A Gravity Approach to Regional and Global Investment Dynamics: Theory and Empirical Findings

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1 Introduction

1.1 Motivation

Economic integration and globalization can be viewed as a historic development of multinational companies. Firms' profit-seeking in free market economies naturally leads them to acquire better and cheaper input factors, optimizing international production chains and technologies, and to supply the market wherever it yields adequate gains. The reduction in terms of market barriers over the past decades and indeed centuries thus increasingly stimulates companies to consider broader factor markets (resources, intermediates, human capital, machinery and equipment) and production technologies, while additionally fostering industries via spillover effects. The targeting of individual market preferences in various countries, the reduction of transportation costs, the acquisition of strategic complementary assets abroad, the spreading of risk – companies have many reasons and motivations to invest abroad. A thorough examination of the history of multinational companies (MNCs) and thus foreign direct investments (FDI) would be an historical, theoretical and even philosophical corpus of work in its own right, as shown, for example, by economic historians such as Godley (1999) or Jones (2006). Such a wide-ranging, explorative study is not, however, central to the present dissertation. While reference is made to historic and political developments which motivated the empirical analyses herein with sound theoretical and econometric bases which have evolved over the past number of decades up until today, the intention of the author is – with the subsequent three essays which all relate to current, state-of-the-art research – to contribute to theoretical and empirical FDI economics by extending existing knowledge, introducing new aspects and data and discussing the results in the context of studies reviewed.

In the modern world of the early 21st century, one could go as far as to consider FDI a "cultural phenomenon": There is little doubt that we, the human population of the early 21st century, produce and consume globally, not on a national level. With this in mind, one could ask why every firm does not become a multinational, and why are there countries which are more attractive than their neighbors when it comes to firms' decision on where to invest? What are the drivers – and restraints –

for FDI and how important a role do they play? How do those and other relevant factors change over time (e.g., political and economic developments, shocks), and what future scenarios can be constructed and comparative analyses provided by economists in order to provide reliable policy advice? These are the key questions with which the research conducted here is concerned. With BREXIT, there is a unique political shock in Europe that allows the application of insights from advanced FDI gravity modelling; this empirical methodology can also be used in other ways in order to better understand the role of countries' membership in international organizations for FDI dynamics. The role of multinational companies, which has increased worldwide since the 1980s, needs to be analyzed in new ways in order to better understand globalization dynamics and to adjust policy patterns in an adequate way.

1.2 Theory and Models

FDI, as the central topic of this work, can be motivated by various aspects. It has fueled an unprecedented rise in the level of economic globalization in the 21st century, in terms of trade and migration, but most persistently in terms of production networks, supply chains and international financial and institutional integration. The perceived need to stabilize political economies in the post-World War 2 setting and to provide a sound basis for lasting peace in Europe were crucial reasons behind FDI in the past, as was the aim to demonstrate the superiority of the free market economy and capitalism over socialism, a rather philosophical question as well, which does not exclude the existence of multinationals in the former USSR, or its satellite states, or in today's China, where companies are, however, closely related to the state, which brings a whole new aspect to the geostrategic reasoning for FDI. While these are interesting economic questions, the emphasis of this dissertation rather focuses on free market economy FDI, where profit maximization and the pursuit of national and global wealth are driving factors, which leads an increasing number of companies (or fraction of the total economy, considering economies of scale and monopolistic interdependencies) to cross borders in search of new opportunities.

In a dissertation about FDI, one cannot early enough cite Dunning's (1979) eclectic paradigm, also known as the OLI (Ownership, Location, Internalization) model, which is however only part of the picture of modern FDI theory. Factor endowment and specialization models á la Heckscher-Ohlin knowledge-capital models are also applied to explain mainly vertical FDI (supply chain optimization), even though risk diversification and production-to-market play an important role in horizontal FDI (companies in a given sector expand abroad in the same sector and level of value activity as in the source country; there is a comparable production process in a variety of similar countries). Market size and market characteristics, transportation and factor costs, political cost-benefit, infrastructure, legal considerations and conflict are further factors being included in several theoretical models more recently (see, e.g., Bloningen 2005; Faeth 2009; Pandya 2016, Nielsen et al. 2017 to name but a few). According to those literature reviews, market growth and relative market size are essential components of modern FDI theory, alongside technological and political variables.

While each chapter in the present dissertation places a focus on related but distinct papers, each with a deeper theoretical foundation, the author subsequently introduces the motivation for gravity modelling in FDI which was utilized in all three papers and which fits modern FDI theory, horizontal and vertical, very well. Gravity models for economics and more specifically for trade theory trace their origin and derive their name from Isaac Newton's Law of Gravitation, whereby export streams are directly proportional to the exporting and importing countries' economic size (usually measured in terms of Gross Domestic Product (GDP)) and inversely proportional to the distance between the trading partners (see also Shepherd 2016). Using GDP figures and distance between trade partners – a proxy for trading costs – as explanatory variables for trade has been found to be a rather practically driven approach, as such models have exhibited very high explanatory power (Tinbergen 1962). The lack of a sound micro-foundation for trade has been successfully tackled by the influential paper of Anderson and Van Wincoop (2003). In the field of Economics, gravity models have not only been utilized for trade analysis in the last decades, but are of increasing importance to FDI researchers as

well, for which a micro-foundation is provided by Anderson et al. (2017).[1] The econometric application for trade gravity and FDI gravity is found to be very similar as is discussed in the subsequent papers; in general, the author widely follows the analytical framework and structures established by Shepherd (2017) who compiles and regularly updates a user guide for UN-ESCAP (Economic and Social Commission for Asia and the Pacific) researchers in international economics, discussing and extending this rather intuitive gravity setting with important econometric and economic contributions. The inclusion of country fixed effects by Anderson (2011) and Head and Mayer (2014) and the adaption of Poisson Pseudo Maximum Likelihood (PPML) estimators in log linearized form for panel data by Baldwin and Taglioni (2007), Martínez-Zarzoso (2011) and Silva and Tenreyro (2006 and 2011) are major milestones, whereby Silva is still very active in supervising and discussing econometric approaches to the 'ppml-command' in Stata. Econometricians like Kareem et al. (2016) and Stammann, Heiß and McFadden (2016, 2018) tackle application issues coming up with the more advanced dyadic fixed gravity in PPML, which is introduced for FDI by Bruno et al. (2016) in order to analyze BREXIT effects on global FDI dynamics, models which Welfens and Baier (2018; chapter 2) largely adapt for similar research interests, discussing a different approach to treating negatives, zeroes and non-value observations in a dyadic fixed panel PPML setting. While similar econometric models are also chosen for the FDI research in chapter 4, the author deviates in chapter 3, utilizing instead micro-founded data on foreign assets and liabilities in the banking and industrial sector from and into one country (UK) only in order to analyze country specific research questions.

1.3 Data

Writing a short passage about data in the introduction of a dissertation might seem odd, but in fact researchers working with FDI data face several difficulties which deserve an early critical handling in order to allow one to discuss and interpret the later empirical findings correctly. When it comes to bilateral FDI data, the kind of

[1] More recently, researchers began fitting gravity models to migration topics, however little research has been dedicated to this field so far and the literature basis here is rather narrow, compared to trade and investment.

data needed for gravitation models, we have *de facto* only two sources available up to this point: The United Nations Conference on Trade and Development (UNCTAD) provides bilateral FDI statistics for 206 economies (basically all nations and aggregated economic areas) for the years 2001-2012, while the Organization for Economic Co-operation and Development (OECD) provides FDI in- and outflow (and stock) to and from all OECD countries from 1985-2017, however they have a break in their data collection methodology in 2013 since when countries are asked to split their reports into Special Purpose Entities (SPE) and non-SPEs, where an SPE is defined as an entity with little or no physical presence in the respective country. Sanity checks of these data show, however, that most countries do not (fully) implement these guidelines and still report only total entities without disaggregating. Combining two datasets which are compiled with two different benchmark definitions (BMD3 and BMD4) is therefore possible and yields a new bilateral FDI dataset 1985-2017 which has not been used by many researchers up to this point, as BMD4 data was just recently released. This explains why almost all previous FDI gravity studies use data only up to 2012[2], as do Welfens and Baier (2018) in chapter 2.

Collecting FDI as macro data, as opposed to utilizing micro-founded databanks such as the Micro-Databank of Direct Investment (MiDi) of the German Bundesbank, or one step further the Bank for International Settlements (BIS) which collects global data from national central banks, additionally and necessarily entails dealing with further issues, such as a lack of quality, deviations in data-gathering standards, splits into sectors etc. While these concerns are discussed in each of the respective chapters, it is to be noted at this point that OECD data is found to be more adequate for empirical econometric gravitation analyses than UNCTAD data, with the result that conducting global studies, including all or most world economies, is an ambitious undertaking. When interpreting results it therefore has to be considered if they hold for OECD countries only or whether qualitative discussion can extend findings to OECD outsider countries. Treating and interpreting the coefficients of cutting-edge findings should be done with care for FDI studies,

[2] In fact, the OECD BMD3 datasets provide columns for 2013 observations as well, but yields no reports for this year for almost all countries.

compared to doing so with the results of more 'tradition' trade gravity studies, which are usually based on a more reliable data basis due to different and standardized data collection methods via tariff tracking and thus more straightforward to interpret. The reasoning on data selection is discussed more extensively in the respective chapters.

1.4 Overview

In the following, a brief summary of the studies discussed in the underlying dissertation is given. Each chapter is an autonomous paper and treats several aspects of FDI and gravity models. Chapters 2 and 3 are co-authored papers, while chapter 4 is based on a single-authored paper. Figure 1.1. illustrates how all chapters and papers are linked with each other; while the models deviate in chapter 3 via the utilization of an event methodology with gravity controls, chapters 2 and 4 employ gravity models. All papers analyze international organizations and globalization aspects (in chapters 2 and 3, the European Union (EU); in chapter 4, certain international financial organizations), while chapters 2 and chapter 4 include corporate taxation aspects.

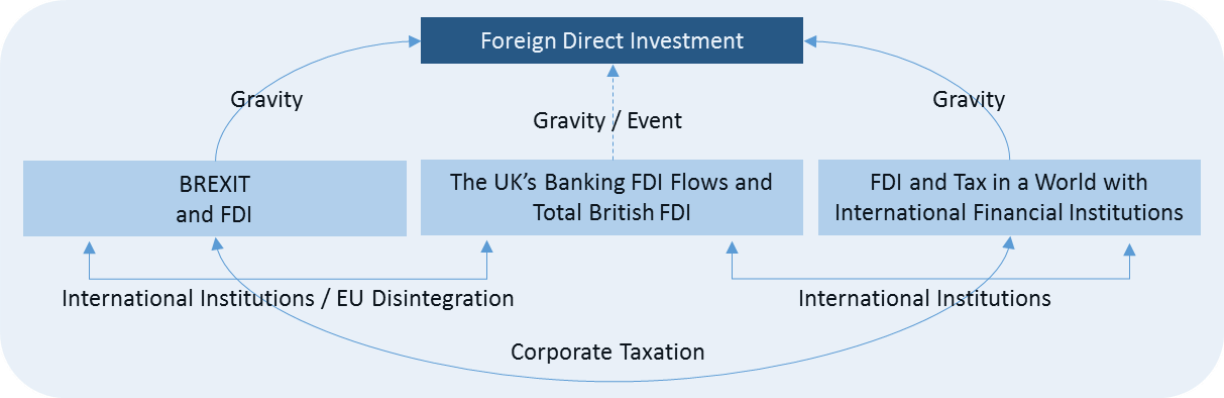

Figure 1.1. Topical and methodological linkages between the chapters.

Chapter 2: BREXIT and FDI

Chapter 2 is based on a paper titled "BREXIT and Foreign Direct Investment: Key Issues and New Empirical Findings," co-authored with Paul Welfens as first author, and is an *MDPI* publication in the *International Journal of Financial Studies* (April 2018, Vol. 6, Issue 2).

The paper is motivated by the BREXIT vote – the majority in favor of the United Kingdom (UK) leaving the EU in a referendum which took place on June 23, 2016, and the UK's envisaged subsequent departure – and designed to analyze and discuss potential international economic interdependence in the field of FDI, where gravity models are found to be an adequate econometric tool in order to consider the "value" of EU membership for FDI attractiveness. The model is based on a BREXIT FDI analysis by Bruno et al. (2016) who utilize dyadic fixed effects, i.e. a set of dummies for each possible country-pair, in order to measure the effect of an EU membership dummy which switches to 1 when a country entered the EU. While the assumption that the value of entering the EU equals the loss of quitting EU membership cannot be taken for granted, we stick with the same assumption, as a member country leaving the EU has not occurred up to this point and therefore we lack a point of reference and experience in such case. Bruno et al. (2016) therefore adapt the concept of previous EU-FDI gravity studies by Straathof et al. (2008) and Fournier et al. (2015), using, however, more adequate PPML estimators instead of OLS (see Kareem et al., 2016, for a discussion of 16 commonly utilized estimation methodologies for gravity studies). In our paper, we also employ the same methodology of dyadic fixed PPML estimators, however we set negative FDI values (about 10% of our total observations) to zero instead of deleting them, as we argue that deleting values results in a higher bias on results. We also decide to drop missing values instead of assigning zeroes due to data sanity checks (see the discussion of data quality above). In the course of our research, we additionally find the need to control for national average corporate tax levels and tax haven countries, real annual exchange rates to the US Dollar (USD), trade openness and the ratio of inward FDI stock to total capital stock, whereas the latter is annually lagged in order to prevent an endogeneity impact of large annual FDI flow on stock.

On top of controlling for pure EU membership, we also control for EU single market participation.

Our findings for EU membership and EU single market participation show that exiting leads to a roughly -35% fall in FDI inflow in the long run, a number which is slightly below those of previous studies. BREXIT will therefore present three impulses for FDI inflows: (1) leaving the EU single market will strongly reduce FDI inflows; (2) foreign ownership of the UK capital stock should strongly increase in the run-up to the (expected) BREXIT year 2019, part of the dampening effects of leaving the EU will be mitigated by the increase of the FDI stock / capital stock ratio, which in turn is likely to reflect a Froot-Stein effect related to the real Pound depreciation for 2016-2018; (3) to the extent that the UK government will want to reinforce output growth through higher FDI inflows, a reduction of corporate taxation could generate significant effects but could also stimulate a downward international tax reduction game. International tax competition can be useful for promoting economic policy reforms on the one hand, on the other hand excessive tax competition could bring political and social unrest if the provision of public infrastructure and public services becomes insufficient once many countries' governments have insufficient funding to finance these key activities.

Chapter 3: The UK's Banking FDI Flows and Total British FDI

Chapter 3 presents the paper "The UK's Banking FDI Flows and Total British FDI: a Dynamic BREXIT Analysis," with Paul Welfens as second author, and is a *Springer* publication in the journal *International Economics and Economic Policy* (January 2019, Vol. 16, Issue 1).

This paper investigates the investment decisions of foreign banks in the UK pre- and post-BREXIT referendum as well as the investment decisions of UK banks in the world (differentiation between EU and non-EU countries). We distinguish between investments in the banking sector and the non-banking sector, as with BREXIT the "single passport" rule for banks will end, which now (pre-BREXIT) still allows international banks in the UK to serve the whole EU28 market from London,

therefore lower FDI inflows in the UK banking sector as well as higher FDI outflows into rest-of-world banking sectors are expected; inflow dynamics should also be shaped by international merger and acquisition (M&A) dynamics influenced by the real Pound depreciation beginning 2016, while the prospects of reduced EU market access post-BREXIT also becomes more relevant for reducing FDI.

Due to the lack of sectoral bilateral FDI data, bilateral locational banking statistics provided by the Bank for International Settlements (BIS) are utilized for one-target gravity models / event studies where the BREXIT-vote dummy switches in Q3 2016, with the typical gravity model control variables. The idea of using locational banking statistics for gravity models come from Head and Mayer (2014) and Brei and Von Peter (2017), just to name the most popular authors amongst others. Data is available on a quarterly basis from 1977-2018, collected from national banks' balance sheets. Due to the largely incomplete balance sheets published by the Bank of England, the authors assemble a unique dataset by merging partner countries' positions in the UK and vice versa. Those assets and liabilities include indebtedness certificates, bonds and securities, investment asset pools, special purpose entities used for the purpose of asset securitization, firm derivatives, banknotes and coins (where the latter stand for a negligible amount only). As data embraces portfolio investment plus direct investments, hypotheses are drawn from the classical FDI literature on EU membership, investment incentives and monetary devaluation / exchange rates, resulting in a model where EU membership, Eurozone membership and exchange rates to USD are used as explanatory variables on inward and outward investment, controlling for financial crises and country fixed effects.

Results show that investments in the UK banking sector decrease after the BREXIT vote, while investments in the UK industry sector increase; when controlling for the Pound depreciation, the positive investment effect in industry loses significance and the total investment effect becomes negative and significant, supporting the theoretical model of Barrell and Pain (1997) where monetary depreciation leads to increasing brownfield investment. Decreasing greenfield and increasing brownfield investments can also be descriptively observed. Investments of UK banks in the EU

and the world do not significantly change up to the end of 2018, in neither the banking sector nor in the industry sector.

Chapter 4: Foreign Direct Investment and Tax in a World with International Financial Institutions

Chapter 4 is based on the paper titled "Foreign Direct Investment and Tax: OECD Gravity Modelling in a World with International Financial Institutions" where the author of the underlying dissertation holds single authorship. The paper is currently under double peer blind review for the *Athens Institute for Education and Research* conference paper series. An earlier version is also available as EIIW discussion paper (Baier 2019).

In this paper, bilateral OECD FDI flow data from 1985-2017 is evaluated and compiled to create a new dataset in order to clarify the controversial (in the literature) role of corporate tax levels on firms' decisions regarding whether or not, and where, to undertake investments. In the course of the research, the need is found to control for interaction with international financial institutions: Membership in the Bank for International Settlements (BIS), the European Bank for Reconstruction and Development (EBRD), the Asian Development Bank (ABD) and the Multilateral Investment Guarantee Agency (MIGA). Quantitative analyses via country and dyadic fixed gravity models firstly provide findings which are consistent with previous studies, and secondly push further in order to expand the knowledge about FDI and tax. Utilizing a new bilateral FDI dataset, current state-of-the-art econometric modelling and the inclusion of financial globalization and data exchange as important aspects for tax gravity modelling, new results relevant for policymakers are provided. It is shown that falling corporate tax rate levels lead to increasing FDI inflows, the effect is, however, smaller than expected and reported by many previous researchers. Various reasons besides the utilization of a broader time frame for panel data are discussed, including double taxation treaties (employing either the credit or exemption system), regional differences in international taxation (an OECD data bias), data availability and access

(micro/macro data collection and data quality), discrete and continuous firm investment choices (amplitudes in annual data) and even a publication bias in the literature (higher tax effects on FDI are more likely to get published). An additional econometric finding indicates that FDI gravity models do not really deviate in their results whether they implement country or dyadic fixed effects, which is important for researchers as dyadic fixed effects settings are in some cases difficult to implement.[3] According to the author's knowledge, this has not been discussed thus far elsewhere in the literature.

The results yielded show that if deviation from international cooperation (financial institutions as proxy) is chosen as a national strategy (i.e., unilateralism), the tax rate, however, gains in importance. On the other hand, unilateralism triggers various effects decreasing FDI inflows, as trade openness – a variable which is highly positive significant with FDI inflow – is likely to decrease, the opportunity costs for other nations to deviate decrease, and therefore bilateral tax differences are likely to decrease as well; which will further reduce the effect of low tax levels. Clear evidence for the phenomenon of implementing low corporate tax levels in order to keep domestic firms within the country and reduce their incentives to invest abroad is not found. Individual multinational firms with rational expectations anticipating parallel tax policy reactions within the OECD will have limited incentives to switch from currently preferred host countries to new alternative locations.

In a world economy with rising global FDI, the insights obtained in the subsequent analysis should be useful not only for policymakers, but also towards stimulating further research. As FDI typically plays an important role for international technology transfer – often via intra-company knowledge transfer within MNCs (e.g., between the parent company and certain subsidiaries abroad; tacit knowledge transfer often also plays an important role) – comprehensive FDI analysis could bring considerable benefits for both OECD countries and Newly Industrialized Countries.

[3] Dyadic fixed effects models absorb all bilateral time non-varying characteristics between target and origin countries which might be in the interest of researchers.

2 BREXIT and Foreign Direct Investment: Key Issues and New Empirical Findings

2.1 Introduction

BREXIT will have considerable effects in OECD (Organization for Economic Co-operation and Development) financial markets in regard to capital flows, including foreign direct investment (FDI) dynamics. FDI, in addition to trade dynamics, is a key element of the economic linkages in Europe, North America, and Asia. Since multinational companies stand for firms with ownership-specific advantages (Dunning 1998), one may expect that FDI inflows also bring international technology transfers. In the case of greenfield investment, inflows also have a positive effect on capital accumulation (Blomström and Kokko 1998; Blomstrom et al. 2000; Herrmann and Lipsey 2003). With BREXIT – the envisaged leaving of the EU by the United Kingdom – the economic links between the United Kingdom and the EU/EEA will be weakened (HM Government 2016; Welfens 2017a), as reduced future British access to the EU single market will be part of a new regime for the UK and the EU27 (all EU-members except UK). Depending on sectoral free-trade agreements yet to be negotiated, there could be at least partial free trade between the UK and the EU27 after 2019, the actual exit year, which raises a question about the role of trade openness as well as the role of FDI dynamics. In addition, the impact of the EU membership/EU single-market membership is not clear and equal for all its members in terms of trade and FDI. If the EU-UK negotiations would lead to a "soft" BREXIT, namely continued membership of the UK in the EU Customs Union (CU) or a set of wider sectoral agreements on trade and FDI liberalization, the negative effects of BREXIT on British inward FDI would be mitigated, as we show in our study.

This holds since existing EU production networks of British firms could largely be maintained. Without single-market membership, rules of origin will become relevant post-BREXIT for UK firms. To the extent that UK production becomes less attractive after 2019, negative FDI inflow effects and increasing outflows are to be expected. Regarding BREXIT-related survey results on FDI, the findings of EY (2018) from spring 2018 among 440 foreign investors in the UK (big multinational companies) clearly indicate that over a time period of three years, many firms from Asia and the EU – less so from the US – are considering divestment in the UK post-

BREXIT. There is some sectoral variation, namely, 16% of chemical/pharmaceutical businesses, 16% of financial services, and 14% of business services companies anticipate moving facilities in the next three years. This is considerable when compared to only 4% of manufacturers. In the long run, about 50% of foreign investors in the UK are considering relocating part of their assets internationally, which implies that FDI gravity modelling (empirical macroeconomic models which analyze global trade and FDI linkages on a bilateral basis) could be useful for understanding BREXIT-related adjustment. This does not mean to overlook that some new changes in the circumstances in which BREXIT takes place cannot be considered in the subsequent empirical analysis of the paper.

In its February 2018 inflation forecast, the UK's central bank reported the findings of its Decision-Maker Panel (DMP) Survey, showing that firms which rank BREXIT among their top three sources of uncertainty have reduced investment spending in 2017 H1 (Bank of England 2018). The more than 2000 companies in the DMP Survey could be split into firms with controlling foreign ownership and firms with dominant domestic ownership, but so far the Bank of England has not made the split sample data available, data which would be quite useful for the group of strong goods exporters, most of them with EU27 destinations. It is noteworthy that from a theoretical perspective, lower British FDI inflows relative to GDP will put pressure on the Bank of England to raise interest rates in nominal and real terms unless net exports of goods should increase relative to GDP, which, however, is unlikely in the medium term since the EU-related trade-diversion effects of BREXIT for the UK should be considerable – again under the assumption of no Customs Union membership. Hence, FDI flow dynamics will have an indirect impact on international portfolio flow dynamics.

The relevance of FDI inflows for BREXIT dynamics is rather strong because a key part of the debate about the referendum refers to the question of GDP losses (e.g., HM Government 2016; Erken 2017) or real GNI (Gross National Income) losses (Welfens 2017b). The forecast revisions of the Office for Budget Responsibility already suggest, comparing the November 2017 forecast up to 2020 with the figures of the November 2015 forecast, that overall investment in 2016 – 2020 is reduced by

about 30% and output for 2020 by almost 5%. Since the share of foreign ownership in the UK in 2016 was 17%, part of the reduced investment and output dynamics will be related to foreign investors. It is noteworthy that, for example, the US subsidiaries in the UK alone stood for about 7% of UK output in 2014.

The gravity equation estimated subsequently allows one to consider the case of BREXIT and the broader role of EU membership. Looking at the period from 1985 to 2013 for a dataset which contains 34 OECD countries, Pseudo Poisson Maximum Likelihood (PPML) dyadic fixed estimations take into account a broad set of approaches and variables. Besides the traditional variables of the EU/EU single-market membership of the source country and of the host country, we further consider the role of trade openness as well as corporate tax rates and the ratio of inward FDI stock to total capital stock, as those variables have a very special impact on the UK economy, as described in Section 3. The analysis shows that trade openness is a variable which can be largely replaced by the inward FDI stock/capital stock ratio so that gravity FDI modelling with a strong emphasis on trade openness is likely to overstate the role of trade and to understate the role of relative FDI accumulation effects. While the corporate tax level is indeed important, we do not find a significant impact of real exchange rates.

