The Impact of Brexit on FDI Flows to the UK

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Summary

In the summer of 2016, the Brits voted in favour of leaving the European Union (EU) – 52% voted in favour against 48% for the opposition (Business Insider, 2016) - resulting in a so-called 'Brexit'. Ever since, many raised questions how the market would react and how the consequences for the Brits would look like.

The purpose of this paper is to quantify the impact of Brexit on FDI flows to the UK by using the gravity equation developed by Tinbergen (1962). In other words, by determining the loss of FDI flows if the UK were to leave the EU. To determine the importance of being in a free trading area (e.g. the EU), we follow the work of Baier and Bergstrand (2007), who study the effects of free trade agreements on its members' international trade. This implies we regress a dummy for EU membership – which equals 1 if both the host and partner country are a member of the EU in the given year, and vice versa – on the bilateral FDI flows between the OECD countries in the period 2000-2012.

We find that being a member of the EU raises inward FDI flows by 86.5%. Therefore, we project this to be the loss to the UK if Brexit happens. Next, we conducted some robustness checks and find that the effect of current EU membership increases to 96.2% when adding one lag of this variable to the model. However, as we use a dataset that covers only five host countries instead of all OECD countries, we believe there remains some omitted variable bias present in the model.

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Abstract

Ever since the Brits voted to leave the European Union (EU), many wonder what the consequences are going to be. The purpose of this paper is to quantify the impact of Brexit on the foreign direct investment (FDI) flows to the UK, using longitudinal data covering 13 years and 34 partner countries. It does so by using the gravity equation developed by Tinbergen (1962). We create a dummy variable representing EU membership which equals 1 if both host and partner country are a member of the EU and vice versa. We find that EU membership significantly increases inward FDI flows with 86.5%. Therefore, we project this to be the loss to the UK when Brexit happens.

Keywords: Brexit, FDI flows, gravity equation

1. Introduction

In the summer of 2016, the Brits voted in favour of leaving the European Union (EU) – 52% voted in favour against 48% for the opposition (Business Insider, 2016) - resulting in a so-called 'Brexit'. Ever since, many raised questions how the market would react and how the consequences for the Brits would look like. Now, nearly two years later, one can conclude that it remains speculative whether in the long run it will benefit the Brits. Some are even discussing to have another referendum to revert the initial decision as they did not expect such large consequences (Independent, 2018).

What has happened since the Brexit announcement? First, the pound sterling has depreciated nearly 20 percent (Bloomberg, 2016). The currency's depreciation has not yet led to a boost in exports, which one normally would expect (Economist, 2017; Guardian, 2017). Moreover, the Brits probably have to start paying bound tariffs as it is plausible they will no longer be a part of the integrated European market (Guardian, 2016). The level of the tariffs is determined by the World Trade Organization (WTO) according to the most favourable nation (MFN) principle.

Besides trade effects, Brexit hurts foreign direct investment (FDI) flows to the United Kingdom (UK). Dhingra et al. (2016) provide three reasons why leaving the EU might hurt the FDI flows to the UK: (i) being in a single market (e.g. the EU) makes the UK an excellent platform to export to for multinationals, as they do not bear large costs from tariff barriers; (ii) many multinationals have fragmented their production and, with the UK leaving the EU, this complicates matters since different components are subject to different regulations; (iii) uncertainty on how future trade agreements between the UK and the EU will look like, tend to decrease FDI flows.

The purpose of this paper is to quantify the impact of Brexit on FDI flows to the UK by using the gravity equation developed by Tinbergen (1962). In other words, by determining the loss of FDI flows if the UK were to leave the EU. To determine the importance of being in a free trading area (e.g. the EU), we follow the work of Baier and Bergstrand (2007), who study the effects of free trade agreements on its members' international trade. This implies we regress a dummy for EU membership – which equals 1 if both the host and partner country are a member of the EU in the given year, and vice versa – on the bilateral FDI flows between the OECD countries in the period 2000-2012. Moreover, this research sheds light on two possible Brexit scenarios: (1) a 'Soft Brexit', where the UK maintains part of the European customs union; (2) a 'Hard Brexit', where the UK is not part anymore of the integrated European market and tariffs are determined by the WTO. More on this in Section 2.2.

The main contributions of this paper to the literature are twofold. First, this study covers a different time period compared to previous studies. Second, the combination of the gravity equation and FDI flows has barely been investigated.

On the one hand, with the pound sterling depreciating, the UK makes an interesting place to invest in for foreigners. On the other hand, however, one also has to take into account the extra costs a separate market brings along. This makes the UK an unattractive country to invest in. Therefore, analysing this ambiguity - the impact of Brexit on FDI flows - makes a very interesting and contemporary topic.

In addition, this research is relevant as FDI is more important to the UK than to any other G7 country; it namely accounts for 11% of the UK's GDP (WAVTEQ, 2017; Dhingra et al., 2016). Figure 1 shows the relative importance of FDI in the UK compared to France and Germany. This fact gives the UK a relatively strong negotiation position vis-à-vis the EU, since it can emphasize its importance to investors.

