	1 648,2	25 713,0	-13 233,0	7 025,2	781,0
Switzerland	10 680,4	64 759,0	-16 302,0	17 250,6	7 389,0
United Kingdom	19 686,0	123 816,0	-79 962,0	44 261,8	16 308,0

Source: Author's calculation

Following the methodology used in Chakrabarti and Scholnick (2002), monthly exchange rate devaluations were calculated (calculated as d=log (e_t/e_{t-1})). As explained by Chakrabarti and Scholnick (2002) the choice to refer exchange rate movements as

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[6] The countries of the sample that adopted the euro in 2002 were: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands and Spain.

"devaluations" or "revaluations" is arbitrary because choosing one, the other will be the inverse, that is, choosing exchange rate movements as "devaluations", "revaluations" of the exchange rate will be simply negative "devaluations". Table 3.1.3 present the descriptive statistics of the movements of the exchange rate.

Table 3.1.3 Summary statistics of monthly devaluations of the Exchange Rate

Countries	*Mean*	*Max*	*Min*	*Std. Dev.*	*Med.*
Austria	-0,0437%	2,7528%	-3,3634%	1,0352%	-0,0673%
Belgium	-0,0443%	2,7528%	-3,3634%	1,0316%	-0,0353%
Denmark	-0,0403%	2,7634%	-3,3781%	1,0258%	-0,0824%
Finland	-0,0455%	2,7528%	-3,3634%	1,0318%	-0,0540%
France	-0,0391%	2,7528%	-3,3634%	1,0277%	-0,0353%
Germany	-0,0437%	2,7528%	-3,3634%	1,0305%	-0,0353%
Ireland	-0,0299%	2,7528%	-3,3634%	1,0278%	-0,0566%
Italy	-0,0245%	2,7528%	-3,3634%	1,0252%	0,0112%
Luxembourg	-0,0443%	2,7528%	-3,3634%	1,0295%	-0,0353%
Netherlands	-0,0448%	2,7528%	-3,3634%	1,0309%	-0,0353%
Norway	-0,0513%	2,4595%	-5,7172%	1,0998%	-0,0828%
Spain	-0,0437%	2,7528%	-3,3634%	1,0308%	-0,0641%
Sweden	-0,0563%	3,0925%	-4,6898%	1,1166%	-0,1173%
Switzerland	0,0226%	3,2176%	-4,7298%	1,0795%	-0,0653%
United Kingdom	-0,0364%	2,5609%	-4,2140%	0,9157%	0,0011%

source: Author's calculation

Then, the annual mean, the annual standard deviation and the annual skewness of the monthly exchange rate devaluations were calculated. A positive sign is expected for the mean devaluation variable, because if exists a devaluation of the target currency, the investors expect a mean reversion in future exchange rates, so they invest in that currency, meaning that a devaluation increases the FDI flows (Chakrabarti and Scholnick 2002).

For the volatility variable, the literature states that it is expected a negative sign, meaning that an increase in the volatility of the host country is associated with a decrease in the FDI from the source country into the host country.

Lastly, for the third independent variable, Chakrabarti and Scholnick (2002) explained that, on the contrary of the mean devaluation variable that gives proportional weight to shocks of all sizes, the skewness differentiates the types of shocks and captures the

effect of relatively large exchange rate shocks predominantly in one direction on FDI flows. For the possible scenarios the authors clarified: "A positive value of skewness indicates the presence of a few relatively large devaluations during the period while a negative value indicates a few large appreciations". (p.11)

The literature defends that it is important to control for other factors when analyzing the effects that movements in the exchange rate have on the Foreign Direct Investment. Therefore, considering the literature, the variables added are:

RGDP – the Real Gross Domestic Product is intended to measure the market size. Considering the importance of the Market Size hypothesis of Aliber (1970), is important to have a variable that is able to control the market size of each country. According to the literature, the real GDP is expected to have a positive influence in the FDI.

The nominal GDP were obtained from the World Bank. Then, it was converted to real 2010 prices using the GDP deflator (2010=100) obtained from the World Bank as well.

