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Common Currencies and FDI Flows

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Abstract

The paper investigates the impact of EMU on foreign direct investment flows. Using the option value approach to investment decisions, it is possible to show how exchange rate uncertainty hinders cross-border investment flows. By permanently fixing bilateral exchange rates, a currency union can then be expected to spur international investment. Results from a gravity model on a sample of OECD countries confirm the hypothesis that currency unions have a positive impact on FDI; moreover, adopting the same currency appears to do more than merely eliminating exchange rate volatility. These findings closely resemble those recently obtained in the trade literature.
JEL Codes: F15, F21.

1 Introduction

In the last few years, the completion of the European Monetary Union (EMU) with the introduction of a single currency in 12 EU-member countries, has renewed the debate about Optimal Currency Areas(OCA). Starting from Frankel and Rose (1998), who stress the static nature of standard OCA criteria, two different views are presently facing each other in the academic arena. The first can be traced to the specialization argument put forward by Krugman (1993) and Krugman and Venables (1996): according to this paradigm closer economic integration (the likely result of a single currency) will produce greater specialization and hence generate more idiosyncratic shocks. Thus adopting a common currency should rise the costs of a unified monetary policy. The competing view, on the contrary, postulates that business cycle correlations and international trade linkages are not independent, but rather intertwined in a dynamic fashion, whereby closer commercial links result in more correlated business cycles (Frankel and Rose, 1998). In a number of papers, Rose (2000, 2004, among others) and his co-authors (Glick and Rose, 2002; Rose and Engel, 2000; Rose and van Wincoop, 2001) have devoted much effort to demonstrate a positive effect of common currencies on trade. If established, this relation would support the endogeneity argument through the link: single currency→more trade→closer output correlation.

In the first and probably most famous of his papers on this issue, Rose (2000) finds that common currencies have an extremely large impact on international trade; there, in fact, he claims that —*ceteris paribus*— countries with the same legal tender trade as much as 3 times

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more than other economic systems. This conclusion has spurred a series of theoretical and empirical papers by other authors[1]. Even without putting excessive trust in point estimates, the bottom line of this stream of literature is that common currencies do have a significant positive effect on international trade. This paper applies the same methodology employed by Rose and many of his followers, namely a gravity-type empirical model, to estimate the effects of common currencies on FDI flows. The rationale for this exercise goes beyond a simple extension of the existing literature and is part of a broader research project aimed at investigating the relevance of endogeneity argument from the point of view of financial integration. In other words, the issue to which this paper wishes to contribute is whether the introduction of the euro is likely to bring about more integration of financial markets and whether this can trigger the cumulative processes that seem to work in the case of goods market. Cross-border investment flows constitute a natural starting point for this analysis since they possess attributes of both financial and commercial transactions. Moreover, as opposed to trade, theoretical literature on investment decisions offers a more solid explanation of the impact of currency unions on international flows. In fact, a strand of literature that emerged in the 1990s (Pindyck, 1991; Dixit, 1992; Dixit and Pindyck, 1994) has shown that there exists an option value for delaying investment decisions. This result is obtained by relaxing the assumptions —implicitly made in standard neoclassic models— that investment opportunities last only one period and that firm decisions are reversible. Despite the fact that under certain conditions the value of waiting arises even in absence of uncertainty, irreversibility makes investment especially sensitive to various forms of risk. Investment opportunities are associated with a perpetual American call option whereby the firm holds the possibility to engage in an investment project at any point in time. Then, by embarking on an investment the firm destroys this option and the consequent opportunity cost must be taken into account when the firm evaluates the goodness of the project. This is because irreversibility makes it impossible (or at least very costly) to liquidate the investment in presence of negative outcomes and the more uncertain is the future, the more valuable is the option to invest. Waiting, in fact, would allow the firm to collect more information on which to base its decision. There are a number of reasons why real investment displays a degree of irreversibility. Pindyck (1991) quotes the fact that the capital is firm or industry specific or the classic lemons problem that makes secondary markets not efficient. In the case under scrutiny here, it seems reasonable to assume that international investments show an even higher degree of irreversibility. A foreign investor that engages in an horizontal FDI, in fact, is likely to have less knowledge of the foreign market, less access to local institutions and business networks. This, coupled with potential differences in regulations, makes it more costly for a multinational enterprise to quickly liquidate its investment and thus rises the degree of irreversibility inherent to any FDI flow.

The rest of the paper is organized as follow: section 2 introduces the relevant literature and provides a brief overview of most significant contributions. This is followed by a simple model that exploits the option value approach to investment decisions to illustrate the effects of currency unions on cross-borders investment flows. Then the empirical methodology and the data are presented (section 4), while section 5 puts forward some predictions based on theoretical arguments and previous results. Sections 6 summarizes the main results of the empirical analysis while the last part (section 7) draws some conclusions.

