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Endogenous OCA Theory: Using the Gravity Model to Test Mundell's Intuition*

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Abstract

This paper presents an empirical assessment of the endogenous optimum currency area theory. This study relies on the original intuition developed by Mundell in 1973. The gravity model is used to empirically assess the effectiveness of the convergence criteria by examining location specific advantages that guide multinational investment within the European Union. A fixed effects model based on a panel data of foreign direct investment (FDI) flows within the EU-15 shows that horizontal investment promotes the diffusion of the production process across the national border. Specifically, the examined Maastricht criteria suggest convergence in interest rate, government fiscal policy, and debt play a significant role in attracting multinational investment.

Keywords: *Economic integration, gravity model, endogenous optimum currency area*
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1. Introduction

This study examines to what extent the transition to the euro endogenously affected the allocation of capital across the European Union. Initiated in 1993, the Maastricht Treaty set out strict guidelines for member states to follow with the ultimate goal of adopting a single currency. The adoption of the common currency in 1999 concluded the European convergence process.

The Maastricht Treaty serves as the blueprint for the eventual adoption of a common currency and identifies several macroeconomic convergence policies to be satisfied by all candidate countries before entrance into the European Monetary Union (EMU). The treaty presents the following convergence criteria:

1. candidate country inflation is no more than 1.5 percent above the average of the lowest three inflation rates in the European Monetary System (EMS);
2. the long-term interest rate of the candidate country is no more than 2 percent higher than the average of the low inflation countries in the EMS;
3. the candidate country is a member of the exchange rate mechanism of the EMS and has not observed a devaluation in the two years preceding entrance into the EMU;
4. the candidate country government budget deficit is no higher than 3 percent of GDP; and
5. the candidate country government debt does not exceed 60 percent of GDP.

Underlying the Maastricht Treaty convergence criteria is the European Commission's (1990) interpretation of the theory of Optimum Currency Areas (OCA) first proposed by Mundell (1961). As we shall see, the five economic criteria in the Treaty of Maastricht are one definition of convergence, and more precisely a macroeconomic definition of convergence.

In order to address the positive or negative externalities of these criteria on the microeconomic level, this study proposes an empirical analysis of the endogenous OCA theory. The first originality of this study is to employ an alternative measure to bilateral trade flows. Indeed, we chose to go back to the first intuition of the endogenous OCA theory found in Mundell (1973b), when he refers to the allocation of capital as a result of the use of a common currency. For this purpose, we will use the bilateral foreign direct investment (FDI) flows as a proxy for the allocation of capital.

The proxy for the allocation of capital is measured by multinational firm investment motivated by location specific advantages that offer firm level incentives for cross-border investment. The second originality is in the combination of this micro-approach (Hecksher-Ohlin variables) with the convergence measure (European macroeconomic aggregates). This approach is inspired by Corsetti and Pesenti (2002) who developed a theoretical model dealing with the micro-structure of national economies instead of bilateral trade: imperfect competition, nominal rigidities in the goods markets, and forward-looking price-setting by firms.

We employ these microeconomic measures through an empirical analysis using a variation of the gravity model of international trade. Generalized, the gravity model explains a flow from country *i* to country *j* by economic forces at the flow's origin, the economic forces at the flows destination, and the forces aiding or resisting the movement of the flow from the origin to the destination.

The organization of the paper is as follows. Section 2 presents background discussion of the endogeneity argument with respect to European integration and its connection to multinational firm theory. Section 3 presents the methodology of the gravity model used in this study. Section 4 follows with a discussion of the empirical analysis. Finally, Section 5 provides some possible policy implications and conclusions.

2. Background literature

The political discussions of the late 1970s following the inception of the ECU (European Currency Unit) focused on the likelihood of transforming this *complementary* currency to existing currencies into a *perfect substitute* to the same existing currencies.