What's more, the Centre for Economic Performance (CEP) also makes an estimation of how FDI flows are affected by EU membership and finds that member states' FDI increase on average with 28%. Moreover, the CEP expects the FDI flows in the UK to fall with 22% due to Brexit. Next, they show that being a member of a Free Trade Agreement (FTA) does not increase FDI (CEP, 2016).
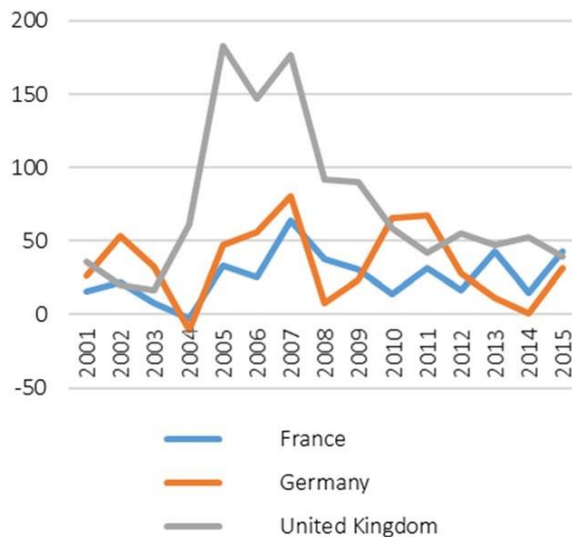
Figure 1: FDI flows in France, Germany and the UK in 2001-2015 (in US$ billions).
Source: Dhingra et al. (2018)

The remainder of this paper is as following. Section 2 contains some background information on Brexit and its motives. Thereby, it outlines the two possible Brexit scenarios. Section 3 elaborates the empirical literature important to this research, whereas Section 4 explains the gravity equation and its features. Section 5 describes the data collection process. The empirical results are depicted in Section 6, accordingly with their economic implications. Finally, Section 7 concludes this study by summarizing the results. Consequently, this study's limitations are presented alongside with recommendations for future research.

2. Background

This section contains some background information on the motives for Brexit. Next, Section 2.2 outlines the different possible Brexit scenarios. Finally, some demands from the EU are listed.

2.1 Brexit motives and transition period

Becker, Fetzer and Novy (2016) study the vote and turnout share of the Brexit referendum by focusing on the variation of vote shares across local authorities. They use a variable selection exercise to identify the most robust predictors of the vote leave result. The authors find that, surprisingly and contrary to much of the political debate, neither exposure to measures taken by the EU (e.g. immigration and trade exposure), nor the quality of public services and fiscal consolidation explain much of the variation in the vote leave share (Becker et al., 2016). According to Becker et

al. (2016), the variation that can explain most of the voting result comes from long run political choices (e.g. educational attainment, demography and industry structure).

The opposite result is found by Goodwin and Milazzo (2017), who, using aggregate and individual survey data, state that immigration is the main motive to voters to vote leave. This latter finding coincides with the finding of McCrae and Portes (2018), who conduct a survey among nursing and midwifery students and find that immigration (68.9%) is the main motive for Brexit, being followed by patriotism (9.9%) and excessive regulation (5.0%).

Between the referendum and the actual Brexit, the UK and EU have agreed on a transition period, which runs until December 31, 2020. During this period free movement of goods and services stays in place (on request of the EU) (BBC, 2018). The key aspects of this agreement are to be found in Appendix 1.

2.2 Brexit scenarios

A first possible Brexit scenario is a 'Soft Brexit', a scenario implying that the relationship between the UK and EU remains as close as possible to the existing arrangements. In this case, the UK gives up its seat in the European council, while it keeps having access to the European Single Market, where goods and services are traded on a tariff-free base (Independent, 2016; PwC, 2016; Dhingra et al., 2016). As the UK will be bound by the four freedoms (i.e. goods, services, capital and labour), this implies that Europeans can work and settle themselves in the UK, and vice versa.

A second possible Brexit scenario is a 'Hard Brexit', a scenario implying that the UK leaves the Single Market and the customs union. In this case, the UK regains full control over its borders and it can negotiate new trade deals (Independent, 2016; PwC, 2016; Dhingra et al., 2016). This latter will happen on terms of the WTO, where all trade occurs using the most favourable nation (MFN) tariffs.

Next, there is the issue of the Irish border: having a 'hard border' between Ireland and Northern-Ireland undermines the Northern Irish peace process established in 1998, which could lead to a conflict between the two countries. However, having a 'soft border', an option ruled out by prime minister May, could lead to a new economic frontier in the Irish Sea (New York Times, 2018). Therefore, this debate could be decisive in the Brexit negotiations.

2.3 What does the EU want?

The European Council stated in a press release some of the outcomes it intends to get from the negotiations with the UK (Euronews, 2017). First, EU nationals in the UK and Brits in Europe should receive equal treatment and the same level of protection. Second, the European Council wants the UK to continue to contribute financing to the European Investment Bank for an indefinite period, since the UK should help the EU in overseeing the consequences of losing the UK's EU membership (Euronews, 2017). Finally, the EU intends to negotiate a soft Irish border, as it fears a conflict between Ireland and Northern-Ireland when the peace process is violated.

Table 1: The difference between a Soft and Hard Brexit.

	Soft Brexit	*Hard Brexit*
Access to Single Market	Yes	Low; UK has to pay import tariffs and NTBs[1] could emerge.
Influence over EU regulations	No	No
Contribution to EU budget	No	No
Independent trade policy	Yes; the UK is allowed to negotiate new FTAs with other countries.	Yes; the UK is allowed to negotiate new FTAs with other countries.
Independent immigration policy	Yes	Yes

Note: Table 1 follows the structure from PwC's study (2016) on the implications to the economy of the UK as a consequence of leaving the EU.
[1]NTBs = non-tariff barriers

3. Literature Review

Despite Brexit being a relatively new topic, much research has already been conducted on the effects of Brexit, mostly trade and welfare effects. However, also some research regarding the effects on FDI flows has been conducted. This section outlines the most important empirical literature. An overview of the studies and their methods is presented in Table 2.

