FDI Flows in Europe: Endogeneity and Credibility

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Abstract

The European sovereign debt crisis has increased the uncertainty regarding the benefits and costs of membership in the Economic and Monetary Union. In this article, we focus on one of the important components of the European financial integration, notably foreign direct investments. In particular, we develop a structural gravity model, influenced by some very recent theoretical and econometric advancements. This new structural gravity approach provides needed theoretical underpinnings as well as strong support for the econometric estimation of gravity models.

Key words: capital mobility; optimum currency area; foreign direct investment; monetary integration.

JEL codes: F21; F33; F45.

> "The endogeneity of OCA criteria has been at the very heart of the political debate on EMU. In a nutshell, this debate has opposed the (loosely speaking) "French" view that monetary union *per se* would accelerate the integration of European markets and a "German" view that monetary union should only be the "crowning" of the integration of European markets".
>
> Coeure (2004, p. 342)

1. Introduction

To what extent the adoption of the Euro has endogenously affected the allocation of capital within the Economic and Monetary Union (EMU)? Has the Euro brought the expected benefits in terms of increased bilateral foreign direct investment (FDI) flows? If so, did the recent global financial crisis wipe out the benefits of the European monetary integration? These are only a few questions that have been involved in the debate about the future of the European single currency.

The increased intra-European capital mobility has been one of the expected benefits of the Euro adoption. There have been several favorable factors that instilled enthusiasm regarding the European financial integration. First, the elimination of intra-area currency risks and the reduction of country-risk premia encouraged significant cross-border capital flows within the Euro area. Second, the first years of the single European currency coincided with an unprecedented growth of global capital flows. Third, new investment relationships appeared between EU country pairs, mainly between the 'old' and the 'new' EU member states. This paper focuses on one important component of the international capital flows, notably the intra-European bilateral FDI flows. More specifically, it re-exposes and further explores the magnitude and the determinants of the so-called 'FDI premium' from the EMU membership. It examines quantitatively and with the help of the most recent formal econometric methods, the importance of the membership in the single currency area for the investment decisions of multinational firms.

There are several motivations to conduct our empirical investigation of the Euro's impact on bilateral investment within the EU. Firstly, the existing body of empirical studies uses data that goes back at least five years. Secondly, and relatedly, the global financial crisis and the European debt crisis may have diminished or even wiped out the benefits of the European monetary integration in terms of efficient allocation of capital. Thirdly, we follow the most recent econometric advancements in gravity modelling in order to shed more light on the macroeconomic and institutional convergence within the Euro area.

To that end, the second section of the paper initially surveys the theoretical advancements in the gravity modelling of international trade, and subsequently, the application of gravity models to foreign investment flows. An augmented gravity model that highlights certain methodological tradeoffs and explains the selection of the estimation techniques is elaborated in the third section. The next section discusses the empirical results based on five formal econometric methods. As a robustness check, we investigate the consistency of the empirical results for different sub-periods, with the exclusion of each EMU member at a time, and after controlling for six additional European institutional convergence variables. The results consistently produce substantial FDI premium from the EMU membership, which is much higher in the pre-crisis period and still significant in the crisis and the post-crisis period. The sixth section concludes by summarizing the results and highlighting their policy implications.

2. Literature review

In trade research, it seems that theorists and empiricists have have not talked to each other until 1995 (Krugman, 1995; Leamer and Levinsohn, 1995; McCallum, 1995; Trefler, 1995). While some economists would propose a traditional approach to gravity equations (Anderson, 1979), empirical approaches were not perceived as being as elegant as trade theories (e.g., the Heckscher-Ohlin-Vanek (H-O-V) or the Heckscher-Ohlin-Samuelson (H-O-S) theory, the new trade theory). In what follows, we offer a concise account of the theoretical development of the gravity theory, outlining the latest major analytical and methodological progresses.

2.1. Gravity Models and the International Trade Theory

Gravity models have originally been designed to explain why the geographic properties of international trade patterns matter. The foundations of the gravity theory were proposed by Tinbergen (1962), Pöyhönen (1963), Linnemann (1966), Leamer and Stern (1971) and Anderson (1979).

Before 1995, the Heckscher-Ohlin-Vanek (H-O-V) model predicted high trade flows, but much higher trade than was actually the case. Armington (1969) explained this by coining the expression "missing trade". Trefler (1995) proposed the notion of "home bias" to explain this missing trade, acknowledging that gravity equations could help explain the missing trade. Krugman (1995) suggested the concept of "remoteness', as an intuition about the "multilateral resistance/ fixed effects revolution" (Anderson and van Wincoop, 2003). The "multilateral resistance" (MR) term was created by Anderson (1979). In this context, an example of fixed effects are the national borders that may still matter (McCallum, 1995). This is why in our methodological protocol, we will build some indicators to capture the H-O-V variables and some of the fixed effects (both the origin and destination countries fixed effects). In some specifications, we will also include the origin and destination fixed effects, being aware that some time-invariant variables will inevitably be dropped.

With the publications of Eaton and Kortum (2002) and Anderson and van Wincoop (2003), the MR brings actual micro-foundations to the gravity equation. Redding and Venables (2004) and Feenstra (2017) promote the use of importer and exporter fixed effects to capture the MR terms that emerge in different theoretical models. Inspired by Redding and Venables (2004), we also build indicators to capture the institutional perspective, more precisely, the institutional convergence.

As aforementioned, the international trade literature has always been looking for bridges between gravity modelling and 'the new trade theory'. A subsequent wave of theoretical advancements replaced the assumption of product differentiation by country of origin by the assumption of product differentiation among producing firms.

In addition, some authors have looked at the trade effects of common currencies. This literature has been the subject of interesting debates. Rose, Lockwood, and Quah (2000) is the first one to add currency union dummies and find that trade doubles within a common currency regime. Baldwin (2006) puts the currency effect around 30%. Silva and Tenreyro (2010) found no effect of the currency union on trade, and they justify it by the already well integrated zone.

Since the articles of Chaney (2008), Helpman, Melitz, and Rubinstein (2008), and Melitz and Ottaviano (2008) on heterogeneous firms, the long-awaited convergence between the theorists and empiricists seems to be occurring.

2.2. Gravity Models and the Foreign Investment Theory

At the origin, gravity models were based on cross-sectional data, with no time dimension. Essentially, they were used to fit inward stocks of FDI. Later on, they were used to measure greenfield investments (Petroulas, 2007; Warin, Wunnava, and Janicki, 2009).

Gravity models have also been used to analyze bilateral FDI flows (e.g., Brouwer, Paap, and Viaene 2008; Warin, Wunnava, and Janicki 2009; de Sousa and Lochard 2011). The rationale is that similar explanatory variables shape the decisions of multinational enterprises whether to proceed with additional fixed cost of a production plant abroad or with additional variable cost of continued exports. The gravity-focused research of the behaviour of bilateral foreign investment has mainly focused on the flows among the members of the currency areas.

A natural ground for testing the gravity models was provided by the Optimum Currency Area (OCA) theory (Mundell 1961; McKinnon 1963; and Kenen 1969). Their work highlighted the importance of 'exogenous' criteria: trade openness, product diversification, wage flexibility and labor mobility. The subsequent work by Frankel and Rose (1997; 1998) sparked a theoretical revival by underscoring the endogeneity argument and the dynamic effects coming from a monetary integration. In particular, the Endogenous Optimum Currency Area (e-OCA) theory was focused on the self-reinforcing processes shaping the currency union. Even if the entry criteria for the OCA were not met initially, a sufficient progress can be made *ex post* due to the assumed benefits from the supranational monetary integration. The subsequent contribution by De Grauwe and Mongelli (2005) decomposed endogeneity into four types: (1) endogeneity of economic integration, and primarily at evidence on prices and trade; (2) endogeneity of international financial integration; (3) endogeneity of symmetry of shocks and output synchronization, and (4) product and labor market flexibility. Our paper goes to the heart of the second type of endogeneity, since the focus is on the efficient capital allocation among the EMU members.

Petroulas (2007) provided estimates of the EMU effect on FDI during the 1992-2001 period. His rationale for using a gravity model was that the arguments for intra-EMU trade creation – and possibly, trade diversion – also apply to bilateral investment flows. Hence, FDI can be viewed either as a substitute for trade (market-oriented or horizontal FDI) or a as complement to trade (cost-driven or vertical FDI). His empirical results demonstrate that the EMU increases inward FDI flows within the Euro area by approximately 16%, inward FDI from member countries to non-members by approximately 11% and a weak increase in inward FDI from non-member countries to member countries of around 8%.

Brouwer, Paap, and Viaene (2008) also document a positive effect of the EU and EMU enlargements on FDI among the new member states during the 1990-2004 period. Using a simulation-based technique, they estimated the potential impact of the EMU on FDI in the non-EMU member states of the EU between 18.5% for Poland and 30% for Hungary. Warin, Wunnava, and Janicki (2009) examined several European convergence variables in addition to the traditional gravity-type variables. They provided strong evidence of growing horizontal integration of the EU-15, predominantly based on market access and consumer income. The intra-industry linkages have been identified as the main factors that deepen market integration and allow for synchronization of demand and trade-based shocks. Their conclusion is that Europe is becoming an OCA in terms of allocation of capital, as formulated by Mundell (1973).

