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ABSTRACT

We examine factors affecting OECD bilateral Foreign Direct Investment (FDI) stocks over 1995-2016. We emphasise the effect of patterns of Research and Development (R&D) as well as the relative cost of various locations. Higher real exchange rates encourage inward FDI, as do low levels of domestic R&D. Increases in national saving reduce the real exchange rate, and also increase the possibility of investing more in R&D. As such they form part of the defences needed to maintain significant presence in manufacturing. We find that EU membership is a significant determinant of FDI even when we condition on other gravity variables. The importance of robust economic institutions and freedoms is discussed, with implications for countries that are reducing such freedoms.

Keywords: Research and development; foreign direct investment; gravity equation; dynamic panel data.

JEL classification: F14; F15; F21; C23

1. Introduction

Foreign Direct Investment (FDI) has long been seen as an important force in the globalisation of the world economy, and it has been shown to be driven by many factors including costs, capacities and trade barriers. It is also often seen as a positive force for growth in the recipient economy, bringing new technologies, new ways of doing and new products to new markets. This latter element has been linked to the capacity of the home economy to undertake innovative research into new products and effectively develop them. In the last 20 years research in this area has not always looked at the role of Research and Development (R&D) in driving FDI. In this paper we embed new insights in to FDI and R&D in gravity models based on Arkolakis et al (2018) and we also investigate the importance of relative cost of various locations. We conclude that both sets of factors matter, and that the real exchange rate is an important determinant of FDI patterns. We test as to whether distance should be measured geographically or by time zone differences. We show that only time differences matter, much as one might expect when the importance of R&D is being evaluated.

The literature on FDI has been extensive, starting with the traditional Industrial Economics approach based on structure, conduct, performance to more theoretical approaches based on firm behaviour that have emerged from the new trade theory of the 1980s and more recently the development of gravity based approaches. In our second section we focus on the more recent literature starting with the canonical gravity model work discussed in Antras and Yeaple (2014). This emphasises relative size, and other attraction factors as well as frictions to movement. We then look at the older new trade theory literature that discussed the role of R&D and its impact on trade and FDI. This approach has been extended and integrated into the gravity approach by Arkolakis et al (2018). We also discuss the determination of the real exchange rate in relation to national savings and look at the implications of low national savings and high real exchange rates for FDI and the decline of traditional manufacturing in countries such as the US and the UK. In our third section we integrate these three streams into a simple theoretical gravity based framework broken into the effects of size and country capacities, frictions and institutions.

Our objective is to test hypotheses about FDI and its determinants and in the fourth section we discuss both our data on bilateral FDI stocks in the OECD and look at the factors that might influence these. We also spell out the need to use Generalised Methods of Moments Estimators and in our fifth section we look at our core model using this technique. We find a significant role for the core canonical components of size and significant one for a measure of distance based on time zones as well as some institutional variables such as indices of governance quality. We include R&D indicators and find that both home and host levels are significant, but with opposite signs. We look across various measures of competitiveness, and we find the commonly used relative cost measure based on trade patterns is not significant. However, we find that home versus GDP weighted host costs are significant as are GDP weighted relative costs amongst hosts. These market-based measures tell us a great deal, but we show they are less good than a direct comparison of bilateral home and host costs. We conclude that countries that do more R&D do more FDI, but a high real exchange rate will reduce outward FDI and encourage inward FDI, all else equal. The real exchange rate is seen as exogenous to the FDI decision, but is clearly influenced by other factors, some of which may be under the control of policy makers. Policies that lead to high real exchange rates, such as lax fiscal policies, may well increase outward FDI and lead to a hollowing out of domestic production.

In our sixth section we look at the robustness of our results and conclude that we do not need to add to our underlying model or change our sample or our estimation techniques. We fist add a measure of geographic distance and find it is not significant, and we also investigate whether the effects of time zones and of R&D are changing over time. We conclude that there is little evidence to support the death of the distance effect on FDI, and that the effects of R&D have not been becoming more important over time. Because of the implications of changes to NAFTA for location in Mexico and also the UK's exit from the EU we test to see if there are any reasons to presume that they are 'different', and attracted more FDI than other factors suggested. We conclude they are not. We then look at a range of issues associated with the European Union and its significant impact on FDI. We test to see whether membership of monetary union boosts FDI, and we suggest that it does not. Institutions and relative costs differ a good deal within the EU and we test to see if they affect FDI stocks. We show that this is the case only in the new members in the three years before Accession. Finally, we look at the problem of missing observations, and show that the exclusion of Japan, the country with the most 'unavailable' observations, does not change our results. Our last section concludes.

2. Recent Discussions of Factors Affecting FDI

In this paper we study stocks of FDI as these reflect the level of involvement of foreign firms in the domestic economy, whilst flows only denote changes in involvement. Other papers also use outward stocks of FDI (Baltagi et al., 2007: Stein and Daude, 2007) for these reasons. The framework for the analysis of multinationals developed in Antras and Yeaple (2014) demonstrates a strong case for taking account of the relative size of countries as well as the frictions associated with moving between them. The Gravity model's flexibility allows for both "push" factors originating in home countries and "pull" factors arising from host economies. It has been widely employed to study FDI recently for instance in Sondermann and Vansteenkiste (2019) which has a focus on issues associated with the European Union.

2.1 The Canonical gravity model in the literature

There are a number of factors in the recent gravity literature that are common to all studies. Relative size is measured by GDP in almost all studies of bilateral FDI even when they are not cast explicitly in a Gravity framework. Within the more formal framework discussed by Antras and Yealple (2014) there are clear production capacity reasons for measuring size in this way, and the effects of size might well be the same in home and host economies. Home country GDP can be taken as a measure of specialist capacity to produce products which can either be exported or produced abroad. Host country GDP is assumed to reflect both the capacity of that economy to produce goods and also the size of the potential market to be served. As such its impact may be greater than that of home country size, and this proposition can be tested. In addition to country size, it is common to include variables such as some measure of distance, trade links and relative unit labour costs in papers on bilateral FDI.

Proximity between locations has a number of dimensions, and these must reflect the ease of communications and the costs of transportation. This latter dimension is less likely to be important for FDI than for trade in physical goods. A geographic measure of distance developed by Mayer and Zignano (2011) has become common in gravity studies of trade and migration in the last decade, but there are many other variables that can be used to calibrate the effects of proximity, and they may be more relevant to efficiently maintaining R&D based FDI stocks. Blonigen and Piger (2014) indicate that common language is still considered as one of the important determinants of FDI, as this allows efficient interaction over space. However, distance over space does not properly capture the costs associated with the need to interact quickly. In particular, telephone, e-mail and teleconference communication are close substitutes for face-to-face interaction. These are much easier if both parties are both within their normal working hours, and this is facilitated if they are in the same or adjacent time ones. Time zone effects have been found to be important by Stein and Daude (2007) amongst others, and they have a plausibility related to the need for managerial control in real time. The comparison of these measures of 'distance' is clearly testable, and we return to this issue below.

The question of whether labour costs affect the investment decision across OECD countries is the subject of some debate. Firms may compare cost at home with other locations in general, or they may look at the relative costs between themselves and specific new locations. Relative unit labour cost is seen by many authors to be the most relevant measure for location decisions. Bevan et al. (2004), as has been common in the literature based on country level data, found higher labour costs raised outward and reduced inward FDI. However, Devereux and Griffith (1998) found unit labour costs differentials to be a non-significant driver of the location choices of US multinationals in the EU. The overall results on competitiveness effects have been mixed, especially in firm specific studies and when trade related relative costs have been used, with clear results only for the EU Accession countries.