The OCA theory, first introduced by Mundell (1961) served to frame both the costs and benefits of monetary integration within this political discussion. Since then a vast literature has developed, with notable contributions by McKinnon (1963) and Kenen (1969). According to Frankel and Rose (1998), this literature focuses on four interrelationships between the members of a potential OCA: (1) the extent of trade; (2) the similarity of shocks and cycles; (3) the degree of labor mobility; and (4) the system of risk-sharing, usually through fiscal transfers.

Given the suitable aspect of this literature for Europe integration, the European Commission (1990) started to work on the stages necessary to enter into an OCA. However, according to Eichengreen (1990), Europe at the time was clearly not an OCA. In order to make it become one before the use of a common currency, the Treaty of Maastricht was implemented in 1993 across the European Union to make countries converge. Five economic proxies had been used to insure the convergence on the three public policy dimensions: (1) the monetary policy (in a closed and open economy perspective); (2) the fiscal policy; and (3) the structural policy. The proxies were respectively: inflation, exchange rate, national debt, public deficit, and long-term interest rate.

Although it was uncertain that Europe was an OCA before the inception of the euro (Bayoumi and Eichengreen, 1993, 1994, 1996), economic literature started to develop an e-OCA theory (to copy molecular scientists who created the Oca-B) known as the endogenous optimum currency area theory. According to Frankel and Rose (1998), the "examination of historical data gives a misleading picture of a country's suitability for entry into a currency union, since the OCA criteria are *endogenous*." In other words, waiting for two economies to be in phase before adopting the same currency is only one part of the path towards an OCA since using a common currency will also force the economies to become an OCA.

We can already find a similar argument in Mundell (1973a, 1973b): if countries adopt a common currency without substantial changes to their purchasing parities, and thereby eliminate uncertainty in the exchange rate, then they gain a better allocation of capital. Although this is not yet the endogenous OCA (since Mundell argues that purchasing parities should demonstrate some steadiness over time), he nevertheless emphasizes that gains in terms of allocation of capital are necessary to help create an OCA.

We can also find the e-OCA already in the European Commission (1990)'s report stating that the EMU will reduce the incidence of country-specific shocks.

According to Frankel and Rose (1998), endogeneity comes from the fact that "Entry into a currency union may raise international trade linkages … more importantly, tighter international trade ties can be expected to affect the nature of national business cycles." Further studies, for example Devereux and Engel (2002) or Borda and Romalis (2003), have developed empirical analyses of the e-OCA using trade and exchange rate models. The roots of these studies are in the examination of the two-way interaction between trade pricing and exchange rate volatility proposed by Baldwin and Lyons (1993, 1994).

Another noteworthy point in Frankel and Rose (1998) is the difference between trade and business cycles:

> From a theoretical viewpoint, closer international trade could result in either tighter or looser correlations of national business cycles. Cycles could, in principle, become more idiosyncratic. Closer trade ties could result in countries becoming more specialized in the goods in which they have comparative advantage. The countries might then be more sensitive to industry-specific shocks, resulting in more idiosyncratic business cycles. However, if demand shocks (or other common shocks) predominate, or if intra-industry trade accounts for most trade, then business cycles may become *more* similar across countries when countries trade more.

The OCA definition is *not* related to convergence in business cycles. When policymakers talk about the convergence needed to become an OCA, attention should be paid to the type of convergence being considered. In separating convergence in trade from convergence in business cycles, Krugman (1993) argues that specialization will occur in Europe due to the reduction of transaction costs, which is opposed to the European Commission's (1990) report.[1] Further research like Fontagne and Freudenberg (1999) show using bilateral EU trade during 1980-1994 that the EMU is likely to foster intra-industry trade in Europe, leading to more symmetric shocks between member states. In other words, the monetary union will endogenously create the conditions of its success.