By using a micro-founded gravity model, de Sousa and Lochard (2011) examined the impacts of the single European currency on the intra-EMU foreign investment during the 1992-2005 period. They found that the EMU has increased intra-EMU FDI stocks on average by around 30%. Since their study dates back over a decade, it is important to explore how the EMU effect has responded to the global financial crisis.

Among the EMU skeptics, Taylor (2008) argues that intra-zone FDI turns out weak after the launch of the Euro, both in relation to previous trends and as a share of major economies' global FDI flows. His study provides a descriptive statistical analysis that the Euro appears to have given a modest stimulus to inflows from other major investing economies. One of the most important corollaries is that there was simultaneously an even larger upsurge in outflows from the Euro area, both absolutely and in relation to trend. This suggests that both surges may have been due to wider factors. He attributes the modest after-EMU increase in bilateral FDI to the end-century cross-border merger and acquisitions' boom.

3. An Augmented Gravity Model

There are at least three important corollaries from the literature survey. The first one is that the reliance on a sole econometric method must be avoided. In other words, a set of formal econometric methods has to be applied to ensure consistency of the empirical results. The second corollary is that heteroskedasticity causes severe problems, both in the traditional gravity equations inspired by Tinbergen (1962) and in gravity equations with multilateral resistance terms or fixed effects, as outlined by Anderson and van Wincoop (2003). The third one is that the ignorance of the zero investment data tends to lose important information on investment patterns.

An increasingly popular solution to address the heteroskedasticity problem and the problem of zero investment (or trade) data was proposed by Silva and Tenreyro (2006), who design the pseudo-maximum-likelihood (PML) estimation technique. Another influential solution has been offered in a seminal study by Helpman, Melitz and Rubinstein (2008). They implement parametrically, semi- parametrically, and nonparametrically a Heckman Sample Selection procedure that predicts the extensive margin (the decision to export from *i* to *j*), and the intensive margin (the volume of exports from *i* to *j*, conditional on exporting). The first stage encompasses estimating a Probit equation that specifies the probability that country *i* exports to *j* as a function of observable variables. The predicted components of this equation are then used in the second stage to estimate the gravity equation in log-linear form. Gomez-Herrera (2013) surveys the competing gravity models of international trade and advocates for the use of the Heckman sample selection model as appropriate estimation method when data are heteroskedastic and contain a significant proportion of zero observations.

Last, but not least, the use of a currency unit (CU) dummy appears to be problematic. Baldwin and Taglioni (2007) explain that the original contribution of Rose, Lockwood, and Quah (2000) is to add a common CU dummy to the list of covariates. A potential problem is that the estimates will be marked by omitted variable biases, in particular, the "multilateral trade resistance" by Anderson and van Wincoop (2003) and "remoteness" by Frankel, Stein, and Wei (1997). Put differently, the omitted variables are correlated with the trade-cost term. A CU dummy contains all other determinants of bilateral trade costs, and as a result the coefficient on the CU dummy is upward biased. This is the reason why we use the convergence variables (H-O-V and institutional) to capture some of these omitted variables.

3.1. Model Specification

The selection of data for the dependent variable (bilateral FDI flows) can have serious implications for the final empirical results. The destination country reports the amount of inward FDI flows from each origin country, whereas the origin country reports the amount of outward FDI towards each destination country. Not surprisingly, there are significant statistical discrepancies in recording the investment amounts among the EU member states. These discrepancies between national FDI statistics are non-negligible and therefore, we initially use three types of data for the dependent variable:

- natural logarithm of inward FDI data, as reported by the destination country *j* (*lnifdi*);
- natural logarithm of outward FDI data, as reported by the origin country *i* (*lnofdi*), and

- average bilateral FDI data (*lnfdicorr*) [=0.5 x (natural logarithm of the inward FDI data + natural logarithm of the outward FDI data)]. Note that the dependent variable FDI represents the flow value rather than stock measurement. For reasons explained in section 6, our preferred set of data is defined in line with the third concept.

We group the list of explanatory variables into three building blocks:

(1) The ‘core’ of the model consists of four Heckscher-Ohlin variables (market size, market similarity, relative endowment, and distance) that resemble the Helpman (1987) specification:[1] *size* is a measure of “market size”, or overall “economic space”; *similarity* is an index that captures the relative size of the two economies that is bounded between absolute divergence in size and equality in country size, called “market similarity”; *endowment* measures the relative difference between the two countries in terms of their gross capital formation per capita (Warin, Wunnava, and Janicki 2009).

(2) The second building block consists of three European macroeconomic convergence variables: the absolute differences in the reference interest rates (*intdif*), in the general government budget balances as a percentage of GDP (*bgtdif*), and in the debt-to-GDP ratios between countries *i* and *j* (*dbtdif*).

(3) The third building block encompasses six variables that control for the European institutional convergence. Yet these variables are introduced later in the robustness analysis.

The empirical specification has the following form:

$$\begin{aligned}\ln\left(FDI_{ij,t}\right) = \alpha_s &+ \beta_1 G_{ij,t} + \beta_2 S_{ij,t} + \beta_3 R_{ij,t} + \beta_4 D_{i,j} + \beta_5 INTDIF_{ij,t} + \beta_6 BGTDIF_{ij,t} \\ &+ \beta_7 DBTDIF_{ij,t} + \lambda_0 EMU_t + \lambda_1 (G * EMU)_{ij,t} + \lambda_2 (S * EMU)_{ij,t} \\ &+ \lambda_3 (R * EMU)_{ij,t} + \lambda_5 (INTDIF * EMU)_{ij,t} + \lambda_6 (BGTDIF * EMU)_{ij,t} \\ &+ \lambda_6 (DBTDIF * EMU)_{ij,t} + \varepsilon_{ij,t}\end{aligned}$$

where bilateral country pairs are denoted *ij= Austria-Belgium, Austria-Denmark,…, UK-Sweden* [756 pairs], and time t = 1995, 1996,…,2015 [21 years]. The dependent variable is the natural logarithm of bilateral FDI flows in the destination country. $G_{ij,t}$ denotes the market size, $S_{ij,t}$ stands for the market similarity, $R_{ij,t}$ is a measure of a relative factor endowment, $D_{i,j}$ denotes the physical distance between the economic centres of the two countries, $INTDIF_{ij,t}$ is the absolute value of the difference between the reference interest rates, $BGTDIF_{ij,t}$ is the absolute value of the difference between the budget balances (as a percentage of countries’ GDP) and $DEBTDIF_{ij,t}$ refers to the absolute value of the difference between the debt-to-GDP ratios. This model with interaction terms is developed to test for a structural shift in the FDI as a result of a country’s entry into the Euro area. *EMU* is a dummy variable that takes a value of 0 for every year when at least one country in the pair is a non-EMU member, and 1 when both countries in the pair are EMU members. For pairs with countries that are not yet EMU members the value is zero for the entire period. This approach enables us to use these pairs as a de facto control group, an approach that will be reinforced by the interaction variables. In empirical terms, we interact this dummy variable with the variables representing market size, market similarity, factor endowments, distance, interest rate, differences in budget deficits, differences in public debts, and the interactions with all the European institutional convergence variables. This helps us isolate whether being an EMU member matters or not compared to not being a member, while using the exogenous variables we specified.

The fixed effects, denoted as α_i, recognize not only country-specific or symmetric heterogeneity, but also homogeneity when $i = j$ (for instance, when i = Austria or j = Austria, then the dummy variable

[1] Bergstrand (1989) linked the gravity equation with the Heckscher-Ohlin model of inter-industry trade and the Helpman-Krugman-Markusen models of intra-industry trade.

takes a value of 1, and zero otherwise). Therefore, heterogeneity models country-specific participation or investment intensity instead of modeling heterogeneity between source and host countries. The error term, $\varepsilon_{ij,t}$, represents all unobserved bilateral effects.