The following analysis highlights the relevant literature in Section 2 and evaluates available data and methodology in Section 3. Empirical results are presented and interpreted in Section 4. The final section looks into policy conclusions and prospects for future research.

2.2 Literature Review

2.2.1 Selected BREXIT FDI Aspects

It is useful to emphasize that the Treasury's study (HM Government 2016) on the long-run benefits of British EU membership – or, in a mirror perspective, the cost of BREXIT – has suggested that the UK could witness a 10% real income loss in the long run. The analytical focus of the Treasury reports is primarily on trade and only partly on FDI when modelling the key economic effects of reduced future British access to

the EU single market. It is not fully clear what higher FDI barriers imposed on the UK by the EU27 after March 2019 could mean, but clearly there would be serious economic effects that could already be gauged by referring to the study of Francois et al. (2013) on the economic effects of a Transatlantic Trade and Investment Partnership (TTIP) on the EU28 (all EU-member countries) or the study by McGrattan and Waddle (2017) estimating the effect of BREXIT on FDI and production structure. Basically, in Chapter 6 of that study, the authors present some FDI gravity modelling and consider the scenario that the transatlantic barriers to trade would be reduced to the same level as the intra-EU FDI barriers, which are assumed to be a quarter lower than transatlantic FDI barriers. The result of a hypothetical elimination of the extra transatlantic barrier is more transatlantic FDI and an 11% employment increase in US subsidiaries in the EU28. One may add that BEA statistics show that US-cumulated FDI in the EU28 accounts for about 3% of gross domestic product. Based on the derived employment effects, one would naturally assume that the induced output expansion effects from reduced-FDI barriers would be 0.33% of GDP. In a mirror perspective, one may ask the question of how strongly EU27 barriers faced by UK firms would increase after March 2019 and how serious therefore real output reduction effects in the UK could be in the context of British FDI reduction in the EU – or, if there should be arguments for an expansion of British FDI in the EU, how large output and employment effects would be for the EU27.

Barrell and Pain (1997) have presented a multisector panel data analysis for UK outward FDI and German outward FDI which shows, as key drivers of FDI: the output of the host country; the technological strength – knowledge-based assets – in the form of the stock of patents registered in the US by domestic firms; the relative unit costs in the respective home country; country-specific and industry-specific indicators for labor relations – namely, the number of strikes in host countries; the exchange rate stability; and the ratio of interest payments relative to the cash-flows in the case of UK firms, which is an industry indicator for the EU single market as well as a services sector indicator for the EU single market, plus a financial indicator for firms. While the German model showed significant results for

business sector profitability and the growth of real equity prices, a tighter financial situation reduces outward FDI. Regarding the single market variables, both the industrial sector variable and the services sector variable showed a significant impact. The implications from the Barrell/Pain approach with respect to BREXIT are thus threefold for UK industrial outward FDI if one considers it rather likely that the UK's leaving of the EU will reduce profitability of UK firms, lead to higher exchange rate instability, and reduce British access to the EU single market:

- British FDI outflows will reduce in the EU and this should dampen knowledge accumulation in EU27 countries;
- Taking additionally into account the arguments of Froot and Stein (1991), British FDI outflows – with an emphasis on international M&As (Mergers and Acquisitions) – will particularly reduce to those EU27 countries where the real appreciation (a mirror of pound depreciation) is rather high. One may assume that the Eurozone's appreciation rate will be higher than that of other EU countries to the extent that BREXIT itself will create nervous markets for some time and thus could reinforce the role of Germany, France, the Netherlands, and Luxembourg as typical safe-haven countries in the Eurozone. Thus, one should consider real exchange rate effects and control for them in FDI gravity models, especially in the case of drastic policy changes such as BREXIT.

One may also argue that the real depreciation of the pound observed in 2016/2017 – about 14% in the year after the British EU referendum of 23 June 2016 – will, in line with the Froot and Stein (1991) argument, reinforce international M&As in the UK; at the same time, greenfield investment will reduce in the context of slower output growth. It should be emphasized that higher shares of foreign capital ownership in the UK – reflecting international M&As in the BREXIT context – imply that consumption growth will reduce since consumption is proportionate to gross national product, not to GDP. With a higher share of foreign capital ownership in the UK, dividend payments transferred abroad, as a share of British GDP, will increase and hence GNP growth will be smaller than GDP growth until a new steady

state is reached (Welfens 2017a, 2017b). We therefore note that the share of foreign capital ownership within a country highly matters for FDI inflow.

2.2.2 FDI Dynamics within the EU

Regarding EU countries, FDI should be expected to be affected by major institutional changes, such as the creation of the EU itself in 1957, major enlargement rounds (e.g., UK, Denmark, and Ireland joining the EU in 1973; and the EU's eastern enlargement in 2004), and the establishment of the EU single market. Free trade and foreign direct investment as well as free portfolio capital flows plus free migration are the four pillars of the EU single market created in 1993 – with free trade in goods already having been established in the period between 1957 and July 1968. To some extent, foreign direct investment and trade in goods and services could be substitutes, namely in the context of tariff jumping where foreign investors create subsidiaries abroad in order to bypass import tariffs. After 1993, this could be a relevant case only for investors from third countries. At the same time, one should not overlook that the elimination of FDI barriers in the EU single market gave incentives to create European production networks, a perspective that was reinforced by the two-stage EU eastern enlargement in 2004 and 2007.

In a single market, foreign direct investment and trade should be substitutes or complements for macroeconomic and structural reasons:

- To the extent that trade reinforces specialization and that, in turn, specialization gains raise factor productivity, there will be enhanced investment opportunities, particularly in those countries where technology-intensive Schumpeterian sector production has increased. Jungmittag and Welfens (2016) has shown in an empirical analysis for the EU15 (all EU-members previous 2004) that output in those EU countries which have achieved more high-technology specialization is raised through trade. According to the theory of asset-seeking foreign direct investment (e.g., Makino et al. 2002; Ivarsson and Jonsson 2003), such a specialization pattern will attract higher FDI inflows as foreign investors seek to acquire firms with

technological advantages that are complementary to the respective foreign firm's core research and production activities.

- The combination of regional free trade and free capital flows implies that there are particular opportunities for regional production networks in the EU. As offshoring (i.e., imports of intermediate products as intra-MNC (Multinational Companies) trade) and international/interregional (intra-EU) and regional outsourcing is reinforcing the international competitiveness of multinational firms, such firms, following the OLI (Ownership-, Location- and Internalization Advantages) approach of Dunning (Dunning 2001), should increase production abroad. In the case of EU countries, this implies that FDI outflows to third countries (e.g., to the US) should increase.
- As trade-related specialization gains raise per capita income, demand for differentiated products will increase and those products in turn stand for technology-intensive and knowledge-intensive goods that are typically produced by multinational companies. If the economic logic of production suggests that producers should have production in geographic proximity to markets (e.g., Raff and Von der Ruhr 2001), it is obvious that multinational production would expand in a way that enhances FDI. This points to a positive reciprocal link between trade and FDI.
- The single market enhances trade in intermediate products which will raise the productivity of internationalized firms in a way that will contribute to more exports as more productive firms can benefit through higher export shares (Melitz 2003). Hence, there is a reciprocal link between FDI and trade in this respect.
- Another reciprocal link between trade and FDI comes from the fact that FDI inflows go along with international technology transfer for the host country – and in the case of greenfield investment, with a higher capital stock in the host country – so that output and gross national income, respectively, are raised. Therefore, imports will be raised and, following the logic of the trade gravity model, both imports and exports would increase. Hence, trade will be raised as well so that there is a positive reciprocal link between FDI and trade.

Oligopolistic interdependence could also play a role (Knickerbocker 1973). If there is an oligopoly, there will be an interdependence reaction of leading firms. For example, if multinational companies from the US invest in the EU in certain sectors – say, in the pharmaceutical sector – EU firms could fight back and try to take over US pharmaceutical firms. If the relevant market is the EU, there could also be an intra-EU FDI intensification where, for example, German firms take over some firms in France, the UK, and Italy, which would induce counterattacks in the form of foreign FDI inflows from French, British, and Italian investors willing to invest in Germany. The implication of such EU interdependency would be that the EU single market is a strong driver of foreign direct investment inflows in the US. Tariff jumping could also play a role in the context of BREXIT – however, EU import tariffs outside agriculture are only about 3% (Lawless and Morgenroth 2016). A more serious aspect would have to be considered in the case of sectoral EU-UK FTAs since this brings rules of origin into play: a typical requirement would be, judging by the international FTAs of many OECD countries, that there is a 60% local content requirement imposed on the UK. British firms with established European production networks thus would have to close down some of the production facilities in EU27 countries, or British subsidiaries on the continent and in Ireland would be sold. UK firms might, however, also consider whether additional FDI outflows to EU countries could be useful in order to avoid costly regulatory costs — for example, in the case of pharmaceuticals.

2.2.3 Gravity FDI Flow/Stock Studies Targeting the EU

Membership in currency and policy unions and their effect on trade and FDI attractiveness historically find broad interest amongst researchers and policy makers, with the literature comprising thousands of studies. Therefore, we focus especially on FDI flows and stocks and the effect an EU membership can potentially have in order to anticipate the “worth” of a membership concerning FDIs. While it is important to look at this area as new data becomes available and variables of

interest change over time,[4] we take the forthcoming BREXIT as a reason to accurately analyze this topic further. In this regard, we use various methods and data and compare our results amongst each other as well as with previous studies, in an attempt to discern a clear-cut picture in the so far partly contradicting pattern.

The first important study using a modern EU FDI gravity model comes from Straathof et al. (2008), who analyze the internal market effect, more specifically, EU membership, on trade and FDI. Deviating from previous FDI studies which suggest that flow and stock depend on variables such as country size (GDP, population) and the distance between partners (see Straathof et al. 2008, pp. 51–52), they more specifically point to the gravity studies of Brenton et al. (1999) and Egger and Pfaffermayr (2004). Whilst the former authors create a single model for each country instead of a combined study, Egger and Pfaffermayer split EU integration into three separate phase models. The aim of Straathof et al. (2008) therefore was to close this gap and show the EU's effect on FDI in a combined model. They follow those two previous studies in using OECD FDI stock data instead of flow data, as they see those as presenting a "better proxy for the sales activities of foreign affiliates as a measure of the capital stock", (Straathof et al. 2008, p. 53). They use bilateral data of 30 OECD countries from 1981 to 2005 for their country-year fixed effect model, covering the 1986, 1995, and 2004 EU enlargements, noting that they struggle with data availability and bad data quality, particularly relating to the 1980s.[5] Their findings show that bilateral FDI within EU countries are 28% higher than between non-EU countries, and that EU countries attract 14% more FDI from EU-outsiders than non-EU countries.

Next, we take a closer look at the study by Fournier et al. (2015), who examine the EU single market effect with a gravity fixed effect (on country level) Pseudo Poisson Maximum Likelihood (PPML) model on trade and inward FDI. Their contribution to previous studies is to include product market regulation, employment protection, and trade intensity (i.e., the ratio of trade to GDP) to the analysis. Using OECD flow

[4] Some variables, such as distance, might lose importance with falling transport costs. Others, such as digitalization and innovation, gain due to globalization.

[5] Therefore, they ran two models, 1981–2005 and 1994–2004. They did not find significant differences.

data, their findings for the linear regression OLS (Ordinary Least Squares) method are a surplus of 57% if the target country is an EU member and a surplus of 48% if the origin country is an EU member. Findings for the favored PPML methodology are a surplus of 48% if the target country is an EU member and a surplus of 58% if origin country is an EU member. If both countries are EU members, no significant effect is found.

The study by Bruno et al. (2016) is the most advanced and precise study so far and therefore a good reference point for our study. They use bilateral FDI flow data of all 35 OECD countries from 1985 to 2012 and test it with dyadic fixed and time fixed OLS and PPML methodology. They use classical gravity variables, GDP, and GDP per capita of both the target and origin countries, while for all pairs the country-pair-specific characteristics such as distance, common language, cultural past, etc., are controlled for via dummies for each possible pair. If the target country is an EU member, the OLS methodology predicts a surplus of 33%, and the PPML estimator predicts a surplus of 38% in terms of FDI inflows. An EU FDI origin country will send 129% (PPML) more FDI than a non-EU origin country, which exaggerates previous studies by far. They apply their study using EU membership directly to BREXIT, assuming that if a country leaves the EU, the losses incurred will be opposite to the gains realized when a country joins the EU. While this is indeed a strong assumption, especially since bilateral FDI data is only available up to 2012/2013 for OECD countries, such a gravity FDI BREXIT study can give indications on how and to what extent FDI flow and stock will be affected. Furthermore, questions still remain regarding to what degree UK will actually "leave" the EU.[6] This is important when discussing "soft" or "hard" BREXIT. However, such a distinction was not made by Bruno et al. (2016). They only proxied BREXIT as the opposite of a country joining the EU without further discussion.

A recently published working paper by Barrell et al. (2017) also examines EU membership, exchange rate volatility, and common currencies. They use FDI outward stocks (divided by a GDP deflator) as the dependent variable for selected

[6] What is the decisive connection between an EU dropout and FDI flow/stock and to what extent; for example, currency union, policy union, migration, free trade areas, etc.

OECD countries in the years from 1995 to 2012. Their findings show that bilateral FDI stocks are at least 50% higher if both countries are members of the EU.[7] However, this effect is mainly due to the EU single market. Furthermore, a decline in exchange rate volatility leads to increasing FDI. Common currencies seem to have little to no effect. Further, general FDI gravity variables such as GDP, distance, and trade openness are shown to be significant. In Section 3, we therefore introduce the exchange rate aspect into our model.

Folfas (2011) and Wojciechowski (2013) use Hausman–Taylor gravity estimators to determine FDI flows between EU countries. Their reason not to utilize PPML models is that time-invariant variables such as distance represent critical variables in their research question. The exclusion of fixed effects leads to different results concerning the variable "EU membership", which has to be taken into account when comparing their findings with Fournier et al. (2015) and Bruno et al. (2016). Folfas (2011) focuses especially on the corporate tax rates of countries as a driver of FDI (low tax rates attract FDI, tax haven effect) and controls for offshore financial centers, naming Cyprus, Luxembourg, and Malta in particular, via a dummy variable. He finds no significant effect of EU membership on FDI flows, although he does find a significant tax haven effect and significant variables representing cultural similarity. Wojciechovski, however, finds a significant effect if both countries are in the European Economic and Monetary Union. We pick up their idea on including corporate tax levels into a FDI gravity model in Section 3.

One clear drawback of using OLS is that zero flow (or stock) observations mislead the results, especially if this is combined with too many missing values, as is the case especially in the earlier years. Even though bilateral OECD FDI flow data quality is superior to UNCTAD (United Nations Conference on Trade and Development) data, this has to be strongly considered. In general, UNCTAD data has the advantage of being globally available (2001–2012), but as it is collected by national statistical authorities, the data collection methods are not uniform — contrary to the OECD. With UNCTAD, bilateral inflow data can deviate by up to a multiple of the

[7] They use a two-step system Generalized Method of Moments (GMM) estimator for their gravity model.

counterpart's reported outflow. Missing values are very often also problematic, especially for Asian and Latin American countries. Researchers working with UNCTAD data prefer using stocks instead of flows, as due to the large stock figure, annual deviations will not present a significant problem. Also it is easier to "fix" data holes by averaging previous and subsequent annual stocks. For our purpose, OECD flow data prove more consistent than stock and UNCTAD flow/stock data, although we do also control for stock. Table 2.1 compares the findings of the most important EU gravity studies utilizing OECD data and illustrating models used.

Table 2.1: EU-membership and its effect on FDI; gravity studies.

Study	Data	Model	OLS Results	PPML Results
Straathof et al. (2008)	OECD stock (1981–2005)	OLS dyadic fixed	+14% (from EU outsiders), +28% (from EU insiders)	
Fournier et al. (2015)	OECD flow (mid-1990s–2011)	OLS country fixed, ppml country fixed	+57% (if target is EU), +48% (if origin is EU)	+48% (if target is EU), +58% (if origin is EU)
Bruno et al. (2016)	OECD flow (1985–2012)	OLS dyadic fixed, ppml dyadic fixed, Heckmann Sample Selection	+33% (if target is EU)	+38% (if target is EU), +129% (if origin is EU)

Due to data structure and quality, PPML dyadic fixed panel estimation is the clear model of choice: we use PPML estimators in the gravity framework with fixed effects for each possible country pair[8] (dyadic) and for each year[9] (panel). For an in-depth review of eight of the most popular estimation methods for gravity models see Kareem et al. (2016), who carefully explain the relative merits of alternative approaches; there, PPML is identified to be the preferable methodology. It shall be noted that the conclusion that Whyman and Petrescu (2017) draw in their literature review on BREXIT gravity FDI modelling by interpreting the results of different models as being either optimistic or pessimistic is somewhat misleading, as PPML is

[8] Direction matters.

[9] This is a workaround to more commonly used panel estimations with OLS in Stata, enabling calculation of panel-estimations with PPML.

superior. It is therefore emphasized that the results of the model with the best fit is noted as “central”.

As we evaluate the methodology used by Bruno et al. (2016) as being the most suitable for the available data (Silva and Tenreyro 2011; Head and Mayer 2014; Kareem et al. 2016), we base our study on their work, especially as they apply their findings to the implications of BREXIT. However, we pick up open questions from previous literature and additionally control for corporate income tax and tax havens (Folfas 2011), the (relative) size of foreign owned capital stock (Jungmittag and Welfens 2016), and real exchange rates (Barrell et al. 2017). Trade will be included in the model by constructing the classical openness-indicator of relative exports and imports to GDP. Additionally, we want to check whether the properties of an EU membership is the driving force of FDI flows, or if we can reduce the explanatory power to the characteristics of being a member in the single market, as suggested by Barrell et al. (2017). This leads us to the formulation of the following hypotheses:

1. EU (EU single market) membership of target and origin country will increase FDI flows.
2. Trade openness will increase FDI flows.
3. Corporate tax level constrains FDI flows.
4. A higher relative FDI stock will attract more FDI flows. The FDI stock variable is considered relative to the total capital stock that may be assumed to implicitly reflect some path dependency as well as reinvestment of profitable subsidiaries abroad (as we want to explain, FDI inflows endogeneity might be a potential problem; this is addressed by lagging this variable by one period). [10]
5. A low real exchange rate (to USD) will attract more FDI flows — depreciation of the home currency stimulates higher FDI inflows.

[10] The methodology of lagging endogenous variables with respect to time in order to mitigate potential endogeneity problems has become more popular in recent literature; in this regard we follow Köhler (2018). We also use cluster robust standard errors, clustered by country pair, and check the adequacy of the methodology via a Durbin–Wu–Hausman test.

2.3 Econometric Specification and Data

2.3.1 Theoretical Foundation of the Gravity Model

Newton's law of gravitation serves as an eponym for the gravity model of trade, where the countries GDPs serve as pull factors stimulating trade and the distance between them as a push factor constraining it.[11] Anderson and Van Wincoop (2003) provide the sound econometric basis for a broad range of models utilized in empirical research. Shepherd (2016) refers to the traditional models as "intuitive", contrary to the "structural" gravity models, as they underlie the microeconomic foundation by bringing the consumer side, production side, and trade cost together. In its simplest form, exports from country i to country j depend on their economic size *Y* and trade cost *t'*. However, more recently, gravity models have also been used to predict FDI flows and stocks from origin to target country and find a broad empirical fit. In order to capture multilateral resistance terms[12] in structural models, the fixed effects panel data estimation method established itself as useful, see Anderson (2011) and Head and Mayer (2014). In panel-structured data, time-varying country and dyadic fixed effects control for national characteristics as well as characteristic relationships which would probably be largely unobservable otherwise. However, all time invariant variables such as the distance between the countries or trade agreements (if constant over panel) are captured by those fixed effects, which makes it hard to interpret them. Country-specific variables can overcome this by constructing them bilaterally.[13]

For our estimation, we derive the model in log-linearized form under consideration of common econometric misspecifications in modern gravity modelling, especially panel data implications, as unveiled by Baldwin and Taglioni (2007) and Silva and Tenreyro (2006). The dependent-variable FDI flow from origin country – *o* to target country (destination country) – *d* in time period – *t* is defined as follows:

[11] Utilization of the model in economic research is described by De Benedictis and Taglioni (2011).

[12] Outward and inward resistance: exports from country i to country j depend on trade costs of all possible export markets (outward resistance); imports into country i from j depend on trade costs of all possible import markets.

[13] Controlling for EU membership in an era without entries or exits in a country fixed effects setting will not work (due to omitted variable bias). Bilateral dummies are constructed: (1) member exports to member; (2) non-member exports to member; (3) member exports to non-member; the non-non case acts as a baseline for interpretation.

$$\ln \mathrm{FDI}flow_{odt} = \alpha_0 + \alpha_1 \ln X_{ot} + \alpha_2 \ln X_{dt} + \alpha_3 Z_{od} + \delta_{odt} + \tau_t + e_{odt},$$

with the following notation:

$\boldsymbol{\alpha_0}$ — regression constant ($\boldsymbol{\alpha_{1-3}}$ – regression estimators respectively),

$\boldsymbol{X_{ot}}$ — characteristics of the origin country (GDP, GDP/capita, EU membership),

$\boldsymbol{X_{dt}}$ — characteristics of the target country (GDP, GDP/capita, EU membership, openness, R&D (Research and Development) investment, ICT (Information and Communication Technology) investment, corporate tax level, relative FDI stock),

$\boldsymbol{Z_{od}}$ — characteristics of the relationship between country pairs (distance, cultural and historical differences, etc.),

$\boldsymbol{\delta_{od}}$ — dyadic fixed effects, i.e., one dummy variable for each possible set of partner countries, controls for all unobservables and satisfies the multilateral resistance requirement),

$\boldsymbol{\tau_t}$ — time fixed effects, i.e., one dummy variable for each year,

$\boldsymbol{e_{odt}}$ — error term.

As most components of $\boldsymbol{Z_{od}}$ are not time-varying, they coincide with dyadic fixed effects. It is assumed that common culture and history does not change significantly over the relatively short period of about 30 years.

2.3.2 Data

2.3.2.1 Definition and Sources

Data for FDI flows (in current USD) is obtained from the OECD due to higher data quality compared to UNCTAD, as mentioned above. An additional benefit is the longer time series available (1985-2013), even though there is almost no data available for 2013 (only if new data sets would become available will an updated regression be possible). One drawback, however, is that important relevant newcomers to FDI such as Russia or China are not included; OECD countries account for roughly 70% of global FDI flows (UNCTAD 2017). This first step of data quality evaluation is highly necessary in order to understand the tradeoffs we need to

accept, as well as to discuss potential biases by including only OECD countries in the econometric analyses.

GDP and GDP per capita (in current USD) is obtained from the World Bank, as is data for openness (import + export/GDP). Corporate tax on a country level from 1985 to 2007 is obtained from Mintz and Weichenrieder (2010) and from KPMG (data available 2003-2017). Relative FDI stock is obtained by dividing FDI in-stock (the total FDI inward position of the target country in current USD; data source: OECD) by total inward capital stock (capital stock at constant 2011 national prices; converted into current USD via the price level of capital stock, price level of USD in 2011 = 1; data source: Feenstra et al. 2015). Therefore, we use FDI stock in current USD over total capital stock in current USD; the variable describes a relative index and we do not have to deflate numbers. Index is lagged by one year to minimize the endogeneity problem annual FDI flow can have on FDI stock index. We applied the Durbin-Wu-Hausman test in order to check if our specification has achieved avoiding an endogeneity problem: The null hypothesis that the variable "foreign_capstock_share_lagged" is endogenous can be rejected (p-value = 0.8571), while the null hypothesis that the variable "foreign_capstock_share" is endogenous must be accepted (p-value = 0.0000).[14] Therefore, the BREXIT-related findings are robust.

Real exchange rates are calculated as follows: nominal exchange rates to USD multiplied by the US consumer price index, divided by the home consumer price index (data source: OECD). Taking logs is necessary, as statistical outliers are by definition very large for a big fraction of the data. Finally, when controlling for the EU single market, we introduce a dummy variable representing whether the European Economic Area agreement is ratified, including EU28, Iceland, and Norway. Switzerland is additionally included, as bilateral treaties with the EU mirror a very similar relationship. We decided not to include Turkey, as we find heavy

[14] Regressions were run separately just for the purpose of validation of variable exogeneity, with FDI inflow as a dependent variable and EU-membership and FDI capital stock share (lagged) as explanatory variables, using the xtivreg2 Stata command, see Hayashi (2000), as there is no endogeneity test implementable within the PPML.

institutional deviance (especially migration and legislation). Table 2.2 gives an overview on the main variables utilized.

Table 2.2. List of variables.