For this study, we propose an empirical analysis of the e-OCA through the use of a different proxy than the bilateral trade: the bilateral FDI flows. By doing so, we want to measure Mundell's (1973b) intuition about the better allocation of capital that would result from the use of a common currency. We use FDI flows as a proxy for the allocation of capital, and – as in Mundell's (1973b) argument – we will consider the exchange rates among other variables. This model conforms with the micro-structure approach by Corsetti and Pesenti (2002).

We will use a gravity model to analyze FDI flows. This model is commonly employed in the study of international trade. FDI is the movement of production activity across the national border. More specifically, FDI is the acquisition of 10 percent or more of foreign firm assets. According to Feenstra (1999), this internal activity is significantly different from inter-firm linkages that can be established when independent firms interact. The acquisition of a foreign subsidiary for production or branch distribution includes benefits such as lower trade costs and information costs. Barrel and Pain (1997) argue that FDI is not simply an alternative method to increase firm production capacity, but becomes a channel for the transfer of knowledge capital and transaction technology.

Multinational activity is usually described with reference to ownership-specific advantages, internalization incentives, and location-specific advantages outlined in Dunning (1981). Ownership-specific advantages refer to a firm's propriety rights or exclusive or favorable access to inputs and factors of production. Internalization incentives include legal safeguards such as absence of price discrimination, institutions that protect property rights, and protection against exploitation through government intervention (e.g., tariffs, tax differences, and quotas) to protect the firm. Location-specific advantages, the focus of this study, assume firm profitability in producing a product in a foreign country rather than simply producing it at home and exporting to the foreign market. Transport and communications costs are the most obvious examples. Others include input prices, quality and productivity of labor, energy, materials, and intermediate goods as well as the distribution of inputs and markets in the production process of firm operation in the foreign country.

From a theoretical perspective, location advantages can be divided into two competing arguments. The factor proportions hypothesis, presented in Helpman (1984), Markusen (1984), and

[1]For a more detailed presentation of the debate, see De Grauwe (2003).

Helpman and Krugman (1985), states that multinational activity arises only in the presence of sufficient differences in factor endowments among countries. When these differences in factor prices are equalized across borders, no incentives exist for the firm to maintain a foreign center of production. It should be noted that an important limitation to this strand of literature was the assumption of zero transportation costs.

The second argument, known as the proximity-concentration hypothesis (Brainard 1993, 1997) arose largely as a consequence of the work of Krugman (1991) on positive transportation costs. Brainard (1993) combined positive trade costs with the Markusen (1984) framework of symmetric factor endowments through a trade-off between multinational firm proximity to a destination market and advantages in maintaining plant production abroad to supply the destination market. The absence of factor price differentials forces firms to consider the additional fixed cost of a production plant abroad versus the additional variable cost of continued exports to supply the foreign market.

An extended model, presented in Markusen and Venables (1998, 2000) incorporated Brainard's positive transportation costs, but also allowed for asymmetries between countries due to country size, factor endowments, and technology. Horizontal expansion by multinational firms is driven by an overall large market, and similarities in relative market size, similar labor costs, and high transportation costs and tariffs.

According to the convergence criteria, the 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 the focus of past empirical research. The following section presents the model used in this empirical analysis and application of the convergence criteria into an econometric framework.

3. Methodology and data

The empirical analysis is based on a variant of the gravity model, commonly used to analyze bilateral trade flows.[2] The dataset is composed of aggregate annual bilateral flows of foreign direct investment between EU-15 members (Austria, Belgium, Denmark, France, Finland, Germany, Greece, Italy, Ireland, Luxembourg, Netherlands, Portugal, Spain, Sweden, and United Kingdom). There are N = 14 × 13 = 182 bilateral relations per time period (i.e., aggregated cross-sections).[3] The data cover the period from 1994 to 2000, yielding a total sample of n=182×7=1274 bilateral observations. Since the dataset includes a few missing observations, the actual dataset is slightly smaller and unbalanced.[4]

The model is estimated using the following gravity equation and includes Hecksher-Ohlin variables (market size, income similarity, factor endowments, and distance) as well as proxies for capturing the European convergence (interest rate difference, budget difference, and debt difference):

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[2]The model was first independently derived by Tinbergen (1962), and Pöyhönen (1963). For a theoretical background, see Anderson (1979), Bergstrand (1989), and Deardorff (1998).