Wage – another variable that is usually controlled in the literature is the wage costs. The variable should measure the cost of labor input for foreign production. As Liu and Deseatnicov (2016) explained, a host country with low production costs and therefore low wages are regarded as an advantage in the attraction of foreign manufacturing firms. As in Liu and Deseatnicov (2016), the GDP per capita is used as a proxy for labor costs. The GDP per capita was obtained dividing the real GDP by the population of the particular country. The sign is expected to be negative since higher wages of the host country discourage the FDI into that country. (Cushman 1987)

Taxes – Taxes on the Corporate profits is a variable that has been associated as a determinant of the Foreign Direct Investment. The literature states that it has a large adverse impact on the Foreign Direct Investment, therefore is expected a negative sign for the variable since higher taxes on the corporates profits normally discourage the FDI. The data on the tax on corporate profits were collected from the OCDE database.

Interest Rate – the nominal interest rate is used to control for the financial costs in the host country. To measure it, the 3-month interbank rate was used as a proxy of the interest rate, obtained from the Federal Reserve Economic Data (FRED). As for the corporate taxes, the expected sign for the interest rate variable is also a negative sign since a higher cost of funding normally provokes a discouragement of the FDI.

Openness – The trade openness reflects the level of openness of the country. It is a variable widely used by many authors, such as Jehan and Hamid (2017) or Furceri and Borelli (2008), and it is calculated by dividing the sum of the exports and the imports, by the GDP. The exports and imports of goods and services were obtained from the World Bank and then summed before dividing by the GDP. The sign expected is a positive sign, meaning that a high value of openness attracts FDI.

3.2   Methodology

To test the effects that a bilateral exchange rate has on the Foreign Direct Investment, was used data of annual FDI flows into, and from, the United States from fifteen[7] (Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Norway, Spain, Sweden, Switzerland and United Kingdom) European countries over the period 1996-2016 (21 years). Two analyses were conducted: the first analyzed the impact that the exchange rate has on the European Foreign Direct Investment in the USA (USA inward) and the second analyzed the impact that the exchange rate has on the U.S. Foreign Direct Investment in Europe (USA outward).

As explained before, was followed the method used in Chakrabarti and Scholnick (2002) for the independent variables, and then, were added some control variables following other authors like Liu and Deseatnicov (2016) or Jehan and Hamid (2017), as explained in the previous chapter.

The model used was the following:

$$FDI_{it} = \beta_0 + \beta_1 D_{i,t-1}^{mn} + \beta_2 D_{i,t-1}^{sd} + \beta_3 D_{i,t-1}^{skew} + \beta_4 RGDP_{i,t-1} + \beta_5 W_{i,t-1} + \beta_6 Taxes_{i,t-1}$$
$$+ \beta_7 IR_{i,t-1} + \beta_8 OPE_{i,t-1}$$

, where the model is constituted by the FDI flow as the independent variable and by three independent variables that were calculated through the bilateral exchange rate. They are $D_{i,t-1}^{mn}$, the yearly mean of the devaluations, $D_{i,t-1}^{sd}$, the yearly standard deviation of the devaluations, and $D_{i,t-1}^{skew}$, the yearly skewness of the devaluations of the exchange rate, that were calculated as the mean, standard deviation and skewness of the monthly exchange rate devaluations of the currency of the target country during the preceding year, respectively. Furthermore, was decided to incorporate other variables to control for other factors (all

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[7] All the other European countries that were not included in the sample were due to data problems.

yearly data): $RGDP_{i,t-1}$, the Real Gross Domestic Product, $W_{i,t-1}$, the Wage, the $T_{i,t-1}$, the Corporate Taxes, $IR_{i,t-1}$, the Interest Rate and, $OPE_{i,t-1}$, the Openness, as explained before.

The variables in the model have all a lag of one year because as defended by Chakrabarti and Scholnick (2002) the FDI decision take some time to react to the exchange rate changes and therefore a lag of one year allows for the reaction take place and to be noticed in the data.

3.3   Econometric Considerations

Following the procedure applied by Chakrabarti and Scholnick (2002), to analyze the relationship mentioned before, a panel data estimation strategy was used. Various panel methodologies were used to understand the relationship in study: First, was conducted an OLS estimation, followed by a Fixed and Random effect estimation, and lastly a Generalized Least Squares (GLS) estimation.

However, knowing the data used in the database, correlation and heteroscedasticity concerns were real. The probability of existing heteroscedasticity and correlation problems in the sample was very high so the OLS estimates would be inefficient or giving misleading inferences, however, the OLS estimation was performed anyway for comparison reasons.

In order to know if we were in presence of autocorrelation and heteroscedasticity problems, some likelihood ratio tests were conducted as in Schmidt and Broll (2009).