There is a considerable literature on the determinants of FDI that augments the more traditional models by further factors such as exchange rate regimes, political and economic stability, openness, product-market regulation and labour market arrangements. Blonigen and Piger (2014) used Bayesian statistical techniques to choose from a large set of candidates those variables likely to be FDI determinants. The variables are traditional gravity variables along with parent-country per capita GDP, cultural distance factors, relative labour cost, and regional trade agreements. Variables with little support for inclusion in this study are openness, costs of the host country business, recipient country infrastructure (including credit markets), and recipient country institutions. Openness comes in various forms, and it has generally been acknowledged for instance in Baltagi et al (2008) that the members of the EU are more open to each other than to outsiders because of common product market regulation and similar labour market arrangements that might make cost differentials more important in driving FDI. There are also other factors that could drive higher FDI within the EU such as monetary union. The introduction of the euro could have led to lower the business cost, reduced transaction costs, and facilitated capital mobility, as a result changing the weight of factors determining FDI decisions, as is discussed in De Sousa and Lochard (2011). The scale of the impact on FDI of common markets such as the EU is generally found to be quite large in empirical studies, and Barrell and Nahhas (2020) illustrate this and discuss the literature on the topic.

Political and economic instability are expected to reduce FDI since they create uncertainty, and this may have been affecting FDI to the Accession countries before they began the process of accession to the EU. The role of economic freedom has been investigated in the economic and business literature, for instance by Herrera-Echeverri et al. (2014), and most studies indicate the positive link between economic freedom (good institutions) and economic performance. A number of researchers have used the 'Free Economics Index'[1] in studies of FDI and of growth, and it was one of the FDI determinants identified by Economou (2019) who confirms the high level of economic freedom attract foreign investors in some European countries. Reductions in the level of this index would indicate that countries are moving outside the 'Narrow Corridor' that Acemoglou and Robinson (2019) argue is available to maintain economic growth. This may matter for some Accession economies, such as Poland and Hungary, that have recently been moving towards the exit from the corridor.

2.2 Competitive Products: the roles of R&D and the real exchange rate

There are many concepts of competitiveness in use in economics discussions, and they are much broader than the simple comparison of relative costs between producers or countries. These latter indicators matter, but so does the concept of product quality, which may not be easy to measure. Firm specific information and capacities may be embedded in products, and these can come from the impacts of specifically skilled workers, the way that the management structure has been built up to improve quality, and also the capacity of the firm to produce effective R&D that becomes embedded in the products they use. As Griffith, et.al. (2004) show, R&D has two faces, the ability to produce new goods more effectively, and the ability to absorb information in order to improve existing goods. R&D therefore gives both a competitive advantage and a defence against competition. Of course, these can in part be offset by lower prices, but these may imply lower profits or lower wages. Both costs and R&D, however, must be seen as important elements of competitiveness, and they have been significant in the study of FDI for some time, albeit not always with clear results, especially in the case of costs, as we have seen above.

The new trade literature of the 1980s allowed us to see that the location of R&D and of production could be separated, as Helpman (1984) showed. This meant that more innovative firms were more likely to produce in a multiple of plants across a geographical area, and hence would be more likely to become multinationals. The relevance for FDI, and a survey of the

[1] Economic freedom has been defined as 'the absence of government coercion or constraint on the production, distribution, or consumption of goods and services beyond the extent necessary for citizens to protect and maintain liberty itself'. This index is an indicator of the quality of the economic environment. It not only captures the economic policy of the government, but also the legal soundness of the economy and macroeconomic stability.

associated literature, can be found in Markusen (2002), and the empirical conclusions were clear, that we would expect that countries that undertook more R&D would also undertake more FDI. However, this early literature did not use the extensive insights of the Gravity model approach which are discussed above, and did not fully recognise the importance of R&D intensity as a defence against foreign penetration, much as would be suggested by the second face of FDI discussed in Griffith et al (2004).

Recent work by Arkolakis et al (2018) has extended the canonical gravity approach to FDI discussed above and embedded the role of R&D into it. This approach has taken the underlying theory of gravity models in the area, as spelled out by Antras and Yeaple (2014) which is in part based on Melitz (2003). They assume that innovation is created by heterogenous firms that sell differentiated goods in monopolistically competitive markets. Those firms can locate production outside their home market with similar levels of plant productivity to their home levels. The ability to produce outside the home market allows firms to specialise in R&D in some locations (perhaps only one) and produce in others. These authors also look at the role of specific trade costs and at the control costs associated with multinational activity. They then embed their insights into a calibrated model and undertake policy analyses. However, their work has clear testable implications, and we look at these issues here. In particular their work suggests that high R&D countries should undertake more FDI than other countries, and face less inward FDI. This latter concept is challenged by Driffield et al (2016) for instance, who suggest that at least some FDI is designed to absorb technologies from the host economies into home production. This may be an endemic problem, and if it were we would expect more FDI in to high R&D countries, especially in specialised sectors with easily moveable concepts such as information technology.

Although technical capacity, as indexed by R&D spending is an important part of the drivers of FDI, there are other factors to consider. In particular price and cost competitiveness may matter, and they may be driven by systemic factors that affect both the current account and the location of activity. In a closed economy saving must equal investment as income can only be spent on consumption goods or on investment goods, and saving is the difference between income and consumption. This identity holds in a different way in an open economy, where an excess of domestic saving over domestic investment leads to investment abroad. A symmetrical way of saying this is that if domestic spending is less than national output then there must be a balance of payment surplus, and that finances the net increase in foreign assets. The excess of saving over investment may come either from the choices of individual savers and firms, or as Barrell and Weale (2010) stress[2], from the choices of governments, as they can run budget surpluses. As long as exports and imports are not perfectly substitutes for foreign produced goods (for exports) or domestically produced goods (for imports) then an increase in national saving that requires an increase in the current account surplus will therefore lead to a fall in the real exchange rate to induce foreign residents to buy more domestic goods and domestic residents to buy fewer foreign goods. We can conclude that in the long run the real exchange rate is largely determined by the current account, as a reflection of national saving, and not the other way round, as popular discussion suggests.

The structure of foreign assets acquisition is however driven by a number factors, and a higher real exchange rate may well raise the scale of outward FDI. This rise in outward FDI resulting from an increase in the real exchange rate may well affect the sectors of the economy in different ways. Easily replicated manufactures, such as cars produced by multinational corporations, will be more affected by a high real exchange rate, and relocation will take place. Production of other less elastic goods will remain 'at home'. The implications are clear for the low national saving US as compared to high national saving Germany. The traditional US manufacturing sectors such as steel, vehicles, and clothing will be hollowed out, unlike in Germany. If the US had saved more, and had lower government borrowing, then US manufacturing would not have shrunk so much in the last 30 years. As Case and Deaton (2019) suggest, this has been a major factor in changes in US society, many of which were avoidable with different macroeconomic policies. Manufacturing in Germany has survived much better in part because national saving has been higher, and therefore as a consequence the real exchange rate has been lower than it would otherwise have been in order to generate the current account surplus driven by high savings.

Our discussion suggests that there are two sets of factors that we should take account of in addition to those discussed at the start of this section that are associated with canonical gravity models of FDI. Firstly, we should look for a pervasive effect of high levels of R&D on outward FDI and a strong role for domestic R&D as a factor reducing FDI inflows. We should also look for changes over time in these factors. Secondly, we should investigate the role of the real exchange rate, defined in a variety of ways to capture the impacts of reduced competitiveness on the location decision. It is clear from our discussion that levels of R&D, the scale of trade

[2] Barrell and Weale (2010) discuss the relevance, or lack of it, of Ricardian equivalence for this distinction between private and government savings and investment decisions.

links and the volume of FDI are jointly determined, and we should take account of this when investigating our data.