2 Literature Review

As mentioned in the introduction, Rose (2000) has triggered a large quantity of work trying to asses the impact of a single currency on international trade. There, in fact, the author finds that common currencies have an extremely large impact on cross-border goods flows. He claims that

[1]The interested reader may refer to Andy Rose's web site http://faculty.haas.berkely.edu/arose/RecRes.htm#CUTrade for a list of the most relevant attempts.

countries with the same legal tender trade as much as 3 times more than other economic systems: this conclusion has obviously spurred a series of theoretical and empirical papers by other authors trying to explain, validate, shrink or reverse the result. Even though point estimates have to be taken with some caution, the bottom line of this literature is that common currencies do have a significant positive effect on international trade. Rose (2000) exploits a cross-country dataset covering bilateral trade between 186 economic systems at five-year intervals. Only about 1% of the observations involves currency union members and most of them tend to be small and/or poor. The outcome of the paper —obtained using a linear gravity model— is even more difficult to interpret considering that exchange rate volatility plays no significant role in the picture, both in Rose's analysis and in previous research[2]. Though the issue is a controversial one, so that it is not possible to conclude that exchange rate volatility has not impact on international trade, this influence is at best small and not particularly robust. As Rose (2004, p.3), himself quotes,

> "*Almost all the subsequent research in this area has been motivated by the belief that currency unions cannot reasonably be expected to triple trade*".

Subsequent papers have put forward different type of critiques concerning both the dataset and the econometric techniques employed. In particular, the use of cross-sectional variation does not address the relevant policy question (what happens to trade when a single currency is introduced) since it concentrates on the difference in trade flows between economies using the same legal tender and those retaining monetary independence. A number of studies[3] have then used country-pair fixed effect with panel data in order to isolate the time-series variation. As noted by Micco et al. (2003), this focus on the time-series dimension should mitigate the problem of reverse causality that would rise if countries tend to form currency unions with partners with which they trade a lot. Rose (2004) presents a meta-analysis of twenty-four recent studies investigating the impact of currency unions on trade. While referring to this paper for a concise yet rather complete review of the relevant literature, it is worth noting the results of this meta-analysis that evaluates some 440 point estimates of the effect under discussion. Though the analyzed papers use different data sets (some of which going back to the gold standard era, some other including early evidence from EMU members) and exploit a whole battery of econometric tools (from cross-sectional to time-series variation, from matching techniques to country specific fixed-effects), almost all studies confirm that currency unions have a positive effects on trade, especially large for small open economies sharing the currency of a larger trading partner. A good number of the studies represents variations on the theme of a gravity-type empirical model to which a dummy variable for common currency is added. Though the gravity model has often been criticized for its lack of solid theoretical foundations[4], it has proven in the years a fairly accurate instrument for investigating the determinants of trade flows, and since the early works of Tinbergen (1962) and Linnemmann (1966) it has become a standard tool in international economics. Moving from commercial flows to FDI may seem to preclude the use of a gravity model, and hence to impede the kind of analysis performed by Rose, his followers and his competitors. On the contrary, a number of recent studies has used the gravity specification to explain FDI flows and financial transactions. With even less theoretical backing than in the case of international trade flows, these empirical works has proven surprisingly (or maybe not, depending on the degree of personal trust on economic

[2]The impact of exchange rate volatility on international trade is a controversial topic. Among early attempts to detect a systematic relationship, Hooper and Koohlhagen (1978) find no significant impact of nominal exchange rate; Cushman (1983) uses the same methodology but gets conflicting results; Kenen and Rodrick (1986) find a negative impact of real exchange rate fluctuations

[3]See Glick and Rose (2002), Micco et al. (2003), Pommerenke (2003).

[4]In truth, it is possible to derive the basic gravity model, i.e. an equation relating trade flows to some measure of economic "mass", such as GDP and GDP per capita, and "distance", from a theoretical model (see Anderson (1979) and Deardorff (1998)). However, the more complex gravity equations usually employed in empirical works, which include a number of additional controls(common language, adjacency and the like) do not have explicit theoretical foundations.

modeling) accurate. In particular, the fact that portfolio investments decrease with distance strikes as a sharp contrast with standard diversification theory[5]. The wide body of literature witnessing the presence of home bias in portfolio allocation points in the same direction and furnishes a possible explanation to the apparent oddity of the result. Portes et al. (2001) and Portes and Rey (1999, 2002) suggest that international capital markets are not frictionless at all, but rather segmented by informational asymmetries that dominate them; hence distance proxies for information costs and that is why it displays a significant negative coefficient in the regressions. Indeed, additional variables representing more directly informational flows are also significant but their inclusion reduces the effect of distance and thus corroborates the authors' intuition. Loungani et al. (2002) and Mody et al. (2003) tackle the role of information in driving FDI flows more directly. In order to explain this "distance puzzle"[6], both papers develop an information-based model of international transactions that goes beyond the notion of physical proximity and defines the concept of transactional distance. In particular, Mody et al. (2003) find that greater host-country transparency reduces FDI relative to trade flows. They explain this result with the fact that when information is more reliable and accessible, the informational advantage of direct ownership is reduced and counterparts can rely on simpler forms of international transaction such as trade. A similar conclusion is reached by Helpman et al. (2004) who present a model populated by heterogeneous firms, some of which serve foreign markets either via exporting or via FDI. The decision to use the former of the latter strategy depends on the firm's productivity and on the host country's characteristics: higher transport costs and higher country-specific fixed costs reduce exports relative to FDI's. Hence, lower fixed costs (and informational barriers may reasonably be included in this category) increase exporters' market share relative to multinational firms.