Heckscher-Ohlin variables

Market size. The market size - or the overall economic space - serves as a proxy for foreign investment that is motivated by market expansion reasons (Helpman 1987). The expected value is positive for investment flows under circumstances of horizontal firm integration. In empirical terms, the market size is calculated as follows:

$$G_{ij,t} = ln\ (Y_{i,t} + Y_{j,t}) \tag{2}$$

Market similarity. S is an index that captures the relative size of the two economies that is bounded between absolute divergence in size and equality in country size, called "market similarity. If two countries have roughly equal GDP, the coefficient approaches -0.69 = ln(0.5). Perfect dissimilarity yields a coefficient value that approaches ln(0). A positive coefficient is interpreted as evidence of horizontal firm integration, as argued by Brainard (1997) and Markusen and Venables (1998). Similarity in country size is one of the main theoretical determinants of multinational expansion to determine market similarity. Its empirical specification takes the following form:

$$S_{ij,t} = ln\ (1 - (\frac{Y_{i,t}}{Y_{i,t}+Y_j})^2 - (\frac{Y_{j,t}}{Y_{i,t}+Y_j})^2) \tag{3}$$

The relative factor endowment is the difference in factor endowments between two countries. In empirical terms, it is the difference in the ratios of gross fixed capital formation and country's population. The factor endowments variable takes a minimum value of 0, representing equality in relative factor endowments, and a maximum value that approaches 1, the largest possible difference in the relative factor endowment. The importance of factor endowments varies significantly depending on the trade theory hypothesis. Horizontal firm integration theory postulates that factor endowment differences are irrelevant and should not be significant, or even exist, among developed countries. As the EU represents a group of well-developed and relatively wealthy countries, movement toward equalization of relative factor endowments is expected to yield an increase in bilateral FDI outflows. The empirical specification takes the following form:

$$R_{ij,t} = |ln\ (\frac{gcf_{i,t}}{N_{i,t}})\ - ln\ (\frac{gcf_{j,t}}{N_{j,t}})\ | \tag{4}$$

Geographical distance is captured by the log of the distance – commonly proxied by kilometers or miles – between the capital cities or the economic centers between countries *i* and *j*. Broadly speaking, distance is a proxy for trade and transportation costs, which have a negative impact on investment and trade flows. More distant markets tend to be served by overseas affiliates rather than by exporting. Markusen and Venables (2000) argue that distance may not be relevant as the transportation costs for the foreign entry of multinational firms. The investment that promotes production for the foreign market *a priori* should not be greatly influenced by distance. If distance and transportation costs are inextricably linked, the coefficient on *D* is expected to be negative. The costs associated with distance, such as communication and coordination costs, reduce incentives to new investment.

European macroeconomic convergence variables

According to the convergence criteria put in place by the Treaty of Maastricht (1993), the European integration process is focused on inflation, budgetary, exchange rate, and interest rate convergence. These criteria account for every aspect necessary for monetary, fiscal, and structural stability, yet the effect of these measures on bilateral foreign investment – largely a microeconomic phenomenon – has not been sufficiently explored by the past empirical research. We define the European macroeconomic convergence variables as follows:

$$INTDIFF_{ij,t} = |int_{i,t} - int_{j,t}| \quad [5]$$

$$BGTDIFF_{ij,t} = |budget_{i,t} - budget_{j,t}| \quad [6]$$

$$DEBTDIFF_{ij,t} = |debt_{i,t} - debt_{j,t}| \quad [7]$$

European institutional convergence variables

The European institutional convergence variables are measured as the the absolute value of the difference in the estimates for the six World Bank good governance indicators: voice and accountability (*vadiff*); political stability (*psdiff*); government effectiveness (*gediff*); regulatory quality (*rqdiff*); rule of law (*rldiff*), and control of corruption (*ccdiff*):

$$\text{vadiff}_{ij,t} = |\text{va}_{it} - \text{va}_{jt}| \quad [8]$$
$$\text{psdiff}_{ij,t} = |\text{ps}_{it} - \text{ps}_{jt}| \quad [9]$$
$$\text{gediff}_{ij,t} = |\text{ge}_{it} - \text{ge}_{jt}| \quad [10]$$
$$\text{rqdiff}_{ij,t} = |\text{rq}_{it} - \text{rq}_{jt}| \quad [11]$$
$$\text{rldiff}_{ij,t} = |\text{rl}_{it} - \text{rl}_{jt}| \quad [12]$$
$$\text{ccdiff}_{ij,t} = |\text{cc}_{it} - \text{cc}_{jt}| \quad [13]$$

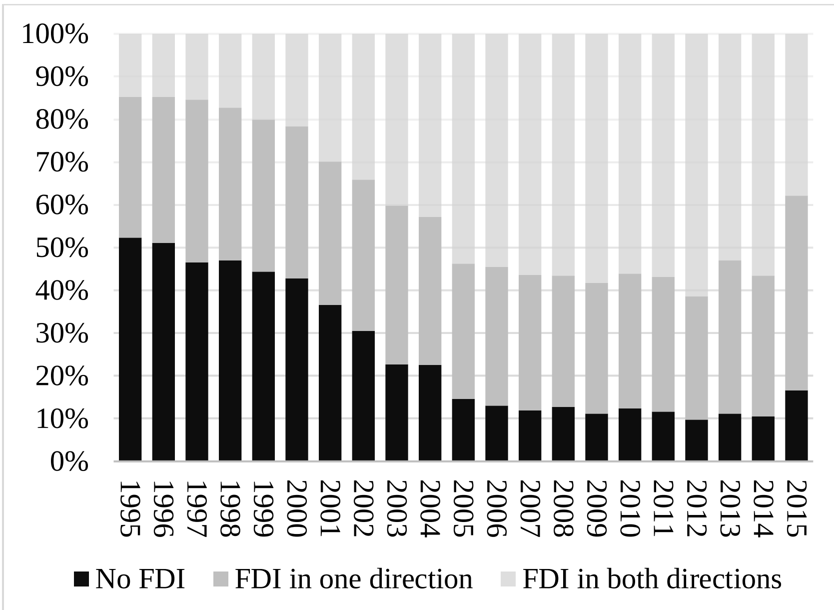
Smaller differences tend to reflect similar aspects of the business environment and to encourage bilateral investment flows.

4. Data

The initial data inspection offers valuable insights in the structure of bilateral FDI flows. The dataset is composed of aggregate annual bilateral flows of FDI between the present EU-28 member states and are expressed in million ECU/ Euros. There are $N = 28 \times 27 = 756$ bilateral relations *per annum* (i.e., aggregated cross-sections). Since the data cover the period from 1995 to 2015, this yields a total sample of $n = 756 \times 21 = 15{,}876$ bilateral observations.

Many researchers have been rather silent on the nature of the bilateral FDI dataset, which constitutes the dependent variable. First of all, at least one third of such samples contains zero investment observations. As illustrated in Figure 1, the number of country pairs with no bilateral FDI flows was above 50% in mid-1990's. The share of country pairs with no bilateral FDI has been steadily decreasing afterwards, indicating increased European financial integration. In the same period, the share of country pairs with bidirectional FDI flows substantially increased with the introduction of the European single currency.

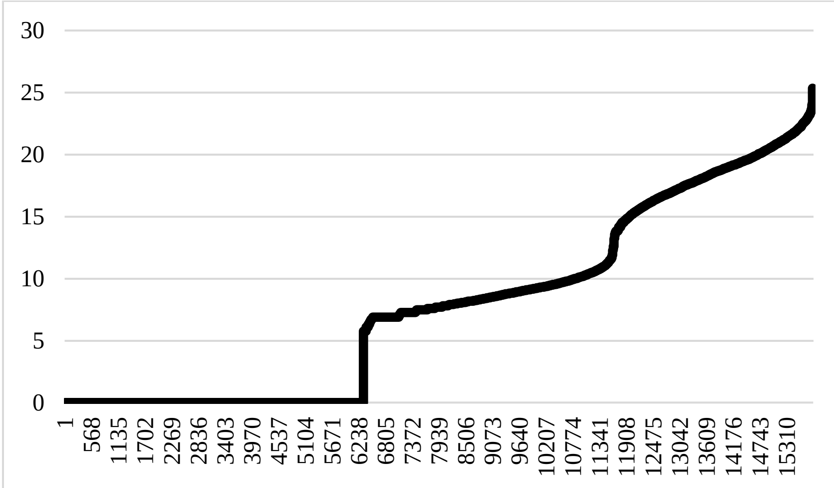
Figure 1. Distribution of Country Pairs Based on Direction of FDI (1995-2015, In Percent)



Source: Authors' calculations based on Eurostat data.

As underscored in the literature review, the treatment of the zero values has been widely debated in the literature (e.g., Helpman, Melitz, and Rubinstein 2008; Gómez-Herrera 2013). We could have just dropped observations when investment flows are nil, but Westerlund and Wilhelmsson (2011) - among others - point out that the elimination of investment (or trade) flows when zeros are not randomly distributed leads to a sample selection bias. Moreover, according to Baldwin and Harrigan (2011): "most potential export flows are not present, and the incidence of these 'export zeros' is strongly correlated with distance and importing country size. Second, export unit values are positively related to distance and negatively related to market size." The ordered data for the dependent variable, illustrated in Figure 2, offers valuable insights on the presence of zero investment data in our sample.

Figure 2. The dependent variable [$\ln(FDI_{ij,t})$] ordered by the size



The visual inspection of data also reveals significant convergence in the interest rates in the EMU during the pre-crisis period (Figure 3). In contrast, there is a substantial cross-country heterogeneity in terms of the debt levels over time. Table 1 reports the descriptive statistics for the dependent and the explanatory variables for the entire sample during the 1995-2015 period.