First, a likelihood ratio test of autocorrelation was conducted to see if both panel models should be corrected for autocorrelation. The common AR (1) specification across all the countries was tested and, in both databases, the null of the hypotheses was rejected, indicating the presence of serial correlation in the error terms (in the USA inward database the p-value was p=0.0000 and in the USA outward database the p-value was p=0.0000).

Secondly, a likelihood ratio test of heteroscedasticity was performed to see if both panel models should be corrected for heteroscedasticity. The results of the tests showed that both databases rejected the null hypotheses, indicating that the residuals are heteroscedastic and therefore needed to be corrected (in the USA inward database the p-value was p=0.0000 and in the USA outward database the p-value was p=0.0000).

Considering the presence of autocorrelation and heteroscedasticity, the Generalized Least Squares models are a good alternative to test the relationship since it allows to relax

the classical OLS-type assumptions concerning the variance-covariance matrix of the error terms and therefore makes it possible to allow for heteroscedasticity across countries and autocorrelation over time within countries (Chakrabarti and Scholnick 2002).

The next chapter will present the empirical results of the four models.

4 Empirical Estimation

As said before to understand the relationship between the Exchange Rate and the Foreign Direct Investment two analyzes were conducted. Was analyzed the impact that fluctuations of the exchange rate have on the European Foreign Direct Investment into the USA (USA inward) and was analyzed the impact that fluctuations of the exchange rate have on the USA Foreign Direct Investment into Europe (USA outward).

4.1 OLS Estimation

As explained before, the first estimation was the OLS estimation where the results are presented in the table 4.1.1 To notice that in the case of the USA inward sample all the variables were not statistically significant what reinforces the inefficiency of the model. In the case of the USA outward sample, only the variables Real GDP and Openness are statistically significant.

Table 4.1.1 OLS estimation results

	USA Inward			USA Outward		
	Coefficient	Std. Error	Prob.	Coefficient	Std. Error	Prob.
Mean devaluation	-344829,70 (-1,14)	303191,10	0,2563	-12168,57 (-0,05)	269410,50	0,9640
Std. Dev. devaluation	104364,00 (0,99)	105269,10	0,3223	-30902,16 (-0,34)	89813,83	0,7310
Skewness devaluation	1629,56 (0,78)	2097,16	0,4377	872,50 (0,46)	1884,69	0,6437
Real GDP	0,0111 (1,54)	0,0072	0,1246	0,0048 (4,07)	0,0012	0,0001
Wage	-3,65 (-1,31)	2,79	0,1924	0,0438 (0,51)	0,0864	0,6123
Openness	-101266,80 (-1,28)	78901,37	0,2003	15517,31 (7,35)	2111,94	0,0000
Interest Rate	128132,70 (1,09)	117506,00	0,2764	17242,25 (0,31)	56060,06	0,7586
Corporate Taxes	272905,80 (0,79)	346597,70	0,4317	-25951,98 (-0,35)	74467,08	0,7277
Constant	35038,01 (0,79)	44123,73	0,4278	-12296,78 (-2,52)	4870,20	0,0121
A (1) p(value)	0,0000			0,0000		
R^2	0,036909			0,220855		
N	315			315		

source: Author's calculation

4.2   Fixed and Random Effects Estimation

The model was also estimated by fixed and random effects, where the results are displayed in Table 4.2.1 and 4.2.2, respectively. The fixed effects model allows for correlation between the unobserved effect and the independent variables and therefore in the presence of such correlation the fixed effects model generates consistent estimators. In the other hand, the random effects model has the assumption of zero correlation between the observed explanatory variables and the unobserved effect and therefore in the presence of correlation between those two parameters the random effect model is inconsistent (Wooldridge 2010).

Table 4.2.1 Fixed Effects Estimation Results

	USA Inward			*USA Outward*		
	Coefficient	Std. Error	Prob.	Coefficient	Std. Error	Prob.
Mean devaluation	-345083,70 (-1,19)	289118,30	0,2336	96715,15 (0,43)	223476,50	0,6655
Std. Dev. devaluation	164424,80 (1,61)	102050,70	0,1082	37714,13 (0,50)	75347,93	0,6171
Skewness devaluation	1355,47 (0,68)	2002,77	0,4991	1822,04 (1,04)	1751,47	0,2991
Real GDP	0,0113 (1,64)	0,0069	0,1011	-0,0045 (-1,11)	0,0041	0,2686
Wage	-3,75 (-1,41)	2,65	0,1588	0,1952 (1,50)	0,1298	0,1337
Openness	-108185,80 (-1,44)	74884,95	0,1496	24746,14 (4,57)	5413,07	0,0000
Interest Rate	117089,20 (1,05)	111532,50	0,2947	-8488,043 (-0,17)	49478,15	0,8639
Corporate Taxes	367954,20 (1,11)	330778,50	0,2669	-72304,86 (-0,78)	92375,34	0,4344
Constant	35598,42 (0,85)	41886,28	0,3961	-20054,23 (-2,71)	7376,71	0,0069
R^2	0,172709			0,503036		
N	315			315		