Moving from methodological to theoretical issues, the relation between investment and the exchange rate has long been studied. Again, as in the case of trade, empirical results are often contradictory and a clear cut result is no available. This paper draws from two streams of empirical literature. The first explicitly addresses the relation between exchange rates and FDI's starting from the standard neoclassic investment theory la Hartman (1972) and Abel (1983); the second employs Dixit and Pindyck (1994) option value approach to asses the potential impact of exchange rate fluctuations (and misalignments) on investment decisions, although not much work is directly related to FDI's.

Reviewing the relevant empirical literature on the topic, Kiyota and Urata (2002) distinguish between the studies that have tackled the relation between exchange rate levels and international investment flows and those focusing on exchange rate volatility. The former tend to find a negative correlation, so that a depreciation of the domestic currency encourages FDI inflows. Froot and Stein (1991) rationalize this using an imperfect financial markets approach: in presence of credit constraints personal wealth matters and thus exchange rate levels affect relative wealth position between domestic and foreign agents. Hence devaluations can lead to a surge of foreign acquisitions. Klein and Rosengren (1994) find strong evidence that relative wealth significantly affects U.S. inward FDI's. Similar findings are presented by Bayoumi and Lipworth (1998) and Goldberg and Klein (1998). The common idea behind all these works is that a devaluation of the host currency vis--vis the potential investor's currency makes cross-border acquisition cheaper and thus spurs international direct investment flows[7]. While these studies provide a univocal answer, works concentrating on the impact of exchange rate volatility offer contradictory results. Goldberg and Kolstad (1995), for instance, postulate a positive link based on

[5]The underlying assumption is that greater distance is associated with less business-cycle correlation and hence grants more scope for diversification.

[6]This label appears in Loungani et al. (2002)

[7]Expectations about long-term movements in the exchange rate do not enter the picture here, and this appears as a major weakness of this strand of empirical analysis. Moreover, in general one would expect capital inflows to be associated with expected future appreciation of the currency, which in turn should feed back into the investment decision tempering the initial wealth effect of devaluation.

a non-negative correlation between export demand shocks and real exchange rate shocks that spurs multinational enterprises to optimally choose to locate some productive capacity abroad. Their evidence is supportive of this hypothesis. On the contrary, Benassy-Quere et al. (1999) and Kiyota and Urata (2002) find that volatility is detrimental to foreign direct investments[8]. Aizenman (1992) presents a model that can help to explain this variability in empirical results. In his paper, in fact, under a flexible exchange rate regime the sign of the correlation between investment and exchange rate variability depends on the nature of the shocks: negative when nominal shocks dominates, it turns positive in presence of real shocks[9]. The discussion about the role of exchange rate volatility leads naturally to an examination of the literature that analyses investment decision using the option-value approach. Combining uncertainty with irreversibility, two features inherent to almost all investment decisions, this approach reaches the intuitive conclusion that greater uncertainty reduces investments by increasing the value of waiting. This is in contrast with the earlier conclusion of Hartman (1972) and Abel (1983), who find that increased uncertainty may rise investment because it has a positive effect on the value of a marginal unit of capital[10]. Carruth et al. (2000) offer an interesting survey of empirical literature stimulated by Dixit and Pindyck's influential work. An important point made in the article is that option-based models do not offer a theory of investment, but rather identifies a set of factors that may influence the threshold point at which investment is triggered. Translating theory into empirical work presents some difficulties, the first of which is whether the relation between investment and uncertainty found at firm level will also hold at aggregate level, or if the researcher will have to rely only on microdata. Bernanke (1983) and Bertola and Caballero (1994) argue that microeconomic irreversibility —together with idiosyncratic uncertainty— is relevant also for aggregate behavior. Hence they eliminate the potential risk of idiosyncratic shock canceling out at industry- or economy-wide level. Aggregate empirical studies that associate investment and some measure of uncertainty find a negative correlation between the two variables. This relation is robust to different model specification and different proxies for uncertainty[11]. In particular, Calcagnini and Saltari (2000) consider demand and interest rate uncertainty and show theoretically that, in presence of irreversibility, they both reduce demand for capital goods. Empirical analysis using aggregate data on the Italian economy confirms the importance of demand uncertainty, while finds no significant role for interest rate uncertainty. On a more disaggregated level, Guiso and Parigi (1999) find that uncertainty does weaken the response of investment to perceived demand conditions[12], but that there is considerable heterogeneity in the effect. In addition, they show that this negative impact cannot be explained by uncertainty proxying for liquidity constraints Shifting the focus on studies that investigate the impact of exchange rate uncertainty, Goldberg (1993) performs both aggregate and 2-digit industrial analysis but finds only weak evidence of a negative impact. Using a 4-digit panel of FDI's Campa (1993) finds exchange-rate volatility to be negatively correlated with cross-border investment inflows, especially in industries characterized by high sunk costs. Darby et al. (1999, 2000) show theoretically that increased exchange rate uncertainty can have opposite effects on investment decision depending on model parameters, so that exact determination of the relation remains an empirical matter. They find evidence of a negative correlation, which however is neither particularly strong nor independent of the industrial structure; moreover, volatility seems not to be more important than misalignments which, particularly when persistent, have

[8] While Kiyota and Urata (2002) confirm the negative relation between exchange rate levels and FDI's, Benassy-Quere et al. (1999) find a positive correlation in oil exporting countries and explain this as the symptom of a "Dutch didease".