Firstly, one might wonder why countries welcome FDI at all. The literature provides several reasons. Some of the direct benefits are that foreign firms are more productive and pay higher wages than domestic firms (Dhingra et al., 2016). This beneficially affects domestic workers as

productivity (due to competitive pressure) and wages in the domestic country will increase. Indirectly, FDI brings along technological and managerial know-how (Bloom et al., 2012), where domestic firms can learn from via an internationally integrated supply chain (Dhingra et al., 2016; Harrison & Rodríguez-Clare, 2010). Moreover, Haskel et al. (2007) find that there are spill-over effects to other UK owned firms in the same industry.

3.1 Effect EU membership on FDI flows

The literature regarding the effects of Brexit on FDI flows is rather conclusive in a sense that the expectation is that Brexit will decrease foreign investment flows. For example, Bruno et al. (2016) use a gravity equation to estimate the effect of being a member of the EU on inward bilateral FDI flows, taking all standard gravity equation control variables into account (e.g. GDP, common language, geographical distance, colonial history), including dyadic fixed effects to control for variables like culture and geography that do not change much over time. Therefore, the coefficients of interest are the changes in trading relationships over time (Bruno et al., 2016). To control for global macroeconomic shocks, they include a full set of time dummies. By using a dataset that covers 34 OECD countries between 1985 and 2013 – representing more than 70% of the global FDI inflows - the authors find a significant positive effect of being an EU member on inward FDI, with an average magnitude of 28%. Moreover, they argue that Brexit causes a future decline in FDI of about 22% (Bruno et al., 2016).

Similarly, Campos and Coricelli (2015) study the possible consequences of a Brexit leave vote. They focus their study on three main areas (trade, FDI and finance) and conclude that the UK benefits significantly from European integration in all these areas. Campos and Coricelli (2015) use a dataset covering all European countries between 1973 and 2004 from the moment they joined the Union. The authors find, by estimating different synthetic scenarios and using a difference-in-difference method, that EU membership increases FDI by 25-30%. Therefore, they project this to be the loss when the UK decides to leave the EU (Campos & Coricelli, 2015).

These results are supported by Straathof et al. (2008), who find that EU membership increases inward FDI. They study the advantages of being in an internal market (e.g. the EU) on FDI flows. Using panel data covering 30 countries and over 300 partner countries and regions between 1981 and 2005, the authors find, by running a gravity equation, that bilateral FDI between EU countries is on average 28% higher than for countries that are both not a member of the EU. This result is as the authors expected, since the EU is an economic integrated union which bears low transaction

costs (Straathof et al., 2008). A drawback of this study, though, is that they have highly unbalanced panel due to missing data from the 1980s. Therefore, Straathof et al. (2008) run another gravity equation for the same countries, but between 1994 and 2004 and find, despite a better data coverage, similar results.

Welfens and Baier (2018) investigate Brexit and its impact on foreign direct investment. The authors use the gravity equation with a dataset that covers the 34 OECD countries from 1985 to 2012. They include dyadic fixed effects to control for time-invariant variables (e.g. culture, geography, etc.). Missing values, negative values and zeroes are dropped from the dataset to avoid bias. Their study shows three main results: (1) leaving the EU Single Market strongly reduces the UK's inward FDI flows: they find that being a member of the EU increases inward FDI flows by 62%; (2) if, partly because of the pound sterling's depreciation, foreign capital stock was to increase during the transition period, this could mitigate the effects of Brexit hurting the FDI flows to the UK; and (3) introducing a lower corporate tax law could attract foreign investors, which would dampen the Brexit impact. However, this could also start downward international corporate tax reduction game (Welfens & Baier, 2018). A drawback of their study, though, is that major FDI sources like Russia and China are excluded from the dataset as they are not part of the OECD.

A study by Fournier et al. (2015) investigates the effects of EU membership on FDI flows and trade. They use the OECD FDI flows database from the mid-1990s to 2011 to run a gravity equation with country fixed effects. Fournier et al. (2015) contribute to existing literature as they include product market regulation, employment protection and trade intensity (i.e. the ratio of trade to GDP) in their analysis. The authors find that EU membership has a significant positive effect on both FDI flows and trade. However, they do find a negative effect of the North American Free Trade Agreement (NAFTA) on FDI flows, which implies that being a member of NAFTA decreases bilateral FDI flows. Fournier et al. (2015) contribute this finding to a substitution effect from FDI to trade.

Ramasamy and Yeung (2010) study FDI and its determinants by using a panel data that covers all the OECD countries between 1980 and 2003. The authors excluded a number of countries as these had too many missing values or the data was lacking accuracy (e.g. Belgium and Luxembourg were reported by some sources as one country). They use the generalised methods of moments (GMM) estimator proposed by Arellano and Bover (1995) to incorporate dynamic effects and find that openness is the single most determinant of FDI, implying that being in a free trading area like

the EU increases bilateral FDI flows significantly (Ramasamy & Yeung, 2010). More specifically, they find that a 1 percentage point increase in the services trade to GDP ratio leads to $1.98 billion increase in inward FDI flows.

Table 2: An overview of studies investigating the effects of EU membership on FDI flows.