3. Theoretical Approaches to Foreign Direct Investment

We assume that bilateral foreign direct investment is a production decision, with different producers having different endowments and efficiencies, as Arkolakis et al (2018) discuss. They emphasise the role for Research and Development in driving the pattern of FDI in advanced economies. This approach formalises and extends the 'new trade theory' approach discussed above, which saw R&D as producing new varieties of goods and hence leading to an increase in foreign production. This approach will give us the traditional factors such as country size and characteristics, as well as include barriers which will affect monitoring costs. These trade-like features lead naturally to the framework discussed in the Head and Mayer (2014) paper on Gravity Models. The Gravity model was first adopted to analyse international trade flows and then subsequently used in other applications such as global financial markets. Its advantages are the simplicity of structure and its compatibility with a wide range of theoretical frameworks (Head and Mayer, 2014; Antras and Yeaple, 2014). Microeconomic foundations for this Gravity approach were developed by Anderson and van Wincoop (2003) and Melitz and Ottaviano (2008) amongst others. The model's flexibility allows for both "push" factors originating in home countries and "pull" factors arising from host economies. These may involve the size of the economy as an indicator of the ability to produce relevant products, the nature of the market there, the efficiency of producers and any legal or cultural barriers or ties that may be present. We may summarise these in a model of foreign direct investment (Y) from country i to country j written multiplicatively for simplicity of exposition as

$$Y_{ij} = E_{ij}\, Z_i Z_j\, G_{ij}\, (X_i)^{a1}\, (X_j)^{a2} \qquad (1)$$

We discuss the size variables X_i and X_j and the home and host indicators Z_i and Z_j first, and we then look at the friction variables G_{ij} and the institutional measures E_{ij} as these include many of the indicators that we stress.

3.1 Capacities and costs

The size of home (X_i) and host countries (X_j) are commonly measured by real GDP in trade studies, and has been used in nearly all recent empirical studies of bilateral FDI. A larger home country in terms of GDP will generally have a wider range of firms and products and will generate larger FDI outflows, and more FDI should be received into a larger host country market, as measured by GDP, as it will also have a wider range of production capacities.

Therefore, for both variables we expect a positively signed coefficient. We do not impose the same coefficient on home and host GDP, although this is common, as we wish to evaluate whether market oriented factors might increase the impacts of host size.

The papers discussed above strongly emphasise the role of R&D in determining patterns of FDI, and we include it in both home and host economies, indicating the capacity to produce products for production abroad, $R\&D_{it}$, and the strength of such production capacity in the host, $R\&D_{jt}$. It is of course possible that only home country R&D effects matter, and this is a testable proposition, as are other impacts of R&D on FDI, such as a search for new technologies from hosts to be used at home, which would reduce the negative impact of host R&D on inward FDI.

Specific home and host country factors considered in this study include relative costs, RC_{it},, of production, which are usually measured by relative unit labour costs in the country in question as compared to others. It is normal to use a measure based on the trade weighted costs of competitors, but this is not the only way such a comparison can be done. Producers with R&D based products will be looking for new markets where there may not have been much trade before, and we look at this issue by investigating three further measures of relative costs. The new markets may be either large markets, or perhaps those with low costs relative to others or to the home country where production can take place for export to other proximate markets. We spell out four measures all tell different stories. The first is the traditional measure which is related to existing trade patterns and is consistent with the well established 'new trade theory' from the 1980s and 1990s. The second measure we use reflects the choice of location amongst GDP weighted hosts, independent of home costs, and it is not commonly looked at in the literature on FDI. It is also consistent with the 'new trade theory', as it indicates a decision to invest abroad, and then a second decision as to where the investment takes place. Our third and fourth measures involve cost comparisons relative to the home country. These can be measured either by a weighted average, for instance with host GDP weights, or by direct cost comparisons of home costs relative to those of the host. These latter measures are consistent with the new approach to the role of R&D in FDI decisions epitomised by Arkolakis et al (2018) . We would expect home costs to have a positive impact, with high costs driving firms away from the home country, with the impact of costs amongst hosts being an empirical matter, and hence a testbed for the two sets of approaches we discuss.

There are other home and host country capacity factors to look at, and these are generally associated with legal and political institutions,. The existence of political risks in a country, and the specific nature of market risk in host countries, will affect the ability and willingness of cross border firms to invest in host countries. There are various ways we can measure these factors, which we may call R_i for home country risk and freedoms, and R_j for hosts. We can write an equation for country specific factors, Z_i (or Z_j) as

$$Z_i = b_i \, RC_i^{\,b1} \, R_i^{\,b2} R\&D_i^{b3} \qquad (2)$$

3.2 Frictions and Institutions

Bilateral frictions can be related to monitoring costs for production and there are various indicators of monitoring costs, and the most prominently used include some indicator of distance between home i and host j, D_{ij}. In trade studies geographic distance is commonly used, but it is not clear that it is so directly relevant to FDI decisions when other factors are taken on board. Stein and Daud (2007) use a measure of differences in time zones, and we prefer that in this study. If FDI plants are direct clones they may need little interaction with the clone parent, but in general they are more likely to need direct and immediate communication with the parent where R&D is an important factor in the FDI decision. Bilateral trade patterns (EXP_{ij}), included in G_{ij}, are widely seen as having had a significant effect on the scale of FDI, as greater openness of the economy may provide support for foreign investment. Other frictions have been associated in the literature in section 2 above with a common official language, $Lang_{ij}$. We can hence write the friction variable as an equation

$$G_{ij} = c_{ij} \, D_{ij}^{c1} \, EXP_{ij}^{c2} \, Lang^{c3}_{ij} \qquad (3)$$

There are other institutional factors that may affect home and host at the same time. The EU Single Market Act was in part designed to remove barriers to cross-border movements of capital as well as goods and labour. This legislation that established the Single Market changed the nature of the internal market and as a result can be expected to have changed FDI stocks. Most of these changes would be associated with cross border regulation or market access controls. We denote common membership of the European Union at time t as $EU_{ij,t}$. Other institutional factors might be associated with cost differences between EU countries, differences in political structures within the EU or membership of the European Monetary Union. We might denote these factors as EC_{ij}, as there are both different risk factors involved in making investment decisions and different regulations to follow in different EU countries. We may write a regulatory and environmental issues relationship as

$$E_{ij} = e_{ij}\, EU_{ij}^{e1}\, EC_{ij}^{\,e2} \qquad (4)$$

We can substitute GDP_{it}, GDP_{jt}, along with (2), (3) and (4) back in to (1) and produce an extended gravity model that builds on the simple canonical model with only size and distance to include country and environment factors that affect the behaviour of firms undertaking foreign direct investment.

4. Data and Methodology

We have annual stock data on bilateral FDI from 14 high income OECD countries to 31 OECD countries (see Appendix) spanning the period 1995 to 2016. The dependent variable is the outward bilateral FDI stock divided by a relevant GDP deflator. An investment from country *i* to country *j* ($FDI_{i,j}$) is seen as an outflow from the perspective of country *i*. We measure the size of home and host countries by real GDP in a common currency. As we estimate a dynamic model with fewer than 30 time series observations the autoregressive coefficient is likely to be biased downwards, implying that the model is best estimated using a systems GMM method or an instrumental variables estimator.