[9] The same model predicts that fixed exchange rates are more conducive to FDI's relative to a flexible regime.

[10] If the marginal product of capital is a convex function of the random variable, greater uncertainty implies a higher expected marginal product and hence increases investment. This result is an implication of Jensen's inequality: if $f(x)$ is a convex function of x, then $E[f(x)] > f(E[x])$.

[11] See Carruth et al. (2000, Table 1).

[12] The authors use information on the subjective probability distribution.

a relevant impact. Byrne and Davis (2002) find that "*exchange rate uncertainty as measured by conditional volatility from GARCH estimates, is harmful to investment*"[13]. This brings to the stage the question of how to model uncertainty. Carruth et al. (2000) survey a range of different volatility specification and suggest that results are scarcely affected by the particular choice of the researcher. A potential critique of the GARCH approach comes from Darby et al. (1999) who note how quarterly exchange rate data appear too low a frequency for such an approach, usually applied to high frequency financial data.

3 A Simple Model

Calcagnini and Saltari (2000) present a continuous-time model that analyzes the impact of demand and interest rate uncertainty on investment decisions. These are exactly the channels through which the introduction of the single currency in Europe is supposed to affect FDI's. First, exchange rate stability reduces demand uncertainty because prices no longer depend on the exchange rate; second, the convergence required by the Maastricht Treaty and by the Stability and Growth Pact should grant lower and more stable real interest rates. Following Pindyck (1991) and Dixit (1992) this section illustrates the effects of currency unions on investment behavior by means of a very simple model where uncertainty is introduced through exchange rate fluctuations. Consider a firm that at time has the opportunity to engage in FDI activity at a cost F. This investment will grant a perpetual production of 1 unit of good to be sold in the foreign market (horizontal FDI) at the price p^*. Abstracting, for the sake of simplicity, from production costs, the revenue to the multinational (in domestic currency) would then be

$$\pi_t = p_t \cdot 1 = p_t^* \cdot s_t = p^* \cdot s_t \tag{1}$$

where s_t is the exchange rate[14]. Note that here there is no demand uncertainty in that the price at which the good is sold in the foreign market is assumed fixed. Now, suppose that the exchange rate follows a geometric Brownian motion of the form:

$$ds = \mu s dt + \sigma s dz. \tag{2}$$

This process finds widespread application in economics since it provides a good approximation of the dynamics of exchange rates and numerous other asset prices[15] . By setting the model will assume that there is no trend in the exchange rate movement, so that for any short period dt the expected change in the exchange rate (ds) equals zero. This setting is consistent with the random walk hypothesis for exchange rate movements, which is supported by the data[16]. Hence,

$$E[s + ds] = s.$$

The goal of the firm is maximizing the (expected) value of the investment opportunity (which is equivalent to the expected present value of its cash-flow):

$$V(s) = maxE_t \left[(\pi_T(s) - F) \, e^{-\rho T} \right]$$

where T is the future time when the investment is made and ρ the discount rate. The Bellman equation for this problem is

$$\rho V(s) dt = E_t \left[dV(s) \right]; \tag{3}$$

equation (3) states that the return from the investment project —the capital gain accruing from the change in its value— must equal the normal return $\rho V(s)dt$. Using Ito's Lemma to expand

[13] Byrne and Davis (2002, p. 31).

[14] Price of the foreign currency in terms of domestic currency units.

[15] See Dixit (1993, pp.6–7).

[16] See Meese and Rogoff (1983) for a classic contribution on the forecasting ability of several structural models of exchange rate determination versus a simple random walk.

the right hand side and exploiting both the smooth pasting and the value matching boundary conditions it is possible to get a closed form solution for the threshold value of the revenue[17]. This is the level of reimpatriated profit the firm requires before committing in the investment project:

$$\pi^* = \frac{\beta}{\beta - 1} F \tag{4}$$

where β is the positive root of the quadratic equation associated to the problem and takes the form

$$\beta = \frac{1}{2} + \sqrt{\frac{1}{4} + \frac{2\rho}{\sigma^2}}.$$

Note that in the simple setting chosen for the model, profits equal the exchange rate times a constant (see equation (1)), hence the volatility of profits is proportional to the volatility of the exchange rate. Some tedious algebra shows that

$$\frac{\partial \pi^*}{\partial \sigma^2} = \frac{\left(\frac{8\rho}{\sigma^4}\right)}{\sqrt{1 + \frac{8\rho}{\sigma^2}} \cdot \left[\sqrt{1 + \frac{8\rho}{\sigma^2}} - 1\right]^2} > 0 \tag{5}$$

hence an increase in exchange rate volatility rises the level of return required by the firm to engage in the investment project.