Study	Data	Model	Results
Bruno et al. (2016)	OECD countries (1985-2013)	Gravity model	+ 28% on average
Campos & Coricelli (2015)	EU countries (1973-2004)	Synthetic counterfactuals (OLS)	+ 25-30%
Fournier et al. (2015)	OECD countries (mid-1990s-2011)	Gravity model	+ 48%
Straathof et al. (2008)	30 countries (1981-2005)	Gravity model	+ 28% on average
Welfens & Baier (2018)	OECD countries (1985-2012)	Gravity model	+ 62%

3.2 Effect FDI flows on GDP

Alfaro et al. (2004) study the various links between FDI, financial markets and economic growth. The main purpose of their paper is to test whether countries with a better integrated financial system benefit more from FDI in terms of economic growth than countries that are less developed. The authors use two sets of data: (i) 20 OECD countries and 51 non-OECD countries between 1975 and 1995 focussing on credit market indicators, and (ii) 20 OECD countries and 29 non-OECD countries in the same period focussing on equity market indicators. To deal with endogeneity issues, Alfaro et al. (2004) introduce several instrumental variables. Next, by running a simple OLS regression, they find that FDI contributes significantly to economic growth (GDP), mostly for countries with a highly developed financial sector. This finding aligns with the results of Judi and Levieuge (2015), who find significant results conditional on certain circumstances such as a highly developed financial sector.

Dhingra et al. (2016) base their study on the work of Alfaro et al. (2004) to predict the loss in GDP in case of Brexit. The authors estimate the loss to be 3.4% when Brexit is realized. However, they make a strong assumption to reach this conclusion. Dhingra et al. (2016) assume that the fall in FDI lasts for ten years and then reverts to its original level. Therefore, some caution is advised when using these results (Dhingra et al., 2016).

4. Gravity Model

This research uses the gravity equation developed by Jan Tinbergen (1962). In its essence, this theory states that countries trade proportionally according to their GDP and proximity (UNCTAD, n.d.). Hence, this implies that larger countries import and export more than smaller countries.

The derivation of the gravity equation used in this paper stems from the work of Baier and Bergstrand (2007), who use the gravity equation to study the effect of trade agreements on its members' international trade. This study uses the same formula, but replaces trade with FDI flows. The formula looks like the following:

$$FDI_{ij} = \beta_0 (GDP_i)^{\beta_1} (GDP_j)^{\beta_2} (INTEREST_i)^{\beta_3} (DIST_{ij})^{\beta_4} e^{\beta_5 (LANG_{ij})} e^{6(EU_{ij})} \varepsilon_{ij} \quad (1)$$

where FDI_{ij} is the monetary value of the bilateral FDI flows from country i to j, GDP_i (GDP_j) is the gross domestic product (PPP) in country i (j), $INTEREST_i$ is the interest rate set by country i. $DIST_{ij}$ is the distance between country i and j, $LANG_{ij}$ is a dummy variable which equals 1 if countries i and j share a common language and 0 otherwise, EU_{ij} is a dummy variable which equals 1 if both countries i and j are a member of the EU and 0 otherwise.

However, Anderson and Van Wincoop (2003) state equation (1) is biased if one does not include prices into the gravity equation. Therefore, they suggest that the gravity equation is estimated as follows:

$$\ln \left[\frac{FDI_{ij}}{GDP_i GDP_j} \right] = \beta_0 + \beta_3 (INTEREST_i) + \beta_4 (lnDIST_{ij}) + \beta_5 (LANG_{ij}) + \beta_6 (EU_{ij}) -$$
$$lnP_i^{1-\sigma} - lnP_j^{1-\sigma} + \varepsilon_{ij} \quad (2)$$

subject to N equilibrium conditions:

$$P_1^{1-\sigma} = \sum_{i=1}^{N} P_i^{1-\sigma} \left(\frac{GDP_i}{GDP^W} \right) e^{\beta_3 (INTEREST_i) + \beta_4 (lnDIST_{i1}) + \beta_5 (LANG_{i1}) + \beta_6 (EU_{i1})} \quad (3)$$

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$$P_N^{1-\sigma} = \sum_{i=1}^{N} P_i^{1-\sigma} \left(\frac{GDP_N}{GDP^W} \right) e^{\beta_3 (INTEREST_i) + \beta_4 (lnDIST_{iN}) + \beta_5 (LANG_{iN}) + \beta_6 (EU_{iN})} \quad (4)$$

where GDP^W denotes the world's GDP, constant across countries. $P_i^{1-\sigma}$ and $P_j^{1-\sigma}$ are expressed as the 'multilateral price resistance terms'. In order to account for these resistance terms, to generate unbiased estimates of the betas, one has to incorporate bilateral fixed effects (Anderson & Van Wincoop, 2003).

4.1 Endogeneity bias

Baier and Bergstrand (2007) point out that there might potential correlation between the error term and EU membership (i.e. unobserved heterogeneity among country pairs). Though, before considering this potential correlation, one first needs to consider the likelihood of countries being a member of the EU or an FTA in general. This subject has been studied by Baier and Bergstrand (2004), who find, by using a probit function, that pairs of countries that share an FTA tend to share economic characteristics. For example, if a pair of countries has a similar GDP or similar size, they tend to share an FTA. The authors find in their probit estimate a pseudo-R^2 of only 70%, leaving much unobserved heterogeneity. The question then is: how is the unobserved heterogeneity associated with the likelihood of an FTA?