Variables	Definition	Source
inflow	Inward FDI flows (origin to target), in current USD	OECD database
target_gdp	GDP of FDI target country, in current USD	World Bank
origin_gdp	GDP of FDI origin country, in current USD	World Bank
target_gdp_per_capita	GDP per capita of FDI target country, in current USD	World Bank
origin_gdp_per_capita	GDP per capita of FDI origin country, in current USD	World Bank
target_openness	Total imports plus total exports of FDI target country, divided by its GDP	World Bank
foreign_capstock_share_lagged	Total FDI inward stock in the target country (in current USD) by total inward capital stock (converted from constant 2011 national prices into current USD); lagged by one year	OECD database; Feenstra et al. (2015) for conversion methodology
target_corporate_taxrate	General corporate tax rates, including average/typical local taxes	Mintz and Weichenrieder (2010); KPMG (2017)
target_rer	Nominal exchange rates (target country to USD) multiplied by US consumer price index, divided by home consumer price index	OECD database

2.3.2.2 Treating Missing Values

For the period from 1985 to 2012, our dataset contains 34 OECD countries (without Latvia which joined the OECD only in 2016) and 29,262 possible bilateral FDI flows. Dropping 13,903 observations due to missing values (listwise deletion) leaves the dataset with 15,359 observations, of which 5278 are negatives or zeroes, characterizing the problems with regard to OLS estimations (see Kareem et al. 2016). While Bruno et al. (2016) address this issue by assigning very small values to non-observed or zero flows, we do not want to follow this quite strong assumption,

especially due to well-known weaknesses regarding the inaccuracy of FDI data. We will concentrate solely on the explanatory power of the PPML model, which fits the data quite well, and use OLS only as a robustness check. Utilizing listwise deletion seems an adequate solution, as more than 15,000 observations are fully sufficient for gravity modelling (for comparison: (Straathof et al. 2008) and (Fournier et al. 2015) work with roughly 11,000 observations for their FDI gravity analyses). That way we additionally avoid extensive matrix calculations which commonly occur in two-way fixed effects estimations involving large datasets as described by Stammann (2017). The econometric solution they offer for handling large amounts of data is not applicable so far with PPML models. As a drawback, a possible selection bias must be noted; however, we assess this bias to be smaller than the bias which would occur by assuming missing data equals zero flow.

2.3.2.3 Treating Negative Values

As neither PPML nor OLS estimators work with negative values, this leaves us with three options: re-scaling flows,[15] dropping flows, or setting flows equal to zero. While the first is not straightforward to interpret, dropping flows would result in a larger bias than when setting negatives to zero.[16] While this is indeed a strong assumption, as pointed out by Folfas (2011), we will follow their approach in order to be able to use PPML estimators, leaving us with 15,359 observations, of which 5278 represent a flow of one USD. To distinguish between "real" and "negative" one-dollar-flow (zero flow), a dummy is inserted. According to UNCTAD data, before 1985, the total amount of FDI flows was relatively low, gaining importance in the 1990s and speeding up from 1997, especially within the EU and USA. Portugal and Spain joined the EU in 1986, Austria, Sweden, and Finland in 1995, and Estonia, Latvia, Lithuania, Poland, the Czech Republic, Slovakia, Hungary, Slovenia, Malta, and Cyprus in 2004.

[15] Setting the smallest equal to zero and adding up.

[16] In previous literature, this problem was not addressed in detail, although Fournier et al. (2015) and Bruno et al. (2016) seemed to have assigned zeroes (which then convert to one, in order to be able to also utilize OLS) to negatives instead of dropping them. Comparing their datasets and non-dropped observations lead to this conclusion.

2.3.2.4 Special Role of UK in Descriptive Data

The corporate tax levels of FDI target countries are expected to have an impact on FDI inflows, as described by Folfas (2011). Within our dataset of 34 OECD countries, we label Iceland, Ireland, Luxembourg, and Switzerland as "tax havens", attracting firms with relatively good business conditions; corporate taxes are part of firm-friendly conditions, but do not define tax havens per se.[17] In recent years, the UK converges to the group of tax havens in terms of the corporate tax level, see Figure A1 in the Appendix A. This is regarded with special interest when discussing the findings of hypothesis 3 in the context of BREXIT.

Another critical explanatory variable in our analysis is the relative FDI stock size of the various countries. For the regressions, we use OECD data for reasons referred to above, even though UNCTAD stock data is to some degree more reliable. Ireland, as an example of a tax haven country, has relatively high values of foreign capital, similar to the Netherlands. The USA, Germany, and Mexico are on similar levels below 10%, while 16% of the UK capital stock is comprised of foreign owned facilitates (see Figure A2 in the Appendix A). Again, the special role the UK takes in those descriptive statistics will be discussed with regard to hypothesis 4 and BREXIT.

2.4 Empirical Findings

2.4.1 PPML Dyadic Fixed Estimations

Findings from the preferred PPML estimator are presented in Table 2.3. Several models were developed, all including country-pair fixed effects ("dyadic fixed effects"), i.e., one dummy variable for each FDI origin to target direction. It should be noted that not only country-relationship (as, for example, the classical gravity variable "distance") but also direction matters.[18] We clustered the regression by country pairs in order to avoid problematic variance matrix calculations (singular or non-symmetric variance matrices occur with large numbers of fixed effects

[17] Countries with the lowest corporate tax levels include Ireland, Switzerland, Slovenia, Chile, the Czech Republic, Poland and Hungary.

[18] For example, one dummy for Australia-Austria, but also one dummy for Austria-Australia.

dummies and missing data). Furthermore, we treated panel data via time dummies for each year.

Initially, one can see that the methodology fits the data well, as about 66% of FDI flows are explained by the model.[19] Model (1) results are presented in the first column, showing the classical gravity variables of "size" via GDP and also GDP per capita, representing "wealth". Distance, including all time non-varying trading costs and time non-varying country- and country pair-specific characteristics, is captured via fixed effects. This also explains the relatively high R-squared values. EU membership is also included in model (1) as a time-variant dummy variable, as is the real exchange rate. In columns (2), (3), and (4), the corporate tax rate on firms' profits of the target country, trade openness indicating import/export activities, and the share of the capital stock which is owned by foreign countries was added.

Overall, the four models show a clear-cut picture without changes in the signs of significant coefficients and quite even results across models, with the exception of trade openness of a country. It loses explanatory power as soon as we control for FDI inward stock, suggesting that trade is closely linked with FDI.[20]

The effect of EU membership on FDI attractiveness and FDI outflows is mixed. While FDI attractiveness is not influenced by EU membership, countries send significantly more FDI abroad if they are a member of the EU. Specifically, FDI outflow is increased by 62% (origin_eu 0.480 ***, standard error 0.181). Origin country membership findings are in line with Fournier et al. (2015) and Bruno et al. (2016), while the effect of target-country membership lost significance when negative flows are checked for via a dummy. We therefore suggest considering multiple econometric approaches for negative dependent variables in gravity model settings.

[19] For R-squared interpretation in PPML models we follow Shepherd (2016).

[20] The variables target_openness and foreign_capstock_share_lagged show a correlation coefficient of 0.75, indicating that the capital stock variable swallows the explanatory power of trade openness; see Tables A1 and A2 in the Appendix A.

Table 2.3. Results for dyadic fixed panel data estimation using PPML estimators for FDI inflow.

	(1)	(2)	(3)	(4)
Variables	**inflow**	**inflow**	**inflow**	**inflow**
target_eu	0.235	0.135	0.0378	0.124
	(0.152)	(0.151)	(0.157)	(0.161)
origin_eu	0.589 ***	0.504 ***	0.511 ***	0.480 ***
	(0.205)	(0.184)	(0.184)	(0.181)
ln_target_gdp	1.346	3.958 **	3.859 **	3.204 *
	(1.519)	(1.966)	(1.907)	(1.700)
ln_origin_gdp	1.766 *	1.269	1.302	1.178
	(1.073)	(1.083)	(1.068)	(1.017)
ln_target_gdp_per_capita	0.185	−2.233	−2.216	−1.972
	(1.642)	(1.880)	(1.829)	(1.684)
ln_origin_gdp_per_capita	−1.104	−0.529	−0.580	−0.431
	(1.132)	(1.156)	(1.135)	(1.097)
ln_target_rer	0.819	1.305 *	1.177 *	1.004
	(0.629)	(0.716)	(0.709)	(0.674)
target_corporate_taxrate		−4.077 ***	−3.775 ***	−3.804 ***
		(1.165)	(1.136)	(1.096)
target_openness			0.634 **	0.161
			(0.290)	(0.324)
foreign_capstock_share_lagged				2.092 ***
				(0.795)
Observations	15,359	15,359	15,359	15,359
R-squared	0.639	0.648	0.655	0.657

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

Before going deeper into an analysis of the explanatory variables, we checked whether it is EU membership or rather participation in the EEA, i.e., access to the European single market, which has a significant impact on FDI flows. Table 2.4 shows the results as above, but the EU membership variables for both origin and target countries are dropped in exchange for variables indicating access to the European single market, yielding cumulative models (5), (6), (7), and (8).

We noticed a shift in GDP and GDP per capita compared to the table above, which makes sense as EU countries' and other countries' access to the single market correlate unequally to those. All other variables remain similar, confirming the robustness of the results. In both model (3) and model (7), trade openness of the

target country has a significant (and similar) impact on FDI flows. However, this effect vanishes in model (4) and (8), indicating a correlation between trade and FDI stock. Both the corporate tax rate and the foreign owned share of the target country's capital stock (flow-independent) have strong significant impacts in all models, as do the variables indicating participation in the EU single market.

Table 2.4. Results for dyadic fixed panel data PPML estimation for FDI inflow, single market access as explanatory variable.

	(5)	(6)	(7)	(8)
Variables	**inflow**	**inflow**	**inflow**	**inflow**
target_eu_singlemarket	0.545 **	0.468 **	0.408 **	0.349 *
	(0.215)	(0.196)	(0.204)	(0.190)
origin_eu_singlemarket	0.634 ***	0.618 ***	0.626 ***	0.602 ***
	(0.216)	(0.204)	(0.199)	(0.198)
ln_target_gdp	2.958	5.280 **	5.078 **	4.276 **
	(1.854)	(2.201)	(2.165)	(1.954)
ln_origin_gdp	2.562 **	2.096 *	2.152 **	2.000 *
	(1.079)	(1.097)	(1.088)	(1.048)
ln_target_gdp_per_capita	−1.704	−3.841 *	−3.703 *	−3.203
	(1.996)	(2.194)	(2.157)	(1.986)
ln_origin_gdp_per_capita	−2.003 *	−1.463	−1.539	−1.359
	(1.163)	(1.195)	(1.180)	(1.154)
ln_target_rer	0.558	1.022	0.920	0.834
	(0.562)	(0.642)	(0.639)	(0.612)
target_corporate_taxrate		−3.936 ***	−3.653 ***	−3.720 ***
		(1.080)	(1.076)	(1.040)
target_openness			0.576 *	0.157
			(0.304)	(0.329)
foreign_capstock_share_lagged				1.945 **
				(0.780)
Observations	15,359	15,359	15,359	15,359
R-squared	0.645	0.654	0.659	0.661

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

2.4.2 Results

1. The EU membership of the origin country has a significant impact on FDI flows, namely +62% if the origin country is an EU member. No significant impact on FDI flow concerning the target country and EU membership is found. This contradicts previous studies, especially Bruno et al. (2016), as they also use OECD flow data. We ascribe the different results to not controlling for negative flows, as we get similar results to Bruno et al. (2016) when we do not control for them. FDI origin country and EU membership findings mirror those in literature.

   When controlling for single market instead of pure membership, we find a highly significant impact of both origin and target country having access to it. Interpreting model (8), which includes the total set of variables of interest, a country attracts +42% FDI inflows and sends +83% FDI outflows if it has access to the EU single market. While this number seems very high, it mirrors previous findings (see Table 2.1).

   ➔ Hypothesis 1 is therefore accepted, indicating that access to the single market results in considerably higher FDI in- and outflows.

2. Trade openness has a significant impact on FDI flows, with a 1% increase in openness leading to a 0.6% increase in FDI flows (model 7). When controlling for the share of foreign ownership of a country's capital stock, the effect vanishes, as both variables correlate strongly (see Tables A1 and A2 in the Appendix A). To the extent that there is an FDI stock endogeneity problem, one would take model (3) as the preferred version, which clearly indicates the strong relevance of trade intensity. If this network should be damaged through a modest EU-UK free trade agreement, serious negative post-BREXIT effects on FDI should be expected.

   ➔ Hypothesis 2 is neither accepted nor rejected. While many studies prove the significant impact of the classical openness indicator, we show that it is important to focus attention on other variables, especially the share of already existing foreign capital within a country. Further research

concerning trade and FDI is needed (keywords: production to market, supply chain analysis, etc.), and will be discussed to some extent in the conclusion.

3. The corporate tax level has a negative impact on FDI flows, with a 1% increase in the statutory corporate tax level leading to an almost 4% decrease in FDI flows, and therefore results are in line with Folfas (2011). This will have different implications on greenfield and brownfield investments, mainly impacting decisions on where to construct new production plants. In addition, this should be considered in the context of tax havens.

   ➔ Hypothesis 3 is accepted. High corporate tax levels in home countries constrain FDI inflows.

4. If the foreign-owned share of a country's capital stock (namely inward stock over capital stock, lagged by one year to control for annual inflow) increases by 1%, the FDI inflow will increase by 1.9%. On one hand, with an annually rising FDI stock by aggregated inflow, depreciated and growth-considered, the stock-flow relationship is straightforward. On the other hand, we are interested in the cluster and spillover effects which pre-existing investment has on further investment. By lagging stocks we neutralize the direct inflow effect, leaving only the cluster effect.

   These findings are assessed to have strong implications, especially when considering policy changes such as an exit from the EU. To mirror this effect more clearly, an intertemporal gravity model could be altered, which we suggest for future research in the field of FDI flows but especially stocks.

   ➔ Hypothesis 4, that the relative foreign share of the capital stock of a country attracts increasing FDI, is accepted.

5. According to Barrell et al. (2017), we would suspect that a low real exchange rate vis-à-vis USD will attract a higher FDI inward flow. However, the real exchange rate of home country to USD does not significantly impact FDI inward flows. However, this variable may not be compiled in an optimal way and further research needs to be done.

   ➔ Hypothesis 5 is rejected.

2.5 Policy Implications and Future Research

We evaluated recent FDI literature and selected those variables which had the biggest impact on FDI flows and stocks between countries. FDI gravity models and the two common data banks for bilateral FDI, UNCTAD and OECD, were analyzed. Bilateral FDI data is assessed to be a bit disappointing, as the latest data we could get was for 2012 and for OECD countries only (due to large discrepancies in UNCTAD data), therefore only the PPML estimator in a dyadic fixed panel setting for gravity models seems to be adequate for an FDI analysis.[21] EU membership and participation in the European single market are the critical variables of interest in our study, also due to the forthcoming BREXIT as well as the broader anti-European sentiments which could be witnessed in other countries in 2016/2017. We control for the size of the relative foreign capital stock within the target country, the statutory corporate tax rate of the target country, and the real effective exchange rates between partners. Our findings are in line with previous studies, although we suggest analyzing access to the EU single market instead of pure-EU membership (also due to higher R-squared in respective models).

This indicates that in the case of BREXIT, it will be important for the UK to remain in the EEA and to have similar bilateral treaties with the EU as Norway does, for example, which they could reach when achieving a soft Brexit. Considering the hard Brexit case, the UK would lose almost half their FDI inflows from other European countries in the long run (20 years plus), especially from the Netherlands, Belgium,

[21] Barrell et al. (2017) were the first to take on a different modelling approach. Their findings are quite similar to ours, however they did not use fixed effects and as well FDI stocks rather than FDI flows.

and Luxemburg, but also Germany and France, amongst others. That a hard Brexit would have no impact on FDI inflows from EU outsiders shall be doubted, as discussed in detail below. UK FDI outflows, i.e., UK investments abroad, will also decrease in the long run. A solution to counteract decreasing FDI flows could be to decrease the statutory corporate tax rate, as a 1% decrease leads to 3-4 % increase in flows. However, the statutory corporate tax rate of the UK has already reached a very low level, competing with other OECD tax haven countries. We would be careful in giving policy advice to further decrease the tax rate. The relatively large FDI stock in the UK will, however, absorb the BREXIT effect to a small degree or at least slow down the process of reducing FDI inflows. Considering the exchange rate of the British pound to USD, it can be suspected that a cheaper pound stimulates FDI activities, especially brownfield investments. However, we do not find a significant effect of real exchange rates against USD.

Figure 1 shows hypothetical combinations of changes in the statutory corporate tax rate which would be necessary to neutralize the combined effects of a hard Brexit (no EU single-market membership) and the various cases of an assumed increase in the foreign share of the target capital stock (for example, due to increasing M&A activities for 2015 – 2020). We have highlighted in red the required policy action in the sense of reducing the UK statutory corporate tax rate. As can be seen from the figure 2.1, a given foreign share in the UK capital stock would require a reduction of a corporate tax rate by 11% to offset the BREXIT decision (interpreted here as losing access to the EU single market). If, for instance, the increase in the foreign share of the UK capital stock, driven by a real pound devaluation, would be 5%, the corporate tax rate would have to decrease by 8% in order to neutralize BREXIT in the long run.

Increase in foreign share of target capital stock, lagged (UK)	Decrease in Corporate Tax Rate										
	0%	-1%	-2%	-3%	-4%	-5%	-6%	-7%	-8%	-9%	-10%
0%	0.0%	3.7%	7.4%	11.1%	14.8%	18.5%	22.2%	25.9%	29.6%	33.3%	37.0%
1%	1.9%	5.6%	9.3%	13.0%	16.7%	20.4%	24.1%	27.8%	31.5%	35.2%	38.9%
2%	3.8%	7.5%	11.2%	14.9%	18.6%	22.3%	26.0%	29.7%	33.4%	37.1%	40.8%
3%	5.7%	9.4%	13.1%	16.8%	20.5%	24.2%	27.9%	31.6%	35.3%	39.0%	42.7%
4%	7.6%	11.3%	15.0%	18.7%	22.4%	26.1%	29.8%	33.5%	37.2%	40.9%	44.6%
5%	9.5%	13.2%	16.9%	20.6%	24.3%	28.0%	31.7%	35.4%	39.1%	42.8%	46.5%
6%	11.4%	15.1%	18.8%	22.5%	26.2%	29.9%	33.6%	37.3%	41.0%	44.7%	48.4%
7%	13.3%	17.0%	20.7%	24.4%	28.1%	31.8%	35.5%	39.2%	42.9%	46.6%	50.3%
8%	15.2%	18.9%	22.6%	26.3%	30.0%	33.7%	37.4%	41.1%	44.8%	48.5%	52.2%
9%	17.1%	20.8%	24.5%	28.2%	31.9%	35.6%	39.3%	43.0%	46.7%	50.4%	54.1%
10%	19.0%	22.7%	26.4%	30.1%	33.8%	37.5%	41.2%	44.9%	48.6%	52.3%	56.0%

Figure 2.1. Scenario matrix for corporate tax and FDI inward stock changes on FDI inflows. Source: own calculations.

Taking into account that the total amount of FDI inflows of the countries considered have amounted to $0.735 trillion in 2012 and to $1.121 trillion in 2016, one gets a clear idea of just how important FDI inflows are. The reduction of the statutory corporate tax rate in the UK by 1% in 2017 and the US reduction of the statutory corporate tax rate by 15% should have a strong impact on the country breakdown of FDI flows in OECD countries. Taking into account the particular role of China, one could also include China into future enhanced FDI gravity modeling — once sufficient data for this country are available.

As regards BREXIT, the implication is that the UK would not only face a negative income effect related to reduced trade dynamics but that lower FDI inflows will also be relevant. As the UK government wants a hard BREXIT, it is clear that the full effect of the single market variable should be relevant unless some “quasi-EU membership” could be achieved in the form of a broad treaty on UK access to the EU single market. The approach presented here could also be applied to an FDI gravity equation with a specific sectoral analysis (see Figure A3 in the Appendix A), where financial services FDI are of particular interest in the case of the UK and BREXIT. Information and communication technology (ICT) FDI dynamics should also

be of special interest since ICT is a major driver of innovation and growth in most OECD countries. The ICT sector might also be more footloose in the context of the relevant technologies so that the relevant parameter estimates should differ from the broader analysis presented here. For policy makers interested in targeting ICT sector inflows, additional insights from modified gravity modelling could indeed be quite important.

In particular, the approach presented could be applied to financial sector FDI flows and BREXIT analysis. As is well known from statistics (see Appendix A), about 30% of the British inward FDI stock consists of FDI in the financial services sector. Future UK-EU27 relations will most likely not reflect a continuation of the banks' single passport which has allowed them to cover all banking services for clients in EU27 countries from the City of London as the UK's global financial center. The European Central Bank, as well as the national prudential supervisors of EU countries, will require that banks offering financial services in the EU27 will have to get a separate banking license and to provide additional (separate) equity capital in order to be able to serve the EU single market post-BREXIT. The implication is that many British banks, US banks in London, Japanese banking subsidiaries in London, etc., will move banking activities — assets and staff — to EU27 countries, mostly Ireland, Germany, France, Luxembourg, and the Netherlands, so that one may anticipate a real Euro appreciation effect in the context of a structural adjustment in the British and Eurozone banking sectors. It is noteworthy that a study by Wyman (2017) has estimated the necessary additional capitalization needs of "London banks" doing business in EU27 could amount to close to €50 billion in a post-BREXIT situation. The implication then is that the overall supply of financial services in the EU27 should not change much compared to 2018 (the last full year of EU28 activities), but that there will indeed be a one-off FDI inflow effect in the EU27 financial services sector.

From a theoretical perspective, one may argue that FDI outflow/inflow patterns should differ by sectors if one considers technology intensity on the one hand and industrial versus financial sectors/firms on the other hand. Regarding the future access of British industrial firms to the EU27 single market, one may also point out

that sectoral free trade agreements will typically require a minimum of 50-60% in value-added in the UK for British exports to qualify for duty free/preferred access to the EU single market. This implies that British firms will have to give up part of their existing EU28 production networks in order to raise the British value-added share from the current, often rather low, share of 30-40% in order to achieve the higher future minimum value-added shares. This implies a one-off disinvestment in EU27 countries by British firms on the one hand, and on the other hand it implies that the relative unit cost of many UK sectors which reduce their European supply chain production will increase. From the Barrell and Pain (1997) study, it is known for German multinational firms that relative unit costs are a significant FDI outward variable, and Germany's outward FDI to the UK is about one quarter of all EU27 FDI in Great Britain. Thus the UK should face lower inward FDI flows from Germany (and other EU27 countries) in the future.

This, however, does not rule out that a massive real depreciation of the British pound would trigger larger international M&As in the UK. This would clearly have a negative impact on the growth of real national income (*Z*). If one considers a case of asymmetric cumulated FDI inflows only, we can write $Z = Y(1 - \alpha^{*}ß)$, with α^{*} denoting the share of foreign ownership in the capital stock, ß representing the share of profits in GDP under competition in goods and factor markets, and a Cobb-Douglas production function $Y = Kß(AL)1 - ß$ with *A* representing technology and *L* labor respectively. The implication is that as an approximation (assuming $\alpha^{*}ß$ to be close to zero), we can write $lnZ = lnY - \alpha^{*}ß$ and therefore $dlnZ/dt = dlnY/dt - ßd\alpha^{*}/dt$. If BREXIT raises the share of foreign ownership in the UK capital stock by 10%, and we take the standard assumption that $ß = 0.33$, the growth rate of real income will be reduced by 3.3% through BREXIT. If the Treasury analysis of −10% of GDP due to BREXIT were correct, the total effect would be −13.3%. This is still an underestimation since UK-EU27 is a case of interdependency. Trade links, FDI links, and innovation links, with cumulated FDI capital accumulation contributing to Schumpeterian innovation dynamics, have to be considered simultaneously. Only in such a broader perspective can this lead to an understanding of output development over time.

One potentially important aspect that could be considered in future research is the changing geographical composition of UK FDI inflows post-BREXIT and the impact on sectoral FDI inflows and outflows in banking and finance in particular. For example, a higher inflow of US FDI in manufacturing and nonfinancial services is likely to go along with more US FDI inflows in banking and finance, where the US is a relatively strong source country in a global perspective. Manufacturing FDI inflows from advanced OECD countries are likely to bring a positive international technology transfer that could affect both economic growth and the long-run current account position of host countries. To the extent that higher US FDI outflows would overcompensate lower EU27 FDI outflows to the post-BREXIT UK, the overall FDI position of the UK is not weakened. However, a similar FDI result for the UK could have been expected under an EU–US TTIP agreement which had been envisaged under the Obama Administration but which was no longer a priority under President Trump.