source: Author's calculation

From the results in table 4.2.1 we can observe that the explanatory power of the model was improved (however in the case of the USA inward it is still low). In the case of the USA inward all the variables are not statically significant as in the OLS estimation. For the three independent variables only, the skewness devaluation has the expected sign (positive), while the other two variables (mean and standard deviation) have opposite signs.

In the case of the USA outward, this time, only the variable openness is statistically significant, which indicates that an increase in the degree of openness attracts Foreign Direct Investment into that country. The independent variables are all positive, which means that the mean and the skewness have de expected sign and the standard deviation have the opposite sign of what expected.

Table 4.2.2 Random Effects Estimation Results

	USA Inward			USA Outward		
	Coefficient	Std. Error	Prob.	Coefficient	Std. Error	Prob.
Mean devaluation	-345497,40 (-1,20)	288570,00	0,2321	73878,69 (0,33)	222765,40	0,7404
Std. Dev. devaluation	141704,70 (1,40)	101230,80	0,1626	32957,28 (0,44)	75023,97	0,6608
Skewness devaluation	1454,74 (0,73)	1997,91	0,4671	1928,34 (1,12)	1719,65	0,2630
Real GDP	0,0112 (1,64)	0,0069	0,1029	0,0023 (0,86)	0,0027	0,3902
Wage	-3,71 (-1,40)	2,65	0,1630	0,1288 (1,12)	0,1149	0,2631
Openness	-105581,90 (-1,41)	74875,48	0,1595	19569,48 (4,55)	4304,59	0,0000
Interest Rate	121245,80 (1,09)	111515,40	0,2778	-4157,547 (0,09)	48611,39	0,9319
Corporate Taxes	331941,60 (1,01)	330045,10	0,3153	-107923,5 (-1,25)	86351,45	0,2123
Constant	35366,04 (0,84)	41894,86	0,3992	-17029,47 (-2,36)	7229,14	0,0191
R^2	0,043309			0,134147		
N	315			315		

source: Author's calculation

The results of the Random effects estimation are very similar to the results of the Fixed effects estimation where the significance levels and the signs of the variables are the same (only the openness (positive) is statistically significant in the USA outward database). However, to notice that the R^2 decreased substantially indicating a lower explanatory power of the model.

In the case of the skewness variable, the signs of the independent's variables in both models are the same and in line with the results found by Chakrabarti and Scholnick (2002)

and Udomkerdmongkol et al. (2009). The results of the mean variable are in line with the results of Schmidt and Broll (2009) in the case of the USA Inward investment. In the case of the Outward USA investment, the results are more what was expected and in line with the results of Froot and Stein (1991) and Dewenter (1995). For the standard deviation variable, the results of both models are positive which goes against what was expected but still follow the results of Dhakal et al. (2010) and Liu and Deseatnicov (2016).

4.2.1 The Hausman Test

To understand which estimation is preferable The Hausman Test was conducted. The Hausman Test tests the assumption of the existence of correlation (or not) between unobserved effect and the independent variables since for the Fixed effects model the correlation is allowed and for the Random effect model the correlation needs to be zero. The test was proposed based on the differences between the random effects and fixed effects estimates (Wooldridge 2010).

Therefore, the Hausman Test was conducted where the H0 hypothesis is: The Random model is appropriate, and the H1 hypothesis is: The Fixed model is appropriate. For the USA Inward, the p-value was 1,0000 so the null hypothesis was not rejected, indicating that the Random effects model was the preferred model. For the USA outward the Random effects model was also the preferred one with a p-value of 0,2171.

4.3   Generalized Least Squares Estimation

An alternative model of the ones presented before is the Generalized Least Squares as used in Chakrabarti and Scholnick (2002). Since it allows the relaxation of the classical OLS-type assumptions concerning the variance-covariance matrix of the error terms, it is possible to allow for heteroscedasticity across countries and autocorrelation over time within countries. The results are presented in the table 4.3.1.