The fundamental structure behind the systems GMM estimator developed by Blundell and Bond (1998) is to estimate two equations: one in levels and the other one in first-differences. The strictly exogenous variables need to be chosen either empirically or from theory, and we need to demonstrate they are exogenous using the Sargan Hansen test. They serve as standard instruments for the level equation. The equivalent difference equation includes a set of variables that can be used as bases for the instruments for the endogenous variables in the levels equation. It in turn is instrumented by variables from the levels equation, and choices need to be made over the number of lags to be used in the instrumenting process.

Two conditions need to be met to ensure the validity of the System-GMM estimator (Roodman, 2009). First, based on the validity of the levels specification of the model, the first-differenced residuals should exhibit negative and significant first-order autocorrelation as this model will normally be over-differenced, but there should be no second order autocorrelation. Second, the instruments should be uncorrelated with the error term. This condition can be tested using the Hansen J-test of over-identifying restrictions which evaluates the joint validity of the instruments.

Equation (5) below includes the lagged dependent variable, and three endogenous variables, Home R&D, bilateral exports and trade weighted relative unit labour costs in the home country, all of which are correlated with the error.. If we assume all variables are exogenous, we fail the Hansen test for instrument validity, and we continue to do so as we expand the set of endogenous variables until we select these variables. Recent theory, for instance in Arkolakis et al (2018), indicates that FDI, R&D and trade should be treated as simultaneously determined, and our data set confirms this suggestion. It is not surprising therefore that trade related relative costs might also be endogenous. However, our discussion of the current account and its determinants suggests that the real exchange rate, as measured by costs relative to others independent of trade patterns may well be an exogenous variable. This is the case for our three measures of relative costs, GDP weighted host comparisons, GDP weighted home versus host comparison, and bilateral comparisons, all of which are independent of trade patterns. We use four lags for our instruments, because the use of three means we fail the Hansen J test, whilst the use of five raises its value to levels that suggest over-instrumenting is taking place.

We start by specifying a gravity equation used to estimate the determinants of bilateral FDI stocks based on the analysis in the previous section.

$$y_{\mathrm{i,j,t}} = a_0 + \lambda y_{\mathrm{i,j,t-1}} + a_1 \log(EXP_{\mathrm{i,j,t}}) + a_2 \log(GDP_{\mathrm{i,t}}) + a_3 \log(GDP_{\mathrm{j,t}}) + a_4 \log(D_{\mathrm{i,j,t}}) + a_5 R_{\mathrm{i,t}} + a_6 R_{\mathrm{j,t}} + a_7 \log(RC_{\mathrm{i,t}}) + a_8 \log(R\&D_{i,t}) + a_9 \log(R\&D_{j,t}) + a_{10} EU_{\mathrm{i,j,t}} + a_{11} CU_{\mathrm{i,j,t}} + a_{13} Lang_{\mathrm{i,j}} + a_{14} \log(ULC_{\mathrm{i,j}}) \quad (5)$$

Variable definitions are largely given above, but we collect and expand them here. The dependent variable $y_{i,j,t}$ in logarithms is the stock measure of bilateral outflow (Y_{ijt} above) from the home country (*i*) to the host country (*j*) in year *t*, with FDI in current dollars deflated using the home country's GDP deflator in dollars, its lagged value is indicated by the subscript t-1, and λ is the adjustment coefficient in the dynamic form of the gravity model. $GDP_{i,t}$ is real GDP for the home country and $GDP_{j,t}$ real GDP for the host country, $EXP_{i,j,t}$ is bilateral exports from the home to host country. $R_{i,t}$ is the economic freedom index for the home country and $R_{j,t}$ for the host country. $D_{i,j,t}$ is a measure of time zone differences, and this may vary over time as well as over space. We add the log of Geographic distance in our robustness tests. There are indicators of R&D intensity (R&D as a percent of GDP) both at home $R\&D_{it}$ and in the host, $R\&D_{jt}$ respectively. We have a number of measures of relative unit labour costs, and we denote them as a direct measure of costs between two countries ULC_{ijt} and relative costs of a country $RC_{i,t}$, and with the latter term taking several forms that compare one country's costs to a group of others. Definitions are clarified in the tables below, but the numerator country in our cost comparisons can be either the home, or the host, and the comparator group can be either trade weighted host or GDP weighted hosts (excluding the base host if that is the numerator country). We also capture further cultural similarity factors using $Lang_{i,j}$ which is defined as the use of a common official language, which reflects cultural similarities. Adoption of the single currency is measured by a dummy variable that changes from zero to one when both of the countries are members of the Euro zone, denoted $CU_{i,j,t}$. The dummy $EU_{i.j.t}$ is the variable that captures EU membership by both parties is an indicator that takes the value one from the point the country receiving FDI from an EU member itself entered the EU, and is zero before then, and also when only one country, or neither country, are EU members.

To summarise the discussion of the variables, Table (1) below displays the variables that are considered here and their definitions.

Insert Table (1) here

There are of course missing observations in the matrix, and this can cause problems for estimation and for interpretation when many observations are missing. There is a significant debate on zeros in trade flows models, and this is summarised in Head and Mayer (2014). In our sample, some 1831 observations, or about a fifth of the possible observations are absent, but only 186 are zero. Two thirds of the zeros are for Korea, where there are data errors in 2002 and 2005 when all stocks are recorded as zero whilst the total outward stock of FDI from Korea in these years is similar in scale to that in adjacent years. These data points are best treated in the same way as other 'absent' observations. The majority of the other missing, or 'absent', observations also come from non-reporting of data. For instance, there are no disaggregated data for Belgium from 1995 to 2007, and none for Spain from 1995 to 2002, despite the fact that aggregate FDI stocks of considerable size are reported.

In addition, the FDI data contain a considerable number of cells that are 'not available' due to reporting and confidentiality restrictions[3], as publication can reveal market sensitive information. The bilateral FDI data at a national level are built up from individual industry data, and where there are a small number of firms in an industry then publishing this detailed information can potentially reveal commercially sensitive information. If all other industry level cells are published, then the sensitive information will be revealed if the aggregate is published. Hence 'not available' is common at the aggregate level. Reporting based restrictions

[3] The largest set of not availables is for Japan, but our results are not particularly affected by omitting Japan, as we see below.

on data availability depend on country specific disclosure rules, and these differ significantly.

In both cases with missing data or not available observations discussed above we have a problem where missing cells should not bias coefficients, as there is no reason to presume they differ from filled cells. These two statistical problems leave us with an unbalanced panel with just over one percent of observed data points being actually zero, and these may be different from other cells, in that absence may have different causes from the scale of FDI once the decision to invest is made. We discuss this issue in our robustness section below.

5. Empirical findings for models estimated by GMM

The results from the two-step system GMM estimator are presented in Table (2). Several model specifications are developed. First of all, we add our R&D and European Single Market variables to a traditional Gravity model and this is presented in column (1), and then in column (2) to that model we add a competition amongst hosts indicator based on GDP weighted costs. In column (3) a home versus host cost indicator, where we weight hosts by their GDP, is added to the traditional gravity model, and in (4) a direct indicator of home costs relative to specific host costs is added. Each of these three variables are significant when included on their own and we choose between them in columns (5) and (6). First the host costs relative to other weighted hosts is included with the direct home and host comparison, and then home versus weighted host costs are included with the direct comparison. In both cases the direct comparison is preferred, suggesting that column (4) should be our preferred explanation.

The dynamic specification seems to be well defined, and a Hansen test of the validity of the instruments (and the appropriateness of the specification) is passed by all our equations. Across all specifications in Table (2), the results for the tests of serial correlation are as expected. Although it is not possible to accept the null hypothesis that there is no first order serial correlation, higher order serial correlation does not appear to be a problem as it is not possible to reject the null of no second or third order serial correlation.