Appendix A

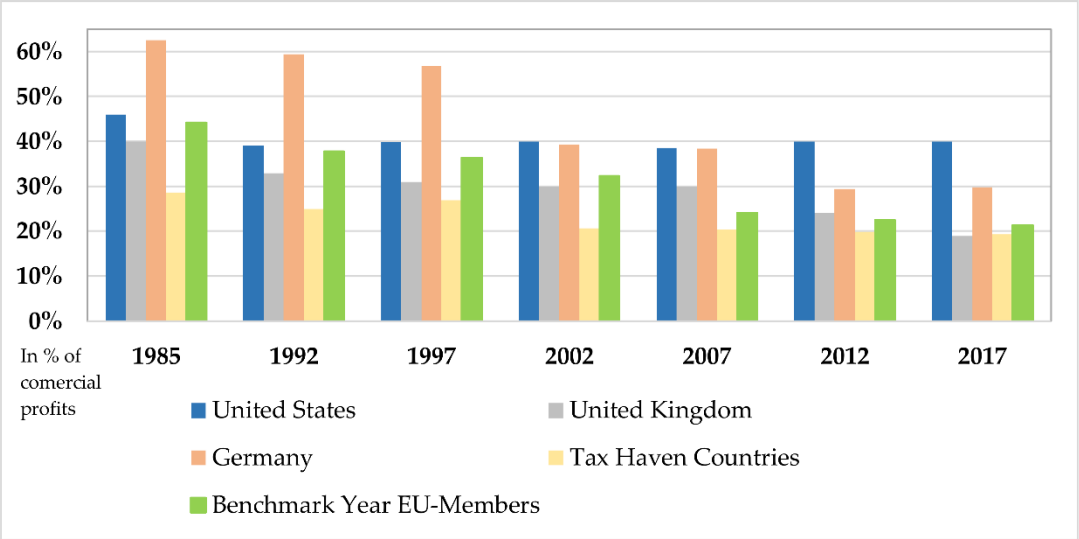

Figure A.1. Corporate tax levels of selected countries. Source: Mintz and Weichenrieder (2010) (timeframe 1985–2008) and from KPMG (timeframe 2003–2017).

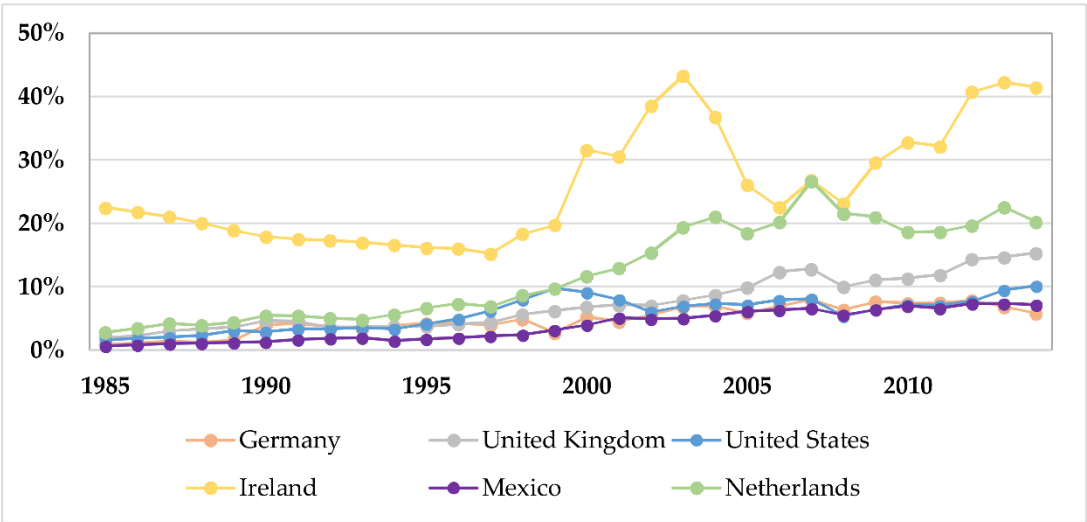

Figure A.2. FDI inward stock as percentage of national capital stock. Source: UNCTAD.

Table A.1. Correlation matrix for selected explanatory variables to FDI flow.

var_list	ln_target_rer	target_corporate_taxrate	target_openness	foreign_capstock_share_lagged
ln_target_rer	1	-	-	-
target_corporate_taxrate	−0.2153	1	-	-
target_openness	−0.057	−0.4553	1	-
foreign_capstock_share_lagged	−0.1741	−0.3248	0.7546	1

Source: own calculations.

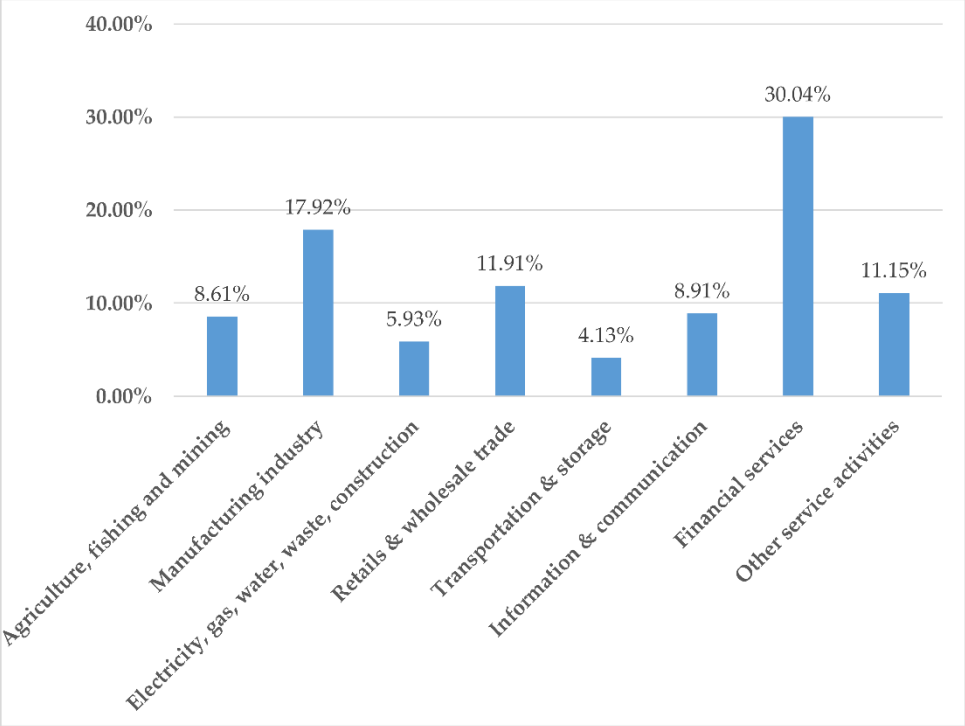

Figure A.3. FDI inward stock UK, by industry, 2015. Source: Office for National Statistics, UK 2017.

3 The UK's Banking FDI Flows and Total British FDI: A Dynamic BREXIT Analysis

3.1 Introduction

The Thatcher-era banking deregulation of the 1980s resulted in banking FDI flowing into London over a number of decades fuelling the subsequent expansion of the UK financial services sector which increasingly has been able to successfully serve EU27 (EU28 without the UK) clients from London's financial centre. In this context, exploiting economies of scope – locational advantages of the City of London – as well as economies of scale for specific banking transactions has contributed to the growth of the London banking centre which, of course, has benefitted from the EU single market implemented in 1993 (with some years of delay for all financial services, including insurance). EU regulations have contributed to creating and restoring confidence in the London financial centre with its many foreign banks, among them subsidiaries or branches of all leading banks from the US, Europe, Japan; and after 2000, also from China. The UK even quickly became a founding country of the multilateral Asian Infrastructure Investment Bank (AIIB) once China had agreed to set up the European AIIB subsidiary in London.

With BREXIT, the UK will face a serious challenge to the London banking system which is a global financial centre and also the leading banking centre in the EU28 (Coeuré 2017; Donnery 2017). The estimate for the market share of London, i.e. "City", banks in the EU27 wholesale market has been close to 90% (Sapir et al. 2017). The UK has had a competitive banking services supply side; with some notable exceptions - as has emerged after the Transatlantic Banking Crisis where investigations have revealed that the Libor interest rate was rigged by the group of banks involved in calculating this important reference interest rate. Foreign direct investment (FDI) into the UK has contributed to making the City, London's financial centre, the biggest such centre in the world and for decades the UK has been involved in the designing and implementation of EU financial services and banking regulations. These were revised and the relevant institutions modernized – including the creation of the European Systemic Risk Board (ESRB) in 2010 – after the banking crisis. EU institutions, including the European Commission and the European Banking Authority (EBA) have been part of the institutional setting under

which foreign banks could be active in the UK, while national regulations have been complementary to the EU framework after the Transatlantic Banking Crisis of 2008/09, which affected many UK banks with activities in real estate in the US (the write-down of asset values in the US thus affected both US and British banks in London and contributed to higher spreads; see Born and Enders 2018).

While the government of Prime Minister May wishes to retain access to goods markets in the EU through an UK-EU free trade agreement, the policy stance in the field of financial services is to stay out of the EU single market and to rather rely on a new equivalence regime that could partly be a substitute for the current passporting of banks which is a system that allows any EU bank with a banking licence in one EU country to offer banking services in all EU countries, namely through a branch or through a subsidiary. For many financial services offered in the EU27, the ECB expects that City banks will set up a subsidiary in the EU27 if current business is to be carried on in full, while the ESMA (European Securities and Market Authority) could also require that specific activities have to be set up with adequate capitalization, banking infrastructure and staff in the EU27. Against this background, one may anticipate that there will be reduced banking FDI inflows to the UK in the context of BREXIT and more banking FDI inflows to the EU27. Gravity modelling on overall FDI in OECD countries has shown that EU membership as well as participation in the EU single market is a significant variable in terms of raised FDI inflows so that leaving the EU will reduce the inward FDI of the UK in the context of BREXIT (Welfens and Baier 2018). Lower overall UK FDI inflows and, in particular, lower banking FDI inflows into the UK could have an effect on the UK's overall portfolio capital inflows. Eichengreen (2018) has shown that the inward stock of portfolio investment is reduced by 12 percent for the UK post-BREXIT. This implies that London, as a financial centre, could face lower liquidity and profits after BREXIT and foreign investors from the banking sector will anticipate these developments; other aspects could also affect inward banking FDI as well as overall FDI. However, in the subsequent analysis the key aspect is not so much true banking FDI, for which data are unavailable, but rather outward and inward deposits assets of banks in banking and non-banking sectors, respectively. The following analysis takes a closer

look at the question of how outward banking activities are affected by BREXIT and also how inward banking activities can be expected to react with respect to BREXIT.

Looking effectively at the prospect for the UK banks' outward FDI in the banking sector and the non-banking sector, one would have to anticipate the post-BREXIT trade and regulatory regime for the UK and the EU27. It seems clear that the worsening of the London City banks' access to EU27 markets is a realistic case even if some equivalence rules will be implemented. Since the overall investment of UK banks in non-banking is somewhat smaller than in banking (in terms of foreign assets), the BREXIT will affect the relative international asset position of the banking sector to non-banking and thus the international risk exposure of UK banks; and this normally should lead to regulatory adjustments in the UK and in the EU27.

Based on a theoretical analysis one can analyse the UK's banking FDI outward prospects to EU27 and other countries in an empirical framework and then also draw policy conclusions for the UK, the EU27 and other countries. The key insights will be the asymmetric FDI dynamics in the UK's banking and non-banking FDI – and, more broadly speaking, the internationalization of banks' assets and of non-banking firms' assets.

3.2 Theoretical Aspects

As regards the economic logic of banking FDI, the general approach of combining ownership-specific advantages, locational advantages and internalization advantages has played a role with regard to the cumulated FDI inflows (Dunning 1998, 2001). Economies of scale/density and networking effects also played a particular role for London as a banking centre (Gehrig 1998). As regards international mergers & acquisitions (M&As) one can clearly point to the role of the real exchange rate as emphasized by Froot and Stein (1991): A real devaluation will lead to higher overall FDI inflows. One may, however, consider sector-specific aspects and to the extent that the focus is on banking FDI, the changes in post-BREXIT City of London access to the EU single market suggests a strongly declining attractiveness of the UK for banking FDI; hence FDI banking inflows to the UK

should decline. To the extent that US banks in the City would relocate to New York, in doing so they would benefit from existing equivalence agreements between the US and the EU which largely maintains that the regulatory quality in the US is equivalent to that in the EU so that banks located in the US could offer services from the US to EU27 clients within the level playing field of a transatlantic financial market.

As regards the role of rather low corporate tax rates, one can also argue that there is a positive link to FDI inflows in OECD countries as the empirical gravity equation of Welfens and Baier (2018) has shown. The Bank for International Settlements has looked into some of the key aspects of the internationalization of the banking sector (Brei and Von Peter 2017).

To the extent that British banks could develop specific ownership advantages, this would contribute to the UK's financial services current account surplus on the one hand, on the other hand such banks also gain an improved basis for becoming successful with outward FDI. Until the pro-BREXIT majority in the EU referendum of 2016, there was, however, no big incentive for UK-based banks to set up major activities in the EU27. This has broadly changed after 2016 since the European Central Bank (ECB) and European Banking Authority (EBA) have signalled that London banks interested in offering the full range of standard banking activities would have to create subsidiaries in the Eurozone so that branches of primarily London-based banks would have to become subsidiaries with a distinct source capitalization.

Overall, foreign direct investment inflows into the UK have increased in the British EU referendum year of 2016, but FDI inflows to the banking sector and the financial services sector should generally fall if banks are not anticipating that the EU passport solution for banks would hold after the UK's leaving of the European Union; and also not anticipating that equivalence rules would be broad enough to be an effective substitute for British and non-British banks in London to continue their pre-BREXIT level of banking and financial services provided to EU27 clients from the UK. To the extent that neither continued passporting nor broad

equivalence is possible from a UK perspective, BREXIT brings the following analytical outlooks:

- The short-term impact of BREXIT will be a strong nominal Pound depreciation which will facilitate international M&As in all sectors initiated by foreign investors in the UK; this is an argument, based on Froot and Stein (1991), to expect an expansion of UK FDI inflows, namely in a world of imperfect capital markets;
- as most simulations for BREXIT imply a long-run reduction of economic growth in the UK, this dynamic negative market size effect will dampen the appetite of foreign investors to invest strongly in the UK. The net impact of the above real exchange rate effect and the market size-dampening effect of BREXIT should be additional FDI inflows. One should note, however, that uncertainty about the reduction of medium-term UK economic growth will depend on the outcome of the UK-EU negotiations in 2019 – the broader the future British market access to the EU27 single market, the smaller the growth-dampening effect of BREXIT will be. Only in the worst case scenario of a No-deal BREXIT could one expect that the market size effect would quickly dominate the real exchange rate effect;
- as regards the sectoral banking perspective, there are two impulses for relocating UK banking activities abroad, namely partly to the EU27 and partly to the US (New York or other US financial centres). US banks with London subsidiaries will often have a tendency to relocate activities back to New York which for certain financial transactions would represent a second-best economies-of-scale solution;
- one particular aspect of banking FDI in some fields could be oligopolistic interdependency which has been emphasized from a theoretical perspective – and with a focus on many sectors with oligopolistic structures – by Knickerbocker (1973). This could imply that once a major US investment bank in London decides to relocate activities *i* back to the US and relocate banking activities *j* to the EU27, other US banks would

follow suit. Moreover, as soon as one big British bank relocates to the EU27, other big UK banks will likely follow.

The subsequent empirical analysis will focus on the key issue of to what extent BREXIT has affected FDI – or rather general total investment flows into banking in the UK, on the one hand, and British outflows on the other. The analysis naturally considers the development of the nominal exchange rate for the British Pound over the period 1977-2018, while the nominal interest rate vis-à-vis the US$ will be of particular relevance.

3.3 Empirical Analysis

The first problem we face when analysing the structure of foreign investments and assets in the UK banking and non-banking sectors is that a broader databank for bilateral sectoral FDI data does not exist; while the UNCTAD and OECD databanks provide bilateral FDI data, they do not do so on a sectoral level. Although both provide sectoral data, this data is not on a bilateral but rather an aggregated level. Therefore, our first challenge is to find alternative data which describes investment patterns in the UK banking sector and the UK non-banking sector, which is our primary contribution to economic science.

On a national level, some countries do collect micro-data on their firms, including banks, and their investments abroad, such as the MiDi databank of the Deutsche Bundesbank. However, this is done on an individual country level and consolidated statistics or databanks do not exist up to this point. Data on international banking activity (structured with loans/assets/deposits) is also collected on a country level, and then reported to the Bank for International Settlements (BIS). The BIS collects this information relating to the banks of 44 reporting countries and publishes a quarter-wise dataset, the “Locational Banking Statistics” (LBS). Following the bilateral and sectoral structure of the dataset, it becomes evident that this can be analysed using gravity models quite well.

3.3.1 Gravity Models for FDI and Banking

The term gravity model is used in general to describe models in which the economic size of two trading countries, measured in terms of GDP, is a trade stimulating factor, whereas the distance between those two countries restricts or dampens trade between them (Tinbergen 1962). A solid theory evolved around this, at first purely intuitive, model with Anderson and Van Wincoop (2003), who provided a solid econometrical basis considering the consumption- and production-side of countries and transportation costs. In order to capture multilateral in- and outward resistance[22], the fixed effects panel data estimation method has established itself as useful, see Anderson (2011) and Head and Mayer (2014). Those models were extended with dyadic fixed effects by Bruno et al. (2016) for FDI BREXIT analyses, and refined by Welfens and Baier (2018) with respect to zero and negative FDI flows and missing values, getting an even more precise model. The latter is considered as the current state-of-the-art model when analysing multilateral panel (dyadic) fixed effects gravity FDI.

Brei and Von Peter (2017) use the locational banking statistics (LBS) data of the BIS to measure the distance effect in banking, and base their methodology on Head and Mayer (2014). They provide a rather short, but up-to-date literature review on gravity models in international banking and finance focusing on transaction and monitoring costs, which seem to be linear with respect to the distance between an investing bank in country *i* and the subject of the investment in country *j*. This proxies relative frictions limiting the volume of transactions between countries. Frictions in international banking can arise due to issues such as risk assessment[23], information frictions and asymmetries[24], including search costs. Lane and Milesi-Ferretti (2008) analyze bilateral factors driving portfolio equity holdings across countries, using the Coordinated Portfolio Investment Surveys (CPIS) of the IMF. This dataset was also used by Okawa and Van Wincoop (2012) to examine asset

[22] Exports from country i to country j depend on trade costs across all possible export markets (outward resistance); imports into country i from country j depend on trade costs across all possible import markets (inward resistance).

[23] The farther away an investment is, the more difficult it is to anticipate correctly changes and developments in investments; this might be linked to economic and cultural differences, but also, for example, to something as seemingly innocuous as different time zones.

[24] Collecting information about clients and customers is increasingly costly over greater distances.

trade and the cross-border financial frictions which underlie them. The authors also provide a broad literature review on papers which use BIS data in a gravity framework in order to analyze external claims by banks.[25] This confirms the structural convenience of the dataset for gravity estimations with particular respect to precision and quality of the data it contains. The dataset will be described in more detail below.

As identified above, it is not only distance-related frictions which arise in the field of international investment and banking, where traditionally we do not have transportation costs or other similar costs. In analysing significant structural policy changes, such as BREXIT, where the distance between partners does not change in terms of the number of miles or kilometres between them, we rather focus on frictions such as the ending of the "single passport" rule, possible exclusion from the EU single market and exchange rate dynamics, all of which are important for M&A, but also greenfield investment decisions.

3.3.2 BREXIT and the Effect on Investments in Banking and Industry

On the one hand, global investment bankers face higher risks when investing in UK banks, as there has been no structured BREXIT plan delivered up to this point and investors have been left in uncertainty for the past two years (i.e., from 23 June 2016 to December 2018). While there have been discussions with the EU27 on maintaining free trade in goods, but not in services, aspects such as FDI restrictions have been quite neglected in the negotiation process, the omission of the "single passport" rule, which allows international banks in the UK to serve the EU27 market from London, increases uncertainty about future investment in the UK banking

[25] A substantial number of papers also use data on external claims by banks from the BIS. Some recent papers that have estimated empirical gravity equations for equity, bond and bank holdings include Ahearne et al. (2004), Aviat and Coeurdacier (2007), Balli (2008), Balli et al. (2008), Balta and Delgado (2008), Berkel (2007), Bertaut and Kole (2004), Buch (2000, 2002), Chan et al. (2005), Coeurdacier and Martin (2009), Coeurdacier and Guibaud (2005), Daude and Fratzscher (2008), de Santis and Gerard (2009), Eichengreen and Luengnaruemitchai (2006), Faruqee et al. (2004), Forbes (2008), Gande et al. (2009), Garcia-Herrero et al. (2009), Gelos and Wei (2005), Ghosh and Wolf (2000), Hahm and Shin (2009), Jeanneau and Micu (2002), Kim et al. (2006), Kim et al. (2007), Lane and Milesi-Ferretti (2005, 2008), Lane (2005), Martin and Rey (2004), Pendle (2007), Portes and Rey (2005), Portes et al. (2001), Rose and Spiegel (2004), Salins and Benassy-Quere (2006), Vlachos (2004) and Yu (2009).

sector. The risk of a No-deal BREXIT followed by considerably increasing transaction barriers exists. Even in the event of a soft BREXIT, the international market share of UK banking services will decrease. Decreasing growth in the UK economy is dampening the appetite of investors to decide to invest in the UK banking sector. Business is currently being transferred to New York, Dublin, Amsterdam and Paris, not only due to increasing cross-border frictions but also for reasons of oligopolistic interdependencies.

On the other hand, the Pound depreciation in the last two years can lead to increasing brownfield investment, as international investors can "buy out" UK plants more easily and more cheaply. Increasing trade barriers can also be an additional reason for increasing investments in the producing sector: Following Dunning's (1979) eclectic paradigm, especially location-specific advantages such as production-to-market and supply-chain maintenance for UK industry are arguments for increasing investments especially during the run-up to the implementation of BREXIT. Considering the effects of corporate tax rates on FDI inflows (Welfens and Baier, 2018), the announcements in September 2018 of Prime Minister Theresa May with regard to cutting the UK's corporate tax rate to the lowest in G20 is likely to foster foreign investments in the UK's industrial sector.

Vice versa, when we look at UK investments in the EU and the world, one expects that especially investments in the banking sector are spreading, while investments in the industry are stagnating.

3.3.3 Data and Model Specification

We use data on the assets, loans and deposits of global banks in the UK, and of UK banks in the world, respectively, provided by the CBS from the BIS, which describe cross-border banking. In order to understand how this data is compiled in detail, we look at the raw data format which is reported to the BIS by individual countries:

- Data is delivered to the BIS on a monthly basis, on the external positions recorded on the balance sheets of domestic banks.

- The format of the data is prescribed by the ECB's Balance Sheet Items Statistics (BSI); all domestic banks (including the domestic offices of foreign banks) are required to report the aforementioned data according to the ECB format.
- The data is used to observe the global activities of domestic banks; they serve as an input for monetary and balance-sheet statistic aggregates and are the basis for the LBS.
- Assets and liabilities include indebtedness certificates, bonds and securities, investment asset pools, special purpose entities used for the purposes of asset securitization, firm derivatives, banknotes and coins.[26]

Therefore, in the present analysis we rather look at bilateral financial positions, and not at fixed assets or real FDI. The currently available data ranges from 1977 to the first quarter of 2018, reported on a quarterly basis (as of September 23, 2018). In general, the CBS has global data, but availability can depend on the willingness of countries' central banks to report.[27] We use that data in a country-to-country format where we match data reported by the UK with the data of the counterpart country, following Brei and Von Peter (2017), and find that the bilateral data is of an overall good quality compared to bilateral FDI data from OECD or UNCTAD (with few differences in counterparty data, where deviation does occur these are relatively small in dimension). We always use the highest number reported. The UK reports data for only 30 counterpart countries (and offshore centers) who are investing in UK banks and industries, resulting in 4,860 observations.[28] The most important partners, including the US, France, Germany, Netherlands, Japan etc., are covered, also covered are many countries often regarded as tax havens such as

[26] A detailed listing and definition of assets/liabilities/claims can be found on the website of the Deutsche Bundesbank:
https://www.bundesbank.de/resource/blob/611438/f16d975bfe10fc0baba76e984b1cdac4/mL/statso-1-05-auslandstatus-banken-data.pdf pp. 263-268

[27] Some central banks are reticent for reasons of banking secrecy; mainly due to tax avoidance strategies and competitive advantages between countries and their banking sectors. The Bank of England, for example, is one of the central banks who do not report their total linkages to all foreign countries and banks.

[28] Country list of UK partners: Austria, Australia, Belgium, Brazil, Canada, Switzerland, Chile, Germany, Denmark, Spain, Finland, France, Guernsey, Greece, Hong Kong SAR, Ireland, Isle of Man, Italy, Jersey, Japan, Korea, Luxembourg, Macao SAR, Mexico, Netherlands, Philippines, Sweden, Chinese Taipei, United States, South Africa.

Switzerland, Hong Kong, and Luxembourg. We are therefore confident that our dataset presents a representative and meaningful sample size.

Figures 3.1 and 3.2 show the financial claims of global banks in the UK and vice versa. It cannot be determined definitively what effect the BREXIT vote in particular has had, as many factors, which would need to be controlled for in an extended statistical analysis, influence (especially short-term) investment positions. The generally increasing interdependence of global investments from the 1980s on and the 2008 financial and banking crisis, which started with the collapse of the Lehman Brothers investment bank in New York in September of that year, can be seen quite clearly.