[3]For the empirical study, Belgium and Luxembourg are combined yielding fourteen member states. The number of bilateral trading partners is always one less than the number of member states because domestic investment is not considered.

[4]Note that fourteen cross sections are missing in the dataset. The majority of these bilateral flows originate from or are destined to Greece. Therefore, N=168, and n=908.

$$\ln\left(FDI_{ij,t}\right) = \alpha_s + \overset{+}{\beta}_1 G_{ij,t} + \overset{+}{\beta}_2 S_{ij,t} + \overset{-}{\beta}_3 R_{ij,t} + \overset{-}{\beta}_4 D_{ij,t} + \overset{-}{\beta}_5 IRDIF_{ij,t}$$
$$+ \overset{-}{\beta}_6 BGTDIF_{ij,t} + \overset{-}{\beta}_7 DBTDIF_{ij,t} + \varepsilon_{ij,t}$$

where bilateral country pairs are denoted *ij*= Austria-Belgium, Austria-Denmark,..., UK-Sweden [168], and time *t*=1994, 1995,...,2000 [7]. The explanatory variables take the following forms:

$$G_{ij,t} = \ln\left(Y_{it} + Y_{jt}\right)$$
$$S_{ij,t} = \ln\left(1 - \left(\frac{Y_{it}}{Y_{it} + Y_j}\right)^2 - \left(\frac{Y_{jt}}{Y_{it} + Y_j}\right)^2\right)$$
$$R_{ij,t} = \left|\ln\left(\frac{gcf_{it}}{N_{it}}\right) - \ln\left(\frac{gcf_{jt}}{N_{jt}}\right)\right|$$
$$INFDIF_{ij,t} = \left|inflation_{it} - inflation_{jt}\right|$$
$$BGTDIF_{ij,t} = \left|budget_{it} - budget_{jt}\right|$$
$$DBTDIF_{ij,t} = \left|debt_{it} - debt_{jt}\right|$$

Expected signs are given above the respective coefficient.[5] Note that the dependent variable FDI represents the flow value rather than stock measurement more commonly used in empirical analysis.[6] In this case, FDI flows capture the creation of new linkages between multinational firms and foreign affiliates.[7] Fixed effects are denoted a_s, and recognize country-specific (symmetric) heterogeneity, but homogeneity when $i = j$ (i.e. when i =Austria or j =Austria, then the dummy variable 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.[8] The error term, $\varepsilon_{ij,t}$, represents all unobserved bilateral effects. The three Hecksher-Ohlin variables (G, S, R) resemble the Helpman (1987) specification and are detailed below.

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[5]An exchange rate variable and an absolute inflation rate variable were included in the initial analysis to account for all Maastricht Treaty criteria. Both variables yielded statistically insignificant results and were excluded from the final model. The exchange rate variable specification is similar to De Grauwe and Skudelny (2000):

$$ER_{ij,t} = \frac{\left(\text{amount of currency i/amount of currency j}\right)_t}{\left(\text{amount of currency i/amount of currency j}\right)_{1994}} \times 100$$

Initial regression results are available from the authors upon request.

[6] See Brenton *et al.* (1999), and Egger and Pfaffermayr (2004) for empirical research employing FDI stock values.

[7] The dependent variable for FDI is in log form, reflecting only positive investment; disinvestment is recorded as 0. Following Chen (2002), a value of 1 is added to each FDI value to avoid $\ln(0)$. This does not bias the estimates as $\ln\left(1 + FDI_{ij,t}\right) \approx \ln\left(FDI_{ij,t}\right)$ when $FDI_{ij,t}$ is large. But, where $\ln\left(FDI_{ij,t}\right) = 0$, then $\ln\left(FDI_{ij,t} + 1\right) = 0$.