Figure 3. Evolution of the interest rate differences in the EU and EMU member states, 1995-2015

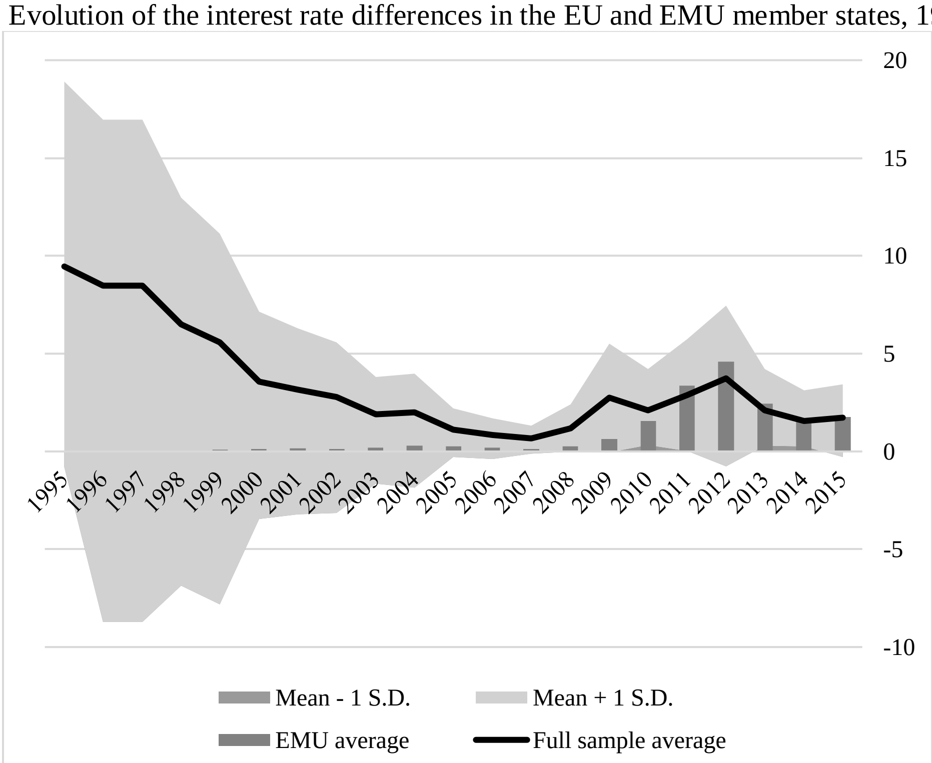
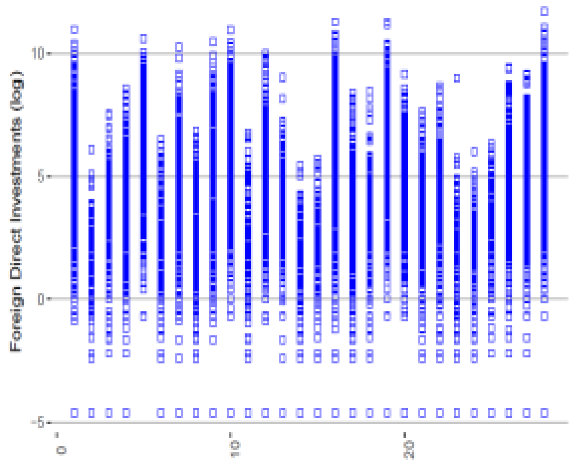


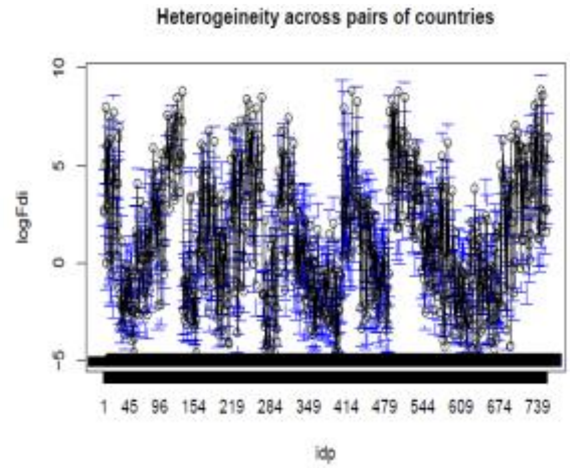
Table 1. Data description

Variable	Symbol	Obs	Mean	Std. Dev.	Min	Max
Natural logarithm of FDI	*Ln (FDI)*	13440	-0.25	4.76	-4.61	12.14
Market size	*G*	15876	13.44	1.13	10.10	15.68
Market similarity	*S*	15876	-1.54	0.89	-5.20	-0.69
Relative endowment	*R*	15876	0.91	0.70	0.00	4.45
Ln (Distance)	*D*	15876	7.07	0.66	4.04	8.23
Interest rate difference	*INTDIF*	15876	4.37	11.49	0.00	113.73
Budget balance difference	*BGTDIF*	15876	3.50	2.99	0.00	32.50
Public debt difference	*DEBTDIF*	15876	34.48	26.79	0.00	169.70
EMU	*EMU*	15876	0.21	0.41	0.00	1.00
Voice and accountability diff.	*VADIF*	15120	0.41	0.31	0.00	1.98
Political stability diff.	*PSDIF*	15120	0.49	0.36	0.00	2.15
Government effectiveness diff.	*GEDIF*	15120	0.76	0.55	0.00	2.69
Regulatory quality diff.	*RQDIF*	15120	0.53	0.39	0.00	2.20
Rule of law diff.	*RLDIF*	15120	0.75	0.53	0.00	2.49
Control of corruption diff.	*CCDIF*	15120	1.01	0.70	0.00	3.19

Let us now have a quick look at the heterogeneity across countries and country pairs in our dataset. As illustrated in Figure 4, even the visual inspection does suggest that we should control for the fixed effects.

Figure 4. Heterogeneity Across Countries and Country Pairs





Additional support to employ a fixed-effects model comes from the Hausman specification test. Even more important question is whether the fixed effects are cross-sectional or time-based. Indeed, when we need to run fixed effects model, then the question arise to know whether we need to test in particular for time-based fixed effects. We ran a Breusch-Pagan test for unbalanced panels, and it did provide justification for the use of time-fixed effects. The next salient step is to check for the potential presence of contemporaneous correlation or cross-sectional dependence. Based on the Breusch-Pagan test and the Pesaran test, we also detected cross-sectional dependence. In the next step, we also test for serial correlation using the Breusch-Godfrey/Wooldridge test. Unfortunately, it highlighted the presence of serial correlation in the idiosyncratic errors. To complicate a little further, we investigated the presence of a unit root or nonstationarity of the time series. If the series is non-stationary, then the general method of moments (GMM) estimators would be excellent candidates. Here, there is no unit root, though this does not exclude the use of the GMM estimators. Lastly, we need to check for the potential presence of heteroskedasticity. Based on the Breusch-Pagan test, we also highlight the presence of heteroskedasticity. To summarize all these disturbing diagnostics, we detect serial and cross-sectional dependence in our stationary and heteroscedastic unbalanced dataset. Since there is no silver bullet to tackle these problems, in the next section we employ five formal econometric methods.

5. Selection of the Econometric Technique

Based on the aforementioned diagnostic tests, we put a protocol in place with alternative estimation techniques to investigate the consistency of our empirical results.

For a large *T* dimension, Driscoll and Kraay (1998) demonstrate that the standard nonparametric time series covariance matrix estimator is robust to very general forms of cross-sectional and temporal dependence. Ignoring potential correlation of the disturbances over time and across units can lead to severely biased statistical inference. Therefore, we initially use the >*xtscc*< command in the statistical software STATA to estimate pooled OLS and fixed effects (within) regression models with Driscoll and Kraay (1998) standard errors in an unbalanced panel setting. We take the results from this estimator with caution, because it works better with large *T* dimension, which may not be the case with our dataset.

Our second empirical strategy is to apply the 'system GMM' designed by Arellano and Bover

(1995) and Blundell and Bond (1998). This approach instruments the lagged dependent variable and any other similarly endogenous variables with variables considered as uncorrelated with the fixed effects. One of the important innovations brought by the system GMM is that it circumvents the main problem of difference GMM, i.e. the weak assumption that past levels of the variable are good instruments for first differences. More precisely, for variables that may display a random walk, past changes may be more predictive of current levels than past levels are of current changes. The system GMM uses more moment conditions, because the explanatory variables expressed in first differences are instrumented with lags of their own levels, and the explanatory variables in levels are instrumented with lags of their own first differences. In order to limit the instrument proliferation - with the instrument count quadratic in time dimension (*T*) - and avoid potential "overfitting", we apply the >*collapse*< option in the >*xtabond2*< user-written command in the statistical software Stata 12.0 package to minimize the number of instruments being used. Lastly, we apply the Windmeijer (2005) finite-sample correction to the reported standard errors in the two-step estimation.