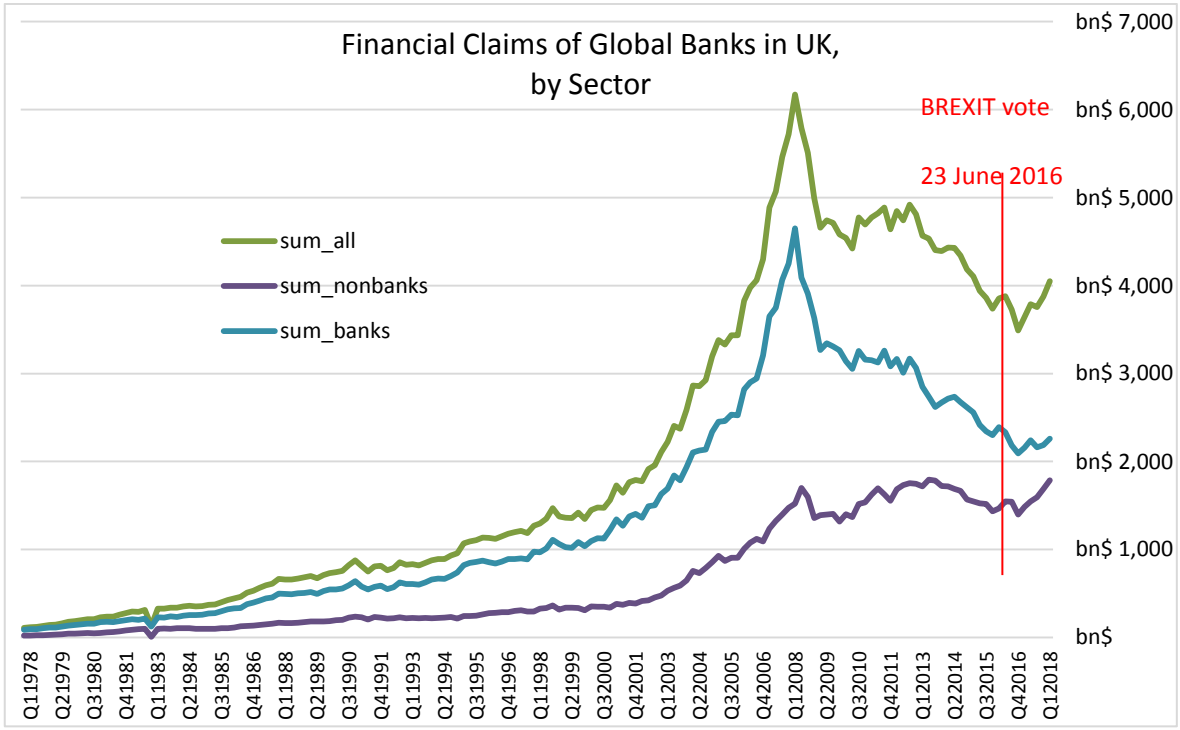

Figure 3.1. Financial claims of global banks in UK, by sector. Source: own calculations; combining the assets/liabilities of UK partner countries, based on data reported by BIS (timeframe 1977-2018).

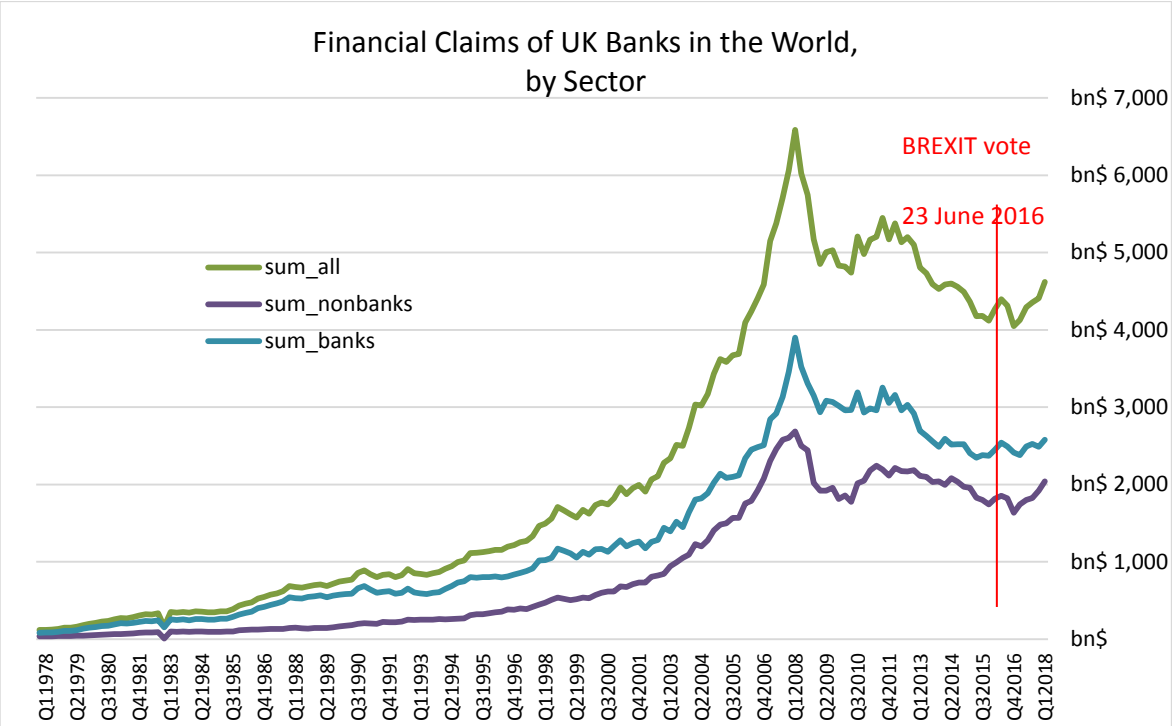

Figure 3.2. Financial claims of UK banks in the world, by sector. Source: own calculations; combining the assets/liabilities of UK partner countries, based on data reported by BIS (timeframe 1977-2018).

Note that while all claims (and assets as counterpart) are reported in current USD, they have originally been recorded in countries' own currencies and British Pounds, respectively, and therefore are affected by a different set of exchange rates to USD. When controlling for exchange rates to USD later, via time fixed effects and a control variable, this negatively affects the integrity our data to a small extent, as the consolidated data relates to many different exchange rates and not only those relating to the USD. Particularly affected in this regard are holdings of coins and banknotes as direct cash reserves, which might lead to a distortion of our results. Therefore it is of interest to determine what magnitude holdings of coins and banknotes are included; as we have no access to internal Bank of England data, we check data on German cash reserves in foreign currencies total (as only aggregates are accessible) and find that they account for only a marginal fraction of total foreign assets (about 0.01%).[29] Taking this as a benchmark and even assuming that

[29] In September 2018, German banks reported holding €233 million in foreign coins and banknotes in contrast to €1,855,669 million in other assets. Source: Balance sheet statistics of German banks,

UK banks would hold more foreign coins and cash due to dimensional differences (significance of Euro(zone)-Pound transactions), we feel confident in neglecting this aspect in our further analyses.

It should be noted that asset position changes could reflect both FDI flows as well as portfolio flows. FDI stocks are expected to play a rather strong role in the financial sector – on obvious reputational grounds which require a strategic investor and often strong control from the equity side; FDI stocks are also expected to play a strong role in technology-intensive sectors where foreign investors would typically seek 100% ownership in high-technology sectors (Jungmittag and Welfens, 2016). The available database does not allow to make a distinction in terms of FDI versus portfolio capital flows in the respective sectors considered in the case of the UK.

In addition, as we see no possibility to control for exchange rate splits (Euro, USD, Yen etc.) described above, due to the nature of the collected data, and considering that previous studies using said data neglected this effect completely, we see the need to point this aspect out but do not correct for it in our analysis. To show that this effect should be quite small, consider the main currencies' exchange rates individually.

Figure 3.3 and Table 3.1 show the split of investments in the UK of the seven biggest investors in the UK; one can see that the US is traditionally the biggest partner of the UK, followed by France which started catching up with Germany after the financial crisis of 2008. Switzerland traditionally had a very large share of total investments in the UK in relative terms, but did not experience a rise of investment as for example the US did, especially since the turn of the millennium, as we can see from the absolute numbers in Table 3.1.

September 2018, Deutsche Bundesbank.

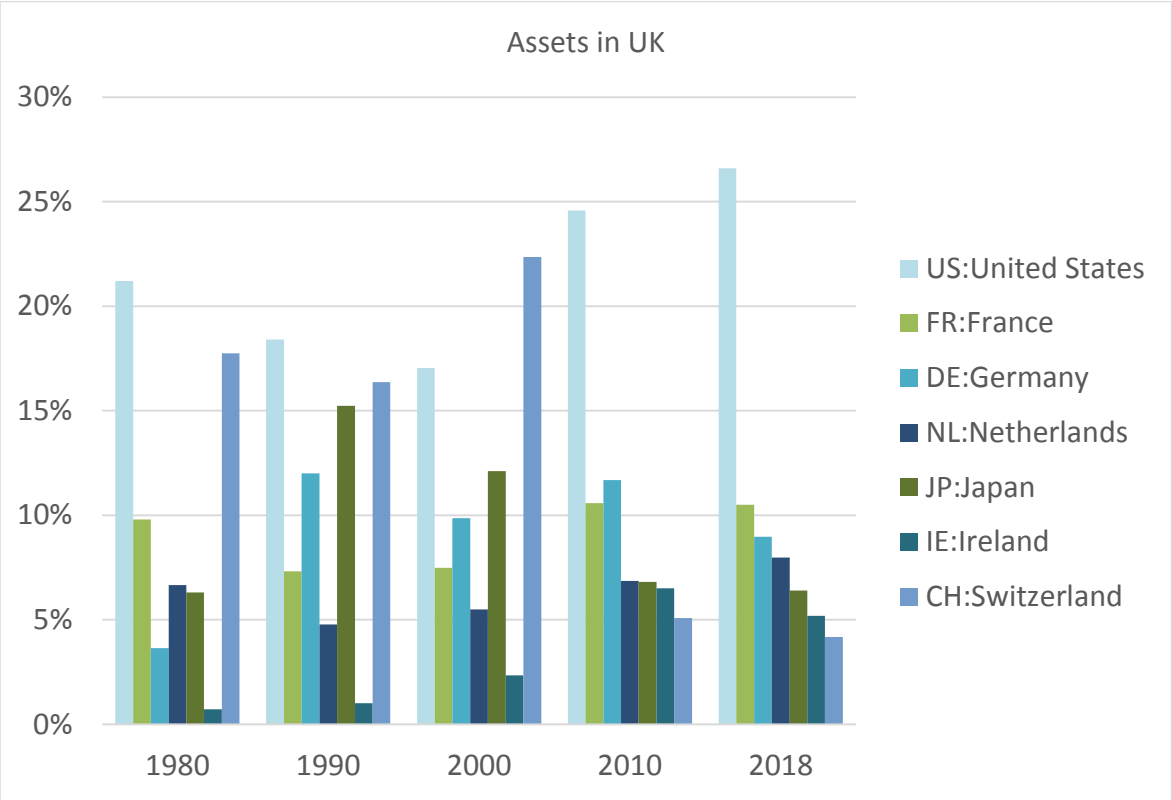

Figure 3.3. Financial claims in the UK of the UK's top seven partners. Source: own calculations; combining assets/liabilities of UK partner countries, data reported by BIS reported data (timeframe 1977-2018).

Table 3.1. Financial claims in the UK of the UK's top seven partners, in billion USD.

	1980	**1990**	**2000**	**2010**	**2018**
US:United States	42	137	247	1,116	1,077
FR:France	19	54	109	481	425
DE:Germany	7	89	143	531	364
NL:Netherlands	13	36	80	312	323
JP:Japan	12	113	175	309	259
IE:Ireland	1	7	34	296	210
CH:Switzerland	35	122	324	231	169

Source: Own calculations; combining assets/liabilities of UK partner countries, data reported by BIS (timeframe 1977-2018).

Our study uses these data as dependent variables in a gravity setting, resulting in six different models. Models (1)-(3) use global investments in the UK in total and by sector (banking and non-banking), while models (10)-(12) use global UK investments

(total, by sector).[30] The GDPs of countries traditionally serve as control variables for the economic size of the respective countries and sectors, while we control via country fixed effects for a broad range of individual unobservable factors which are time-invariant (such as language, culture, history, whether countries share a border or have access to the sea, but also for example the World Bank's "doing business" indicator which is time non-varying for many countries). The panel structure controls for years and quarters, and therefore also for time-variant USD exchange rates, assumed it evolves relatively constant.[31] We therefore compile the following model:

$$\ln POSITION_d = \alpha_0 + \alpha_1 lnGDP_{ot} + \alpha_2 lnGDP_{dt} + v_d + \delta_o + \tau_t + e_{odt},$$

with the following notation:

α_0 – regression constant,

GDP_{ot} – time-variant characteristics of the origin country such as GDP,

GDP_{dt} – time-variant characteristics of the destiny country such as GDP,

v_d – destination event BREXIT vote,

δ_o – country fixed effects for the origin country,

τ_t – time fixed effects,

e_{odt} – error term.

We additionally control in models (10)-(12) for whether the origin/destination country is a EU27 member, in order to check whether EU27 countries have different investment patterns when it comes to their decision to invest in the UK. We capture the BREXIT effect with a dummy variable which switches from 0 to 1 as of the third quarter of 2016, i.e. 8 days after UK citizens voted to leave the EU, following Friewald's (2012) methodology. A poisson pseudo maximum likelihood (PPML) setting is utilized (see Welfens and Baier 2018 for a review).

[30] Note that models (4)-(9) represent robustness checks for asset inflow to the UK, including exchange rates and controlling for the Euro Area instead of EU membership

[31] For robustness, we check the model with exchange rates on an annual (not quarterly) basis in order not to interfere with time FE; we use annual data for the period 1977-2016 from the Federal Reserve Bank of St. Louis, for 2017/2018 averaged daily data from the Bank of England, where for 2018 we average the first quarter only; see Table 3 (in Appendix).

Compared to traditional gravity modelling, we therefore use a single-country model and deviate from Anderson and Van Wincoop (2003) regarding multilateral resistance, losing out on the explanatory power of for example 'how do German investments in UK change if the US-German investment relationship changes' to use an example of two very important partners of the UK. However, via country and time fixed effects, we control for a broad part of this. What we gain by using this design is that we can measure UK-specific effects, as we only look at inflows and investment into the UK as well as UK outflows. With a general gravity model, country specific measurements become more difficult, usually quantitative results have to be applied with qualitative arguments to mask certain countries of interest. Moreover, predictions are somewhat hard to discern and defend with this model; our goal is to show whether and how investment patterns have changed due to the BREXIT vote. We want to find answers to our main hypotheses:

- Hypothesis 1: Mid- and long-term banking investments in the UK (total) will drop due to increasing frictions and less economic growth. UK investments abroad will drop for the same reasons.
- Hypothesis 2: The depreciation of the Pound after the BREXIT vote fosters brownfield investment and therefore international financial claims will rise particularly in the non-banking sector. Mirror effect: The UK is more likely to invest less in the non-banking sector abroad.
- Hypothesis 3: EU27 regulatory pressure on London City banks to relocate EU wholesale banking activities to the EU/Eurozone; increasing risks and frictions, a smaller market share of the UK banking industry (in the UK as an EU27 wholesale market) and oligopolistic interdependencies in the banking sector will reduce international financial claims in the banking sector. The mirror effect will be that the UK is more likely to invest more in the banking sector abroad.

The subsequent analysis presents empirical evidence on these hypotheses – with the already mentioned caveat in terms of available data.

3.3.4 Empirical Findings

The findings for models (1)-(3), which analyze monetary inflow, investments and claims of foreign banks in the UK, are presented in Table 3.2. All dependent variables were first tested for stationarity.[32]

Table 3.2. Claims of foreign banks in the UK, in all sectors (non-banking and banking), 1977-2018.

Variables	(1) asset_all	(2) asset_nonbanks	(3) asset_banks
partner_eu	0.0324	0.204***	0.0287
	(0.0543)	(0.0548)	(0.0659)
brexitvote	-0.135	0.207**	-0.521***
	(0.0926)	(0.0935)	(0.112)
ln_partner_gdp	0.513***	0.500***	0.500***
	(0.0420)	(0.0606)	(0.0515)
ln_uk_gdp	1.132***	1.316***	1.163***
	(0.0723)	(0.0746)	(0.0831)
Constant	-26.27***	-32.93***	-28.45***
	(1.813)	(1.663)	(2.085)
Observations	4,270	4,270	4,270
R-squared	0.943	0.968	0.907

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

The *partner_eu* variable indicates whether the home country of the investing bank is a EU27 member, *brexitvote* is a dummy variable which switches to 1 at the third quarter of 2016. Time fixed effects and country fixed effects were applied in all models, but not displayed for ease of interpretation of the results. The relatively high R-squared in all models show that our multiple fixed effects models have good explanatory power. Model (1) shows the total claims of foreign banks in the UK in all sectors, while model (2) and model (3) distinguish between the non-banking sector (2) and the banking sector (3). Countries' GDPs are positive and significant in all models, which is in line with the usual gravity theory.

[32] The Breitung unit root test, Hadri Lagrange multiplier stationarity test, and Im-Pesaran-Shin unit root test show significant P-values indicating stationarity, while Levin-Lin-Chu and Fisher unit root tests show insignificant values; we follow Fidrmuc (2009) and transfer his findings on OLS to PPML stating that our fixed effects take into account potential non-stationarity.

For overall investments in the UK, we find a negative coefficient for the BREXIT vote which is not significant. This indicates that total investments in the UK did not decrease significantly since mid-2016. However, when splitting investments into sectors, we find a positive and significant effect of *brexitvote* in the non-banking sector model (2) (0.207**, standard error 0.094), while we find a negative significant effect for the banking sector model (3) (-0.521***, standard error 0.112), indicating that since the BREXIT referendum, banks have increased their investments in non-banking operations, but decreased investments in the banking sector. For robustness, we estimated the same model including annual average nominal exchange rates for the USD to British pound in Table B1 (see Appendix)[33], where we find that we lose out on the significance of the BREXIT vote with respect to non-banking investments (model 5), but gain significance for a negative overall impact on investments in UK (model 4). This underlines Hypothesis 2 where we argue that due to the BREXIT vote and the subsequent Pound depreciation, we find increasing investments in the non-banking sector, and supports the Barrell and Pain (1996) theoretical model. The coefficients of all other control variables remain unaffected, adding to the robustness of the analyses. When controlling for correlation in Table B3 (in Appendix), we find the expected negative correlation for *brexitvote* and *dollar_pound_rate*, which supports our arguments.

When the 'nationality' of the investing bank is that of an EU27 member country, it only matters significantly for investments in the non-banking sector model (2) (0.204***, standard error 0.055): EU27 countries invest significantly more in the UK non-banking sector.[34] When checking for the Eurozone instead of EU27 membership, we find the same results for *brexitvote* in models (7)-(9), but the Eurozone holds significantly more claims in the UK – especially in UK banks – than the rest of the world (Table B2, in Appendix). Subsequently we find that non-Eurozone EU27 countries are more likely invest in UK industry, while Eurozone EU27 countries are more likely to invest in EU banks.

[33] We use the FRED real foreign exchange rate index; decreasing numbers mean weaker BPS and stronger USD.

[34] Adding exchange rates in model (5) leaves results unchanged.

Table 3.3 shows the findings for models (10)-(12), where we analyze the investment pattern of UK banks outside their home country.

Table 3.3. Claims of UK banks in the world, in all sectors (non-banking and banking), 1977-2018.

Variables	(10) asset_all	(11) asset_nonbanks	(12) asset_banks
partner_eu	-0.240***	-0.948***	0.0960*
	(0.0406)	(0.0505)	(0.0558)
brexitvote	-0.130	0.0183	-0.163
	(0.0925)	(0.137)	(0.120)
ln_partner_gdp	0.854***	0.422***	1.015***
	(0.0467)	(0.0509)	(0.0635)
ln_uk_gdp	0.827***	1.377***	0.596***
	(0.0929)	(0.158)	(0.0986)
Constant	-26.05***	-31.85***	-24.60***
	(2.392)	(4.303)	(2.367)
Observations	4,270	4,270	4,270
R-squared	0.963	0.971	0.903

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

Once again, GDPs show highly significant results; larger countries in terms of GDP attract more investments, which adds to the robustness of the model in general. The variable *brexitvote* shows no significant results in all models (10), (11) and (12), indicating that UK banks' investment choices have not been affected by the BREXIT vote on 23 June 2016. Note that this does not mean that UK investment patterns did not change in the time frame since then, but changes were controlled for via fixed effects and were not caused by preparations for a future BREXIT, which would have been captured by a significant *brexitvote* variable.

EU membership however has significant signs for the total asset model (10), the non-banking sector (11) and the banking sector (12); UK banks invest significantly more in non-EU27 countries than in EU27 countries in total (-0.240***, standard error 0.041), a finding that in large part is explained by the role of the US, where the UK holds assets worth $1,275 billion in Q1 2018 which is about the amount of France, Germany and the Netherlands combined. The UK also has holdings in Japan

worth $390 billion, followed by Australia, Switzerland and Hong Kong, which are all non-EU27 countries. This, however, is mainly driven by the non-banking sector, as we can tell by model (11), whereas the UK is significantly more likely to invest in the EU27 banking sector than in the banking sectors of non-EU27 countries, even though only slightly (0.096*, standard error 0.056). This mirrors the merge of the UK and EU27 banking industries in the last decades, and thus far has not been affected by the BREXIT vote.

The fact that the sectoral effects of the *partner_eu* variable are different in sign could, however, also indicate an indirect BREXIT effect: The *partner_eu* variable has a positive effect and shows that in general there are positive incentives for the banking sector to invest in EU partner countries which could also reflect the particular aspect of the banking sector being part of the services sector which for practical purposes often requires a complementary local presence, for example in investment banking. By contrast, the non-banking sector, read the manufacturing industry, will often consider outward asset stocks (e.g. outward FDI stocks in EU partner countries) to be a substitute for trade which could explain the negative sign for the *partner_eu* variable outside the banking sector. The foreign presence of the home country bank typically will encourage non-banking FDI outflows into the host country selected by the respective bank (for empirical evidence, see Poelhekke 2014). The implication is that British non-banking FDI outflows to the EU27 could increase on the basis of this mechanism to some extent; however, the net effect on non-banking FDI still should be negative according to our regression results.

Overall, we see a one-sided effect: While global banks shifted their UK investments from the banking sector to the non-banking sector after the BREXIT vote, and EU27 investments in the UK non-banking sector additionally increased in general, UK banks' outward investments have not been affected by the UK decision to leave the EU up to this point.

3.4 Policy Conclusions

The full implementation of BREXIT would be a stronger signal than the EU referendum decision which left unclear for most investors how future EU-UK trade and investment relations – and cooperation in the banking sector – would look after March 29, 2019. The results presented have shown a distinct pattern of asset accumulation abroad in the banking sector versus the non-banking sector.

The UK should expect reduced capital inflows into the non-banking sector post-BREXIT while the prospects for inward capital flows into the banking sector are rather unclear as regards the pure BREXIT effect. As, however, most simulations of macro models show a negative long-run GDP effect for the UK post-BREXIT – and very much so in the case of a No-Deal BREXIT (see, e.g., HM GOVT. (2016) a pre-referendum study by the Treasury) – one should expect that overall capital inflows into the UK (both in the banking sector and in the non-banking sector) would decline post-BREXIT. Thus, for the UK government there will be a strong incentive to stimulate output growth in the UK by various policy measures, in the fields of monetary policy, broadly defined, fiscal policy as well as in regulatory policy.

If the UK would want to avoid a negative effect of BREXIT on banking FDI inflows, one could consider three basic policy options:

- To deregulate banking in the UK, by signaling, for example, that the loan-to-value (LTV) ratio policy will be rather generous so that the prospects for an expansion of loans in the UK would be rather favorable. This in turn might attract complementary FDI inflows from outside the banking sector, say in the construction sector. However, any deregulation that pushes for a soft LTV policy stance also runs a risk, namely to the extent that monetary policy is shaped by a Taylor rule (for the case of the US see e.g. Bachmann and Ruth 2017). As the Taylor rule suggests (with r standing for the normal real interest rate, π for the inflation rate and π' for the central bank's inflation target; Y is output and Y' normal output; H and H' are positive parameters) to set the central bank interest rate $i^{CB} = r + H(\pi - \pi') + H'(Y - Y')$, a soft LTV policy that would raise output in the construction sector - and thus raise Y - could lead to a generally more restrictive monetary policy since the Bank of

England would have to react to the more frequent positive output gaps (*Y-Y'*). It is not clear how this interaction would ultimately affect the stability of the UK's banking system and of the British economy at large.

- One natural policy option for attracting higher overall FDI into the UK could be further reductions of the corporate tax rate as emphasized in Welfens and Baier (2018). Whether or not this is politically feasible and how the EU countries would react to such a strategic reduction of corporate tax rates is unclear.
- Promotion of Fintech activities of UK banks could be useful, as higher expected profits of banks would stimulate FDI inflows in the UK.