Table 4.3.1 GLS estimation results

	USA Inward			USA Outward		
	Coefficient	Std. Error	Prob.	Coefficient	Std. Error	Prob.
Mean devaluation	-320804,80 (-5,44)	59024,95	0,0000	28401,43 (0,71)	40260,12	0,4811
Std. Dev. devaluation	57124,01 (2,98)	19196,60	0,0032	-23324,79 (-1,65)	14093,56	0,0990
Skewness devaluation	1307,80 (4,52)	289,59	0,0000	1059,30 (3,37)	314,73	0,0009
Real GDP	0,0102 (6,48)	0,0016	0,0000	0,0043 (15,65)	0,0003	0,0000
Wage	-3,11 (-5,05)	0,62	0,0000	0,0400 (2,64)	0,0152	0,0087
Openness	-91740,61 (-5,32)	17232,19	0,0000	14493,07 (15,27)	948,84	0,0000
Interest Rate	130672,10 (5,17)	25279,43	0,0000	15161,04 (1,83)	8266,39	0,0676
Corporate Taxes	214267,00 (2,94)	72874,88	0,0035	-19820,81 (-2,24)	8837,31	0,0256
Constant	22651,55 (2,29)	9884,40	0,0226	-11707,14 (-15,45)	757,61	0,0000
R^2	0,518991			0,62528		
N	315			315		

source: Author's calculation

The results of the GLS estimation, as we can see, are quite better than the results of the other three models. To notice that for the USA inward, all the variables this time are statistically significant at 1%, 5% and 10%, despite that on the three previous models, not even a single variable was. For the USA outward almost all the variables are statically significant, at least at 10%, except for the mean variable. The coefficient of determination improved for both databases, especially for the USA Inward database, meaning that the GLS has more power of explanation than the other three models. In the table 4.4.1, we have the results of all the estimations summarized.

4.4 Summary of All Results

Table 4.4.1 All Panel Data Estimations

	OLS		Fixed Effects		Random Effects		GLS	
	USA Inward	USA Outward	USA Inward	USA Outward	USA Inward	USA Outward	USA Inward	USA Outward
Mean	-344829,7	-12168,6	-345083,7	96715,2	-345497,4	73878,7	-320804,8	28401,4
devaluation	(-1,14)	(-0,05)	(-1,19)	(0,43)	(-1,20)	(0,33)	(-5,44)***	(0,71)
Std. Dev.	104364,0	-30902,2	164424,8	37714,1	141704,7	32957,3	57124,0	-23324,8
devaluation	(0,99)	(-0,34)	(1,61)	(0,50)	(1,40)	(0,44)	(2,98)***	(-1,65)*
Skewness	1629,6	872,5	1355,5	1822,0	1454,7	1928,3	1307,8	1059,3
devaluation	(0,78)	(0,46)	(0,68)	(1,04)	(0,73)	(1,12)	(4,52)***	(3,37)***
Real GDP	0,0111	0,0048	0,0113	-0,0045	0,0112	0,0023	0,0102	0,0043
	(1,54)	(4,07)***	(1,64)	(-1,11)	(1,64)	(0,86)	(6,48)***	(15,65)***
Wage	-3,65	0,0438	-3,75	0,1952	-3,71	0,1288	-3,11	0,0400
	(-1,31)	(0,51)	(-1,41)	(1,50)	(-1,40)	(1,12)	(-5,05)***	(2,64)***
Openness	-101266,8	15517,3	-108185,8	24746,1	-105581,9	19569,5	-91740,6	14493,1
	(-1,28)	(7,35)***	(-1,44)	(4,57)***	(-1,41)	(4,55)***	(-5,32)***	(15,27)***
Interest Rate	128132,7	17242,3	117089,2	-8488,0	121245,8	-4157,5	130672,1	15161,0
	(1,09)	(0,31)	(1,05)	(-0,17)	(1,09)	(0,09)	(5,17)***	(1,83)*
Corporate Taxes	272905,8	-25952,0	367954,2	-72304,9	331941,6	-107923,5	214267,0	-19820,8
	(0,79)	(-0,35)	(1,11)	(-0,78)	(1,01)	(-1,25)	(2,94)***	(-2,24)**
Constant	35038,0	-12296,8	35598,4	-20054,2	35366,0	-17029,5	22651,6	-11707,1
	(0,79)	(-2,52)**	(0,85)	(-2,71)***	(0,84)	(-2,36)**	(2,29)**	(-15,45)***
R	0,0369	0,2209	0,1727	0,5030	0,0433	0,1341	0,5190	0,6253
N	315	315	315	315	315	315	315	315