Third, we apply the Poisson Pseudo-Maximum Likelihood estimator (>*ppml*< *command*) as proposed by Silva and Tenreyro (2006). This recent econometric advancement aims at addressing the problems of zero investment data and potential sample selection bias as a special case of the omitted variable bias. The method is robust to different patterns of heteroskedasticity and provides a methodologically sounder way to deal with the zero data and fixed effects. Although our tests do not require other fixed-effects (country pairs, or origin and destination fixed-effects) than time-based fixed effects, we consider Harrigan's (1996) methodology. This appears to be the first paper to have included importers' fixed effects and then exporters' fixed effects. Since then, estimating gravity equations with fixed effects for the importer and exporter was strongly recommended by the seminal trade articles (e.g., Anderson and van Wincoop, 2003). In our case, since we use a *TSCS* dataset, we also try without origin and destination countries fixed effects just for robustness checks. An additional rationale is that we substitute time-varying indicators that could serve as a satisfactory replacement of the latent fixed effects, while paying attention to Baldwin's critiques (Baldwin and Taglioni, 2007).

Fourth, we use the so-called threshold tobit model, initially suggested by Eaton and Kortum (2001) (EK-tobit). While Santos Silva and Tenreyro (2006) demonstrate that the probit model estimates could be biased, Head and Mayer (2015) explained that this is not the case with the threshold tobit procedure. The methodologically revived EK-tobit model aims at avoiding the arbitrary replacement of zero data with a small constant, usually up to 1 US $ due for the sake of the logarithmic convenience (e.g., Felbermayr and Kohler 2006). EK-tobit replaces the zeros by a constant *a*, which is the minimum level of FDI observed from origin country *i* to destination country *j* in a particular period.

Fifth, we employ the Heckman two-stage sample selection procedure, as proposed by Helpman, Melitz and Rubinstein (2008). In a nutshell, the estimates from the first-stage Probit selection equation produce the predicted probability to invest in a country *j*. Since the normality assumption for the unobserved costs of foreign investment may not be attainable, we select a valid exclusion variable for the second stage - in our case, one of the institutional variables.

The empirical results from these econometric methods are presented in the next section.

6. Econometric Results

All empirical specifications include include dummy variables for each source country (*i-i* effects), each destination country (*j-j* effects), each country pair (*i-j* effects) and time dummies for the 1995-2015 period. The regressions are presented in Table 2, which for informational convenience also contains the results from the diagnostic tests. The central points of interest are the implied FDI premium from EMU membership - or simply the implied EMU effect - and its driving forces. Because of the log-lin nature of the empirical specification, this effect is calculated as follows:

$$(\partial \frac{LFDI}{\partial euro}) = \lambda_0 + \lambda_1 G_{ij,t} + \lambda_2 S_{ij,t} + \lambda_3 R_{ij,t} + \lambda_4 D_{ij,t} + \lambda_5 INTDIF_{ij,t} + \lambda_6 BGTDIF_{ij,t} + \lambda_7 DBTDIF_{ij,t}$$

$$EMU\ effect = [EXP(\lambda_0 + \lambda_1 mean(G_{ij,t}) + \lambda_2 mean(S_{ij,t}) + \lambda_3 mean(R_{ij,t}) + \lambda_4 mean(D_{ij,t}) + \lambda_5 mean(INTDIF_{ij,t}) + \lambda_6 mean(BGTDIF_{ij,t}) + \lambda_7 mean(DBTDIF_{ij,t}) - 1]\ x\ 100 \qquad [14]$$

Our preferred specifications are those containing the average bilateral FDI data (*lnfdicorr*) as the dependent variable. There are at least two justifications of this decision: (1) our intention to reconcile the significant statistical discrepancies by national FDI statistics, and (2) the lowest coefficient of variation among the alternative estimates of the implied EMU effect on FDI. Therefore, only these specifications will be presented in details.

The European convergence seen through the usage of a common currency matters: once a country enters into the Euro area, the market size of the two countries, the market similarity, and the distance become significant. While the estimated coefficients may differ in terms of the statistical significance and magnitude, the implied FDI premium from EMU membership displays small variation across the different empirical specifications.

Pooled OLS with Driscoll and Kraay (1998) Standard Errors

Column [1] of Table 2 refers to the estimation results from the pooled OLS estimation with Driscoll and Kraay (1998) standard errors. We also perform a heteroskedasticity- robust RESET test (Ramsey 1969) by checking the significance of an additional regressor constructed as $(x'b)^2$, where *b* denotes the vector of estimated parameters. The RESET test does not reject the null hypothesis that the coefficient on the test variable is zero. This may suggest that the Driscoll and Kraay (1998) estimation is not misspecified. Even so, due to the poor properties of this estimator, we consider the estimated FDI premium from EMU membership (28.5%) as indicative only (see column [1] of Table 2).

System GMM Estimation

The empirical results of the system GMM estimation are presented in column [2] of Table 2. Our *a priori* expectations are to find significant coefficient on the lag(s) of the dependent variable. After all, a large body of the empirical literature on the determinants of FDI indicate that past FDI influences present FDI flows (e.g., Egger 2001; Carstensen and Toubal 2004). Having a history of bilateral FDI flows matters since the coefficients of the three lags of the dependent variable are statistically significant at the 1% level across all empirical specifications. The empirical results in column [2] of Table 2 indicate that the system GMM estimator produces an implied FDI premium from the EMU membership of 22.4%.

Poisson Pseudo-Maximum Likelihood Model

In accordance with the econometric breakthrough by Santos Silva and Tenreyro (2006), we also employ the Poisson pseudo-maximum likelihood estimator (the >*ppml*< command in Stata 12.0 package). All *ppml* specifications include include dummy variables for the source country (*i-i* effects), the destination country (*j-j* effects), the country pair (*i-j* effects) and time dummies. As already elaborated, this non-linear least square estimator demonstrates consistency in the presence of both fixed effects and the zero investment observations. Based on the empirical results presented in column [3] of Table 2, the Poisson pseudo-maximum likelihood estimator produce an implied EMU effect of 17.2% during the 1995-2015 period.

Threshold Probit Model

Despite the mathematical tractability, the EK-tobit is slightly misspecified due to the replacement of zero data with the minimum value of observed FDI. Hence, the results are only indicative and serve as a consistency check. The empirical results in column [4] of Table 2 suggest an implied EMU effect of 26.1% during the observed period.

Table 2. Estimations by alternative econometric methods (Entire sample, 1995-2015)

Explanatory variables	Driscoll and Kraay (1998) $\ln(1+FDI_{ij,t})$	System GMM Estimation $\ln(1+FDI_{ij,t})$	PPML Estimation $FDI_{ij,t}$	Threshold Tobit Model $\ln(a+FDI_{ij,t})$	Heckman Selection Model $\ln(1+FD_{Iij,t})$
	[1]	[2]	[3]	[4]	[5]
Market size	**7.56** ***	**0.94** ***	**1.42** ***	**1.27** ***	**9.95** ***
	[3.71]	[12.41]	[18.21]	[10.0]	[3.99]
Market similarity	**4.79** ***	**0.44** ***	**0.42** ***	**0.89** ***	**4.50** **
	[4.57]	[5.35]	[3.09]	[12.63]	[1.97]
Relative endowment	**-0.38** *	0.03	**-0.40** ***	**-0.59** ***	**-1.00** *
	[-1.84]	[0.33]	[-3.20]	[-15.2]	[-1.65]
Ln (Distance)	**-2.75** ***	**-1.03** ***	**-0.91** ***	**-1.83** ***	**-0.41** ***
	[-6.19]	[-10.45]	[-8.26]	[-43.83]	[-2.50]
Interest rate difference	-0.01	**-0.04** ***	**-0.14** ***	0.002	-0.004
	[-1.47]	[-6.97]	[-2.86]	[1.14]	[-0.26]
Budget balance difference	**-0.08** ***	0.00	**0.07** **	0.01	-0.06
	[-2.99]	[0.12]	[2.13]	[1.54]	[-1.05]
Public debt difference	-0.01	**-0.004** *	**-0.009** ***	**-0.003** ***	-0.005
	[-1.25]	[-1.78]	[-2.86]	[-2.95]	[-0.50]
EMU dummy	5.25	**5.00** **	**14.09** ***	**-6.49** ***	**18.74** **
	[0.84]	[2.05]	[7.37]	[-6.92]	[2.18]
EMU x Market size	**-0.80** **	**-0.43** ***	**-0.95** ***	**0.19** ***	**-1.58** ***
	[-2.44]	[-3.66]	[-7.59]	[3.60]	[-3.30]
EMU x Market similarity	**-0.67** *	**-0.30** *	**-0.27** *	0.08	**-1.68** ***
	[-1.97]	[-1.93]	[-1.76]	[1.29]	[-3.13]
EMU x Relative endowment	0.11	-0.22	0.26	**0.68** ***	-0.07
	[0.18]	[-0.69]	[1.07]	[5.74]	[-0.08]
EMU x Ln (Distance)	0.52	0.10	-0.07	**0.54** ***	-0.15
	[1.18]	[0.46]	[-0.53]	[7.33]	[-0.22]
EMU x Interest rate diff.	-0.01	-0.07	0.003	**-0.05** ***	0.02
	[-0.10]	[-1.08]	[0.05]	[-2.68]	[0.12]
EMU x Budget balance diff.	0.05	-0.05	**-0.06** *	0.00	0.05
	[0.91]	[-0.98]	[1.64]	[0.01]	[0.54]
EMU x Public debt diff.	**0.02** **	**0.01** ***	**0.018** ***	**0.004** *	**0.03** **
	[2.42]	[2.65]	[4.09]	[1.94]	[1.97]
Number of country pairs	756	756	756	756	756
Number of observations	15869	13601	15869	15869	15120
Number of instruments	/	55	/	/	/
(Pseudo) R-squared	0.41	/	0.12	0.17	/
AR(1)	/	0.000	/	/	/
AR(2)	/	0.371	/	/	/
Sargan test	/	0.245	/	/	/
RESET test	0.91	0.57	0.11	0.35	0.88
Implied EMU effect	28.5%	22.4%	14.09 B USD	26.1%	24.2%

Notes: [1] The system GMM estimation is estimated with three lags of the dependent variable. The coefficients on the are statistically significant at the 1% level and with the following size: 0.279, 0.184 and 0.138, respectively. [2] All empirical specifications include dummy variables for each source country (*i-i* effects), each destination country (*j-j* effects), each country pair (*i-j* effects) and time dummies for the 1995-2015 period.