After the inception of a currency union, the problem presents a trivial solution: exchange rate volatility would in fact drop to zero. By setting $\sigma = 0$, profits are constant and the optimal choice is to invest immediately if , otherwise never invest. In this case the threshold level is F which is lower than π^*. As a consequence, the elimination of exchange rate volatility caused by the introduction of the euro can potentially facilitate FDI flows by reducing the level of profit required by the firms before engaging in FDI. Does this mean that currency unions increase the level of FDI's? The link between the timing of investment and its actual level is a delicate topic: Carruth et al. (2000) correctly point out that the irreversible investment literature does not describe the level of investment, but rather insists on those factor that may affect the threshold level at which investment is undertaken. Still, it appears that at every point in time, the number of investment projects actually launched will be lower in presence of uncertainty. This is because the ex ante required return is greater: i.e. there exists a range of values of p ($F < \pi < \pi^*$) for which an investment that would be commenced in a world characterized by certainty, is postponed in a stochastic environment. The size of the wedge between the two threshold levels depends crucially on the volatility of the exchange rate s2. The higher the volatility, the larger the wedge and, consequently, the higher the probability that an investment opportunity is deferred. Hence the model suggests that the elimination of exchange rate volatility gives a "nonnegative" impulse to cross-border investment. In what follows the paper focuses on the EMU in order to present empirical support for this link between exchange rate volatility and FDI flows.

4 Methodology and Data

The present study estimates a log-linear gravity model with a parsimonious set of explanatory variables. In truth, this is more a necessity that a choice: given the aim of the paper — establishing the impact of currency unions on international investment flows— there is the need to identify the origin and the destination of FDI's; yet gravity models have proven very accurate in explaining bilateral flows using a limited amount of information. Following Glick and Rose (2002), Micco et al. (2003) and Pommerenke (2003), all time-invariant control variables are

[17]This simple model follows closely Pindyck (1991) and Dixit (1992). These are the references for the exact derivation of the solution.

subsumed in country-pair fixed effects. Using fixed effects allows one to isolate the time-series variation and hence reduces the concerns about endogeneity or reverse-causation. As noted by Micco et al. (2003), in fact, country-pairs dummies separate all “normal” factors that do not change over time and that may influence international transactions. Examples of such variables are easily found in standard empirical literature and range from common borders to common language, from the number of landlocked countries in the pair, to the presence of a common colonizer. The country-pair fixed effects formulation eliminates biases due to missing time-invariant control variables and grants a clearer outcome since the coefficient of these fixed effects are not of interest in this study. Moreover, as underlined by Glick and Rose (2002) and Micco et al. (2003), by focusing on the time-series dimension one answers the “right” policy question: what happens when a country joins or leaves a currency union?[18] The theoretical discussion of the previous paragraphs have been intentionally simplified and has not produced a precise model to be tested empirically. Rather, it has supplied a better understating of the factors that are likely to shape international investments flows and, in particular, the channels through which the introduction of a single currency can influence FDI's. The baseline regression equation is

$$\ln FDI_{ijt} = \alpha_{ij} + \beta_0 \ln GDP_{it} + \beta_1 \ln GDP_{jt} + \beta_2 \ln POP_{it} + \\ + \beta_3 \ln POP_{jt} + \gamma CU_{ijt} + YRD_t + \epsilon_{ijt} \quad (6)$$

where i and j denote countries, t denotes time and other notation is defined as follows:

- α_{ij} represents country-pair fixed effects;
- FDI_{ijt} is the investment flow between countries i and j at time t;
- GDP_{it} is GDP of country i at time t;
- POP_{it} is total population of country i at time t;
- CU_{ijt} is a dummy variable that equals 1 if countries i and j use the same currency at time t and 0 otherwise;
- YRD_t is a set of dummy variables that control for year-specific effects[19].

Equation (6) presents a stylized gravity model explaining international investment flows by means of two “mass” variable, GDP and population, a set of country-pair fixed effects that subsume time invariant controls such as distance, land area, common language and other traditional gravity variables[20]. The equation has been augmented with a dummy for currency union along the line of Rose (2000). This baseline model will be modified to accommodate what economic theory and economic intuition suggest. In particular, according to the empirical literature reviewed in the previous section, one may interpret a positive coefficient for the currency union dummy as a mere re-statement that exchange rate volatility has an adverse impact on FDI's. On the contrary, Rose (2000) confutes this interpretation in the case of trade flows showing that while exchange rate volatility does not enter significantly into the regression, the single currency dummy is positive and significant. Inserting in (6) a measure of exchange rate uncertainty may thus allow the researcher to see whether CU_{ijt} is just capturing the effect of volatility or not. Darby et al. (2000) point out that the separation between short-run volatility and misalignment

[18]It is true, however, that using country-pair fixed effects one looses a lot of *gravity* intuition because the most immediate controls, namely land area and distance, do not appear in the regression.