[8]For a generalized fixed effects gravity model, see Baltagi *et al.* (2003).

G is the measure of overall "economic space" that measures market size and therefore serves as a proxy for investment that is motivated by market-expansion reasons (Helpman, 1987). The expected value is positive for investment flows under circumstances of horizontal firm integration.

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. If two countries have roughly equal GDP, the coefficient approaches $-0.69 = \ln(0.5)$. Perfect dissimilarity yields a coefficient value that approaches $\ln(0)$.[9] A positive coefficient is evidence of horizontal firm integration, as presented 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.

R measures the relative difference between the two countries in terms of relative factor endowments. R in this study is the ratio of gross fixed capital formation and country 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 relative factor endowments. As mentioned in the preceding section, the importance of factor endowments varies significantly depending on the trade theory hypothesis examined. Horizontal firm integration theory dictates that factor endowment differences are irrelevant and should not be significant (or even exist) among developed countries. As the EU represents a set of well-developed and relatively wealthy countries, movement toward equalization of relative factor endowments is expected to yield an increase in bilateral FDI flows.

D denotes the log of the distance between the economic centers of the two countries. Broadly speaking, distance is a proxy for trade and transportation costs, which has a negative impact on investment and trade flows. Markusen and Venables (2000) argue that distance is not relevant, but transportation costs are important for entry of multinational firms. Investment that promotes production for the foreign market a priori should not be greatly influenced by distance. Yet, if distance and transportation costs are inextricably linked, the coefficient on D should be negative. The costs associated with distance, such as communication and coordination costs, reduce incentives to new investment.[10]

IRDIF is the difference in interest rates between country *i* and *j*. The interest rate measures the long-term cost of borrowing. A negative coefficient is expected. Financing of assets and affiliate purchases is likely to come from both the source or target country; convergence in rates of both markets would see an increase in investor confidence and positive FDI flows. In other words, convergence could likely result in tight correlation of the interest rates.

BGTDIF represents the difference in the government budget surplus or deficit as a percentage of GDP between the source and host country. A convergence in the balance of the budget surplus is expected to increase investment. The intuition behind the expectation is clear: the variable attempts to capture the effect of government fiscal responsibility. Presumably, a multinational firm wishing to expand horizontally will be induced to invest in a market characterized by a similarity in government finances relative to the source country.

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[9]In the case of a country pair approaching perfect dissimilarity, the coefficient approaches -∞.

[10]It is worthwhile to point out that if horizontal FDI is aimed as a substitute for exports due in part by higher transportation costs, then the expected value should be positive. This argument is in line with theory presented in Markusen and Venables (1998). This study does not look at lower FDI transportation costs relative to bilateral trade transportation costs; instead, the variable is focused on measuring significance of absolute barriers to investment.

DBTDIF is the difference of the debt-to-GDP ratio between each country pair. This variable represents long-term stability of the government. Since FDI is considered a long-term transaction (as compared to exports, for example), a reduction in the debt differential between countries is likely to lead to an increase in investment flows.

Given the longitudinal nature of data, a simple OLS estimate of our model imposes strict restrictions that might not be justifiable given the complicated nature of our dataset. Specifically, we expect both temporally dependent interactions as well as interactions between country panels that contradict OLS assumptions. The presence of serial correlation and panel heteroscedasticity were of key concern in our estimation of this the model.