Heckman Selection Model

Following the influential study by Helpman, Melitz and Rubinstein (2008), we also apply the Heckman Selection Model. The large number of zero investment data may suggest firm self-selection that lead to potential omitted variable bias. The outcome equation - which describes the relationship between FDI flows and a set of explanatory variables - has identical composition as in the previous models. The selection equation links the latent variable to the same set of observed explanatory variables and a so-called exclusionary variable. In our case, this role is being played by one of the institutional convergence variables - control of corruption. We hypothesize that a number of European firms would not invest in an EU member country having considerably different control of corruption compared to the home country. In order to investigate the robustness of the results, we also employ - one at a time - the other five institutional convergence variables. The empirical results are remarkably consistent, but due to the space limit, they are not reported here. As presented in column [5] of Table 2, the Heckman-corrected (1979) specification indicate an implied EMU effect of 24.2% during the observed period.

At this stage, we can be more transparent regarding the selection of the preferred data for the dependent variable. The choice has a significant impact on the estimated FDI premium from EMU membership (see Table 3). The first column of results refers to estimations in which the dependent variable consists of reported inward FDI data by the destination country (*lnifdi*), the second column refers to reported outward FDI data by the origin country (*lnofdi*) and the third column to the average of the logarithmic transformations of these two variables (*lnfdicorr*).

Table 3. The implied EMU effect under alternative bilateral FDI data and estimators

Estimation technique	*lnifdi* [1]	*lnofdi* [2]	*lnfdicorr* [3]
Driscoll and Kraay (1998) (in %)	15.6	42.8	28.5
System GMM (in %)	35.6	57.2	22.4
PPML (In Billions of USD)	17.4	10.4	14.09
Threshold Tobit (in %)	69.8	3.5	26.1
Heckman Selection (in %)	2.29	57.8	24.2
"Average" effect	28.1	34.3	23.1
Standard deviation	26.1	25.8	5.5
Coefficient of variation	0.93	0.75	0.24

Notes: *lnifdi* refers to inward FDI data reported by the destination country *j*; *lnofdi* refers to the outward FDI data reported by the source country *i;* and *lnfdicorr* is the average of the logarithmic transformation of the two reported amounts.

By using the average of the reported bilateral FDI data (*lnfdicorr*), we may reconcile the statistical discrepancies between national sources and achieve a lower coefficient of variation of the implied EMU effect from the different techniques. A potential shortcoming of our approach is that more developed EU member states follow more rigorous compiling standards and produce more credible statistical data. By averaging the data from two national sources, we may therefore lose a portion of the statistical rigour of the advanced statistical offices.

7. Consistency Checks

In this section we explore the consistency of our results from both temporal and the cross-sectional perspective. First, we investigate whether the results hold consistently over time and capture the impact of the global financial and European debt crisis. In order to restrict proliferation of regressions, we focus only on the threshold tobit model and the PPML technique. Second, we exclude one EMU member country at a time from each estimation to observe if a particular country significantly affects the implied EMU effect. Third, we investigate the stability of the empirical results after the inclusion of the European institutional convergence variables.

7.1. Consistency over Different Sub-Periods

At this stage, we split the sample into two sub-periods: (1) the pre-crisis period from 1995 to 2007, and (2) the crisis and post-crisis period from 2008 until 2015. Then, we gradually increase the first sub-period by an additional year to observe the post-crisis evolution of the implied EMU effect on bilateral FDI. Due to the space limitation, only the implied FDI premium from EMU membership is presented in Table 4. It is calculated from diagnostically justified estimations for various sub-periods. Not surprisingly, the pre-crisis FDI premium was higher; the threshold Tobit model suggests that EMU member states, on average, experienced 36.5% higher bilateral FDI from the other EU members during the 1995-2007 period. Still, the benefits of the European monetary integration were present even during the crisis and the post-crisis period, as the average implied EMU effect was estimated at 18.8%. The PPML estimator that uses the inward FDI data as a percentage of destination country's GDP as a dependent variable also suggests similar pattern. On average, being an EMU member during the pre-crisis period was likely to be associated with 14.7 Billions of U.S. dollars, as opposed to non-EMU members within the EU. The period during and after the global financial crisis had a lower EMU impact on bilateral FDI, given the estimate of 10.2 Billions of U.S. dollars. The credibility of the EMU decreased during 2009 and 2010, but then gradually resumed with the concerted efforts to implement a series of financial support measures such as the European Financial Stability Facility and European Stability Mechanism.

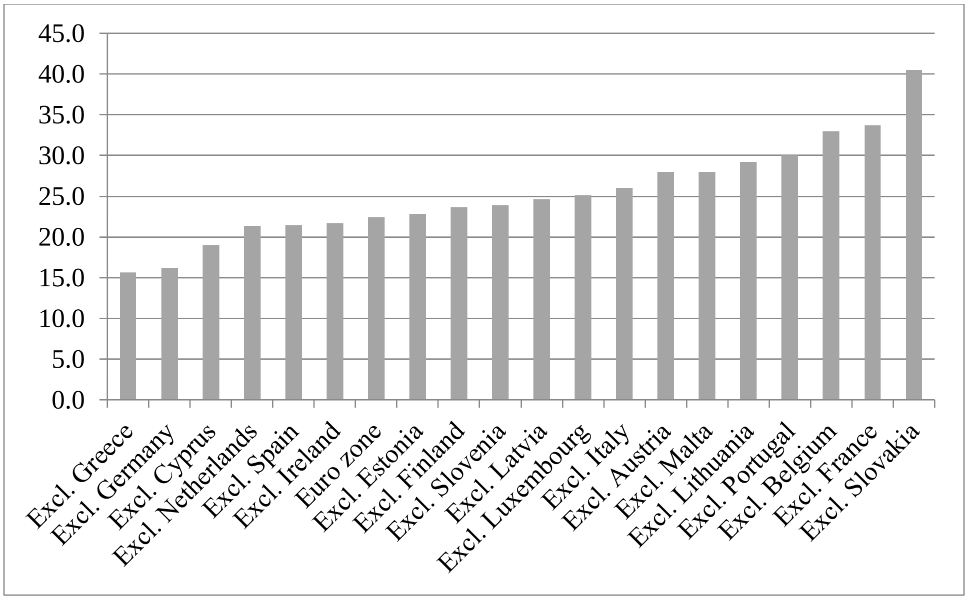
Table 4. The Implied FDI Premium from EMU Membership (Entire sample, different sub-periods)

Estimated FDI premium due to EMU membership	Threshold Tobit Model $\ln(a+FDI_{ij,t})$	PPML Estimation $(FDI_{ij,t})$
Pre- and post-crisis sub-periods	In percent	In Bill. USD
1995-2007	36.5	14.7
2008-2015	18.8	10.2
Post-crisis evolution		
1995-2010	17.8	14.4
1995-2011	21.7	13.5
1995-2012	21.1	13.5
1995-2013	14.1	13.1
1995-2014	14.4	13.6
1995-2015	18.3	14.1

7.2. Robustness to Various Exclusions

We also investigate the consistency of the empirical results by re-estimating the preferred specification for the entire period, yet by excluding one EMU member at a time. As illustrated in Figure 5, there is an implicit benefit for nearly all EMU members (except for Slovakia). The exclusion of investment data for each EMU member state leads to a drop in the implied EMU effect, which is somewhat significant in the cases of Luxembourg, Cyprus and Greece. Put differently, even if we exclude Luxembourg due to its exceptionally large international financial integration, the overall EMU effect on bilateral FDI within EU is estimated at 23% during the entire period.

Figure 5. FDI premium from EMU membership excluding one EMU member at a time (1995-2015)



Notes: The empirical specifications and calculation of the implied EMU effect are based on the threshold Tobit model, excluding one EMU member at a time.

