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, with 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 and moving on 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 Anderson 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,

significant

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 PRGHO provides a framework for empirical analysis of bilateral relationships between home and 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 specialisation and 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 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 Pi92.s8G BT /F2

associated literature, can be found in Markusen (2002), and the main conclusions were clear, that we would expect that countries that undertook more R&D would also undertake

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 of 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 easily replicated goods will remain. Hence the US has had relatively 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.

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 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 7 2Othe2r34 0 0z232 82 841.92 re W* n BT /F2 12 Tf 1 0 0 1 135.26 428.23 BT

$E_{ij} = e_j$

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. Based on theory, for instance in Arkolakis et al (2018), indicates that FDI, R&D

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/or 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 1331 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 missing observations. The majority of the remaining missing 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

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 WKDW LQYHVWRUV¶ home countries that host countries will protect investors, 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 mostly 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

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

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 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 euro. 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 11 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 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 impulse variable it does not affect our overall results and the coefficient on membership of the

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 that R&D, as well as FDI, 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 benefited 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 re

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TABLE (3) Robustness Results

TABLE (4) Robustness Results (2) European Dimensions

Independent Variables	EMU members	EU costs	Accession costs	EU risks	Accession Risks
U	0.1632***	0.1635***	0.1618***	0.1666***	0.1631***
	(0.0480)	(0.0480)	(0.0480)	(0.0482)	(0.0479)
Ž	0.3679***	0.3487***	0.3454***	0.3512***	0.3178***
	(0.0823)	(0.0829)	(0.0851)	(0.0831)	(0.0826)
Ž	0.5111***	0.4909***	0.4871***	0.5205***	0.4724***
	(0.0809)	(0.0822)	(0.0815)	(0.0802)	(0.0778)
Ž	0.4247***	0.4469***	0.4564***	0.4151***	0.4880***
	(0.0679)	(0.0693)	(0.0677)	(0.0668)	(0.0687)
4	0.0207***	0.0187***	0.0179*	0.0143*	0.0183*
	(0.0068)	(0.0070)	(0.0072)	(0.0071)	(0.0072)
4	0.0444***	0.0414***	0.0403***	0.0446***	0.0396***
	(0.0098)	(0.0106)	(0.0105)	(0.0100)	(0.0106)
&	-0.0748***	-0.0699***	-0.0646**	-0.0711***	-0.0596*
	(0.0245)	(0.0257)	(0.0267)	(0.0247)	(0.0273)
. = J	3.1040***	3.3444***	3.4078***	3.2166***	3.4529***
	(0.7900)	(0.9053)	(0.9128)	(0.8748)	(0.8882)
Ž	-0.0514	-0.0556	-0.0521	-0.0394	-0.0471
	(0.1172)	(0.1164)	(0.1177)	(0.1161)	(0.1191)
' 7	0.6406***	0.6287***	0.6580***	0.4552*	0.6563***
	(0.1801)	(0.1898)	(0.1997)	(0.2326)	(0.2013)
Ž	0.4299***	0.4204***	0.4418***	0.4121***	0.4397***
	(0.0939)	(0.0929)	(0.0960)	(0.0942)	(0.0946)
Ž	-0.3641***	-0.3655***	-0.3630***	-0.3760***	-0.3603***
	(0.0686)	(0.0712)	(0.0736)	(0.0689)	(0.0724)
Ž	0.1380***	0.1367***	0.1384***	0.1511***	0.1393***
	(0.0229)	(0.0238)	(0.0229)	(0.0239)	(0.0229)
%	-0.0183				
	(0.1425)				
Home and host costs indicato for EU members only		0.0082			
		(0.0450)			
Home andhost costs indicator for new EU members			0.1321***		
			(0.0484)		
Institutions quality in the EU host				0.0040	
				(0.0029)	
Institutions quality in thenew EU host					