A way to check for autocorrelation is to use Baltagi and Wu's (1999) LBI test or a modified Durbin-Watson test for unequally spaced panel data (Bhargava *et* al., 1982). If there is autocorrelation, the option would be fourfold: (1) a dynamic panel model (two-way random effect model or error-component model) with first differences, sometimes known as a Prais-Winston transformation or a Cochrane-Orcutt transformation; (2) a dynamic model with lagged dependent variables with two slightly different approaches known as one or two step general methods of moments (GMM) estimators as in Arellano and Bond (1991) or Arellano and Bover (1995);[11] (3) a weight-adjusted combination of the White and Newey-West estimator to handle both the heteroskedasticity and the autocorrelation in the model; or (4) a feasible generalized least squares procedure (FGLS, or a two-state generalized least squares model) as in Parks (1967) and Kmenta (1997) in which the model assumes an autoregressive error structure of the first order AR(1), along with contemporaneous correlation among cross-sections.

The initial set of OLS estimates was subject to several tests to determine the interaction between observations. The assumption of zero autocorrelation was rejected by the Baltagi and Wu (1999) LBI test with a test statistic 2.090, while the modified Bhargava *et* al., (1982) Durbin-Watson proved inconclusive for positive serial correlation. Therefore the fourth option above was chosen. The model was estimated using the *cross-sectionally heteroscedastic and time-wise autoregressive model* (Kmenta (1997). Unlike pooled OLS estimation, the Kmenta-Parks method employed here accounts for heteroskedasticity and serial correlation when present.[12]

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[11]GMM is usually robust to deviations of the underlying data generation process to violations of heteroskedasticity and normality, insofar as they are asymptotically normal, but they are not always the most efficient estimators.

[12]First, OLS is used to obtain the regression residuals, which are then used to obtain a transformation that has an asymptotically non-autoregressive and homoscedastic error term. The other characteristics if the general Kmenta-Parks model are as follows:

$$E\left(\varepsilon_{ij,t}\right) = \sigma_{ij}^2 \text{ (heteroscedasticity)}$$

$$E\left(\varepsilon_{ij,t}, \varepsilon_{ji,t}\right) = 0 \text{ (where } ij \neq ji \text{ denotes cross - sectional independence)}$$

$$\varepsilon_{ij,t} = \rho\varepsilon_{ij,t-1} + \mu_{ij,t}$$

$$\mu_{ij,t} \sim N\left(0, \sigma_{\mu_{ij}}^2\right)$$

$$\varepsilon_{ij,t} \sim N\left(0, \frac{\sigma_{\mu_{ij}}^2}{1-\rho^2}\right)$$

$$E\left(\varepsilon_{ij,t-1}, \mu_{ji,t}\right) = 0 \;\forall\; ij, ji$$

The Kmenta-Parks model is slightly modified. When T<N (here T=7 and N=168) the following assumption is necessary: $E(\varepsilon_{ij,t}, \varepsilon_{ji,t}) = 0$, thereby removing the assumption of contemporaneous correlation among cross-sections.

While our choice of estimation method is not immune to criticism, such as those found in Beck and Katz (1995, 2001), the modified FGLS estimates here perform best because of our concern for autocorrelation. One of the main criticisms of the Kmenta-Parks estimates is the possibility of underestimation of standard errors and consequently resulting in an artificially inflated statistical significance. Since the FGLS method could be employed either in a fixed effects or random effects framework depending upon the underlying behavior of cross-sectional heterogeneity, it is critical that an appropriate test be conducted before proceeding with the suitable estimation strategy.[13]

Lastly, we detail the data sources of the variables. FDI flow data are from the European Union Foreign Direct Investment Yearbook (European Commission, 2002a). The flow of FDI is cross-border investment in which the investor has a long-term interest in an enterprise or market in another economy. Investment is composed of two parts: equity capital and other capital. Equity capital includes all branches and ordinary shares in subsidiaries and associates. Other capital is comprised of inter-company debt, such as loans and trade credits, between the investor and the subsidiary (branch or associate). Data are converted from millions of Euros to U.S. dollars using the EC average annual exchange rates and weighted with 1995 as the base year by the CPI provided by the IMF (2003).