7.3. Inclusion of European Institutional Convergence Variables

As a final consistency check, we include six variables to control for the European institutional 'convergence'. They are measured as the the absolute value of the difference in the estimates for the World Bank good governance indicators: voice and accountability (*vadiff*); political stability (*psdiff*); government effectiveness (*gediff*); regulatory quality (*rqdiff*); rule of law (*rldiff*), and control of corruption (*ccdiff*). The empirical results are remarkably consistent in terms of their magnitude and statistical significance. Even after controlling for the six institutional convergence variables and their EMU-interacted multiplicative terms, the implied EMU effect for the entire period is still positive and significant and estimated at 18.71%.

8. Concluding remarks

When we compare the empirical results, we observe that there is an overall positive impact of belonging to the EMU, even when controlling for the 2008 global financial crisis. The implied FDI premium from EU membership is estimated in the range between 22.4% and 28.5%, depending on the employed econometric method. Due to the non-negligible discrepancies between national FDI statistics, one must be very careful and transparent about the selection of data for the dependent variable: inward FDI reported by the destination country *versus* outward FDI reported by the origin country. A battery of consistency checks provides evidence that the exclusion of investment data for each EMU member state leads to a drop in the implied EMU effect, which is somewhat significant in the cases of Luxembourg, Cyprus and Greece. Even if we exclude Luxembourg due to its exceptionally large international financial integration, the overall EMU effect on bilateral FDI within EU is estimated at 23% during the entire period.

We observe a moderately negative impact from the Great Recession, which tends to force core countries to repatriate capital within their borders. From a political economy perspective, the study brings hard facts about the credibility of the Euro and its evolution throughout the worst crisis the Euro area in particular has had to live since the inception of the single currency in 1999.

The empirical results leave a fertile research agenda. One research avenue would be to conduct an analysis based on the Network Theory and then, investigate the consistency of the empirical results. Another research avenue would be to further explore the convergence hypothesis presented by Markusen and Venables (1996). Specifically, the results here follow the hypothesis suggesting that growth in multinational firms is determined by convergence of income levels, relative factor endowments, and the market size. A third research avenue would be to include the intra-European imports and exports in finding further support of European convergence relative to the growth in multinational firm activity.

References

Abiad, Abdul, Daniel Leigh, and Ashoka Mody. 2009. “Financial Integration, Capital Mobility, and Income Convergence.” *Economic Policy* 24: 241–305.

Anderson, James E. 1979. “A Theoretical Foundation for the Gravity Equation.” *The American Economic Review* 69 (1): 106–116.

Anderson, James E., and Eric van Wincoop. 2003. “Gravity with Gravitas: A Solution to the Border Puzzle.” *The American Economic Review* 93 (1): 170–92.

Armington, Paul S. 1969. “A Theory of Demand for Products Distinguished by Place of Production”. *IMF Staff Papers* 16 (1): 159–178.

Baldwin, Richard E. 2006. “The Euro’s Trade Effects.”. Working Paper Series No. 0594. European Central Bank. https://ideas.repec.org/p/ecb/ecbwps/20060594.html.

Baldwin, Richard, and Daria Taglioni. 2007. “Trade Effects of the Euro: A Comparison of Estimators.” *Journal of Economic Integration* 22 (4): 780–818.

Baldwin, Richard, and James Harrigan. 2011. “Zeros, Quality, and Space: Trade Theory and Trade Evidence.” *American Economic Journal: Microeconomics* 3 (2): 60–88. doi:10.1257/mic.3.2.60.

Bergstrand, Jeffrey H. 1989. “The Generalized Gravity Equation, Monopolistic Competition, and the Factor-Proportions Theory in International Trade.” *The Review of Economics and Statistics* 71 (1): 143–53. doi:10.2307/1928061.

Bergstrand, Jeffrey H. 1990. “The Heckscher-Ohlin-Samuelson Model, The Linder Hypothesis and the Determinants of Bilateral Intra-Industry Trade.” *The Economic Journal* 100 (403): 1216–29. doi:10.2307/2233969.

Blanchard, Olivier. 2007. “Adjustment within the Euro. The Difficult Case of Portugal.” *Portuguese Economic Journal* 6 (1): 1–21. doi:10.1007/s10258-006-0015-4.

Bosquet, Clément, and Hervé Boulhol. 2014. “Applying the GLM Variance Assumption to Overcome the Scale-Dependence of the Negative Binomial QGPML Estimator.” *Econometric Reviews* 33 (7): 772–84. https://ideas.repec.org/a/taf/emetrv/v33y2014i7p772-784.html.

Brainard, S. Lael. 1997. “An Empirical Assessment of the Proximity-Concentration Trade-off Between Multinational Sales and Trade.” *The American Economic Review* 87 (4): 520–44.

Brenton, Paul, Francesca Di Mauro, and Matthias Lücke. 1999. “Economic Integration and FDI: An Empirical Analysis of Foreign Investment in the EU and in Central and Eastern Europe.” *Empirica* 26 (2): 95–121. doi:10.1023/A:1007006429600.

Brouwer, Jelle, Richard Paap, and Jean-Marie Viaene. 2008. “The Trade and FDI Effects of EMU Enlargement.” *Journal of International Money and Finance*, Euro Area Expansion: Current State and Future Prospects, 27 (2): 188–208. doi:10.1016/j.jimonfin.2007.12.005.

Carstensen, Kai and Farid Toubal. 2004. “Foreign direct investment in Central and Eastern European countries: A dynamic panel analysis”. *Journal of Comparative Economics* 32 (1): 3-22.

Chaney, Thomas. 2008. "Distorted Gravity: The Intensive and Extensive Margins of International Trade." *American Economic Review* 98 (4): 1707–1721. doi:10.1257/aer.98.4.1707.

Coeure, Benoit. 2004. "The Narrow Road to the Single Asian Currency: Lessons from Optimal Currency Areas and the Euro." In: De Brouwer, G. and Kawai M. (eds), *Exchange Rate Regimes in East Asia*, Routledge, London.

De Grauwe, Paul and Francesco Paolo Mongelli. 2005. "Endogeneities of Optimum Currency Areas: What brings Countries Sharing a Single Currency Closer together?", ECB Working Paper No. 468. April 2005.

Deardorff, Alan 1998. "Determinants of bilateral trade: does gravity work in a neoclassical world?". In: Frankel J. A. (ed.). *The regionalization of the world economy,* 1st edn. University of Chicago Press, Chicago, pp. 7–32.

Eaton, Jonathan, and Samuel Kortum. 2001. "Trade in capital goods." *European Economic Review,* Vol. 45, No. 7, pp. 1195-1235.

Eaton, Jonathan, and Samuel Kortum. 2002. "Technology, Geography, and Trade." *Econometrica* 70 (5): 1741–79. doi:10.1111/1468-0262.00352.

Egger, Peter. 2001. "European exports and outward foreign direct investment: A dynamic panel data approach." *Review of World Economics* 173 (3): 427-449.

Egger, Peter, and Michael Pfaffermayr. 2003. "The Proper Panel Econometric Specification of the Gravity Equation: A Three-Way Model with Bilateral Interaction Effects." *Empirical Economics* 28 (3): 571–80. doi:10.1007/s001810200146.

Feenstra, Robert C. 2017. Advanced International Trade: Theory and Evidence. (Second Edition) (E-Book and Hardcover)." Accessed June 6. http://press.princeton.edu/titles/10615.html.

Felbermayr, Gabriel J., and Wilhelm Kohler. 2006. "Exploring the Intensive and Extensive Margins of World Trade." *Review of World Economics* 142 (4): 642–74. doi:10.1007/s10290-006-0087-3.

Forbes, Kristin, Dennis Reinhardt, and Tomasz Wieladek. 2017. "The Spillovers, Interactions, and (Un)intended Consequences of Monetary and Regulatory Policies." *Journal of Monetary Economics*. Accessed January 17. doi:10.1016/j.jmoneco.2016.10.008.

Frankel, Jeffrey A., Ernesto Stein, and Shang-Jin Wei. 1997. *Regional Trading Blocs in the World Economic System*. Peterson Institute.

Frankel, Jeffrey, and Andrew Rose. 1997. "Is EMU More Justifiable Ex Post Than Ex Ante?", *European Economic Review,* Vol. 41, Nos 3–5, pp. 753–760.

Frankel, Jeffrey, and Andrew Rose. 1998. "The Endogeneity of the Optimum Currency Area Criteria", *Economic Journal*, Vol. 108, No. 449, pp. 1009–1025.

Gómez-Herrera, Estrella. 2013. "Comparing Alternative Methods to Estimate Gravity Models of Bilateral Trade." *Empirical Economics* 44 (3): 1087–1111. doi:10.1007/s00181-012-0576-2.

Gourieroux, Christian, Alain Monfort, and Alain Trognon. 1984. "Pseudo Maximum Likelihood Methods: Applications to Poisson Models." *Econometrica* 52 (3): 701–720. doi:10.2307/1913472.