The Eurozone and the EU27, respectively, could benefit from higher banking FDI inflows in the medium term and the long run, not least since mainly big banks will relocate to some Eurozone countries. Big banks already have subsidiaries or branches in the Eurozone so that legal adjustment is sometimes needed in the short term, while the hiring of more staff and the implementing of complementary asset accumulation could be a gradual stock adjustment process. The stability of the Eurozone/EU27 banking system could be reinforced by the inflow of higher banking FDI from London's City banks. However, there is one caveat, namely that the ratio of banking value-added to the GDP of the respective host country should not be raised toward a higher critical level – if there were any future national or international banking crisis, the governments of host countries must come up with bridging financing and possibly the ability and willingness to recapitalize ailing banks. From this perspective, the Eurozone has no interest in witnessing the attracting of high banking FDI inflows into countries such as Italy, Greece, Belgium or Cyprus, all of which are countries which currently face a high public debt-GDP ratio. A particular challenge for the Eurozone and the EU27 could emerge if a considerable share of London banking activities would be relocated to the US where new banking deregulation and other economic policy initiatives, including tax reforms, would raise the US relative stock market valuation so that US-based banks could more easily take over foreign rivals, for example banks in the Eurozone/EU27. A similar argument holds, of course, if UK banking deregulation would be adopted.

Any broad banking deregulation in the US and in the UK would thus put new pressure on the EU27 to also deregulate banking; if this is done in an excessive way, the seeds of the next international banking crisis would have been sown. From this perspective, it is quite important that EU27 countries would coordinate their international activities more strongly, say at the IMF, the G20 and at the Bank for International Settlements. To the extent that the UK government takes sides with the Trump Administration in multilateral organizations, the EU27 could be facing a rather difficult challenge in the future – post-BREXIT.

If BREXIT should trigger partial instability in the Eurozone – for example in the context of induced conflicts between a majority of Eurozone countries and Italy over the latter's proposed fiscal policy – there could be additional effects to be considered. Outside the banking sector, changes in asset positions and FDI stocks, respectively, could also be influenced by changes in relative unit labor costs. Whether or not British trade unions' wage policy, for example, will change after BREXIT remains an open question. If the EU27 should face a higher concentration ratio in banking post-BREXIT, this could also affect relative labor costs in that sector. These are questions for future research. One may wish that the governments of the EU28 countries would finally consider publishing the available FDI data in the banking sector in a transparent and timely fashion – this would help economists and others to conduct research in a more precise way which, in turn, would generate potential benefits for policymakers who could get a better understanding of FDI dynamics in key sectors of the economy. Once the UK leaves the EU it is likely to adopt broad banking deregulation so that OECD regulatory indices for the UK and the EU27 countries can be expected to differ more strongly post-BREXIT, which represents yet another field for future research.

Appendix B

Table B.1. Claims of foreign banks in the UK, additionally controlling for average annual exchange rates, 1977-2018.

Variables	(4) asset_all	(5) asset_nonbanks	(6) asset_banks
partner_eu	0.0324	0.204***	0.0287
	(0.0543)	(0.0548)	(0.0659)
brexitvote	-0.713***	-0.377	-0.965***
	(0.175)	(0.231)	(0.198)
ln_partner_gdp	0.513***	0.500***	0.500***
	(0.0420)	(0.0606)	(0.0515)
ln_uk_gdp	1.225***	1.312***	1.246***
	(0.0843)	(0.115)	(0.0969)
dollar_pound_rate	-0.784***	-0.746**	-0.615**
	(0.217)	(0.316)	(0.243)
Constant	-27.38***	-31.34***	-29.60***
	(2.048)	(2.744)	(2.302)
Observations	4,270	4,270	4,270
R-squared	0.943	0.968	0.907

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

Table B.2. Claims of foreign banks in the UK, controlling for partner in the Eurozone, 1977-2018.

Variables	(7) asset_all	(8) asset_nonbanks	(9) asset_banks
Partner_euro	0.207***	0.000771	0.327***
	(0.0349)	(0.0634)	(0.0366)
brexitvote	-0.136	0.208**	-0.526***
	(0.0887)	(0.0936)	(0.105)
ln_partner_gdp	0.496***	0.500***	0.479***
	(0.0425)	(0.0649)	(0.0502)
ln_uk_gdp	1.102***	1.320***	1.102***
	(0.0755)	(0.0738)	(0.0862)
Constant	-25.01***	-33.03***	-24.67***
	(1.936)	(1.746)	(2.182)
Observations	4,270	4,270	4,270
R-squared	0.943	0.968	0.914

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

Table B.3. Correlation matrix of investment variables in the UK, BREXIT vote and USD-GBP exchange rates.

	asset_all	asset_nonbanks	asset_banks	brexitvote	dollar_pound_rate
asset_all	1				
asset_nonbanks	0.8799	1			
asset_banks	0.9423	0.6701	1		
brexitvote	0.084	0.1038	0.0582	1	
dollar_pound_rate	-0.0455	-0.0613	-0.0278	-0.3267	1

4 Foreign Direct Investment and Tax: OECD Gravity Modelling in a World with International Financial Institutions

4.1 Introduction

"Big TAX REFORM AND TAX REDUCTION will be announced."

This tweet from US President Donald Trump on April 22nd, 2017, signaled the intention of his administration to reduce firms' incentives to invest abroad and to attract more foreign firms to invest in the US. The tax reform he referred to came into force on January 1st, 2018. However, has the promise of such reform been fulfilled? Will the US attract more investment, creating jobs and wealth?

"Theresa May pledges to slash taxes to lowest rate in G20 to make Britain a post-Brexit economic powerhouse."

This title headline on the British "Telegraph" newspaper on September 26th, 2018, concerned the Prime Minister's plan to mitigate losses due to less foreign direct investment (FDI) inflows to the post-Brexit UK economy. Today, the UK is still a full member of the European Union and even though professionals' opinions are divided about how big the effect of Brexit on FDI flows will be, the broad consensus is that there will indeed be a negative impact. To what extent, and under which circumstances, tax rate reductions could oppose a negative impact will be discussed in the present paper.

The effect of corporate tax on FDI has been discussed extensively over the past 30 years (see for example Baccini et al. 2014; Bénassy-Quéré et al. 2000; Bloningen 2005; Bretschger and Hettich 2005; Chisik and Davies 2003; Ghinamo et al. 2007; Nielsen et al. 2017). Although most researchers find a significant impact, the results are, however, mixed; the estimated impacts on FDI related to a 1 percentage point corporate tax rate decrease (see Feld and Heckemeyer 2011) range between -1.26% and +9.80%, strongly varying between the data (source, time period, flow/stock) and modelling approach employed. In order to provide a clear cut picture, frame conditions for both the data and models used have to be set. Moreover, FDI effectively means international economic cooperation at a firm but also at a country level and therefore requires a global framework and rule-setting in order to develop to its full potential. Looking at recent disintegration processes within the EU and

increasing instances of unilateralism rather than cooperation grounded in multilateralism globally[35], one can consider whether these developments will rather promote or restrict FDI activities in the future. National interactions with international institutions are necessary in order to reach fair agreements, including seeking to prevent individual nations from deviating strongly in their tax policy in order to reap short term and one-sided benefits. If such a deviation strategy and disintegration is indeed seen to be beneficial, this would stimulate an international downward tax reduction game (similar to a "prisoner's dilemma") reaching a new steady state where all parties are strictly worse off than if they cooperate. In the present study, FDI inflows are analyzed between a set of countries roughly homogenous in terms of national fiscal policy, especially corporate taxation, as well as participation in and interaction with selected international financial institutions.

Using bilateral FDI flow data from 1985-2017 in a gravity model framework,[36] the role of corporate tax and financial institutions in firms' investment decisions is analyzed. The findings show significant negative interaction between FDI inflows and the corporate tax rate, however tax evasion strategies rather depend on FDI flow destinations and not on origin countries' fiscal policy, as the home corporate tax rate has no significant effect on the level of outflow. International financial data exchanges via the Bank for International Settlements (BIS) and participation in programs of the European Bank for Reconstruction and Development (EBRD) negatively impact FDI inflows, while memberships of other financial control institutions have no significant impact. The total effect of corporate tax on FDI inflows decreases over time between OECD members.

The remainder of this paper is structured as follows: Section 2 gives a short overview on the theoretical FDI aspects and gravity modelling for FDI, corporate taxation and international financial institutions; Section 3 discusses the data and modelling specification; Section 4 presents and interprets the empirical results; Section 5 discusses relevant policy implications of the findings and concludes.

[35] Here, we abstain from listing specific examples, as several such events can be found detailed in daily media reports (April-July 2019).

[36] Models which use the economic size and distance between interacting countries as major explanatory variables are referred to as gravity models; see Shepherd (2017) for a general introduction and literature review.

4.2 Theory

4.2.1 General FDI Theory and Main Determinants for FDI Inflows

The 21st century has seen an unprecedented rise in the level of economic globalization, most visually in terms of trade and migration, but most persistent in terms production networks, supply chains and international financial and institutional integration. This process of globalization, which has increasingly been monitored since end of World War 2, was originally intended not only to increase global wealth, but also to maintain peace and establish strong free-market economies to counter the spread of socialist ideas in the Cold War era. This increasing industrial and financial globalization can be witnessed particularly when looking at (multinational) firms engaged in foreign countries via direct investments for a) ownership, b) location and c) internalization (OLI) advantages (Dunning 1979). However, the incentives for FDI are much more complex than that. While a broad range of empirical literature exists on the determinants of FDI, including in gravity settings (see, for example, Bloningen 2005, Pandya 2016 or Nielsen et al. 2017, just name but a few), Faeth (2009) gives a review of theoretical models explaining FDI:

- Neoclassical trade theory á la Heckscher-Ohlin factor endowment and specialization models as well as more recent knowledge-capital models in the context of horizontal and vertical FDI; while studies analysing factor endowments as driving factors for FDI show mixed results, the rationale should nevertheless be considered in the field of horizontal FDI with special importance on (risk) diversification.[37]
- A major part of theoretical models centres around the classical OLI-approach, naming "…a combination of ownership advantages, market size and characteristics, factor costs, transport costs, protection and other factors including regime type, infrastructure, property rights and industrial disputes" (Faeth 2009, p. 174). The relative size and growth of foreign

[37] Multinational firms engage in several countries with similar amount and size of business. This sort of FDI is mostly driven by production-to-market and incentives are expected to rise with distance and increasing transportation cost and as well target country market size (GDP).

markets are especially highlighted, as well as ownership advantages in monopolistic terms.[38]

- Policy variables as determinants of FDI are specifically discussed, especially political and investment stability as well as fiscal incentives like corporate tax. While the latter almost always have significant effects on FDI, the magnitude is fairly low and the author advises that those variables shall be used rather as control variables for researchers not including the much stronger policy variables.

Discussing the latter is necessary, as a distinction between countries and economic zones is strongly recommended: While there are close to 200 nations on our planet, only a relatively small number of them are economically large enough to have a significant impact on the global trade and investment networks, also being broadly similar in their individual political endowment (see for example the CPIA database of the World Bank Group, data and indices provided by Transparency International, the Heritage Foundation or V-Dem). So while policy variables are crucial for general FDI theory and theoretical frameworks (see Nielsen et al. 2017 p.65), their utilization is quite restricted in panel gravity FDI studies, especially as policy variables are responsible for little to no variance in major datasets. On the other hand, fiscal incentives, such as the corporate tax rate, can differ significantly between a set of countries with otherwise homogenous political endowments.[39] We choose bilateral FDI flows between all OECD countries as our sample, as those 36 countries account for roughly 70% of global FDI flows and stocks – tackling the homogeneity issue by introducing country as well as dyadic fixed effects in order to control for all time non-varying characteristics.[40]

Other theoretical aspects refer to the role of the size of the source and target economy to promote FDI as well as the (physical and cultural) distance between

[38] Contrary to horizontal FDI, vertical FDI does depend on transportation costs and therefore distance, and not necessarily on market size but rather production factors as for example wages / GDP per capita. See also Bergstrand and Egger (2013).

[39] See Table A1 in the Appendix; missing observations are not significant as only immaterial FDI flows relating to respective targets and years are observed.

[40] In many cases, this already includes common policy variables like corruption, safety and investment security, political stability etc.; the "Doing Business Index" developed by the World Bank is also unsuitable for similar reasons, see Anderson and Gonzales (2013).

them to constrain FDI, legitimating analysing FDI in gravity frameworks. The classical country specific theoretical roots from trade theory are also applicable here, utilizing the CEPII country level data targeting FDI destination and parent firm location, which is discussed in the next sub-chapter.

4.2.2 Gravity Modelling in FDI

Gravity modelling (as originally applied) for trade is derived directly from Newton's Law of Gravitation, as it uses the economic sizes of and the distance between trading partners as major control variables (see Tinbergen, 1962).[41] The lack of a sound micro-foundation is successfully tackled by Anderson and Van Wincoop (2003) who provide researchers with a theoretical model combining international supply (production) with demand, anticipating iceberg transportation costs. Additionally, the model accounts for multilateral (inward and outward) resistance, taking into account that demand and supply does not only depend on the two interacting partners, but on the whole set of market participants.

Since then, the application of the model has been consistently improved, as illustrated by Shepherd (2017) who compiles and regularly updates a "user guide" for UN-ESCAP (Economic and Social Commission for Asia and the Pacific) researchers. Major developments are the inclusion of sets of country and dyadic fixed effects (Anderson 2011; Head and Mayer 2014) and the adaption of Poisson Pseudo Maximum Likelihood (PPML) estimators in log linearized form for panel data[42] (Baldwin and Taglioni 2007; Martínez-Zarzoso 2011; Silva and Tenreyro 2006). PPML is the first choice for such models with up to 50,000 observations in combination with lower thousands control variables including fixed effects (Head and Mayer 2014; Kareem et al. 2016), even though many researchers use Ordinary Least Squared (OLS) estimators for reasons of robustness.[43] Using more data and/or

[41] This was a rather practically driven approach, as estimation results for distance and GDPs held very high explanatory power in those models.

[42] For Stata implementation, annual fixed effects are a practical solution for non-available panel commands when using PPML estimators such as the xtreg.

[43] Following Kareem et al. (2016) and Silva (discussion forum), OLS results degrade quality-wise with increasing numbers of observations; also note that the OLS estimator does not count "zero" flows between countries and therefore is only suitable if few or no zeroes occur; solutions to this issue can involve re-scaling or assigning small numbers, see Welfens and Baier (2018) for a

implementing larger numbers of control variables requires different econometric approaches due to practical issues (see Stammann 2017).

Even though a majority of gravity studies analyses trade relationships, the approach has proven itself useful for FDI researchers as well, and even finds application in migration and labour economics. Chapter 2.1 gives a brief literature overview on gravity models which are applied to FDI. One of the more recent reviews by Nielsen et al. (2017), evaluating 153 empirical studies between 1976 and 2015, also examines the role of corporate tax with regard to FDI destination choice, being used as a control variable in 29 studies, functioning along with target country's GDP as a proxy for demand. Both variables are found to be significant in most studies, even though evaluating results for corporate tax does not give a clear-cut picture. The positive effects of target GDP on FDI flows and/or stock in most studies are perfectly in line with FDI market seeking theory. FDI source country GDP, subsequently origin country GDP, is found not to be as straight forward: Gravity theory for trade would predict a positive interaction, as large and strong economies have the potential to serve a larger share of total global demand. FDI gravity might be more complex here, on one hand large origin economies potentially have more economic power and prospects to interact globally, and multinational companies might be more likely to grow from a national to an international competitor from the base of a large domestic market. On the other hand, multinational firms in today's world do not necessarily 'belong' to their physical home country, or the country in which they were founded, but place their head office for strategic, financial, legal or political reasons to other countries (examples might be Switzerland, Ireland, Luxembourg etc.). Distance is found to be negatively significant in most studies, supporting vertical FDI theory.

As none of those studies considers dyadic fixed effects, which prove to have very high explanatory power, and as PPML estimators are also barely utilized,[44] it is the goal of the present paper to close this research gap. Leading studies using such models have been published by Bruno et al. (2016), Barrell et al. (2017) and Welfens

discussion.

[44] This should be no surprise, as the PPML estimator for gravity is still quite new and is currently being developed.

and Baier (2018) where all analyse the effect of European Union membership and FDI attractiveness (mainly in the context of Brexit), using OECD stock and flow data from 1985-2012. Welfens and Baier (2018) also control for corporate tax, and find similar results as Folfas (2011) and Wojciechovski (2013) for their gravity tax research, who use Hausman-Taylor estimators without dyadic fixed effects, but instead the full set of time non-varying CEPII country and country pair variables such as distance, contiguity, common language or colonial relationship and so on. The fact that all three studies yield similar results despite using different econometrical approaches is picked up subsequently in chapters 3 and 4. The role of tax and international financial institutions for FDI decisions shall be discussed in the following sub-section.

4.2.3 The Role of Tax on FDI

While gravity FDI tax research is limited, there is a broad range of literature on corporate tax rates and FDI; in general, low foreign tax is analysed in combination with FDI incentive factors rather than discussing a high domestic tax rate as a reason for tax avoidance and therefore increasing investment outflows. As an overview on FDI tax reviews is already given in the introduction of this paper, this aspect will not be stressed further and rather relevant arguments by selected authors on which the hypotheses of the present paper are built are discussed.

Feld and Heckemeyer (2011) point out that the effects of tax or tax differentials between countries on multinational companies' decisions are insufficiently analysed, and the findings which have been made – especially on degrees of effects – are very heterogeneous. In their meta-study they collect a range of arguments as to why and to what extents findings can be biased.

- *Double taxation treaties:* For most OECD countries, double taxation treaties came in force since the 1980s[45] or earlier (IBFD Tax Treaties Database), implementing either the credit or exemption system. While the latter does not tax foreign income, because such is already taxed by

[45] Actually prior to the 1980s as well, but that decade saw continuing (re-)negotiations of older treaties which were previously in place.

the country where the income was derived and therefore tax avoidance incentives are present, the credit system taxes all income in a double count (total domestic plus foreign income will be taxed by the home country, foreign income may also be taxed additionally on top, abroad). The firm can offset the foreign-paid tax against the total home country tax bill, and therefore has no incentive for tax avoidance. Thus, the effect of corporate tax on FDI decisions should be rather limited for countries which follow the double taxation credit system (Slemrod 1990). Countries following the exemption system usually counter tax avoidance via national laws.[46] In both cases, thus corporate tax should not significantly affect FDI decisions, even though empirical studies by Jun (1994) and Wijeweera et al. (2007) who explicitly control for double taxation treaties contradict this and find significant effects. In our OECD sample, dyadic fixed effects will control for potential outliers, such as Brazil, which have never signed (or resigned) any tax treaties with several OECD partners. Another solution to double taxation treaties can be the usage of effective average tax rates, which reflect national or bilateral tax incentives, an approach which yields similar results in gravity model settings (Bellak et al. 2009 and Egger et al. 2009) than when using pure corporate tax rates in OECD or EU samples only (Folfas 2011; Welfens and Baier 2018; Wojciechovski 2013).

- *Regional difference in international taxation:* In a global perspective, developing economies face much greater competition pressures concerning FDI attractiveness, and generating corporate tax incentives usually has a higher effect, especially in the absence of (bilateral) tax treaties, where they can use discriminatory tax policy in an "…more targeted and cost efficient manner" (Andersen et al. 2018).
- *Data availability and access:* Studies need to be distinguished on the basis of whether firm level panel data (micro data) or aggregated FDI

[46] In Germany for example, an actually agreed exemption method in the double taxation treaty with another country will be switched to the credit system according to national law if the company earns certain passive income and if there is a low tax rate applicable in the foreign country (§ 20 para. 2 AStG).

data (macro data) is used; using micro data limits a global approach in a sense that data is not (sufficiently) available for many countries and/or years, while macro data generally struggles with problems of precision: In theory, macro data is aggregated micro data by institutions as the World Bank (UNCTAD), OECD or the BIS, to name the most popular. Different national and international (institutional) reporting standards, firm sizes etc. also yield different incentives for foreign investment and therefore impact the importance of corporate tax.[47] The tax effects found in studies using micro data are generally lower than in macro studies (Feld and Heckemeyer 2011), indicating that smaller firms do not care as much for tax incentives as bigger firms do. This is a potential bias we will discuss in our results, as those therefore tend to overestimate the degree of the corporate tax effect.

- *Discrete and continuous investment choices:* Micro data can distinguish between discrete and continuous investment choices which yields different outcomes in respect to corporate tax as well, where rather continuous arguments are of importance as they proxy real economic activity in terms of property, plant and equipment (Buettner and Wamser 2009; Overesch and Wamser 2010). Reviewing the literature concerning that issue, Feld and Heckemeyer (2011) conclude that studies using micro or macro data can control for firm specific location preferences due to already existing tangible fixed assets via country and time fixed effects, "[which]… can indeed alter the size and particularly the significance of tax effects estimates," (Feld and Heckemeyer 2011).
- *Publication bias:* In their meta-study, the authors find robust results for publication selection, i.e. studies which find higher degrees of tax effect on FDI are more likely to get published; taking this into account drops the overall tax effect coefficient from 2.55 to 2.28; when using only micro data the effect drops even lower, naming to 1.19.

[47] For example, micro data in certain countries covers very small firms which otherwise get dropped in a macro aggregation process as reporting standards differ. Small firms value foreign tax aspects differently to large firms, resulting in heterogeneous estimation results; for reference, see for example the Doing Business Report by Anderson and Gonzales (2013).

Summing up, a broad range of potential reasons why the empirical results of corporate tax on FDI attractiveness deviate are identified in the literature. The aforementioned points should be discussed within tax and FDI research in order to receive meaningful information and draw adequate conclusions regarding policy implications, which has, to the author's best knowledge, not been the case for previous research.

When discussing the role of taxation treaties (such as the credit system vis-à-vis double taxation or national tax laws to counter tax avoidance), one should consider why they only prevent firm-level tax optimization to some degree, but not fully; or to put it differently – do such taxation treaties really work and to what extent, what are the restraints and shortcomings? As previously mentioned, taxation treaties are in place between almost all OECD members, so it is important to note the degree of impact on the corporate tax variable in the present study when interpreting the results for global policy implications.[48] The OECD Base Erosion and Profit Shifting (BEPS) project tackles this exact issue, trying to implement an international standard of uniform cross-border taxation, which is a shortcoming of many bilateral taxation treaties. OECD BEPS implementation however also faces the challenge of overcoming significant practical issues, as described in a qualitative study by Taubenheim and Kaffenberger (2019) who rank, for example, the US in place 6 of 43 in "most negative records when taxing affiliated companies", which is quite meaningful regarding the total levels of US FDI. Analysing BEPS in the framework of tax and FDI, Bolwijn et al. (2018) show that profit shifting FDI results in about 200 billion USD of global revenue losses. Further qualitative issues with the implementation of BEPS, such as the lack of data, information on companies and exhaustive tax variables, were described by Acciari et al. (2015).

[48] Quantitatively, this question could be answered by utilizing a diff-in-diff approach in a broader, global dataset such as provided by UNCTAD; unfortunately the quality level of the bilateral data they offer for most countries is quite low (see: Blanchard and Acalin 2016; Wacker 2016; and Welfens and Baier 2018 for a discussion) and, therefore, this analysis will be recommended for future research.

4.2.4 The Role of Institutions in FDI

The lack of (qualitatively good) data and information on a) FDI and b) the tax level is a well-known issue, as identified above. This is tackled by using data in a limited country setting (OECD; covering 70% of global FDI) and discussing results in the context of the aforementioned theory and findings. A lack of information and data impacts not only researchers, but in the first instance the strategic decisions of firms, governments and institutions. Investors prefer information which helps them in monitoring and evaluating prospects (locational advantages for production, profit and market potential) as well as risks (political, fiscal, environmental etc.), while they are sometimes not eager that the potential target country shares information with the parent country.[49] Governments and Institutions have incentives for cooperation and information exchange in order to enforce international law and taxation.

International data exchange and international institutions thus are supposed to have an impact on FDI flows; there is a broad range of literature which analyses the role of international institutions on trade, but also on FDI (see Berger et al. 2012; Buethe and Milner 2008; Dreher et al. 2015; Milner 2014 and many more), where a large share of said studies analyse the role of trade agreements, trade-related institutions and international agreements bolstering stable political systems - as those also target many behind-the-border regulatory issues relevant to multinationals. Controlling for political unobservables and trade via fixed effects and openness, the necessity to additionally control for international financial institutions – who are rather involved in micro-data exchange and project monitoring and planning – when analysing tax and FDI becomes clear.[50] When evaluating literature reviews on international organizations and FDI, we find that the number of studies which estimate the pure effect of international financial agreements is rather limited. However, Jensen (2004) finds that participation in

[49] The so-called "Panama Papers" leak is a famous example illustrating the lack of international (tax) data exchange.

[50] International financial institutions which collect and evaluate firm level data, like the Bank for International Settlements (BIS), the Asian Development Bank (ADB), the European Bank for Reconstruction and Development (EBRD) or the Multilateral Investment Guarantee Agency (MIGA) of the World Bank; in order not to counteract fixed effects, national interaction and membership need to be time variant over the period bilateral FDI data is available, 1985-2017.

International Monetary Fund (IMF) agreements actually leads to lower FDI, struggling to offer a convincing explanation and leaving a lot open for further research.[51] Jensen picks up an argument by Vreeland (2003) that international banking programs might entail sovereignty costs for domestic governments in the form of fiscal self-restriction and restraints which have to be fulfilled in order to avoid international penalization.