Insert Table (2) here

The adjustment coefficient on lagged FDI is positive and statistically significant suggesting significant inertia in the stock adjustment process. The significance of the lagged dependent variable confirms that it is essential to use an instrumental variables estimator. Given the sunk costs incurred by investors to set up distribution networks and services in foreign markets it is not surprising that there is persistence in FDI stocks. The coefficient on lagged

FDI in column (4) is about 0.16, and hence the long run effects of variables are amplified by around a one-fifth as compared to the impact coefficient.

We find that home R&D effects are positive and significant, whichever specification we choose. This gives strong support for the approach adopted by Arkolakis et al (2018), and the impact is particularly strong in our preferred specification in column (4) where we include the direct cost comparison between home and host. The more R&D a home country undertakes, the larger the stock of outward FDI it has, and this stock tends to go to locations that are particularly low cost as compared to the home country. It is also clear that some of the opportunities that are available to home countries that undertake a significant amount of R&D are also available to host countries. The bilateral FDI stock is significantly lower the more the host country undertakes R&D itself. It appears that a strong R&D presence is a defence against the involvement of foreign firms in the economy, although as Driffield et al (2016) suggest there may be situations where FDI takes place in order to capture host country R&D.

There is a strong case to be made that relative cost effects do matter, but that weighting by trade patterns is not particularly useful, as R&D driven FDI does not appear to be a complement or substitute to existing trade, but rather a resource looking for a market. Weighting hosts by their GDP, rather than by their trade links, may be of some value, but direct cost comparisons seem better, as we can see in columns (5) and (6) in Table (2). Lower cost hosts seem to be preferred, as column (2) suggests, but the weighted effect is dominated by the direct comparison, as we can see in column (5). A GDP weighted hosts measure as compared to home costs in column (3) is also significant and positive, as we would expect. However, it is also less important than the direct cost comparison, and becomes insignificant when this is included in column (6).

The EU coefficient estimate is economically and statistically significant suggesting that the bilateral FDI stocks between member states are higher than other factors, such as size and proximity, would suggest. In the long run the initial impact of membership of the Single Market raises FDI from other members with supply chains spreading across the market area. We look at the role of European markets further in our robustness section. Additionally, it is found distance as measured by time zone differences has a significant negative impact on bilateral FDI. If time zone differences increase by one hour, the bilateral stock of FDI falls by about 8 percent in the long run. This suggests that companies prefer investing in countries that are close to them in time zone terms as increases in differences raise control costs.

As for institutional variables, the economic freedom index R_i for the home country and R_j for the host country are positive and significant, presenting evidence that the OECD countries with good institutions managed to attract more FDI. Host country effects are more than twice as important, and the difference is significant at the ten percent level. Institutional quality is important, as Economou (2019) shows for a narrower group of countries than in our study. Even within the OECD stronger institutions and a system of law enforcement signals that investors' rights will more likely be protected in host economies, and that home economies will undertake proper policing of outward foreign investors behaviour, and will not subject outward investors to political pressures driven by worries about the movement of jobs. Our findings suggest cultural similarity, as indicated by a common official language has a significant positive impact, raising bilateral FDI. This factor is partly an Anglo Saxon one, and it is enough to explain the strong presence of US investment in the UK. There is clear evidence to support the notion that transaction costs are reduced as a result of common cultural ties or values and that this encourages bilateral FDI.

The results related to the core variables in Table (2) are also of interest with real GDP of the host and home countries both having a positive sign and being statistically significant in all specifications. The coefficient on bilateral exports is positive and statistically significant, suggesting they are complementary to bilateral FDI. The long run real GDP elasticity of the host country is around 0.6 and we note that the impact from the host country's GDP is almost a fifty percent larger than that of the home country, which is significant at the ten percent level, suggesting that market specific effects augment the gravity part of the relationship. The relative importance of the host market offers support for the addition of R&D capacities to the canonical gravity model of FDI, with significant R&D countries looking for larger markets.

6. Robustness Results

The focus of this paper has been on a number of new variables in the Gravity approach to FDI, and we have looked at the role of the R&D and a variety of relative cost indicators. In this section we investigate the potential role for geographic distance and also whether the time zone based distance effect is declining over time, and whether the UK or Mexico have special advantages.. Changes over time may matter, and we look at whether R&D effects have been increasing. The results are reported in Table (3). We test a number of hypotheses about European integration in Table (4), and ask whether the EU boosted FDI stocks in other ways. We investigate in this section whether membership of monetary union matters for FDI and find it does not. We then look at the impacts of costs amongst members, and find they only mattered for transition economies before membership. The same is true for our risk indicators.

Perhaps the most important robustness test we can use is one where we look at the additional information in geographic distance when we have included a time zone measure. The latter variable is only one possible dimension of separation, and it is possible that the frictions involved in the FDI decision between say Denmark and Spain (which are in the same time zone) are more significant than those between Denmark and Sweden (which are also in the same time zone) because geographic distance is much greater in the former case. If both matter then we would expect both to be significant, albeit with a larger effect from time zone differences. As we can see in column (1) of Table (3), where we add geographic distance to column (4) of table (2), only time zones are significant, and geographic distance has a positive sign, which is the reverse of what we might expect. Hence ,we would argue that our choice of time zone effects over geographic distance is robust.

In Table (3), we also include tests of the special nature of the UK as an FDI platform for countries outside the EU in column (2) and also test in Mexico has special features because of its membership of NAFTA in column (3). We include a dummy in the inward FDI to the UK relationships, and find that this variable has a negative impact and not at all significant, suggesting strongly that the UK has no labour market or competitive environment advantage above the rest of the EU. The scale of FDI into the UK, which has been noticeable, is picked up by other factors in the regression, especially by a common official language with the US and Canada, an advantage shared with Ireland. We see no more FDI in the UK than would be expected given other factors. We can say the same of Mexico, which has benefited from its location next to the US which has raised FDI significantly from all sources. The insignificant Mexico dummy strongly suggests that membership of NAFTA does not have the same effects on Mexico as membership of the EU has for the low cost peripheral countries in the Union.

Insert Table (3) here

Gradual improvements in communications technology and the growth of the internet may lead to the 'Death of Distance', but its demise is clearly an empirical matter. In column (4) of Table (3) we add a new variable to column (4) of Table (2) to test for this effect, and we find that the product of time and time zone differences has a positive effect, indicating that time zone distance is becoming a less important factor over time, but that effect is both very small and not significant. We also test whether the increasing importance of research in new technologies has influenced the effects of R&D on FDI.. In column (5) we include an interaction term for time and home R&D as a percent of GDP, and we find that it is not increasing in importance. We repeat the same exercise in column (6) for host R&D as a percent of GDP, and we find that it has not strengthened defences over time, as it is not at all significant. R&D stocks have been rising as a percent of GDP over the last two decades, but the impacts of stocks have not risen by more than that

We next look at some issues that are particularly relevant for European integration because we have a large and significant effect on FDI of membership of the union. This remains robust to further investigation. It is clear from column (1) of Table (4) that there are no clear advantages for FDI from membership of monetary union in Europe after we take account of the other factors driving FDI, including both gravity variables and R&D and competitiveness effects. Our results do not support the conclusion of the earlier literature on the impacts of monetary union discussed above but we do include both a longer time period and more factors, as well as a stronger distinction between EU and monetary union membership. There is only 60 percent overlap between EU and European Monetary Union membership in our dataset, and hence their effects can be easily separated. As the appendix shows, two home countries (the UK and Sweden) are in the EU, but not in European Monetary Union, as are 3 hosts (Poland, Hungary and the Czech Republic). A further 7 home countries and 14 of our hosts only joined EMU some years after they joined the EU.