Note: The number's presented are the coefficient estimates. The numbers inside the parentheses are the t-statistics. *significant at 10%; **significant at 5%; ***significant at 1%
source: Author's calculations

A result that caused some surprise was the negative sign of the mean devaluation in the USA Inward database when the variable is statically significant. The literature supposable states that the expected sign of the variable should be positive once a depreciation of the host country should attract Foreign Direct Investment into that country since a revaluation is expected in the future. However, in our case, the sign of the mean variable is negative which indicates that a devaluation does not attract Foreign Direct Investment. The same intriguing result occurred in Chakrabarti and Scholnick (2002) and our model was not able to improve those results. One explanation given by the authors is that the investors may react differently, even qualitatively, to large and small shocks. They may "over-correct" their expectations to small shock shocks but "under-correct" to large shocks. Therefore, when the

large and small shocks are not distinguished from each other, the two opposite effects could be diluting the effect of devaluations, but it is something that the authors could not prove. The results do not follow the results of the main literature but are similar also with the results of Görg and Wakelin (2002) and Schmidt and Broll (2009). In the GLS estimation, the sign of the mean variable of the USA Outward database is positive and more in line with the expected. It means that a devaluation of the currency of the European countries leads to an increase in the US foreign direct investment into Europe.[8] This results despite being not statically significant are in line with the results of Jehan and Hamid (2017), Udomkerdmongkol et al. (2009) and Froot and Stein (1991).

The standard deviation variable is only statistically significant in the GLS model for both database, but both databases presented mixed results. The USA inward database presented a positive coefficient which goes against the literature but is in line with the results of Dhakal et al. (2010), Cushman (1985, 1988) and Liu and Deseatnicov (2016). In the case of the USA outward the results are what was expected (a negative sign) meaning that, for example, an increase in the volatility of the European countries currency diminishes the US foreign direct investment into Europe which is in accordance with the results of Campa (1993), Mariel and Pankova (2010) and Chakrabarti and Scholnick (2002).

On the other hand, the skewness variable gave results less contradictory. All the coefficients of the skewness variables are always positive (being statistically significant only in the GLS model), which clearly demonstrates that the large devaluations are associated with Foreign Direct Investment flows in the country where the currency is depreciating. This was also found in Chakrabarti and Scholnick (2002) and Liu and Deseatnicov (2016) for example.

As Leitão (2015) mentioned, understand how certain macroeconomic variables affect the Foreign Direct Investment is crucial for the national governments because it allows them to discover the best way to attract Foreign Investment. Knowing the variables that attract the Foreign Direct Investment, they could follow policies that potentiate those variables in order to attract investment into their country.

Regarding the results of the control variables, we can see that exists some contradictory results. However, it is not the case for the Real GDP. It presents satisfactory

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[8] The results of the Fixed and Random effects for the USA Outward database are also positive but also not statically significant.

results and in accordance with the theory. We can see clearly that the Real GDP is a variable that investors look when deciding where to invest. These results validate the Marker size hypotheses since it explains that the investment will go first to markets that are large enough to provide scale economies that are necessary for the production (Dhakal et al., 2010). Another variable that presented consistent results was the interest rate variable, however, it has the opposite sign of what was expected (positive) which demonstrates that the Foreign Direct Investment in our sample is positively affected by the interest rate, the higher the rate, the higher the FDI. That's an intriguing result since that was expected the opposite sign. This result may be due to the choice of a bad proxy.

The remaining three variables present some contradictory results between databases. The wage variable coefficient is negative for the USA Inward showing a repulsive effect on the FDI, while is positive for the USA outward showing that the FDI is not adversely affected by the wage, and therefore a rising in the wage increases the FDI. The corporates taxes are always positive for the USA inward database which indicates that the European countries are not discouraged by the USA corporate taxes. In the USA outward the coefficient of the variable is always negative showing that the United States are discouraged by the corporates taxes applied in the European countries, which is more in line with the theoretical predictions. The openness variable likewise the corporate taxes is always negative for the USA inward and always positive for the USA outward meaning that the European countries invest more in the USA when the degree of openness is lower, and the USA invest more in European countries when the degree of openness is higher. Since four of the five statistically significant results of the variable openness are positive it appears that the second interpretation is more corrected, which is in accordance with the theory that countries invest more in other countries with a high degree of openness.