If, for instance, the error term (ε_{ij}) in equations (1) and (2) represents some sort of regulation, which inhibits foreign investment, that is not accounted for by the gravity equation and is correlated with the decision to join the EU, then this causes ε_{ij} to be negative. However, the probability of the two countries' governments selecting into an FTA increases if the expected welfare gains from liberalization are large enough (causing ε_{ij} to be positive). Therefore, if one estimates the coefficient for EU membership, one is likely to *underestimate* the coefficient in this case. This selection bias is the major source of endogeneity regarding FTA effects in gravity equations and could lead to distorted results. Therefore, Baier and Bergstrand (2007) propose several ways of correcting for this (i.e. panel data with a fixed effect estimator or first-differencing with panel data). The first is the path this study follows in determining its empirical results. The Heckman correction has also proven itself a useful tool in countering selection bias (see e.g. Puhani (2000); Stolzenberg & Relles (1990); Bushway et al. (2007)), however this paper sticks with the proposed methods by Baier and Bergstrand (2007).

These methods are still frequently used in more recent literature. For example, Lee and Cho (2017) correct for selection bias into FTAs by using the Heckman correction, whereas Parra et al. (2016) follow the work of Baier and Bergstrand (2007) and use bilateral fixed effects in a panel

approach to account for self-selection. Moreover, Lee (2015) uses propensity score matching to counter the selection bias in his study.

4.2 Average treatment effect

Empirical issues regarding endogenous binary variables categorize under the treatment effect, which simply means that FDI flows differ only on the fact whether the country pair shares an FTA or not. The average treatment effect (ATE) of an FTA between a country pair is as follows:

$$ATE(q) = E[x_1 - x_0|q, FTA] \tag{5}$$

where x_1 (x_0) is the logarithm of FDI flows from country i to country j with (without) an FTA and E defines the expectation operator. We assume that the observations of x are identically and independently distributed across country pairs to make sure that the treatment of one country's FDI flows does not interfere with another one's (Baier & Bergstrand, 2007). Running a fixed effects regression allows one to correct for unobserved time-invariant heterogeneity, which we believe is the case in this study as FDI determinants did not change much over time.

5. Data

First, this section describes the data collection process. Table 3 provides a list of all variables. Following, some descriptive statistics are being displayed.

5.1 Data collection

This study uses longitudinal data which includes annual data on the bilateral FDI flows between the OECD countries (excluding Latvia, as it joined the OECD only in 2016, there are 34 OECD countries in total) with the UK, France, Germany, Italy and the U.S as host countries (countries where FDI is going to from the partner countries) in the period 2000-2012. Data on the FDI flows are retrieved from the OECD Database (given in current million US dollars). Next, we take logs of the FDI flows as we look at relative changes. The OECD countries are chosen as partner countries in this model, because they are the most important sources of FDI flows. However, countries like China, Russia and India, which are major providers of FDI, are not included in this dataset as they are not a member of the OECD. Moreover, data limitations may occur when one includes countries outside of the OECD. Inward FDI flows are considered rather than FDI stocks to avoid including outward FDI flows as well.

Next, annual data on GDP of the OECD countries between the years 2000 and 2012 are included in the dataset (given in current million US dollars). This data is retrieved from the World Bank. However, since GDP represents a large number, only the log of this value is considered. To correct for demographic differences, the variable GDP per capita is included. Data concerning the OECD countries' population are retrieved from the World Bank to calculate the GDP per capita.

Following, we add a dummy for EU membership to the dataset which equals 1 when both the host and partner country are a member of the EU and 0 for the opposite case. We include this dummy as this gives the added value of being a member of the EU. Hence, it also represents the loss of not being a member. Moreover, literature shows that having an EU membership significantly increases FDI flows.

The interest rate (average marginal lending facility) in the host country (given as a percentage) is added to the dataset as well to see how attractive the financial environment is to invest in. This data is retrieved from the ECB, Federal Reserve and the Bank of England for the years 2000 to 2012. This variable is important to an investor considering investing abroad. Higher interest rates tend to attract foreign investors as the marginal product of capital is higher and therefore more profits can be made. However, in general, higher interest rates mean higher risk. Therefore, a trade-off ought to be made by the investor.

Following Bruno et al. (2016), we add export and import shares (as a percentage of GDP) to the dataset for the given period to calculate the importance of trade to the host country's economy. As trade might be seen as a substitute to foreign investment, this could give interesting insights. Data on this comes from the World Bank.

Lastly, some gravity model specific variables are included in the dataset (i.e. colonial history, common language and geographical distance). Data on these has been retrieved from the CEPII database, where the dataset of Mayer and Zignago (2011) is published. The first of these gravity specific variables (colonial history) is a dummy variable referring to whether the partner country used to be a colony of the host country. The second (common language), also a dummy variable, signifies whether the two countries share an official language. The latter (geographical distance) represents the bilateral distance between the two countries, which is measured via the great circle formula.

Table 3: List of variables

Variable	Definition	Unit	Source
Bilateral FDI flow	FDI flows from partner to host country	Current million US$	OECD Database
GDP host	GDP of FDI host country	Current million US$	World Bank
GDP partner	GDP of FDI partner country	Current million US$	World Bank
GDP per capita host	GDP per capita of FDI host country	Current US$	World Bank
GDP per capita partner	GDP per capita of FDI partner country	Current US$	World Bank
EU membership	Dummy variable whether both host and partner are a member of the EU	0,1	EU
Interest rate	Interest rate in the host country	%	ECB, Federal Reserve, Bank of England
Export share	Export of goods and services in the host country relative to GDP	% of GDP	World Bank
Import share	Import of goods and services in the host country relative to GDP	% of GDP	World Bank

5.2 Descriptive statistics

Table 4 shows some descriptive statistics of the dataset. In total, there are 2,145 observations (33 countries over 13 years in 5 host countries). FDI flows greatly differ among the different countries throughout the time period, ranging from -$45,995 million (from France to Italy in 2008) to $253,434 million (from the U.S. to the UK in 2007). GDP differences are large, as this obviously depends on the size of the country. GDP per capita has an extensive range as well, however this is due to some outliers, with Luxembourg being the most extreme ($115,762 in 2011).