Insert Table (4) here

The level playing field within Europe may make factors such as cost differences more important. We test this in two ways. First, in column 2 of Table (4), we include our relative costs indicator for EU members only, testing to see if within EU cost differentials had a greater effect on FDI that they do in general. We find that there is no special effect of cost competitiveness within the EU, and this is not a factor increasing FDI within the region. The lower cost economies within that region are in general the accession countries in central and southern Europe, and we test to see if they had a special effect in the run up to accession. In column (3) we have an interaction term with a dummy that is one for the three years before the new EU members joined in 2004 and zero otherwise (see appendix) and multiply that by home relative to host costs. We find that lower cost accession countries attracted significantly more FDI in the run up to accession than did higher cost accession countries. As this is a 3 year impulse variable it does not affect our overall results and the coefficient on membership of the

EU is unchanged when temporary, significant, variables are added. We repeat this exercise for our risk indicator, and in column (4) we show that there is no special role for host institutional strength within the EU by testing an interaction term between host freedom and EU membership. It is not significant. However, in the run up to accession the quality of institutions in the host clearly did matter as in column (5) the interaction term between host indicators and risk in the 3 years before EU membership is significant and positive. The stronger institutions were in the accession countries the more FDI they attracted in the run up to membership.

It is important to assess whether absent or missing observations affect our results, and to do this we have excluded Japan, which the country that is most worrying from this perspective. Belgium, Spain and Japan have similar numbers of missing observations, but as we discuss above the first two result from a failure to publish disaggregated data in the first half of our sample. There are almost 400 observations for Japan that are not available, which is almost a quarter of the missing observations, and hence we can omit that country from the data set. We have tested the equality of the coefficients in the with and without Japan panels based on our maintained hypothesis that the missing observations are a statistical problem, not a structural one. A Wald test of the restriction is easily passed, with a Chi-squared (13) of 377 (prob. 0.9300) and we would conclude that our core results in column 4 of Table (2) are statistically the same as those in this regression excluding Japan. This suggests that our results are robust to selection bias effects from unobservable FDI stocks, which are much more common than zero stocks, unlike in trade based gravity models where zeros are very common

7. Conclusions

We have tested extensively for the impacts of R&D and of relative costs on patterns of FDI within the OECD. Earlier research has shown that FDI can be well explained by gravity like factors such as the relative size of economies. We support these results and in addition we find that the time zone distance apart and institutional quality have significant and positive effects on patterns of FDI. We add R&D data to these FDI relationships and find that both home and host R&D are always significant, albeit with opposite signs. In our initial set of results, we show that relative cost does matter, and that this is best measured by direct comparisons of bilateral cost differentials. These results are robust to the inclusion of both geographic distance and the death of distance effects as well as to the assumption that the effects of a given level of R&D are becoming more important over time. There is little evidence to support either hypothesis, but as R&D has been increasing in scale relative to GDP it has become absolutely more important.

It is clear that levels of R&D are important drivers of outward FDI, but they are also important defences against inward FDI. This may reflect the ‘two faces’ of R&D, as it increases the capacity to innovate, but also the capacity to emulate, and therefore be less attractive to science based producers who see competitors already in place in strong R&D hosts. Within the EU FDI levels are noticeably higher than we might otherwise expect, reflecting common standards and regulations that allow easy movement of products and inputs across borders. These benefits are much larger than those given by free trade arrangements, as many more barriers are removed, and multi-plant, multi-country production is encouraged. The EU Accession countries benefitted just before accession if they had better quality institutions or lower costs (or both) but there is no evidence that relative costs or institutional quality matter more in the EU than elsewhere. Home institutional quality matters, although its impact is only half that of host qualities. It is possible that the decline in the rule of law and the growth of idiosyncratic government in countries such as Poland and Hungary could reduce their inward FDI, and that the US may also see somewhat lower outward FDI given events there between 2016 and 2020. There is also no evidence that the UK has any special status as an FDI destination, as the scale of inward FDI there is fully explained by country size, language barriers and R&D levels as well as relative costs. The combination of exit from the EU and the changing nature and competence of government may make it a much attractive destination for inward FDI, and a less reliable source for other countries inward FDI

Relative costs matter, and if a country wishes to defend itself against the impacts of large scale outward FDI then a lower real exchange rate is of great value. A lower real exchange rate can best be generated by increasing national saving, either by changes in the savings behaviour of the private or the public sector. This which will reduce imports, reduce the real exchange rate, and hence raise exports. Outward FDI will be lower if the real exchange rate is lower, and inward FDI will be higher. These impacts will matter most for easily substitutable products such as cars and steel. Larger government deficits designed to raise employment in the short run reduce national saving and raise the real exchange rate and hence potentially have the reverse effect if they are sustained into the long run.

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Appendix- ***Countries included in the sample*.**

Home countries (14)	**EU Countries (accession dates)**	**Currency Union (dates)**	**Host Countries (31)**	**EU Countries (accession dates)**	**Currency Union (dates)**
Austria	EU	1999	Australia	--	--
Belgium	EU	1999	Austria	EU	1999
Canada (**N**)	--	--	Belgium	EU	1999
France	EU	1999	Canada (**N**)	--	--
Germany	EU	1999	Czech Republic	EU 2004	--
Italy	EU	1999	Denmark	EU	--
Japan	--	--	Estonia	EU 2004	2011
Korea, Rep.	--	--	Finland	EU	1999
Netherlands	EU	1999	France	EU	1999
Spain	EU	1999	Germany	EU	1999
Sweden	EU	--	Greece	EU	2001
Switzerland	--	--	Hungary	EU 2004	--
United Kingdom	EU	--	Ireland	EU	1999
United States (**N**)	--	--	Israel	--	--
			Italy	EU	1999
			Japan	--	--
			Korea, Rep.	--	--
			Mexico (**N**)	--	--
			Netherlands	EU	1999
			New Zealand	--	--
			Norway	--	--
			Poland	EU 2004	--
			Portugal	EU	1999
			Slovak Republic	EU 2004	2009
			Slovenia	EU 2004	2007
			Spain	EU	1999
			Sweden	EU	--
			Switzerland	--	--
			Turkey	--	--
			United Kingdom	EU	--
			United States (**N**)	--	--

Sources, OECD FDI statistics. NOTE: N: NAFTA block member.

TABLE (1)
Variables definitions and data sources.