Harrigan, James. 1996. "Openness to Trade in Manufactures in the OECD." *Journal of International Economics* 40 (1): 23–39. doi:10.1016/0022-1996(95)01395-4.

Head, Keith, and Thierry Mayer. 2014. "Chapter 3 - Gravity Equations: Workhorse,Toolkit, and Cookbook." In

Handbook of International Economics, edited by Elhanan Helpman Gita Gopinath and Kenneth Rogoff, 4:131–95. Handbook of International Economics. Elsevier. doi:10.1016/B978-0-444-54314-1.00003-3.

Head, Keith, Thierry Mayer, and John Ries. 2010. "The Erosion of Colonial Trade Linkages After Independence." *Journal of International Economics* 81 (1): 1–14. doi:10.1016/j.jinteco.2010.01.002.

Helpman, Elhanan 1984. "A Simple Theory of International Trade with Multinational Corporations", *Journal of Political Economy* Vol. 92, pp. 451-471.

Helpman, Elhanan and Paul Krugman. 1985. *Market Structure and Foreign Trade*. Cambridge: MIT Press.

Helpman, Elhanan, Marc Melitz, and Yona Rubinstein. 2008. "Estimating Trade Flows: Trading Partners and Trading Volumes." *The Quarterly Journal of Economics* 123 (2): 441–487.

Helpman, Elhanan. 1981. "International Trade in the Presence of Product Differentiation, Economies of Scale and Monopolistic Competition: A Chamberlin-Heckscher-Ohlin Approach." *Journal of International Economics* 11 (3): 305–40. doi:10.1016/0022-1996(81)90001-5.

Helpman, Elhanan. 1987. "Imperfect Competition and International Trade: Evidence from Fourteen Industrial Countries." *Journal of the Japanese and International Economies* 1 (1): 62–81. doi:10.1016/0889-1583(87)90027-X.

Kenen, Peter. 1969. "The Theory of Optimum Currency Areas: An Eclectic View". In: Mundell, Swoboda, eds. *Monetary problems in the international economy*, Chicago, IL: University of Chicago Press, 41-60.

Kiviet, Jan F. 1995. "On Bias, Inconsistency, and Efficiency of Various Estimators in Dynamic Panel Data Models." *Journal of Econometrics* 68 (1): 53–78. https://ideas.repec.org/a/eee/econom/v68y1995i1p53-78.html.

Krugman, Paul 1981. "Intra-industry specialization and the gains from trade." *Journal of Political Economy*, vol. 89, October, pp. 959-73.

Krugman, Paul. 1995. "Increasing Returns, Imperfect Competition and the Positive Theory of International Trade." Handbook of International Economics. Elsevier. http://econpapers.repec.org/bookchap/eeeintchp/3-24.htm.

Leamer, Edward and Robert Stern. 1971. "Quantitative international economics." *Journal of International Economics*, Vol. 1, pp. 359-361.

Leamer, Edward, and James Levinsohn. 1995. "International Trade Theory: The Evidence." Handbook of International Economics. Elsevier. http://econpapers.repec.org/bookchap/eeeintchp/3-26.htm.

Linder, Staffan Burenstam. 1961. *An Essay on Trade and Transformation*. Uppsala: Almqvist & Wiksells Boktryckeri AB.

Linnemann, Hans. 1966. *An Econometric study of international trade flows*. Dissertation, Netherlands School of Economics.

Markusen, James R., and Anthony J. Venables. 1998. "Multinational Firms and the New Trade Theory." *Journal of International Economics* 46 (2): 183–203. doi:10.1016/S0022-1996(97)00052-4.

Markusen, James R., and Anthony J. Venables. 2000. "The Theory of Endowment, Intra-Industry and Multi-National Trade." *Journal of International Economics* 52 (2): 209–34. doi:10.1016/S0022-1996(99)00055-0.

McCallum, John. 1995. "National Borders Matter: Canada-U.S. Regional Trade Patterns." *American Economic Review* 85 (3): 615–23.

http://econpapers.repec.org/article/aeaaecrev/v_3a85_3ay_3a1995_3ai_3a3_3ap_3a615-23.htm.

McKinnon, Ronald I. 1963. "Optimum currency area". *American Economic Review*, Vol. 4, pp. 717-725.

Melitz, Marc J., and Giancarlo I. P. Ottaviano. 2008. "Market Size, Trade, and Productivity." *The Review of Economic Studies* 75 (1): 295–316.

Mundell, Robert. 1961. "A theory of optimum currency areas". *American Economic Review*, Vol. 51 (Nov), 509-517.

Mundell, Robert. 1973. "Uncommon Arguments for Common Currencies," in H.G. Johnson and A. K. Swoboda (eds.), *The Economics of Common Currencies*, London: Allen & Unwin, pp. 114-132.

Mundell, Robert. 1973. "Uncommon Arguments for Common Currencies." In *The Economics of Common Currencies*, edited by H. G. Johnson and A. K. Swoboda, 114–32. Allen and Unwin.

Petroulas, Pavlos. 2007. "The Effect of the Euro on Foreign Direct Investment." *European Economic Review* 51 (6): 1468–91. doi:10.1016/j.euroecorev.2006.10.005.

Portes, Richard, and Helene Rey. 1998. "The Euro and International Equity Flows." *Journal of the Japanese and International Economies,* Vol. 12, No. 4, pp. 406-423.

Pöyhönen, Pentti. 1963. "A Tentative Model for the Volume of Trade between Countries." *Weltwirtschaftliches Archiv* 90: 93–100.

Ramsey, James B. 1969. "Tests for Specification Errors in Classical Linear Least Squares Regression Analysis," *Journal of the Royal Statistical Society* B Vol. 31, pp., 350–371.

Redding, Stephen, and Anthony Venables. 2004. "Economic Geography and International Inequality." *Journal of International Economics* 62 (1): 53–82. http://econpapers.repec.org/article/eeeinecon/v_3a62_3ay_3a2004_3ai_3a1_3ap_3a53-82.htm.

Rose, Andrew K., Ben Lockwood, and Danny Quah. 2000. "One Money, One Market: The Effect of Common Currencies on Trade." *Economic Policy* 15 (30): 9–45.

Santos Silva, J. M. C., and Silvana Tenreyro. 2006. "The Log of Gravity." *The Review of Economics and Statistics* 88 (4): 641–58.

Santos Silva, J. M. C., and Silvana Tenreyro. 2010. "Currency Unions in Prospect and Retrospect." dp0986. CEP Discussion Papers. Centre for Economic Performance, LSE. https://ideas.repec.org/p/cep/cepdps/dp0986.html.

Santos Silva, J. M. C., and Silvana Tenreyro. 2011. "Further Simulation Evidence on the Performance of the Poisson Pseudo-Maximum Likelihood Estimator." *Economics Letters* 112 (2): 220–22. https://ideas.repec.org/a/eee/ecolet/v112y2011i2p220-222.html.

Sousa, José de, and Julie Lochard. 2011. "Does the Single Currency Affect Foreign Direct Investment?" *The Scandinavian Journal of Economics* 113 (3): 553–78.

Taylor, Christopher. 2008. "Foreign Direct Investment and the Euro: The First Five Years." *Cambridge Journal of Economics* 32 (1): 1–28. doi:10.1093/cje/bel044.

Tinbergen, Jan. 1962. *Shaping the World Economy: Suggestions for an International Economic Policy*. New York: Twentieth Century Fund.

Trefler, Daniel. 1995. "The Case of the Missing Trade and Other Mysteries." *American Economic Review* 85 (5):

1029–46. http://econpapers.repec.org/article/aeaaecrev/v_3a85_3ay_3a1995_3ai_3a5_3ap_3a1029-46.htm.

Warin, Thierry, Phanindra V. Wunnava, and Hubert P. Janicki. 2009. “Testing Mundell’s Intuition of Endogenous OCA Theory.” *Review of International Economics* 17 (1): 74–86. doi:10.1111/j.1467-9396.2008.00802.x.

Westerlund, Joakim, and Fredrik Wilhelmsson. 2011. “Estimating the Gravity Model Without Gravity Using Panel Data.” *Applied Economics* 43 (6): 641–49. doi:10.1080/00036840802599784.

Data sources

Data	**Description**	**Source**
GDP data	Gross domestic product expressed in million U.S. dollars using purchasing power parity (PPP) rates. Data are also converted to a 2005 base year through the CPI provided by Ameco.	Ameco database (European Commission).
Total labor force	Economically active population that contributes to the production of goods and services in the formal economy. It is used in calculating the capital per worker ratio.	World development indicators (World Bank).
Interest rates	EMU convergence criterion bond yields: Central government bond yields on the secondary market, gross of tax, with around 10 years’ residual maturity. Code: tec00097.	Eurostat.
Fiscal balance	General government budget surplus or deficit, expressed as a percentage of a country’s GDP.	Eurostat.
Public debt	Consolidated gross debt of the central government and subsectors including state government, local government, and social security.	Eurostat.