The interest rate is mainly decreasing over the time period, as central banks have been following an expansionary monetary policy to stimulate investments. As described in Section 5.1.1, higher interest rates tend to attract foreign investors. Therefore, we expect a positive coefficient in Section 6. Furthermore, relative export and import shares to GDP differ a lot among the host countries. For example, the export shares range 9.04% in the United States (2003) to 45.98% in Germany (2012), whereas the import shares range from 13.02% in the United States (2002) to 39.93% in Germany (2011). Since these variables represent in a way how involved a country is in the international community, we expect this later on to have a positive (and possibly significant) coefficient.

Table 4: Descriptive Statistics

VARIABLES	(1) N	(2) Mean	(3) Std. Dev.	(4) Min	(5) Max
FDI Inflow	2,090	2,270	9,205	-45,995	253,434
GDP Host	2,145	4,544,000	4,498,000	1,142,000	16,160,000
GDP Partner	2,145	282,200,000	267,700,000	121500	998,500,000
GDP per capita – Host	2,145	37,219	8,142	20,051	51,450
GDP per capita – Partner	2,145	32,316	20,781	3,120	115,762
Interest Rate	2,145	3.158	1.596	0.0800	6.440
Export Share	2,145	25.57	9.130	9.038	45.98
Import Share	2,145	26.09	6.556	13.02	39.93
Distance	2,145	4,297	4,613	173.5	19,264

Note: FDI inflow given in current million US$, GDP is given in current billion US$, GDP per capita is given in current US$, Interest Rate is given as a percentage, just as export and import share, and distance is given in absolute kilometres.

Regarding the gravity equation specific variables, we expect common language and colony to have a positive effect on FDI flows, whereas for distance the opposite is expected. Common language speeds up the regulatory process as it makes contact easier. If the partner country used to be a colony of the UK, this might facilitate some kind of bond between the two countries.

6. Results

This section shows the results of the basic regression of our gravity model. Next, we test its robustness by conducting some diagnostic tests.

6.1 Basic regression

This paper considers the following empirical regression in order to address the question at hand:

$$\ln(FDI_{ij}) = \beta_0 + \beta_1 \ln(GDP_i) + \beta_2(GDP_j) + \beta_3(INTEREST_i) + \beta_4(DIST_{ij}) +$$
$$\beta_5(LANG_{ij}) + \beta_6(EU_{ij}) + \varepsilon_{ij} \tag{6}$$

where especially coefficient β_6 is of particular interest. Table 5 shows the results of the basic regression of our gravity model. More specifically, columns (1) to (5) show ordinary OLS regressions, whereas in column (6) we add country fixed effects to the model to control for the multilateral resistance terms. The gravity specific variables are then dropped from the model, as they are captured by the fixed effects. In total we have 1,573 observations after dropping zeroes, missing and negative values from our sample. Firstly, we note that our main variable of interest, *EU Member,* has a positive significant effect in all columns, ranging from 0.510 to 1.598. From column (4), for example, we derive that EU membership increases inward FDI flows by 80.2% ($e^{0.589}$ - 1 = 0.802). This ATE increases in column (6) when we add fixed effects to 86.5% ($e^{0.623}$ - 1 = 0.865). We project this to be the loss to the UK if Brexit happens.

The magnitude of EU membership's effect on FDI flows is greater than what we found in existing literature. Section 3.1 namely shows us, for example, that Bruno et al. (2016) and Campos and Coricelli (2015) find an effect ranging between 25-30%, whereas Welfens and Baier (2018) find that EU membership increases FDI flows by 62%. This relatively large difference might come from the usage of a different dataset. Other studies use all bilateral FDI flows between the OECD countries, whereas this study chose to limit the number of host countries to five. Moreover, there is the issue of selection bias. Countries tend to self-select into FTAs for several reasons (e.g. tariff-

free trade, lower transaction costs, low regulatory barriers), causing the coefficient of *EU Member* to be biased. Both of these reasons make it possible that we *overestimated* the true effect.

In addition, we run a regression of the logarithm of FDI on *GDP Host* in order to convert the previous finding into an estimation of the expected GDP loss. We find a significant coefficient of 0.055, implying that a 1% increase of FDI leads to a 0.055% increase in GDP. Inserting our finding of 86.5% here, we can show that such an increase raises GDP in the host country with 4.758% (86.5*0.055 = 4.758) due to EU membership. That is why we estimate this to be the loss of GDP when one leaves the EU, as is the case with Brexit. Comparing this result to the main one found in Section 3.2 (-3.4% by Dhingra et al. (2016)), we find a greater loss of 1.358%, which we believe is either due to usage of a different dataset or because of the strong assumption Dhingra et al. (2016) made to reach their conclusion.

Furthermore, we find a positive significant effect for *GDP Host* and negative significant for *GDP Partner*. Taking a closer look at the first, we see that if GDP of the host country increases by 1%, then FDI flows increases by 4.14%.