Variables	Unit	Source
$y_{i,j,t}$ =Log ($FDI_{i,j,t}$/ GDP $Deflator_{i,t}$)	outward stock of bilateral from the home country (i) to the host country (j) in year t, with FDI in current US$ deflated using the home country's GDP deflator in US$.	(OECD)
$EXP_{i,j,t}$	Bilateral exports of goods (As exports of service data are not available for most of the countries in the sample).	(OECD)
Real $GDP_{i,t}$, $GDP_{j,t}$	At constant 2005 prices and converted to US$s.	(OECD)
$D_{i,j,t}$	Variable accounting for the time differential in between the capital cities of the home and host countries.	Encyclopaedia Britannica Inc. 1994
$DIS_{i,j,t}$	Measure in geographical distance in kilometres to proxy transportation costs	CEPII Distance Database (www.cepii.fr)
$R_{i,t}$. $R_{j,t}$	An index of economic freedom that refers to whether there is any restriction on trade in a country.	Heritage Foundation 2015 (www.heritage.org)
$EU_{i,j,t}$	Dummy variable that equals 1 if countries i and j are EU members at time t and 0 otherwise.	(see Appendix)
$Lang_{i,j}$	Dummy variable that equals 1 when both countries share a common official language and 0 otherwise.	www.cepii.fr
$CU_{i,j,t}$	Dummy variable that equals 1 if countries i and j use the same currency (euro) at time t and 0 otherwise.	(see Appendix)
$RC_{i,t}$	labour costs in the home country relative to the countries it trades with country, Exchange Rate Adjusted RULC, Index OECD base year (2010=100)	(OECD)
$ULC_{i,j,t}$	labour costs in the home country relative to the host country, Exchange Rate Adjusted ULC, Index OECD base year (2010=100).log ULC home -USD - log ULC host -USD	(OECD)
home ULC / GDP weighted host ULC	log(home ULC)/(GDP weighted host ULC)), Exchange Rate Adjusted ULC, Index OECD base year (2010=100)	
host ULC/GDP weighted host ULC	log(host ULC)/(GDP weighted host ULC)), Exchange Rate Adjusted ULC, Index OECD base year (2010=100)	
$R\&D_{i,t}$ $R\&D_{j,t}$	Gross domestic spending on R&D total expenditure (current and capital) on R&D carried out by all resident companies, research institutes, university and government laboratories, etc., in a country. It includes R&D funded from abroad, but excludes domestic funds for R&D performed outside the domestic economy.In constant prices using 2010 base year, at Purchasing Power Parities (PPPs) and as percentage of GDP	(OECD)
UK (host)	Dummy variable that equals 1 when the UK is host country and 0 otherwise.	(see Appendix)
Mexico (host)	Dummy variable that equals 1 when Mexico is host country and 0 otherwise.	(see Appendix)
Home and host costs indicator for EU members only	Dummy variable that equals 1 if countries i and j are EU members at time t and 0 otherwise and multiply that by Home and host costs indicator $ULC_{i,j,t}$	(see Appendix)
Home and host costs indicator for new EU members	Dummy variable that equals 1 in the three years before joining EU and 0 otherwise and multiply that by Home and host costs indicator $ULC_{i,j,t}$	(see Appendix)
Institutions quality in the EU host	Dummy variable that equals 1 if host country is EU member at time t and 0 otherwise, multiplied by host $R_{j,t}$	(see Appendix)
Institutions quality in the new EU host	Dummy variable that equals 1 in the three years before joining EU and 0 otherwise multiplied by host $R_{j,t}$	(see Appendix)

**Annual data over the period 1995-2016

TABLE (2) Competitiveness in The Canonical Gravity Model of FDI

Results for dynamic panel-data estimation using two-step SYS-GMM, for FDI stocks.

Independent Variables	Base Model	Host relative costs	Home relative cost	Bilateral costs	Test col(2) to col(4)	Test col(3) to col(4)
$y_{i,j,t-1}$	0.1604***	0.1886***	0.1743***	0.1636***	0.1657***	0.1566***
	(0.0476)	(0.0490)	(0.0478)	(0.0479)	(0.0486)	(0.0482)
$\log(GDP_{i,t})$	0.3666***	0.3426***	0.3605***	0.3480***	0.3449***	0.3587***
	(0.0857)	(0.0855)	(0.0855)	(0.0835)	(0.0847)	(0.0784)
$\log(GDP_{j,t})$	0.4747***	0.4789***	0.5905***	0.4918***	0.4793***	0.3989***
	(0.0827)	(0.0796)	(0.0863)	(0.0806)	(0.0814)	(0.1314)
$\log(EXP_{i,j,t})$	0.4478***	0.4628***	0.4574***	0.4458***	0.4287***	0.3935***
	(0.0670)	(0.0727)	(0.0673)	(0.0689)	(0.0778)	(0.0672)
$R_{i,t}$	0.0208***	0.0254***	0.0178**	0.0181***	0.0202***	0.0248***
	(0.0073)	(0.0069)	(0.0071)	(0.0070)	(0.0069)	(0.0065)
$R_{j,t}$	0.0302***	0.0428***	0.0347***	0.0410***	0.0421***	0.0524***
	(0.0108)	(0.0101)	(0.0105)	(0.0106)	(0.0097)	(0.0110)
$D_{i,j,t}$	-0.0777***	-0.0803***	-0.0640**	-0.0699***	-0.0701***	-0.0856***
	(0.0267)	(0.0254)	(0.0274)	(0.0258)	(0.0251)	(0.0239)
$Lang_{i,j}$	3.6420***	3.1252***	3.7112***	3.4153***	2.8200***	2.6054***
	(0.9477)	(0.8888)	(0.9535)	(0.9026)	(0.8708)	(0.9091)
$\log(RC_{i,t})$	0.0205	0.0365	-0.0512	-0.0515	0.0510	-0.0620
	(0.1170)	(0.1209)	(0.1164)	(0.1166)	(0.1199)	(0.1174)
$EU_{i,j,t}$	0.6343***	0.6082***	0.5891***	0.6331***	0.5615***	0.6533***
	(0.1972)	(0.1870)	(0.1994)	(0.1912)	(0.1814)	(0.1711)
$\log(R\&D_{i,t})$	0.4437***	0.3390***	0.3483***	0.4298***	0.4484***	0.4135***
	(0.0945)	(0.1014)	(0.0914)	(0.0941)	(0.0987)	(0.1007)
$\log(R\&D_{j,t})$	-0.2794***	-0.3627***	-0.3594***	-0.3666***	-0.3466***	-0.3579***
	(0.0747)	(0.0755)	(0.0741)	(0.0714)	(0.0700)	(0.0647)
$\log(ULC_{i,j,t})$				0.1391***	0.1977***	0.2913**
				(0.0228)	(0.0576)	(0.1471)
host ULC versus GDP weighted host ULC		-0.1299***			0.0749	
		(0.0336)			(0.0697)	
home ULC versus GDP weighted host ULC			0.1266***			-0.1584
			(0.0224)			(0.1415)
Constant	-22.8694***	-23.6976***	-26.5863***	-22.9004***	-22.9775***	-19.4284***
	(3.0370)	(3.0465)	(3.1218)	(2.9223)	(3.0706)	(4.9674)
Observation Number	6897	6607	6811	6811	6607	6811
AR(1) test	-4.23***	-4.33***	-4.30***	-4.23***	-4.10***	-4.16***
AR(2) test	-1.09	-0.99	-1.01	-1.06	-0.93	-1.08
J-test~$\chi2(380)$	393.42	384.05	392.67	393.12	384.66	393.26
J-test: p-value	0.307	0.432	0.316	0.310	0.424	0.309

Notes: Endogenous variables, FDI, R&D, bilateral trade and relative costs. All regressions are estimated over the period 1995–2016 using a dynamic two-step system GMM estimator (Blundell and Bond,1998) with finite sample correction to the variance-covariance matrix. Huber–White robust standard errors are reported in parenthesis. ***, **, and * denotes statistical significant at 1%, 5%, and 10% level, respectively. Panel coherent serial correlation tests (AR(*p*)) are for order *p=1,2*. The J-test statistic with p-values related to over-identifying restrictions.