[19]The first year is excluded to avoid colinearity.

[20]This formulation departs a little from the equations used in the literature quoted so far. In particular Micco et al. (2003) use both total and *per capita* GDP whilst excluding population; Loungani et al. (2002) and Mody et al. (2003) include population but not total GDP. Equation (6) above minimizes potential colinearity problems, while feeding the same amount of information to the model.

effects is relevant because overlooking this difference may result in misspecification. Carruth et al. (2000) survey a number of different specifications used in the literature and come to the conclusion that the particular measure chosen makes little difference. The paper then opts for the 3-years (12 quarters) coefficient of variation of bilateral real exchange rate computed using quarterly data[21] as a measure of short-term volatility. Another measure, proposed in Kenen and Rodrick (1986), will be used as a robustness check[22]. To capture misalignments, Bleaney (1992) suggests using the standard deviation of the level of the real exchange rate over a long enough time-span. To correct for the potential bias arising from pooling together exchange rates with different means, the coefficient of variation is substituted for the standard deviation; this time however the time-span is 10 years (40 quarter). Hence two different indicators of real exchange rate volatility are introduced, a short-term indicator aimed at capturing pure volatility ($RERV_t$) and a long-term index meant to measure misalignments (MIS_t)[23]. The new estimating equation then becomes

$$\ln FDI_{ijt} = \alpha_{ij} + \beta_0 \ln GDP_{it} + \beta_1 \ln GDP_{jt} + \beta_2 \ln POP_{it} + \\ + \beta_3 \ln POP_{jt} + \gamma CU_{ijt} + \delta_1 REEV_{ijt} + \delta_2 MIS_{ijt} + YRD_t + \epsilon_{ijt} \quad (7)$$

In a recent review of theoretical and empirical works on international investment flows, Markusen and Maskus (2001) conclude that most FDI's are of the horizontal type and occur between similar countries[24]. This is consistent with Brainard (1997) who shows how overseas production by multinationals increases relative to exports the higher transport costs and trade barriers. Then it is possible to imagine that the EMU area will attract more non-EMU investments after the introduction of the euro, since a single currency allows for a complete penetration of multinational corporations into the whole European market[25]. Hence another indicator ($EMU1_{ijt}$) is added to equation (7): this variable takes value of 1 when at time t only one of the two countries involved in the FDI activity is member of EMU and is equal to zero otherwise.

$$\ln FDI_{ijt} = \alpha_{ij} + \beta_0 \ln GDP_{it} + \beta_1 \ln GDP_{jt} + \beta_2 \ln POP_{it} + \beta_3 \ln POP_{jt} + \\ + \gamma CU_{ijt} + \delta_1 REEV_{ijt} + \delta_2 MIS_{ijt} + \phi EMU1_{ijt} + YRD_t + \epsilon_{ijt} \quad (8)$$

This is yet another indirect test of *deep integration*[26], i.e. the idea that sharing the same legal tender not only eliminates exchange rate volatility, but rather constitutes a reduction of the transactional and informational barriers that evidently plays a major role in shaping international investment decisions. This hypothesis supports the belief that the effect of a currency union goes beyond the mere elimination of exchange rate risk and exchange rate volatility and is thus consistent with Rose (2000). Micco et al. (2003) use the same variable to test for trade diversion, i.e. the possibility that the increase in trade among EMU members comes at the expenses of a deterioration of commercial links with nonmember countries. The same reasoning applies here with respect to investments.

[21]The coefficient of variation of a distribution is defined as the ration between its standard deviation and its mean.

[22]$KR_t = \left[\frac{1}{12} \sum_{i=1}^{12} (\Delta \ln e_{ijt-i})^2 \right]^{\frac{1}{2}}$ where e is the quarter bilateral real exchange rate between countries i and j.

[23]Each volatility index is set equal to zero when $CU = 1$.

[24]While vertical FDI's are aimed at exploiting more favorable conditions in the productive process (the simples example is lower wage rates), horizontal ones are usually driven by the desire to be close to customers in important and large markets and by the will to enter new markets circumventing obstacles to trade (tariffs, transport costs, and the like).

[25]The idea is that a single currency would boost trade along the line of Rose (2000). If this is true, then locating in one member country will grant access to the market of all other participants to the currency union. This in turn increases the extent of the market served by the foreign affiliate and make FDI potentially more profitable.