GDP per capita shows the opposite signs and significances as aggregate GDP. This time, we look more closely to GDP per capita in the partner country. This variable shows a coefficient of 0.714, meaning that a 1% increase in GDP per capita in the partner country leads to 0.714% increase in inward FDI flows. The change in sign can be explained by the fact that if the partner country becomes wealthier, inhabitants of the partner country have more money to invest and they will possibly do this abroad.

Next, the interest rate shows the, as in Section 5.1 expected, positive significant coefficient. We find a coefficient of 0.967, which implies that central banks in the host countries highly influence the incoming FDI flows by their setting of the interest rate.

Moreover, just as in Bruno et al. (2016), the export and import share have a significant negative and positive effect respectively. The first shows a coefficient of -0.062, meaning that if the export share in the host country increases by 1 percentage point, then inward FDI decreases by 6.2%. The latter shows a coefficient of 0.0752, which implies that a 1 percentage point increase in the import share increases inward FDI flows by 7.52%.

6.2 Robustness checks

This section tests the robustness of the results found in Section 6.1. Firstly, it does so by testing whether the model is subject to stationarity and/or heteroscedasticity. The tests we use, respectively, are the Levin-Lin-Chu test and the Breusch-Pagan test. The first points out that the model is stationary and therefore no corrections need to be made. However, the latter shows that the model is subject to heteroscedasticity. That is why we use robust standard errors in this section.

Next, we add lags of EU membership on FDI flows to the model. This is done as it might take some years for an FTA to phase in. Therefore, it is plausible that lagged EU membership has a significant effect on current FDI flows. The results are depicted in Table 6, which tells that up to two lags does not show any significant effect, making it difficult to interpret these coefficients. We experimented up to ten lags, but none of the lags showed any significant effect, which could be because almost all European countries were already in the EU when our sample started. That is why little variation is to be measured. Adding one lag, though, increases the ATE of $EU_{ij,t}$ to 96.2% ($e^{0.674} - 1 = 0.962$), implying EU membership would almost double inward FDI flows. Furthermore, the coefficients of the control variables do not change much and that is why the interpretation remains as in Section 6.1.

Moreover, we follow the example of Baier and Bergstrand (2007) to test for strict exogeneity (i.e. no reverse causality) by adding a future level of EU membership ($EU_{ij,t+1}$) to the regression equation. Before, we found significant ATEs for EU membership, however to determine if there are no 'feedback effects' from FDI changes to FTA changes, we run this final regression. FTA changes are strictly exogenous to FDI changes if $EU_{ij,t+1}$ is uncorrelated with the current FDI flows. Table 6 shows this is the case, as we find a statistically insignificant result for $EU_{ij,t+1}$.

However, a note about the R^2 of the model has to be made, as it is only 0.170 in our model with fixed effects. Therefore, there is still much unobserved heterogeneity present in this model, a problem also encountered by Baier and Bergstrand (2004). That is why future research should include more FDI determinants to raise the R^2 and lower the unobserved heterogeneity (see e.g. Blonigen (2005); Eicher et al. (2012); Ramasamy and Yeung (2010)).

Table 5: Basic regression

VARIABLES	(1) (ln) FDI	(2) (ln) FDI	(3) (ln) FDI	(4) (ln) FDI	(5) (ln) FDI	(6) (ln) FDI
EU Member$_{ij,t}$	1.598***	0.592***	0.579***	0.589***	0.510***	0.623***
	(0.170)	(0.172)	(0.171)	(0.171)	(0.180)	(0.205)
(ln) GDP Host		1.262***	1.379***	1.350***	1.474***	4.140*
		(0.225)	(0.224)	(0.265)	(0.266)	(2.472)
(ln) GDP Partner		-0.0457**	-0.0468***	-0.0472***	-0.0507***	-0.0238
		(0.0182)	(0.0180)	(0.0181)	(0.0180)	(0.0182)
(ln) GDP per capita - Host		-1.349***	-1.309***	-1.384***	-1.370***	-3.218
		(0.362)	(0.359)	(0.424)	(0.424)	(2.474)
(ln) GDP per capita - Partner		1.583***	1.728***	1.723***	1.607***	0.714***
		(0.151)	(0.153)	(0.155)	(0.155)	(0.274)
Interest Rate			0.122***	0.117***	0.114***	0.0967***
			(0.0245)	(0.0248)	(0.0248)	(0.0288)
Export Share				-0.0422	-0.0388	-0.0620**
				(0.0269)	(0.0269)	(0.0312)
Import Share				0.0504	0.0482	0.0752*
				(0.0365)	(0.0365)	(0.0389)
Colony					0.657	
					(0.949)	
Common Language					1.416***	
					(0.456)	
Distance					-8.91e-05***	
					(3.09e-05)	
Constant	4.617***	-31.69***	-37.27***	-35.81***	-38.02***	-87.34**
	(0.217)	(4.067)	(4.191)	(4.686)	(4.700)	(44.38)
Observations	1,573	1,573	1,573	1,573	1,573	1,573
R-squared	0.006	0.501	0.506	0.501	0.530	0.170
COUNTRY FE	NO	NO	NO	NO	NO	YES
TIME FE	NO	NO	NO	NO	NO	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Robustness checks