In the next chapter, we will present other two approaches studying the effects of changes of the exchange rate have on the Foreign Direct Investment.

5 Robustness tests

In this chapter was elaborated two more approaches to study the effects of the exchange rate on the FDI. First, it was re-estimated again all four models but this time with real values for the Exchange rate and for the Interest rate to accounting inflation. Was thought to use real values from the beginning, but since the procedure of the paper that was the base of this dissertation did not use real values, was chosen to use nominal values. Given the importance of the inflation, was decided to include a re-estimation with real values to test if the model is indeed improved. (for simplicity was run only the USA outward database). However, due to data problems, the time period of the samples was reduced to 1998-2016.

Secondly was conducted an approach suggested by Chakrabarti and Scholnick (2002). The authors suggested an alternative approach that consists in removing the outliers from the database and therefore were removed from the sample the lowest 5% and the highest 5% of the sample.

5.1 Estimation with Real Interest Rates and Real Exchange Rate

To transform the nominal exchange rate in real exchange rate the Harmonized Consumer Price Indicator (HCPI) was used. For the real interest rate, the inflation was calculated through the HCPI since it is what is used in the Euro area to calculate the inflation. Was used the HCPI (2015=100) for the countries that belong to the European Union and for Switzerland was used also the HCPI (2015=100). All of the data was collected from the Datastream. For the United States was decided to use the CPI (2010=100) as a proxy since it was not possible to find monthly data of the CPI with a 2015 base year. The data was collected from the Federal Reserve Economic Data (FRED).

To get the Real values of the interest rate first was needed to calculate the inflation:

inflation=$\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}}$ and then the Fisher Rule was applied to get the Real Interest Rate:

Fisher Rule: $r = n - i,$

,where r is the real interest rate, n is the nominal interest rate and i is the inflation.

After calculating the real values all the process of estimation was repeated and was obtained the following results presented in the table 5.1.1 The results are pretty much similar to the previous results. To notice that now the variable openness is statically significant in all the models. Also, the coefficient of the mean devaluation variable in the GLS model has changed to negative, maintaining the statistical significance. All other variables remain statistically significant and with the same sign. Despite the transformation in real values of the interest rate, it continues positive in all the models and statically significant in the GLS model. However, as we can see, with the real values of the exchange rate and the interest rate the explanatory power of the GLS model has increased and now 74% of the dependent variable can be explained by the regressors of the model.

Table 5.1.1 All Panel Data Estimations - USA outward with real values

	OLS	Fixed Effects	Random Effects	GLS
	USA Outward	USA Outward	USA Outward	USA Outward
Mean devaluation	-72838	66936	30365	-33531
	(-0,26)	(0,28)	(0,13)	(-0,78)
Std. Dev. devaluation	-75132	10675	-1216	-62621
	(-0,78)	(0,13)	(-0,02)	(-4,26)***
Skewness devaluation	655	1773	2056	797
	(0,36)	(1,05)	(1,26)	(2,69)***
Real GDP	0,0047	-0,0035	0,0031	0,0045
	(3,70)***	(-0-77)	(1,15)	(23,37)***
Wage	0,0506	0,21	0,16	0,04
	(0,56)	(1,49)	(1,37)	(2,59)***
Openness	15980	25996	18300	15680
	(6,96)***	(3,80)***	(3,91)**	(17,95)***
Interest Rate	73578	65496	70078	56085
	(1,05)	(1,07)	(1,17)	(5,51)***
Corporate Taxes	73578	-87599	-136904	-30954
	(-0,49)	(-0,80)	(-1,41)	(-3,13)***
Constant	-10724	-22004	-16387	-10681
	(-2,06)**	(-2,58)**	(-2,18)**	(-14,23)***
R	0,2250	0,5049	0,1158	0,7407
N	285	285	285	285

Note: The number's presented are the coefficient estimates. The numbers inside the parentheses are the t-statistics. *significant at 10%; **significant at 5%; ***significant at 1%
source: Author's calculation

5.2 Estimation without the outliers

Now, the second approach is to remove the lowest and the highest 5% of the sample and see if the model is somehow improved. All the process is repeated for the GLS model and the results are displayed in the table 5.2.1

The results shown below show that the explanatory power of the model actually decreased from the previous model. All the signs remained the same, but the skewness variable is no longer statistically significant, and the corporate taxes are now only statistically significant at 10%. With that said, we can conclude that removing the outliers was not a strategy that benefited the model.