[26]This label is borrowed from Hoekman and Konan (1999), though they use it in a slightly different way

The structure of the paper grants also the possibility to test the model presented by Mody et al. (2003). There, they postulate a negative link between host country transparency and international investment decisions on the ground that transparency makes the informational advantage of direct ownership less pronounced, so that there is less need to rely on it. Hence different forms of international transaction (trade) are used. The underlying assumption is that FDI substitutes for commercial linkages when the latter are more costly that the former. This interesting conclusion is similar to the argument put forward by Coase (1937) to justify the boundary of the firm: when transaction costs (i.e. the costs related to the functioning of the market mechanisms) grow beyond a threshold, it is more convenient to internalize relevant transactions by means of an organization. Rose (2000) received so much attention because joining a currency union was until then considered, at least in the empirical literature, equivalent to the permanent fixing of exchange rate. But exchange rate volatility has little impact on trade flows (Rose, 2000) and on portfolio allocation (see Portes and Rey (2002) on cross-border equity transactions). Hence the surprising large effect estimated by Rose (2000) tells that a single currency represents something more than the mere reduction of exchange rate volatility. Drawing from Portes and Rey (2002) and Portes et al. (2001) one can take one further step and conclude that a single currency must have something to do with informational barriers. If this is the case, then it is straightforward to assume that currency union will as well increase transparency within the euro area and thus lower FDI relative to trade flows. The estimating equation now becomes:

$$\ln\left[\frac{FDI_{ijt}}{Trade_{ijt}}\right] = \alpha_{ij} + \beta_0 \ln GDP_{it} + \beta_1 \ln GDP_{jt} + \beta_2 \ln POP_{it} + \beta_3 \ln POP_{jt} + \\ + \gamma CU_{ijt} + \delta_1 REEV_{ijt} + \delta_2 MIS_{ijt} + \phi EMU1_{ijt} + YRD_t + \epsilon_{ijt} \quad (9)$$

where $Trade_{ijt}$ is a measure of trade flows that take the same route as the direct investment[27].

Data on annual FDI flows are taken from the International Direct Investment Database of OECD[28] and cover 25 countries[29]. The dataset consists of 300 country-pairs whose data are recorded for 22 years (1980–2001), resulting in a panel of 6600 potential observations. A considerable number of missing values reduces the observations actually available. A problem peculiar to FDI's is their high degree of variability year by year. Since FDI flows are characterized by large investment projects by multinational corporations that are likely to involve massive monetary outflows in the initial years, reported FDI series present a rather erratic behavior. Even though this may save the researcher from the potential trouble of nonstationariety, too much noise can easily be counterproductive. Loungani et al. (2002) and Mody et al. (2003) tackle this problem by taking three-year averages of investment flows, but this leaves them with a very short time-series dimension. This approach is not applicable in the present study for three reasons. First, as already mentioned, the focus here is on the time-series variation of FDI's, so drastically reducing the available time periods would go against the spirit of the analysis. Second, reducing the time series dimension would cut the number of observations for which $CU_{ijt} = 1$ and hence severely limit the explanatory power of the analysis, aimed exactly at unveiling the effect of currency unions. Third, averaging would result in mixing together years for which the currency union dummy equals 1 and years for which it is 0, making any inference not only obscure but rather unreliable. Another potential path to reduce the noise is to apply some sort of filtering procedure to the series. Yet, another bunch of technical problems would arise in this case. Filtering techniques, in fact, are tailored for macroeconomic time-series involving long time spans and are not particularly suited for short panels. Moreover, they may

[27] In the case of inflows from country j to country i, $Trade_{ijt}$ represents imports in country i from country j.

[28] http://www.OECDsource.org .

[29] The countries are Australia, Austria, Belgium and Luxembourg (considered as a single economic unit), Canada, Czech Republic, Denmark, Finland, France, Germany, Hungary, Iceland, Ireland, Italy, Japan, Mexico, The Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, UK, US.

produce unpleasant distortions at the beginning and at the end of the series. Despite the fact that such distortions can be taken care of by creating some out-of-sample extra observations, the short length of the time span and the relative significant presence of missing observations suggest that the risk is not worth taking, especially because in the last years are concentrated all the cases where $CU_{ijt} = 1$.

To correct at least partially for the high degree of volatility that characterizes FDI data, only countries that appear both as reporting and as partner countries have been selected. In this way, in fact, it is possible to match different measures of the same flow and thus dispose at least of some noise. Thus inflows reported by country A as originated in country B have been matched with outflows reported by country B as directed to country A[30]; despite representing the same phenomenon, the two magnitudes are never equal. Averaging among the two values one then obtains one measure of inflows to A from B[31]. In addition, a set of year fixed effects has been added to the gravity equation with the aim of getting rid —at least— of the noise generated by year-specific events common to most countries[32].

Figures are expressed in millions of local currency units of the reporting country (save for some exceptions, where flows are reported in millions of US dollars) so they have been converted in US$ using exchange rates data taken by the IMF's International Financial Statistics (IFS) CD-Rom (series RF.ZF, period average). The same series, together with data on CPI's (series 64ZF), are used to obtain the bilateral real exchange rates needed to compute the volatility indexes[33] [34].

Population and GDP data are taken from the World Bank's World Development Indicators 2003 CD-Rom. Population corresponds to Total Population (series SP.POP.TOTL), while GDP is taken at current US$ (series NY.GDP.MKTP.CD). Real figures are obtained using national GDP deflators (NY.GDP.DEFL.ZS) in the case of GDP data; the US deflator is instead used for all FDI flows since it is difficult to asses which country's cost of living is more relevant[35].

Trade data are obtained from IMF's Direction of Trade Statistics (DOT) CD-Rom. Commercial flows are already expressed in US dollars, so there is no need to operate any conversion. The only currency union present in the sample is the EMU in the last three years of the period, so the CU dummy is easily built[36].