While this is not discussed further in the literature, the present study offers a more detailed explanation when linking the cost in terms of sovereignty to tax policy, where international financial organizations serve as forum for data exchange and as control institutions for multinational companies. This serves as a basis for the enforcement of international law, fair taxation and rule-setting in order to establish a high level of common welfare and prevent single nations from deviating (thus fostering an international tax reduction game). Leaving this international structure – represented by participation and cooperation with said institutions – thus will result in an inward FDI increase for the individual country concerned and FDI decrease for all other countries. Linking our argumentation to an increasing level of globalization over the last 30 years, this also means that deviation incentives regarding national taxation in order to attract a relatively bigger share of the "global FDI cake" are expected to shrink over time.

We can therefore structure chapter 2 into seven hypotheses:

1. An increasing economic size of FDI target country increases the FDI inflow into that country.
2. An increasing GDP per capita of FDI target country decreases the FDI inflow into that country, representing location advantages in vertical FDI theory.
3. An increasing distance between two interacting countries decreases the FDI inflow into that country, following theoretical vertical FDI approaches.

[51] Although Jensen (2004) has been cited quite often, his ideas have been primarily picked up for studies in the context of FDI and political or trade agreements, but not for fiscal policy or taxation; however, Jensen (2013) follows up with a tax-FDI study finding that multinationals pay more tax in democracies than in autocracies, who use subsidies and tax as incentives to attract FDI.

4. Increasing the level of corporate tax for the FDI target country results in decreasing FDI inflows, as location advantages for firms to invest rise.
5. Increasing the level of corporate tax for FDI origin country results in increasing FDI outflows, as this triggers capital flight from the domestic country to foreign countries.
6. The negative corporate tax – FDI flow relationship vanishes over time.
7. Interaction and cooperation with international financial institutions reduces FDI target countries location advantages and thus decreases FDI inflows.

The data and the model are presented in the following section with which it is possible to empirically analyze the present research questions and provide answer to the hypotheses presented in chapter 4.2.4.

4.3 Model Specification and Data

4.3.1 Theoretical Foundation

Following Kareem et al. (2016), the PPML estimator developed by Silva and Tenreyro (2006) is used in order to reach consistent results in the presence of heteroscedasticity and values of zero in our dataset (up to 40%), which stands for a significant share. Heteroscedasticity is identified as a common problem for fixed effects gravity estimations, being needed in order to take into account multilateral resistance and thus satisfy the theoretic micro-foundation by Anderson and Van Wincoop (2003), which was originally developed for trade, but recently updated for FDI as well (Anderson et al. 2016, 2017); in this perspective, FDI is viewed in a knowledge-capital framework and can therefore be interpreted similar to trade in technology service. Technological capital (viewed as a “mobile good”) can be used in several countries on a non-rival basis, whereas its value (in combination with

capital, and therefore investment) differs across countries. Due to the insubstantial nature of knowledge capital, FDI flow or stock is used as measurement.[52]

As is usual amongst FDI gravity researchers, structural gravity with country fixed effects is chosen as a practical approach to FDI estimation where multilateral resistance is controlled for as unobservable, following Shepherd (2017). FDI inflows from origin *o* to destination country *d* in time period *t* depends on economic sizes *Y* of countries and trade cost. Time varying country and dyadic fixed effects (i.e. one dummy for each possible combination of two partner countries; direction matters) control for all kinds of time invariant variables as well as unobservables, which includes many policy variables in the OECD sample, as discussed above. Time fixed effects, i.e. one dummy for each year, are included in order to satisfy norms for panel estimations, since when estimating PPML in Stata, the program does not operate with common panel commands which are usually performed using OLS only. Distance as a time non-varying bilateral variable has to be excluded when introducing dyadic fixed effects. The dependent variable FDI inflow from origin to target country is therefore defined as follows:

$$lnFDI_{odt}^{inflow} = \alpha_0 + \alpha_1 lnX_{ot} + \alpha_2 lnX_{dt} + \alpha_3 Z_{od} + \delta_o + \delta_d + \delta_{od} + \tau_t + e_{odt},$$

with the following notation:

- α_0 – regression constant (α_{1-x} are regression estimators respectively),
- X_{ot} – origin country time variant characteristics (GDP, GDP per capita, corporate tax etc.),
- X_{dt} – destiny country time variant characteristics (GDP, GDP per capita, corporate tax etc.),
- Z_{od} – characteristic of the relationship between country-pairs, time invariant (distance between countries, contiguity, common language, cultural and colonial ties etc.),
- $\delta_o, \delta_d, \delta_{od}$ – time invariant country and country-pair fixed effects (δ_{od} zeroize Z_{od}),
- τ_t – time fixed effects,

[52] An adaption of transportation costs might, however, make sense for future research, as we see in our literature review that direction and degree are fundamentally different when looking at horizontal or vertical FDI; as neither micro nor macro FDI data distinguishes here, application in empirical research is however questionable up to this point; Multilateral Resistance in terms of considering all possible locational factors (for horizontal and vertical FDI) should however be applied.

e_{odt} – error term.

It shall be noted that δ_{od} is not included in a pure country fixed setting, where we control for bilateral time invariant relationship via a different set of Z_{od} control variables provided by CEPII.

4.3.2 Data

Figure 1 shows the proportion of flows and stocks into OECD countries respective to global, transition and developing economies. With our OECD dataset, we cover a decreasing fraction of global FDI flows, which is mainly due to an overall decrease of FDI flows in 2017 and 2018, but also due to an increase to developing economies over the past years. It has to be noted, however, that numbers are constantly updated and corrected upward for the past one to three years due to delays in national data collection, which blurs data quality to some extent.

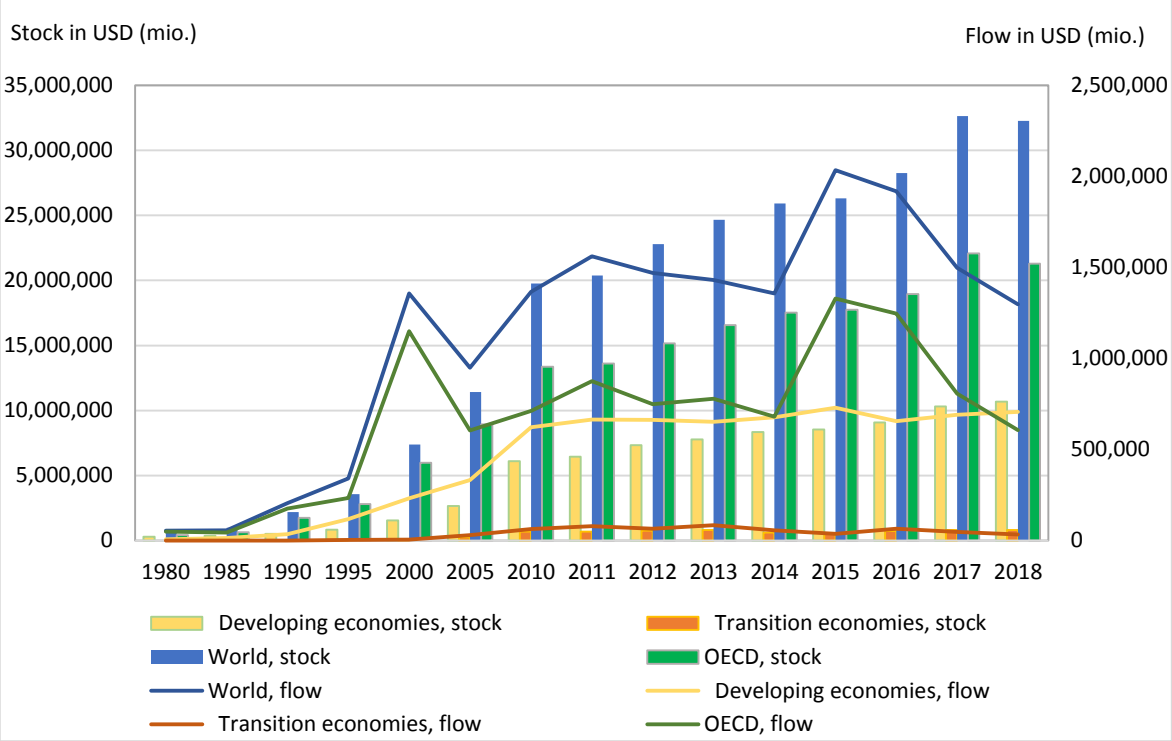

Figure 4.1. FDI flow and stock for World, OECD, Developing- and Transition economies Source: UNCTAD.

Bilateral FDI flow data provided by the OECD is used as our dependent variable, even though UNCTAD aggregated data is used for descriptive (global) reasons. Flow rather than stock data is chosen in order to picture annual FDI decisions and relate them to same-year determining economic and political occurrences. Authors such as Dellis et al. (2017) and Wei (2019) argue that flows should be analysed for FDI-entering decisions primarily, and also due to a book-value bias where FDI stock suffers from discrepancies between the original book value and current market value. Stocks also face higher distortions due to exchange rate volatilities, which cannot be statistically proven for FDI flow analyses (Welfens and Baier 2018).

Following previous gravity FDI studies, annual lagging is not adequate as we suppose the processes towards national changes in corporate tax levels or engagement with international organizations are initiated with a period of a number of months or even years prior to enactment and ratification, respectively, and thus do not come as a surprise to decision-makers in multinational companies. FDI data quality can in general be challenged a lot: whereas trade data is reliable up to a high degree as it is gathered and aggregated via global customs supervision, FDI data gathering is still somewhat in its infancy. National banks collect domestic firms' data on financial activities abroad, an international uniform approach is however not enforced.[53] National micro-databanks are usually of a better quality, but are also not gathered in a uniform manner when we examine micro databanks by the BIS or EUROSTAT and compare them with raw data they gather from national institutions as the Bundesbank for Germany, to name but one example.[54] In addition, raw data material gathered by national institutions are usually confidential and inaccessible to external researchers. We conclude that no general trend has emerged amongst researchers on what data type is the most appropriate, but the work of Baltagi et al. (2007), for example, points out that results are sensitive to the use of different types of data.

[53] Even within the OECD, national banks vary in their requirements for reporting firms concerning business volume, amount of foreign investment activities, or treatment of multinationals with international shareholders.

[54] We gratefully acknowledge the opportunity to work with the Bundesbank MiDi-databank in 2018 and 2019.

Evaluating the two common sources of bilateral FDI data, UNCTAD data is not used for several reasons; firstly, the time-frame only covers 2001-2012 which is perceived as being insufficient for general gravity panel studies, origin-destination reports differ too much for a large share of developing- and tiger states but also for industrialized countries, and a large number of no-observations is found for implausible country-pairs.[55] In opposition to that, OECD macro-data is compiled in a more uniform matter and available from 1985-2017, however the dataset is gathered with two different benchmark definitions (1985-2012 BMD3 and 2013-2017 BMD4) and therefore the two datasets have to be merged. The difference for the BMD4 is the introduction of splitting FDI on the basis of Special Purpose Entities (SPE) and non-SPE FDIs, where an SPE is defined as an entity with little or no physical presence in the respective country and which serves primarily for holding assets and liabilities or raising capital for the multinational firm (OECD 2015). Discussing the SPE FDI split in general makes sense for FDI gravity research, especially in the field of tax (avoidance), however this has to be left open for future research as most countries do not report splits as recommended by the OECD but instead report total FDI equal to non-SPE, indicating that the BMD4 guideline has not yet been successfully implemented. This however simplifies merging both datasets; in addition, a trend-break variable is introduced to control for a potential bias. We convert negative flow values to zero and exclude missing values, as explained in Welfens and Baier (2019).

Our independent variables are defined as described in table 4.1:

[55] US-outflows to Japan are, for example, reported as being multiples of what Japan reports to receive from the US as inflows, while Belgium or the Netherlands barely receive any inflows, etc.

Table 4.1. List of variables.

Variables	Definition	Source
inflow	FDI inflow, from origin to target in current USD; Negative values to zero, excluding missing values	OECD FDI database; BMD3 data 1985-2012, BMD4 data 2013-2017
dist	Bilateral distance between two countries	CEPII GeoDist dyadic dataset; Mayer and Zignago (2011)
target_gdp	GDP of FDI target country, in current USD	World Bank
origin_gdp	GDP of FDI origin country, in current USD	World Bank
target_gdp _per_capita	GDP per capita of FDI target country, in current USD	World Bank
origin_gdp_ per_capita	GDP per capita of FDI origin country, in current USD	World Bank
target_tax	General FDI target country corporate tax rates, including average/typical local taxes	Mintz and Weichenrieder (2010); KPMG (2017)
origin_tax	General FDI origin country corporate tax rates, including average/typical local taxes	Mintz and Weichenrieder (2010); KPMG (2017)
openness	total import plus total export of FDI target country, divided by its GDP	World Bank
contig	Dummy describing whether two countries are contiguous	CEPII GeoDist dyadic dataset; Mayer and Zignago (2011)
comlang_of f	Dummy describing whether two countries share a common official language	CEPII GeoDist dyadic dataset; Mayer and Zignago (2011)
colony	Dummy describing whether two countries have had a common colonizer	CEPII GeoDist dyadic dataset; Mayer and Zignago (2011)
comcol	Dummy describing whether two countries have ever had colonial links	CEPII GeoDist dyadic dataset; Mayer and Zignago (2011)
bis	Target reports and provides (consolidated) data to the Bank for International Settlement[56]	Bank for International Settlements
ebrd	Target is shareholder country of the European Bank for Reconstruction and Development[57]	European Bank for Reconstruction and Development
adb	Target Regional and non-regional membership in the Asian Development Bank group	Asian Development Bank
miga	Target participation in programs ensured by the Multilateral Investment Guarantee Agency	Multilateral Investment Guarantee Agency

The classical bilateral gravity variables identified and provided by CEPII researchers are used, naming “contiguity”, “common official language”, “colony” and “common colony” as cultural barriers, as well as “distance” for physical barrier in country-fixed models as additional control variables. As those are time invariant, they are dropped for dyadic fixed effects where dummies for each possible country-pair are introduced. Institutional variables are dummies describing whether interaction/membership is in place or not; yearly fixed effects are utilized in all models.

[56] Whether a country starts reporting in the first or fourth quarter is disregarded and only the year in which it started data interaction with the BIS is counted.

[57] The level of funds is not accounted, just whether interaction occurs.

Following Anderson and Yotov (2010, 2012), country and dyadic fixed effects validate our structural gravity estimations by dealing with issues of unobserved costs and potential data imprecisions; Fally (2012) adds that PPML estimators in fixed effects gravity perfectly fits the multilateral resistance terms and therefore our theoretical model, which is defended by Head and Mayer (2014) for the case of *heteroscedastic* data as ours (according to White- and Breusch-Pagan testing). Therefore from OLS estimators are forgone. Furthermore, tax, openness, GDPs per capita and GDPs are checked for endogeneity via the Durbin-Wu-Hausman test and are found to be *exogenous*. No serious *correlation* issue is found between our set of independent variables, however all models are also tested without "openness", as a correlation coefficient of 0.51 regarding "target_tax" is found; the effect on tax is found to be fairly small (the coefficient for tax changes from -1.97 (model (5), see chapter 4) to -2.11 when excluding trade openness as control variable). Therefore, "openness" is included as a control variable in all models presented subsequently. The following chapter presents all empirical findings.

4.4 Results

4.4.1 Country-Fixed and Dyadic Fixed Estimations

In a first step, the data is split into several time periods beginning with 1985-2011 and then the data is extended by two years for each subsequent model, as widely varying results are found when evaluating previous research where data for various time frames was used.[58] Therefore, how the coefficients change over time is observable – as in Table 4.2.

[58] Many current FDI gravity researchers use OECD data up to 2012 only (BMD3), as the BMD4 data up to 2017 has just currently been released at the beginning of 2019, and merging BMD3 with BMD4 data has, according to the best of this author's knowledge, not been done so far; however, this is viewed this as unproblematic, as described in chapter three.

Table 4.2. PPML panel country-fixed-effects estimation results for FDI inflow, by time periods.

VARIABLES	(1) inflow_11	(2) inflow_13	(3) inflow_15	(4) inflow_17
ln_dist	-0.406***	-0.399***	-0.388***	-0.387***
	(0.0681)	(0.0661)	(0.0632)	(0.0612)
ln_target_gdp	4.521**	5.178***	4.821***	3.634**
	(1.852)	(1.642)	(1.430)	(1.419)
ln_origin_gdp	2.593*	2.785*	2.358	2.680*
	(1.549)	(1.442)	(1.577)	(1.394)
ln_target_gdp_per_capita	-3.699*	-4.297**	-3.868**	-2.581*
	(1.901)	(1.713)	(1.526)	(1.530)
ln_origin_gdp_per_capita	-1.716	-2.109	-1.638	-1.961
	(1.652)	(1.486)	(1.659)	(1.464)
target_tax	-3.984***	-3.653***	-2.298**	-1.165
	(0.977)	(0.914)	(0.950)	(0.927)
origin_tax	0.104	0.247	0.745	0.216
	(1.130)	(1.066)	(0.939)	(0.910)
openness	0.0804	1.210***	1.712***	1.800***
	(0.305)	(0.317)	(0.291)	(0.260)
contig	0.201	0.178	0.111	0.0783
	(0.157)	(0.155)	(0.156)	(0.161)
comlang_off	0.202	0.136	0.198	0.129
	(0.142)	(0.140)	(0.133)	(0.127)
colony	0.240**	0.313***	0.188	0.209*
	(0.120)	(0.110)	(0.115)	(0.110)
comcol	5.791***	5.694***	5.405***	5.357***
	(0.480)	(0.480)	(0.419)	(0.423)
bis	-0.342**	-0.396***	-0.420***	-0.376***
	(0.158)	(0.150)	(0.139)	(0.138)
ebrd	-0.591**	-0.646***	-0.567**	-0.501**
	(0.258)	(0.247)	(0.244)	(0.244)
adb	-0.285	-0.479	-0.591	-0.629
	(0.366)	(0.408)	(0.424)	(0.425)
miga	-0.0573	-0.0950	-0.0963	-0.0745
	(0.124)	(0.141)	(0.144)	(0.145)
Constant	-26.42**	-28.42***	-17.38*	-21.95**
	(10.49)	(9.240)	(10.54)	(10.14)
Observations	15,678	17,522	19,425	21,357
R-squared	0.484	0.481	0.466	0.461

*Hint: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.*

Country and year fixed effects were included in models (1)-(4) but are not displayed for reasons of space. Standard errors were clustered by each possible country-pair in all models. We find a significant negative effect of distance, a significant positive effect of target country GDP and a significant negative effect of GDP per capita on FDI inflows across all time periods. Neither significances nor coefficient sizes change in a critical manner.

Regarding target country corporate tax level, the following is observed: An effect of -3.984*** (std.error 0.977) for the data period 1985-2011 (1), an effect of -3.653*** (std.error 0.914) for 1985-2013 (2), an effect of -2.298** (std.error 0.950) for 1985-2015 (3) and no significant effect in model (4) which covers the time period 1985-2017. Therefore, a decreasing effect of corporate tax level as FDI attracting variable over time is noted.

When viewing results for trade openness, the opposite effect is found: While in model (1) openness is not significant, it becomes significant in (2) (coefficient 1.210***, std.error 0.317), and the coefficients grow in model (3) (1.712***, std.error 0.291) and (4) (1.800***, std.error 0.260), indicating that trade openness of target country becomes an increasingly important FDI determinant.

While the dyadic gravity control variables seem not to be affected by the choice of data framework, relatively constant effects for our financial institutions are found: ADB and MIGA membership have no significant effect on FDI, while EBRD shareholder target countries and target countries which exchange data and cooperate with the BIS attract significantly less FDI in all models, albeit varying little between different time periods.

It is also interesting to comment on the R-squared in this framework, as with increasing observations from model (1) to model (4), a decreasing R-squared is observed which indicates that the additional observations increase the variance of the data and therefore decrease the fit of the model (Head and Mayer 2014; Shepherd 2017). If this is viewed in the context of observed FDI flow decrease in the more recent years, part of that effect could also be an unsatisfactory quality level of data, as data for the latter years gets constantly updated by gathering and aggregating micro data, a process which takes time. Therefore, the time frame from

1985-2015, i.e. model (3), is chosen and the variables added in a cumulative manner in order to observe potential interactions between the independent variables. Results are presented in Table 4.3 (next page).

At first sight, no noticeable incidents or major changes are observed, supporting the choice of control variables. It is, however, worth noting that when switching from model (5) to model (6), where the BIS variable is introduced, a minor increase of the magnitude of "target_tax" from -1.966** (std.error 0.950) to -2.222** (std.error 0.325) is observed.[59] This indicates two things: a) countries who are NOT cooperating and exchanging data via the BIS profit more, respectively, from a fall in the corporate tax rate, and b) as soon as countries exchange data and cooperate, corporate tax becomes a less important determinant for FDI. In addition, "openness" changes from model (7) (1.593***, std.error 0.325) to model (8) (1.713***, std.error 0.291)[60] and a minor increase of R-squared is observed as well; therefore, ADB and MIGA are included as control variables even though they have no significant impact on FDI flow. The fact that EBRD interaction has a negative effect on FDI inflows could be interpreted as an indication that EBRD as an institution works in the sense that the joint profit maximization of the OECD multinationals can take into account a broader range of investment opportunities abroad, naming in 49 post-socialist transition economies whose institutional reforms and infrastructure projects – often relevant for profitability – are reinforced by EBRD activities; the negative coefficient thus reflects enhanced investment opportunities abroad due to EBRD presence and is a special aspect that deserves further analysis in future research.

[59] The correlation coefficient between tax and BIS is noted with 0.20.
[60] The correlation coefficient between openness and ADB is noted with -0.19.

Table 4.3. PPML panel country-fixed-effects estimation results for FDI inflow, cumulative, 1985-2015.

VARIABLES	(5) inflow	(6) inflow	(7) inflow	(8) inflow	(3) inflow
ln_dist	-0.389***	-0.388***	-0.388***	-0.388***	-0.388***
	(0.0633)	(0.0633)	(0.0633)	(0.0632)	(0.0632)
ln_target_gdp	3.996***	4.512***	4.542***	4.779***	4.821***
	(1.412)	(1.407)	(1.409)	(1.406)	(1.430)
ln_origin_gdp	2.320	2.353	2.354	2.357	2.358
	(1.582)	(1.579)	(1.578)	(1.578)	(1.577)
ln_target_gdp_per_capita	-3.081**	-3.593**	-3.620**	-3.823**	-3.868**
	(1.510)	(1.495)	(1.497)	(1.501)	(1.526)
ln_origin_gdp_per_capita	-1.582	-1.632	-1.633	-1.637	-1.638
	(1.664)	(1.659)	(1.659)	(1.659)	(1.659)
target_tax	-1.966**	-2.222**	-2.244**	-2.290**	-2.298**
	(0.950)	(0.946)	(0.948)	(0.947)	(0.950)
origin_tax	0.723	0.739	0.738	0.740	0.745
	(0.933)	(0.936)	(0.936)	(0.938)	(0.939)
openness	1.566***	1.591***	1.593***	1.713***	1.712***
	(0.323)	(0.325)	(0.325)	(0.291)	(0.291)
contig	0.110	0.110	0.110	0.111	0.111
	(0.156)	(0.156)	(0.156)	(0.156)	(0.156)
comlang_off	0.198	0.198	0.198	0.198	0.198
	(0.134)	(0.133)	(0.133)	(0.133)	(0.133)
colony	0.187	0.188	0.188	0.187	0.188
	(0.115)	(0.114)	(0.115)	(0.115)	(0.115)
comcol	5.392***	5.403***	5.403***	5.404***	5.405***
	(0.421)	(0.420)	(0.420)	(0.419)	(0.419)
bis		-0.427***	-0.428***	-0.459***	-0.420***
		(0.154)	(0.154)	(0.151)	(0.139)
ebrd			-0.553**	-0.567**	-0.567**
			(0.244)	(0.244)	(0.244)
adb				-0.590	-0.591
				(0.424)	(0.424)
miga					-0.0963
					(0.144)
Constant	-17.72*	-17.06	-17.34	-17.45*	-17.38*
	(10.56)	(10.54)	(10.55)	(10.53)	(10.54)
Observations	19,425	19,425	19,425	19,425	19,425
R-squared	0.463	0.464	0.464	0.466	0.466

*Hint: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.*

In Table 4.4 the results for the country-fixed model (3) are compared with the dyadic-fixed model (9), as proposed as an alternative (or even improved) methodology in literature.

Table 4.4. PPML country-fixed versus dyadic-fixed results, 1985-2015.