Table 5.2.1 GLS estimation with real values and without outliers

	GLS
	USA Outward
Mean devaluation	-106982 (-1,36)
Std. Dev. devaluation	-83437 (-3,45)***
Skewness devaluation	676 (1,49)
Real GDP	0,0041 (15,71)***
Wage	0,0464 (2,28)**
Openness	15664 (14,28)***
Interest Rate	53277 (3,71)***
Corporate Taxes	-21963 (-1,79)*
Constant	-10600 (-8,73)***
R	0,6212
N	257

Note: The number's presented are the coefficient estimates. The numbers inside the parentheses are the t-statistics. *significant at 10%; **significant at 5%; ***significant at 1%
source: Author's calculation

6 Conclusions

The relation between the Foreign Direct Investment and the exchange rate is a topic that has attracted the attention of the literature over the years, with the authors trying to dissect the effects that movements of the exchange rate have on the Foreign Direct Investment. Since it is a theme that can affect the policies of certain institutions or the attitude of certain investors, we found that would be interesting to study this effect and see what the results would give us.

In this dissertation, we studied the effects that movements in the exchange rate has on the FDI using annual data of flows between the United States of America and fifteen European Countries. To explore a part of the literature that is less explored, in this dissertation was studied the outward US investment flows towards Europe (the most part of the literature studies the effects that the exchange rate has on the outward US investment flow to somewhere) and, in addition, was studied also the US inward investment flows from European countries.

We followed Chakrabarti and Scholnick (2002) methodology and add some control variables based on other literature. Based on the authors work, it was used the mean, the standard deviation and the skewness of monthly exchange rate devaluations of the currency of that country in the preceding year, to measure the average level of the Exchange Rate, Exchange rate volatility and the Expectations on the Exchange Rate, respectively.

The aim of this dissertation was to test three main hypotheses: (i) If when a depreciation of a country's currency occurs, the inward FDI rises; (ii) If FDI is discouraged by high levels of exchange rate volatility; (iii) if a large devaluation of the local currency attracts FDI into that country.

The two databases presented mixed results concerning the mean devaluation and volatility variables, but they are in agreement concerning the expectations variable. The results of the USA outward confirmed the hypothesis tested (however with the mean devaluation variable not being statistically significant) confirming that a depreciation of a European country's currency (in this case), raises the USA direct investment into Europe and that a high exchange rate volatility diminishes the USA direct investment into the UE. The results of the USA Inward, on the other hand, confirmed only the hypothesis of the expectations variable, rejecting the other two hypotheses. Both database results showed that

a large devaluation of a European country currency attracts USA direct investment and that a large devaluation of the dollar attracts investment from Europe.

These results could indicate that the US investors are more risk-averse than the European countries since in the outward US investment the relationship with the volatility is negative, meaning that high volatility in the currencies of the European countries discourages the US investment. The results of the US inward database showed that the Europeans investors are not affected by the high levels of volatility since the results showed a positive relationship between the exchange rate volatility and the foreign direct investment.

As Leitão (2015) mentioned, understand how certain macroeconomic variables affect the Foreign Direct Investment is crucial for the national governments because it allows them to discover the best way to attract Foreign Investment. Knowing the variables that attract the Foreign Direct Investment, they could follow policies that potentiate those variables in order to attract investment into their country.

For example, speaking in the case of the European governments, the determinants that they should look to increase in order to attract US investment are the real Gross Domestic Products, the wage, the level of openness and the interest rate. Our results showed clearly that Real GDP and the level of openness are a variable that US investors look when are deciding where to invest, so establishing policies that increase the Real Gross Domestic Product and the level of Openness, could be a way to attract US Investment. Since the results of the variable wage and the variable interest rate were not the results that were expected, maybe due to a bad proxy used, it is still not clear the real impact that they might have. Another way to attract US direct Investment could be decreasing the corporate taxes since they discourage the investment since the higher the rate, the higher expenses the investors have to face.

The results of this dissertation and similar works are important to understand which variables really affect the Foreign Direct Investment and how it is affected by them. With the levels of the Foreign Direct Investment increasing over the years, it is important, especially for national governments, to understand which are the aspects that should be potentiated in order to attract Foreign Direct Investment and potentiate their economy.

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