GDP data are taken from the World Bank (2003) and expressed in millions of U.S. dollars using Purchasing Power Parity (PPP) rates. Data are also converted to a 1995 base year through the CPI provided by the IMF. The total labor force (used in the capital per worker ratio) is defined as the economically active population that contributes to the production of goods and services in the formal economy. The variable was obtained from the World Bank.

Distance data were obtained from Jon Haveman's website.[14] The variable is defined as the distance between the economic center of one country to another. Note that this does not lead to a value of 0 when countries are adjacent to each other. In the empirical study, we loosely follow Polak (1996), who addresses the built-in bias of the gravity model that is "downward" for "far-away countries" and "upward" for "close-up countries." The solution is to make the distance variable relative to the size of the host country economy. The variable therefore, is weighted by the host country population.

Interest rates represent central government bond yields on the secondary market with a residual maturity of ten years (European Commission, 2002b). Budget surplus/deficits as a percentage of a country's GDP were obtained from the IMF. The budget of the consolidated central government

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[13]According to the Hausman specification test, the cross-sectional heterogeneity can be treated as random, if the null hypothesis $H_0 : E(\mathbf{Z}'_{ij,t}, \varepsilon_{ij,t}) = 0$ can not be rejected, signifying a lack of correlation between the explanatory variables and the disturbance term. However, with $\chi^2_7 = 184.6$ which is significant at < .01 level, the stated null hypothesis could be rejected, signifying correlation between the explanatory variables and the disturbance term. Accordingly, a fixed effects model is preferred. Specifically, the cross-sectional heterogeneity dimension is captured by employing thirteen symmetric dummies given a total of fourteen countries included in the sample. As suggested by Greene (2003), a maximum likelihood estimation method is employed for obtaining the FGLS estimates reported in Table 1.

[14]http://www.macalester.edu/research/economics/page/haveman/trade.resources/TradeData.html

includes operations of budgetary central government, extra budgetary units, and social security funds. Debt data are compiled by Eurostat. Debt is defined as consolidated gross debt of the central government and subsectors including state government, local government, and social security debt. The econometric analysis and discussion of the results are presented in the next section.

4. Interpretation of the results

Our results suggest that multinational FDI flows can be explained by destination market characteristics such as large, high-income consumer markets and fiscal and structural stability. These findings are in line with current theory. The findings here suggest multinational firms are not primarily concerned with lowering labor costs by investing abroad, but are sensitive to communication and transportation costs that are incurred through firm expansion. The Maastricht convergence criteria are found to have a positive influence on investment: low interest rates, reduction in budget deficits, and size limits on government debt all play a significant role in attracting multinational firms. Detailed results of our findings are presented in Table 1.

A. Hecksher-Ohlin Variables

As shown in Table 1, the total market size is highly significant. The positive relation between the estimated coefficient and the dependent variable can be broadly interpreted as the source country's desire to seek out markets that increase the overall access to consumers.

The β_2 coefficient is positive, meaning convergence in terms of income between the country pair results in an increase in FDI flows. According to these results, multinational firms prefer to invest in markets that are similar in size relative to the host country.

The β_3 coefficient is negative, but statistically insignificant. The sign of the coefficient suggests multinational firms are not likely to expand production across borders strictly on the premise of lower labor costs in the country of investment within the European Union.

The findings suggest that transportation costs limit intra-EU investment by multinational firms. The β_4 coefficient is negative and statistically significant. Distant markets suffer. Investment, therefore, is not a cost-saving measure in the face of high transportation costs.