	(3)	(9)
VARIABLES	**inflow**	**inflow**
ln_dist	-0.388***	
	(0.0632)	
ln_target_gdp	4.821***	4.793***
	(1.430)	(1.461)
ln_origin_gdp	2.358	2.104
	(1.577)	(1.640)
ln_target_gdp_per_capita	-3.868**	-3.864**
	(1.526)	(1.560)
ln_origin_gdp_per_capita	-1.638	-1.469
	(1.659)	(1.730)
target_tax	-2.298**	-2.417**
	(0.950)	(0.946)
origin_tax	0.745	0.101
	(0.939)	(0.914)
openness	1.712***	1.655***
	(0.291)	(0.289)
contig	0.111	13.46***
	(0.156)	(3.275)
comlang_off	0.198	7.282
	(0.133)	(4.753)
colony	0.188	-1.265
	(0.115)	(3.325)
comcol	5.405***	6.688***
	(0.419)	(2.368)
bis	-0.420***	-0.362***
	(0.139)	(0.135)
ebrd	-0.567**	-0.513**
	(0.244)	(0.251)
adb	-0.591	-0.609
	(0.424)	(0.412)
miga	-0.0963	-0.0678
	(0.144)	(0.144)
Constant	-17.38*	-36.83***
	(10.54)	(7.800)
Observations	19,425	18,710
R-squared	0.466	0.541

*Hint: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.*

Model (9) excluded 157 regressors (country-pair dummies) to make sure that the estimates exist (too few observations), leaving 18,710 observations instead of 19,425 observations for model (3); Distance as a time non-varying variable is also excluded in the dyadic model. For model (3) it should be noted that the coefficient is in line with the literature, the same holds for GDP and GDP per capita of the FDI receiving country in models (3) and (9). It is however very surprising that the results, and even R-squared, for both models vary only slightly; this comparison has – according to author's knowledge – not been done so far in previous gravity FDI flow research.[61] The result for corporate tax is slightly higher in model (9) with a coefficient of -2.417** (std.error 0.946), the coefficients for BIS and EBRD are slightly smaller than in (3); further control variables remain basically the same.

4.4.2 Empirical Findings

We use model (3) and model (9) for evaluating our country and dyadic results, and will additionally critically discuss the findings in model (4).

- GDP of target country, our proxy for economic size, is found positive in model (3) with a coefficient of 4.821*** (std.error 1.430) and positive in model (9) with a coefficient of 4.793*** (std.error 1.461).
  - ➔ **Hypothesis 1 is accepted**; an increasing economic size of the FDI target country increases the FDI inflow into that country. Therefore findings are in line with theoretical models on vertical FDI and relative market size (Faeth 2009 for a literature review) and previous empirical findings (Barrell et al., 2017; Bruno et al., 2016 and Welfens and Baier, 2018 amongst others).

[61] This is very useful for gravity researchers, as dyadic fixed effects estimations with many countries and observations are associated with sometimes quite high operating expenses in the sense of time and computing power, not speaking of frequently occurring failures or infinite iterating when calculating in Stata; for an econometric discussion see Stamman et al. (2016) and Stammann (2018).

- GDP per capita is as well almost equal in model (3) and model (9) with a coefficient of -3.868** (std.error 1.526) in the country fixed case; increasing GDP per capita therefore decreases FDI inflows into that country, representing locational advantages for FDI in the producing sector where wages play an important role.

  ➔ **Hypothesis 2 is accepted**; an increasing GDP per capita on the part of the FDI target country decreases FDI inflows into that country. This is in line with neoclassic factor endowment and specialization models (Faeth 2009).

- Distance is only measured in model (3) where it is found to be highly negatively significant with a coefficient of -0.388*** (std.error 0.063), meeting previous findings in the literature.

  ➔ **Hypothesis 3 is accepted**; an increasing distance between two interacting countries decreases the FDI inflows into that country. Findings are in line with vertical FDI theory (Faeth 2009) and previous empirical findings (Nielsen 2017 for a literature review).

- The corporate tax rate of the target country is found to be negatively significant in model (3) with -2.298** (std.error 0.950) and in model (9) with -2.417** (std.error 0.946); the corporate tax level is therefore proven to be an important determinant for FDI inflows; a drop of 1 percentage point of corporate tax will lead to approximately 2.3% - 2.4% more FDI inflows, which meets the result frame of a majority of previous studies targeting corporate tax and FDI.

  ➔ **Hypothesis 4 is accepted**; increasing the level of corporate tax for the FDI target country results in decreasing FDI inflows. Considering a macro-data bias, the effect should however corrected in a downward direction; Following Feld and Heckemeyer (2011) the actual corrected effect would be approximately 1.2% FDI increase for a 1 percentage point drop of tax; in addition, it shall be noted that this effect holds for OECD countries

only, and is supposed to be more impactful in non-OECD countries, rising economies, third world countries, autocracies and countries which are generally not integrated as well in international cooperation networks (Andersen et al. 2018).

- The variable "origin_tax" which describes the corporate tax level in the FDI sending country is not found to be significant in any of our models.
  - ➔ **Hypothesis 5 is rejected**; a high domestic corporate tax level does not lead to significantly more FDI outflows. Corporate tax therefore has no effect on whether or not FDI decisions are made, but does have an effect on the decision to which country the FDI will go.

- Looking at the results for "target_tax" in Table 4.2, a strongly decreasing effect of corporate tax over time is found, which however is still significant in models (1)-(3) but loses significance in model (4). Especially when extending the data from 2013 to 2015, the variable experiences a vast drop. There is a variety of reasons why this might be the case, which are discussed in chapter 5; nevertheless, it can be speculated that the tax variable will regain its significance when the time frame is extended up to 2019 or 2020.
  - ➔ **Hypothesis 6 is accepted**; the negative corporate tax-FDI relationship vanishes over time. It is discussable if there is even a tax effect left today (2019), but lacking data quality which reaches only up to 2017 for the past one to two years as well as the exclusion of the tax drop effect from 40% to 21% in the USA mid-2017 are arguments expecting the corporate tax variable becoming significant again as soon as more recent data is available (probably for a panel from 1985-2019, data which is expected to be available by 2021).

- The BIS variable is found to be highly significant with -0.420*** (std.error 0.139) in model (3), and -0.362*** (std.error 0.135) in model (9); we as well find EBRD shareholders with -0.567** (std.error 0.244) in (3) and 0.513**

(std.error 0.251) in (9) respectively; ADB and MIGA are not found to be significant.

➔ **Hypothesis 7 is accepted**; it is found that especially interaction with institutions is what matters here, and simple membership is a rather bad proxy; in addition, it is found that exchanging financial data via the BIS has an effect on the tax variable, as the degree of the effect on FDI inflows increases for countries who do not share data with the BIS. The effect is however decreasing as well, and expected to vanish with political disintegration in other fields as trade for example; while trade openness is only included as control variable in the underlying research, it is nevertheless important to note an increasing and quite impactful effect on FDI over time.

4.5 Conclusion and Policy Implications

Bilateral FDI flow data from 1985-2017 for all OECD countries is evaluated, and a dataset – which has not been utilized for gravity equations up to this point – is compiled in order to clarify the role of corporate tax levels on firm decisions whether and where to invest. In the course of the research, the need to control for interaction with international financial institutions is identified. The empirical findings are consistent with a majority of previous findings and additionally expand the available knowledge about FDI and tax by providing new results relevant for policy makers.

The results assert that the role of corporate tax has been overestimated so far on FDI target decision, and additionally has no significant impact at all on the question of whether or not to invest, but rather on where to invest. While this research is almost entirely consistent with the numbers proposed by Feld and Heckemeyer (2011), after controlling for an (overestimating) publication bias, of a 2.28% FDI increase with 1 percentage point drop of corporate tax level, whereas model (3) presented herein determines a 2.298% FDI increase, there is sufficient reason to

argue that the actual impact is even lower when considering a macro-data bias.[62] In addition, it is found that the impact of corporate tax decreases over time, and in fact has no impact on FDI when utilizing the dataset up to 2017. It is however reasonable to question the data quality of newer observations (2017) as the BMD4 databank is currently still getting updated almost weekly. The corporate tax reduction conducted in the US in 2018, for which data is not yet available, however, has the potential to reflect a comeback of significance for the tax variable; the reason might primarily lie in the leading role the US has as FDI attractor in the data, but also the current "America First" strategy by president Trump.

Increasing unilateralism, along with economic and political disintegration encourage aberrations in terms of national strategies vis-á-vis fiscal politics and retreating engagement in international cooperation and institutions, which is proxied in the present research with several financial institutional dummies. While pursuing this kind of unilateralist and individualist approach will attract additional FDI as long as it is an international outsider strategy, the effect will vanish as soon as more and more countries "drop out" of the global cooperation network.[63] Furthermore, it is shown that international cooperation leads to a decreasing effect of FDI attractiveness via a low corporate tax level, or put differently, fights/prevents micro-level tax avoidance strategies and tax havens, assessed as being damaging to the global economy (Bolwijn et al. 2018). The choice of proxies for international financial cooperation works with regard to capturing unobservables which can be described by the OECD BEPS program as well, which analyzes shortcomings and aims to improve enforcement of international law, fair taxation and rule-setting.

From a qualitative perspective, Taubenheim and Kaffenberger (2019) rank the US in particular as being problematic case for taxing foreign facilities in 2017/2018, even though various international tax cooperation laws are in force. This might also indicate that the willingness for implementation is not always fully present in bilateral relationships, and the target country's corporate tax level can be an

[62] The usage of macro data is likely to overestimate the effect of tax, as this is mainly relevant for larger multinationals which stand for a major share of the data.

[63] The same accounts for corporate tax levels; as soon as an international downward tax reduction begins, the effect for single deviator vanishes and everyone will be worse off.

investment incentive – even in the presence of double-taxation-credit treaties, a discussion started by Slemrod back in 1990 but still lacking in theoretical explanation.

As a concluding remark, the reader is referred to the two quotations in the beginning of this paper: While it is statistically proven that reducing corporate tax levels leads to increasing FDI inflows, this effect is smaller than expected and vanishes over time due to other gains from international cooperation; if deviation from international cooperation is chosen as a national strategy (unilateralism), tax however gains importance. Unilateralism on the other hand trigger various effects decreasing FDI inflows, as trade openness is likely to decrease (and is of increasing importance for FDI, see Table 4.2), the opportunity costs for other nations to themselves deviate decrease and therefore bilateral tax differences are likely to decrease as well; which will further reduce the effect of low tax levels in the long run (see Footnote 29). Implementing low corporate tax levels in order to keep domestic firms within the country and reducing their incentives to invest abroad are not found to be relevant.

Appendix C

Table C.1. Average corporate tax rates in OECD countries, in percent.

Countries	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**
Australia	39	36	34	30	30	30
Austria	30	34	34	25	25	25
Belgium	40	40.2	40.2	33.9	33.9	33.9
Canada	41.5	42.9	42.4	36.1	31	26.5
Chile			15	17	17	24
Czech Republic		41	31	26	19	19
Denmark	40	34	32	28	25	22
Estonia			26	24	21	20
Finland	44.5	25	29	26	26	20
France	42	36.7	37.8	33.83	33.33	33.33
Germany	54.4	55.1	52	38.31	29.41	29.72
Greece	46	35	40	32	20	29
Hungary	40	18	18	16	19	19
Iceland			30	18	18	20
Ireland	43	38	24	12.5	12.5	12.5
Israel			36	34	25	25
Italy	46.4	53.2	37	37.25	31.4	31.4
Japan	50	50	40.9	40.69	40.69	33.86
Korea			30.8	27.5	24.2	24.2
Latvia				15	15	15
Lithuania				15	15	15
Luxembourg			37.5	30.38	28.59	29.22
Mexico	36	34	35	30	30	30
Netherlands	35	35	35	31.5	25.5	25
New Zealand	33	33	33	33	30	28
Norway	50.8	28	28	28	28	27
Poland		40	30	19	19	19
Portugal	40.2	39.6	35.2	27.5	25	21
Slovak		40	29	19	19	22
Slovenia			25	25	20	17
Spain	35	35	35	35	30	28
Sweden	53	28	28	28	26.3	22
Switzerland	30.6	28.5	24.9	21.99	18.75	17.92
Turkey			33	30	20	20
UK	34	33	30	30	28	20
USA	38.7	39.6	39.3	40	40	40

Source: Mintz and Weichenrieder (2010), KPMG (2017).

5 Concluding Remarks

In writing three empirical papers, deeper insights into global FDI dynamics were gained which can have useful implications for policymakers and future research.

While chapters 2 and 3 topically discuss BREXIT as a policy shock, the approach taken in both papers varies greatly. The paper on which the latter chapter is based analyzes the short-term impacts on investment flows to the UK – and foreign asset holdings in the UK - as well as British outflows/stock effects which were influenced or provoked by the event of the BREXIT vote in 2016, whereas the former paper analyzes the long-term gains in FDI attractiveness due to economic integration in the EU single market. Chapter 4, and therefore the third paper in this dissertation, does not pick up a concrete policy change or shock, but rather tackles the general linkage between FDI and corporate tax rates, a very broad topic to which many researchers have previously contributed . The inclusion of financial integration - and globalization variables in addition to the utilization of the newest FDI data make this paper a valuable contribution to knowledge on global FDI and tax dynamics, which are closely linked to international institutions. Regarding the bigger picture, the underlying omnibus volume can therefore be referred to as scientific research in the field of FDI dynamics in global integration and disintegration processes. In a period of enhanced globalization, which combines trade dynamics and higher FDI dynamics, the insights obtained from the contributions presented is crucial for policymakers in open economies. The roles of integration, tax policy and the institutional linkages of countries are considered as drivers of FDI.

Working with gravity models in all three papers additionally pushes the border of scientific knowledge in that field to a modest, but nonetheless significant degree: Discussing the treatment of missing values in bilateral FDI datasets is a topic which thus far has not attracted much attention, as the author evaluated from previous research and experiences gained during the course of the 4th Mainz FDI workshop. Sanity checking missing values and zeroes is identified as an important aspect relevant for model selection, as is the treatment of negative values which cannot be utilized in log-linearized models. Especially in chapter 2, the author discusses several approaches and rates their usefulness for gravity researchers. Another small

alteration to gravity FDI research is the econometric assessment that the findings (coefficients) for the "usual suspects" in gravity, namely GDP, GDP per capita, distance, common language, colonial relationship etc. do not change by much whether estimating them in country or in country-pair fixed effects models. This finding is very helpful for applied research, as it offers a workaround to dyadic fixed models with which many researchers apparently struggle: The sheer number of observations and control variables (which can easily reach several tens of thousands) is capable of impeding the computing power of Stata and R. While this problem is barely described in empirical gravity research, statisticians and programmers are currently working on such problems and already provide alternative computing processes, which however deviate from the classical PPML to some extent; an evaluation of the development of new estimators proxying PPML is still not provided by gravity researchers (it is, however, provided from the mathematical side) and opens up a topic for future research.

Concerning the current data situation for bilateral FDI flows and stock, there is found to be a lot to improvement, especially in the field of data quality. While a uniform data collection methodology / guideline for countries' national banks exists on paper, this is however not fully implemented, as can be seen especially for UNCTAD data where reports from origin (investing) countries can deviate (sometimes to multiples) of what target countries report (for example Japan's FDI inflows from the USA), or only very one-sided data is available and consequently not all data for certain country-pairs. UNCTAD bilateral data has the advantage of (theoretically) covering the world economy, whereas OECD data is restricted to OECD member states' reports only, even though data on flows from and to OECD outsiders have been repeatedly updated in the past months so that the datasets have consistently increased in quality since the author of the underlying dissertation started working with them. While UNCTAD does not seem to make great effort to update their panel, the current OECD release, which is constantly updated, is a newer (BMD4) dataset effectively starting from 2013. Firstly, a merging of both BMD3 and BMD4 datasets makes sense for researchers, as described in chapter 4, and the OECD should give serious consideration to providing

such data. Secondly, the intended split in SPE and non-SPE in the updated reporting guidelines makes sense for researchers, as it would enable the option of distinguishing between FDI related to real projects or pure money shifting; citing the OECD: “The existence of SPEs is one important factor that can distort foreign direct investment (FDI) statistics”. The split is however not yet implemented for most countries as primarily only non-SPEs are reported in most cases. This is something the global community (central banks and their reports to the OECD) could provide for researchers in order to gain from better and more precise economic research output in the future. The same holds for the BIS locational and consolidated banking statistics, where central banks, such as the Bank of England for example, do not necessarily have much interest in sharing their precise annual balance sheets (which could undermine banking confidentiality which is in the interest of potential customers / investors).

5.1 Policy Implications

Identifying policy implications relevant to the current BREXIT negotiations is, at the point of the submission of the present dissertation, an invidious task; in the political sphere, Boris Johnson replaced Theresa May as Prime Minister of the UK on July 24th, 2019, and it appears to political observers and the media as if the UK is indeed heading for a hard BREXIT on October 31st, 2019, in a very chaotic and haphazard manner. While the long-term predictions regarding FDI dynamics if the UK leaves the EU and does not manage to replace its current single market membership with (semi-)equivalent bilateral agreements are strictly negative, our findings are not as extensive as those predicted by Fournier et al. (2015) and Bruno et al. (2016) however, especially considering the existence of a very large fraction of foreign ownership in the UK capital stock (about 16%) which basically serves as an additional FDI attractor. While McGrattan and Waddle (2017, revised 2018) argue that new bilateral treaties with the USA and Japan, who are more favorable to investors than the EU, have the potential to increase inward FDI, we show in chapter 3 that in fact EU outsider countries choose the UK (and the City of London) as an “entry port” to the European market, especially in the banking sector, while a

significant drop in greenfield FDI is also registered in UK from EU outsider investors. In order to inhibit the ongoing FDI decrease with all its consequences (on productivity, wages, household income, GDP, growth etc.), a hard BREXIT should be avoided and bilateral agreements providing single market access not only in terms of trade but also for FDI and the European freedom of movement should be signed, also for the sake of trade openness which is highly positively significant for the attraction of FDI. In order to retain its leading status in terms of banking services for the European region, the UK is advised to include free passporting for that sector, which given the current status of BREXIT negotiations, however, is a scenario that is unlikely to be reached. In the case of a hard BREXIT, a general restructuring of the UK economy is therefore inevitable.

An additional aspect of BREXIT and FDI, alongside negative long-term growth and GDP effects, is the political and economic uncertainty investors are confronted with since the vote, as presented in chapter 3. The rather chaotic scenes in the House of Commons and the discord within the current government discourages investors in terms of long-term FDI decisions especially linked to supply chain maintenance, changing trade dynamics and (local) market conditions within the UK, issues which will all accompany the leaving of the EU to some extent, independently of whether a hard or soft BREXIT will ultimately be carried out. The UK's trade and FDI relations with neighboring states such as Ireland, the Netherlands, Belgium, France and to some extent Germany, are impacted the most since their economies are closely linked through multinationals and supply chain production, as observed in UNCTAD's country fact sheets released 2019; while UK total inflows dropped from 196 billion USD in 2016 to 101 billion USD in 2017, and 65 billion USD in 2018, inflows into the Netherlands, France and Germany increased (UNCTAD 2019) while Ireland and Belgium are on the losing side (UNCTAD 2019). This change is mainly related to FDI shifting from the UK to other countries, as recently discussed by Bruls et al. (2019).

The proposal of Theresa May to mitigate decreasing FDI attraction through a more investor-friendly tax policy in 2018 motivated the authors of the paper in chapter 2 to control for the effect of average national corporate tax levels - the significant

negative effect of tax on FDI inflows is only discussed briefly and intuitively as a locational firm advantage; a deeper discussion of this extensive topic follows in chapter 4 where the author dedicates a whole paper to that research question. Besides analyzing tax on the basis of a broad literature review, a newer dataset and tax-related control variables are implemented. Results show that while there is indeed a significant negative effect of corporate tax on FDI, it is much lower than initially expected and usually found in literature.[64] Figure D.1. in appendix D reveals results from more recent research and shows that it is in fact impossible to even significantly mitigate BREXIT losses via lowering the statutory corporate tax rate, especially as the UK already has a very low rate which is currently 19%.

In fact, with increasing globalization and institutional integration, the tax effect is decreasing over time, and there is even reason to discuss whether corporate tax levels matters for FDI decisions within OECD countries in 2019.[65] Lowering corporate tax as a policy option in order to increase FDI is therefore rather unlikely to work, especially in OECD countries; this could however differ for countries that are not as well integrated in the global economy via trade (openness) and international agreements in general (see literature review chapter 4). Deviating from international financial agreements and data exchange however does serve as a significant FDI attractor and is in fact more important than the (low) corporate tax rate itself; disintegration can therefore be a legitimate political instrument to increase FDI, the effect however decreases over time and also encompasses the risk of instigating an international disintegration spiral.

Low corporate tax rates, therefore, especially hold as an FDI attractor for nations deviating or withdrawing from international agreements, which on the other hand not an advisable course of action for OECD countries for several reasons; besides the risk of entering a disintegration spiral where many countries offer low corporate tax to investors, where the gains for a single or few deviators vanish, unilateralism

[64] Figure 2.1. in chapter 2, which builds on the tax coefficient -3.7 from model (8), table 2.4., therefore shall be updated with the tax coefficient -2.3 from model (3), table 4.4.; discussing the coefficient while considering macro-data bias, it is reasonable to further reduce it to -1.2 as proposed by Feld and Heckemeyer (2011); the updated figure can be found in appendix D, Figure D.1.

[65] Current data up to 2017 indicates that there is no effect today; the extensive reduction of corporate tax in the USA could, however, lead to a revision of that finding as soon as data up to 2019 is available, as the USA is the biggest global FDI player.

and “our country first” strategies will result in decreasing trade and trade openness, which is a major factor for FDI with an indeed increasing effect over time. Last but not least, shrinking domestic markets (and purchasing power) will also negatively impact inward FDI, which is proxied by GDP in gravity models and a major significant factor in all models of the underlying dissertation. Finally, no empirical evidence to support the policy of the implementation of low corporate tax rates in order to keep domestic companies from investing abroad is found. Regarding FDI attractiveness the author therefore emphasizes that politics in OECD economies should rather focus on international cooperation and integration in order to foster trade and economic growth, and not on a policy of low corporate tax rates and withdrawing from (financial) organizations and control institutions.

5.2 Limitations and Future Research

The focus on OECD countries due to data availability and quality, as discussed above, limits the underlying studies to some extent, even though this is tackled by discussing results within a global framework taking a review of literature on FDI and descriptive global data into consideration. The theory which is based on firm profit maximization, therefore, does not account for geostrategic (political) FDI motivations, which have the potential to distort certain FDI dynamics. When it comes to more recent increasing investment activities by China in Asia, Africa and as well in Europe (“One Belt, One Road” initiative) in particular, should neoclassic FDI theory be challenged in future research. Including emerging economies and newer large economies, such as China, in future research will become even more necessary than it is today, where data up to 2012/2017 is utilized in which OECD member states still represent that major share of FDI (UNCTAD world investment report 2018). These numbers are, however, changing over time in favor of mostly Asian economies; the Association of Southeast Asian Nations (ASEAN) is an economic structure modeled to some extent on the EU which should be considered as a future important player in global FDI. Geostrategic aspects for FDI are not well covered in modern gravity FDI theory where Anderson et al. are taking a major role;

in their recent publication (Anderson et al., 2019[66]) the authors calibrate general equilibrium model findings for especially physical and technological capital into their micro-founded model and show that the protection of intellectual property, for example, is a major driver for FDI, an interesting aspect considering Chinese strategy in past years.[67] Gravity FDI analysis therefore definitively retains its topicality and becomes even more important with changing international economic dynamics and power shifting towards Asia.

[66] The working paper version is cited in chapter 4 with Anderson et al., 2017; the paper is in press since September 2019 at the European Economic Review.

[67] They use data from 2011 however, which potentially limits their findings concerning Chinese FDI.

Appendix D

Increase in foreign share of target capital stock, lagged	Decrease in Corporate Tax Rate										
	0%	-1%	-2%	-3%	-4%	-5%	-6%	-7%	-8%	-9%	-10%
0%	0.0%	1.2%	2.4%	3.6%	4.8%	6.0%	7.2%	8.4%	9.6%	10.8%	12.0%
1%	1.9%	3.1%	4.3%	5.5%	6.7%	7.9%	9.1%	10.3%	11.5%	12.7%	13.9%
2%	3.8%	5.0%	6.2%	7.4%	8.6%	9.8%	11.0%	12.2%	13.4%	14.6%	15.8%
3%	5.7%	6.9%	8.1%	9.3%	10.5%	11.7%	12.9%	14.1%	15.3%	16.5%	17.7%
4%	7.6%	8.8%	10.0%	11.2%	12.4%	13.6%	14.8%	16.0%	17.2%	18.4%	19.6%
5%	9.5%	10.7%	11.9%	13.1%	14.3%	15.5%	16.7%	17.9%	19.1%	20.3%	21.5%
6%	11.4%	12.6%	13.8%	15.0%	16.2%	17.4%	18.6%	19.8%	21.0%	22.2%	23.4%
7%	13.3%	14.5%	15.7%	16.9%	18.1%	19.3%	20.5%	21.7%	22.9%	24.1%	25.3%
8%	15.2%	16.4%	17.6%	18.8%	20.0%	21.2%	22.4%	23.6%	24.8%	26.0%	27.2%
9%	17.1%	18.3%	19.5%	20.7%	21.9%	23.1%	24.3%	25.5%	26.7%	27.9%	29.1%
10%	19.0%	20.2%	21.4%	22.6%	23.8%	25.0%	26.2%	27.4%	28.6%	29.8%	31.0%

Figure D.1. Scenario matrix for corporate tax and FDI inward stock changes on FDI inflow; an update to Figure 2.1 with smaller tax-effect.

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