TABLE (3) Robustness Results: Time, Place and Distance

Independent Variables	Add Distance	UK advantage	Mexico advantage	Death of TimeZone	Home RD and time	Host RD and time
$y_{i,j,t-1}$	0.1635***	0.1640***	0.1621***	0.1626***	0.1691***	0.1656***
	(0.0478)	(0.0480)	(0.0480)	(0.0481)	(0.0480)	(0.0479)
$\log(GDP_{i,t})$	0.3412***	0.3465***	0.3492***	0.3567***	0.3701***	0.3289***
	(0.0858)	(0.0839)	(0.0848)	(0.0844)	(0.0827)	(0.0890)
$\log(GDP_{i,t})$	0.4866***	0.4910***	0.4878***	0.4966***	0.5215***	0.4760***
	(0.0815)	(0.0825)	(0.0808)	(0.0814)	(0.0829)	(0.0834)
$\log(EXP_{i,j,t})$	0.4501***	0.4465***	0.4450***	0.4457***	0.3970***	0.4640***
	(0.0657)	(0.0690)	(0.0691)	(0.0696)	(0.0663)	(0.0738)
$R_{i,t}$	0.0176**	0.0181**	0.0177**	0.0199***	0.0222***	0.0159**
	(0.0070)	(0.0071)	(0.0071)	(0.0069)	(0.0070)	(0.0073)
$R_{j,t}$	0.0404***	0.0408***	0.0405***	0.0440***	0.0421***	0.0372***
	(0.0106)	(0.0107)	(0.0108)	(0.0107)	(0.0099)	(0.0117)
$D_{i,j,t}$	-0.0803*	-0.0700***	-0.0710***	-0.0691***	-0.0758***	-0.0649**
	(0.0486)	(0.0258)	(0.0267)	(0.0247)	(0.0249)	(0.0293)
$Lang_{i,j}$	3.5158***	3.4344***	3.5326***	3.1373***	3.2255***	3.6441***
	(1.0181)	(0.9265)	(0.9439)	(0.9104)	(0.8953)	(0.9026)
$\log(RC_{i,t})$	-0.0513	-0.0513	-0.0482	-0.0693	-0.0858	-0.0304
	(0.1162)	(0.1172)	(0.1169)	(0.1166)	(0.1132)	(0.1186)
$EU_{i,j,t}$	0.6547***	0.6328***	0.6480***	0.6272***	0.6166***	0.6220***
	(0.2083)	(0.1927)	(0.1958)	(0.1841)	(0.1842)	(0.1969)
$\log(R\&D_{i,t})$	0.4343***	0.4301***	0.4264***	0.4515***	0.2772***	0.4147***
	(0.0938)	(0.0941)	(0.0942)	(0.0968)	(0.1050)	(0.0998)
$\log(R\&D_{j,t})$	-0.3674***	-0.3658***	-0.3505***	-0.3660***	-0.3521***	-0.4102***
	(0.0719)	(0.0723)	(0.0766)	(0.0692)	(0.0678)	(0.1133)
$\log(ULC_{i,j,t})$	0.1412***	0.1388***	0.1367***	0.1408***	0.1200***	0.1391***
	(0.0237)	(0.0228)	(0.0233)	(0.0228)	(0.0212)	(0.0229)
$\log(DIS_{i,j,t})$	0.0536					
	(0.2110)					
UK (host)		-0.0184				
		(0.3726)				
Mexico (host)			0.2067			
			(0.3050)			
Ttimediff				-0.0003		
				(0.0008)		
$TR\&D_{i,t}$					0.0004	
					(0.0063)	
$TR\&D_{j,t}$						0.0054
						(0.0096)
Constant	-23.0024***	-22.8447***	-22.7744***	-23.5133***	-23.1743***	-22.0100***
	(2.9285)	(2.9544)	(2.9347)	(3.1081)	(3.1338)	(3.1655)
Observation Number	6811	6811	6811	6811	6811	6811
AR(1) test	-4.24***	-4.23***	-4.22***	-4.23***	-4.24***	-4.25***
AR(2) test	-1.07	-1.06	-1.07	-1.06	-1.01	-1.07
J-test~$\chi 2(380)$	393.08	393.26	393.18	393.29	393.15	393.20
J-test: p-value	0.311	0.309	0.310	0.308	0.310	0.309

Notes: See definitions at the bottom of Table 2.

TABLE (4) Robustness Results (2) European Dimensions

Independent Variables	EMU members	EU costs	Accession costs	EU risks	Accession Risks
$y_{i,j,t-1}$	0.1632***	0.1635***	0.1618***	0.1666***	0.1631***
	(0.0480)	(0.0480)	(0.0480)	(0.0482)	(0.0479)
$\log(GDP_{i,t})$	0.3679***	0.3487***	0.3454***	0.3512***	0.3178***
	(0.0823)	(0.0829)	(0.0851)	(0.0831)	(0.0826)
$\log(GDP_{i,t})$	0.5111***	0.4909***	0.4871***	0.5205***	0.4724***
	(0.0809)	(0.0822)	(0.0815)	(0.0802)	(0.0778)
$\log(EXP_{i,j,t})$	0.4247***	0.4469***	0.4564***	0.4151***	0.4880***
	(0.0679)	(0.0693)	(0.0677)	(0.0668)	(0.0687)
$R_{i,t}$	0.0207***	0.0187***	0.0179**	0.0143**	0.0183**
	(0.0068)	(0.0070)	(0.0072)	(0.0071)	(0.0072)
$R_{j,t}$	0.0444***	0.0414***	0.0403***	0.0446***	0.0396***
	(0.0098)	(0.0106)	(0.0105)	(0.0100)	(0.0106)
$D_{i,j,t}$	-0.0748***	-0.0699***	-0.0646**	-0.0711***	-0.0596**
	(0.0245)	(0.0257)	(0.0267)	(0.0247)	(0.0273)
$Lang_{i,j}$	3.1040***	3.3444***	3.4078***	3.2166***	3.4529***
	(0.7900)	(0.9053)	(0.9128)	(0.8748)	(0.8882)
$\log(RC_{i,t})$	-0.0514	-0.0556	-0.0521	-0.0394	-0.0471
	(0.1172)	(0.1164)	(0.1177)	(0.1161)	(0.1191)
$EU_{i,j,t}$	0.6406***	0.6287***	0.6580***	0.4552*	0.6563***
	(0.1801)	(0.1898)	(0.1997)	(0.2326)	(0.2013)
$\log(R\&D_{i,t})$	0.4299***	0.4204***	0.4418***	0.4121***	0.4397***
	(0.0939)	(0.0929)	(0.0960)	(0.0942)	(0.0946)
$\log(R\&D_{j,t})$	-0.3641***	-0.3655***	-0.3630***	-0.3760***	-0.3603***
	(0.0686)	(0.0712)	(0.0736)	(0.0689)	(0.0724)
$\log(ULC_{i,j,t})$	0.1380***	0.1367***	0.1384***	0.1511***	0.1393***
	(0.0229)	(0.0238)	(0.0229)	(0.0239)	(0.0229)
$CU_{i,j,t}$	-0.0183				
	(0.1425)				
Home and host costs indicator for EU members only		0.0082			
		(0.0450)			
Home and host costs indicator for new EU members			0.1321***		
			(0.0484)		
Institutions quality in the EU host				0.0040	
				(0.0029)	
Institutions quality in the new EU host					0.0085***
					(0.0027)
Constant	-23.8784***	-22.9335***	-22.9052***	-23.1815***	-22.4865***
	(2.9496)	(2.9083)	(3.0097)	(2.9212)	(2.8953)
Observation Number	6811	6811	6811	6811	6811
AR(1) test	-4.21***	-4.23***	-4.26***	-4.20***	-4.31***
AR(2) test	-1.05	-1.07	-1.07	-1.05	-1.11
J-test~$\chi 2(380)$	392.96	392.94	394.96	393.35	394.37
J-test: p-value	0.312	0.313	0.288	0.308	0.295

Notes: See definitions at the bottom of Table 2.