Table 1: FGLS Estimates [Double-Log Specification]

Dependent Variable: $\ln(FDI_{ij,t})$. Mean: 4.676, Std. Dev: 2.378

Variable	Mean	Std. Dev.	Coefficient	z-statistic
Heckscher-Ohlin Variables				
Market Size	13.644	0.791	6.248***	12.78
Market Similarity	-1.187	0.495	3.569***	13.61
Factor Endowment	0.724	0.989	-0.115	-1.06
Distance	4.221	1.309	-0.175***	-4.45
European Convergence Variables				
Interest Rate	1.187	1.857	-0.143***	-10.20
Budget	2.904	2.171	-0.047***	-4.17
Debt	25.730	25.337	-0.012***	-9.26
Country Fixed Effects				
Austria			3.172***	6.97
Belgium/Luxembourg			5.097***	12.38
Denmark			5.533***	8.95
Finland			5.409***	8.80
France			-0.303***	-2.68
Germany			-1.134***	-7.20
Greece			2.963***	5.85
Ireland			7.727***	11.17
Italy			-0.719***	-5.40
Netherlands			3.762***	12.29
Portugal			3.612***	7.01
Spain			0.475***	2.66
Sweden			4.301***	9.15
Constant			-80.584***	-11.52
n =908	Likelihood Ratio ~ $\chi^2_{20} = 350.084$***			

*** <.01 significance

B. European Convergence Variables

A decrease in the long-term interest rate in the source and host countries lowers the cost of borrowing for multinational firms. Specifically, firms that are headquartered in the source country are willing to finance investment projects in either the destination market or the source market. Consequently, equalization of financing costs tends to increase the inflow of investment into the host country.

Fiscal responsibility plays a significant role in the economy of the target country as a means to attract inflows of foreign investment. A negative β_6 coefficient implies that convergence of government fiscal policy increases FDI flows between the country pair.

Similarly, management of government debt is also a significant determinant of FDI flows. The negative coefficient β_7 implies that levels of government debt that are similar across countries tend to attract multinational investment.

C. Country Fixed Effects

Lastly, we briefly mention the symmetric country dummy variables that proxy country participation (both inflow and outflow) of FDI within the region. Interestingly, the most active countries in terms of multinational investment during the period observed have been Ireland, Denmark, Finland, and Belgium/Luxembourg. These findings are plausible as, comparatively speaking; the home markets of these countries are small relative to those of the region's larger economies. Consequently, multinational firms based in those countries would be the most willing to expand to other markets.

5. Policy Implications and Conclusions

The primary results of this empirical analysis find evidence of growing horizontal integration of the EU-15 based predominantly on market access and consumer income. These intra-industry linkages are the main factors that deepen market integration and allow for synchronization of demand and trade-based shocks. The magnitude of the Hecksher-Ohlin variables, specifically market size and income similarity, allows for a more visible role in determining the creation of horizontal linkages. The statistical significance of the European convergence variables suggests that Europe is becoming an optimum currency area in terms of allocation of capital as formulated in Mundell (1973a).

Defined in terms of allocation of capital, convergence also seems to have occurred. This supports the European Commission's (1990) view, instead of Krugman's (1993) comparative argument.

The convergence process of the European member states in the 1990s presents several factors that will guide the future entry of member countries into the monetary union. In May 2004, the European Union expanded to include ten Central and Eastern European accession candidates. The findings here suggest key characteristics that are necessary to attract intra-EU multinational investment during their accession into the EMU.

Recent studies by Brenton *et al.* (1999) and Janicki and Wunnava (2004) show that trade between the European Union and these accession candidates is still based primarily on differences in factor endowments – such as labor costs – where production is aimed at re-export back to the EU market, rather than consumption in the candidate countries. Brenton *et al.* (1999) refer to this as the integration of the accession candidates into the European production process. The results presented here, however, suggest that the structure of current EU production process is quite different. The entry of the accession candidates into the EMU will depend not on the timetable presented by the European Commission; entry will depend on the development of intra-industry linkages and the continued creation of horizontal intensity of investment.

Future empirical research could be useful in further exploring the convergence hypothesis presented in Markusen and Venables (1996). Specifically, the results here follow the hypothesis suggesting growth in multinational firms is determined by convergence of income levels, relative factor endowments, and size. A future analysis of intra- European imports and exports in modeling domestic firm behavior might be useful in finding further support in an empirical study of European convergence relative to growth in multinational firm activity.

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