VARIABLES	(1) (ln) FDI	(2) (ln) FDI	(3) (ln) FDI	(4) (ln) FDI
EU Member$_{ij,t}$	0.623**	0.674**	0.569**	0.502*
	(0.304)	(0.319)	(0.322)	(0.349)
EU Member$_{ij,t-1}$		-0.0656	0.0867	0.0850
		(0.177)	(0.181)	(0.181)
EU Member$_{ij,t-2}$			-0.179	-0.163
			(0.159)	(0.160)
EU Member$_{ij,t+1}$				0.169
				(0.204)
(ln) GDP Host	4.140*	4.116	4.062	4.405*
	(2.496)	(2.495)	(2.511)	(2.521)
(ln) GDP Partner	-0.0238	-0.0232	-0.0219	-0.0206
	(0.0224)	(0.0226)	(0.0228)	(0.0225)
(ln) GDP per capita - Host	-3.218	-3.215	-3.204	-3.523
	(2.544)	(2.545)	(2.552)	(2.550)
(ln) GDP per capita - Partner	0.714**	0.728**	0.762**	0.706**
	(0.306)	(0.314)	(0.322)	(0.334)
Interest Rate	0.0967***	0.0972***	0.0979***	0.0984***
	(0.0328)	(0.0329)	(0.0328)	(0.0328)
Export Share	-0.0620	-0.0630*	-0.0636*	-0.0621
	(0.0376)	(0.0376)	(0.0376)	(0.0376)
Import Share	0.0752*	0.0771*	0.0787*	0.0800*
	(0.0416)	(0.0414)	(0.0416)	(0.0415)
Constant	-87.34*	-86.86*	-85.80*	-91.90**
	(44.55)	(44.53)	(44.82)	(45.02)
Observations	1,573	1,573	1,572	1,571
R-squared	0.170	0.170	0.170	0.171
Year FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

7. Concluding Remarks

This section concludes this paper by summing up the findings from Section 6. Next, the limitations of this study are presented. Finally, policy recommendations are made.

7.1 Conclusion

The purpose of this paper has been to quantify the impact of Brexit on FDI flows to the UK using the gravity equation developed by Tinbergen (1962). It did so by creating a dummy variable representing EU membership, which equals 1 if both host and partner country are a member of the EU, and vice versa. The dataset used covers 13 years and 34 partner countries. In Section 6, we find that being a member of the EU raises inward FDI flows by 86.5%. Therefore, we also project this to be the loss to the UK if Brexit happens. Next, we conducted some robustness checks and find that the effect of current EU membership increases to 96.2% when adding one lag of this variable to the model. However, as we use a dataset that covers only five host countries instead of all OECD countries, we believe there remains some omitted variable bias present in the model. That is why we advise caution with extrapolating these results.

7.2 Limitations

Although this master's thesis tried to cover as an extensive model as possible, this paper is subject to some limitations. First, no dynamic effects are incorporated in the model. Instead, a static model is run, which could miss out on some important effects. Therefore, future research should include some dynamics by for example adding expectations about future returns. Furthermore, the effects of Brexit on welfare could be included in the model to see how it affects the average citizen in the UK.

Second, the dataset could be extended to get more accurate estimations. For example, some of the largest suppliers of FDI, China, India and Russia, are not incorporated in this dataset and this might bias the results. However, data limitations might occur when extending the dataset, especially in databases available to students. Moreover, this could be done by extending the time period or adding more control variables to the model.

Third, the gravity model did not encounter any risk diversification, which is an important concept regarding investments, an argument also pointed out by Anderson (2010). Future research could include this risk diversification, however this was beyond the scope of this research.

Fourth, as many endogeneity issues as possible are corrected for. However, it might still be possible that our estimation is biased to some extent, as the model could be subject to measurement errors or omitted variable bias. Furthermore, future research could create an instrumental variable to encounter possible reverse causality.

Finally, one could run bilateral FDI flows of other countries to create a valid control group. For instance, it could be interesting to investigate the difference in impact of NAFTA versus the EU. Though, the focus of this paper is to estimate the added value of EU membership alone.

7.3 Policy recommendations

Whether Brexit is a wise decision by the Brits, is yet to be seen in some years from now. First, all British parties have to agree on what kind of Brexit they want (i.e. Soft Brexit or Hard Brexit), as they need to form a united block in the negotiations with the EU. Next, the UK's government has to start looking for new funding as it is important they replace the EU's funding with new public or private funders. Moreover, the government has to reduce uncertainty in the British market and protect its citizens, mainly the ones located within the EU.

Furthermore, as Section 6 shows us, the interest rate plays a significant role in attracting foreign investment. A higher interest rate means higher returns, making the central banks play an important role in obtaining new funds. Therefore, close collaboration between the Bank of England and the government is needed.

Finally, the EU needs to negotiate a soft Irish border to avoid a conflict in that area. Thereby, it also has to cope with many migrants moving from the UK to the European mainland as many institutions will replace their headquarters to the EU.

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Appendix

Key aspects from the agreement in Brussels

- The transitional period will last from Brexit day on 29 March 2019 to 31 December 2020.

- EU citizens arriving in the UK between these two dates will enjoy the same rights and guarantees as those who arrive before Brexit. The same will apply to UK-expats on the continent.

- The UK will be able to negotiate, sign and ratify its own trade deals during the transition period.

- The UK will still be party to existing EU trade deals with other countries.

- The UK's share of fishing catch will be guaranteed during transition but UK will effectively remain part of the Common Fisheries Policy, yet without a direct say in its rules, until the end of 2020.

- Northern Ireland will effectively stay in parts of the single market and the customs union in the absence of other solutions to avoid a hard border with the Republic of Ireland.

Appendix 1: The key aspects of the agreement reached in Brussels concerning the transition period.
Source: BBC (2018)