The presence of numerous cases in which the reported FDI flow is zero or negative poses a serious econometric problem. The log-linear structure of the gravity model implies the impossibility of exploiting observations for which the natural logarithm does not exist. In order to exploit the maximum amount of available information, data have been modified in a way that makes possible to use a Tobit model (a censored regression that assumes a normal distribution). In particular, calling $investment_{ijt}$ the variable reporting the investment flow occurring at time

[30]According to the so called directional principle recommended by the IMF, each country reports transactions with foreign affiliates as outward FDI flows, while the controlled enterprise's country registers the same operations as inflows. For a survey on FDI statistics, see Falzoni (2000).

[31]Empirical work on the original series appears to be dominated by noise. Rose (2000) applies the same "trick of the trade" to his trade data. It is true. however, that trade statistics display a superior degree of standardization than FDI data, so that this operation has a smaller impact than in the present case.

[32]Year fixed effects are also likely to incorporate at least part of the "euro effect" thus leading to potential underestimation of the CU parameter.

[33]The only difference lies in the fact the volatility measures are obtained using quarterly data.

[34]Bilateral exchange rates with the dollar for EMU member are obtained from the product of the $/€ exchange rate and the irreversibly pegged conversion rate of member countries' currency with the € (published at www.ecb.int).

[35]A robustness check performed using US GDP deflator instead of national deflators shows that this choice plays no relevant role in the empirical findings. These results are not presented but are available upon request.

[36]This short time-span may severely limit the ability of the paper to address the longer-term impact of currency unions on FDI flows; nonetheless the number of occurrences in which $CU_{ijt} = 1$ represents a share of the sample ranging between 2.5% and 4%, in line with the 1% presented by Rose (2000).

t between country i and country j[37], the following transformation has been applied:

$$flow_{ijt} := \begin{cases} 0 & \text{if } investment_{ijt} \leq 0 \\ investment_{ijt} & \text{if } investment_{ijt} > 0 \end{cases};$$
$$FDI_{ijt} := 1 + flow_{ijt}.$$

The variable used in the regression analysis is then $\ln FDI_{ijt}$, which displays a left censoring limit at zero.

5 Predictions

The first and foremost expectation from empirical analysis is a positive and robust coefficient for CU_{ijt} in equation (6), suggesting that currency unions do have a positive impact on FDI's. In equation (7) the exchange rate volatility indexes should have a negative sign, suggesting that an increase in exchange rate uncertainty hinders cross-border investment flows. If the CU_{ijt} coefficient is still positive and significant then one could conclude that, as in the case of trade, a currency union not only eliminates exchange rate fluctuations, but also eliminates some of the informational barriers that play an important role in shaping international investment decisions[38]. Equation (8) provides yet another test of this *deep integration* hypothesis by means of the inclusion of the $EMU1_{ijt}$ indicator. A positive marginal effect on this variable confirms the idea that once the single currency is in place, non-European multinational corporations may find investing in the euro area more favorable than before because the single currency provides more direct access to the wider market represented by the aggregation of national markets of all participating countries. Additionally, it is possible to incorporate one of the predictions emerging from the model presented by Mody et al. (2003). There they postulate a negative link between host country transparency and international investment decisions on the ground that transparency renders the informational advantage of direct ownership less pronounced. Hence, agents should substitute away from direct ownership into trade relations. If currency unions contribute to increase transparency, then the model developed in Mody et al. (2003) predicts that they will have a negative impact on FDI's relative to trade: hence in equation (9) γ should be negative. Table 1 summarizes the predictions on the key coefficients contained in each of the four estimating equations.

6 Empirical Results

The number of nonmissing country-pair observations in which countries are joined by the use of the same currency is 133. This implies that currency union members represents about the 2.8% of nonmissing observations, compared to the 1% quoted by Rose (2000) for his dataset. A note of warning —worth making explicit— is that the formulation chosen for the gravity equation is in no way exhaustive. The paper is not trying to explain FDI flows just as a function of GDP's, populations, some time-invariant fixed effects and a dummy variable for common currencies. Rather, it is using previous results that have shown how few simple "gravity-type" variables can predict reasonably well cross-border investment decisions, to explore the effect of an additional regressor (the currency union dummy). Thus the attention is focused on the significance of this latter variable rather than on the overall explanatory power of the model, which is by construction quite rough.

Table 2 presents a plain-vanilla OLS model with year dummies and country-pair fixed effects. Following Micco et al. (2003), the analysis is performed using both nominal and real controls

[37] This variable is the result of the averaging procedure described above.

[38] See Portes and Rey (1999, 2002), Portes et al. (2001), Loungani et al. (2002), Mody et al. (2003).

in order to limit the potential bias due to exchange rate movements[39]. Given the substantial depreciation undergone by the euro between 1999 and 2001, and the relative importance of EMU members in the dataset, the two estimates should provide one with some sort of "confidence interval". Columns (1) to (3) reports the outcome from the regression of real FDI inflows on nominal GDP figures, while results displayed in columns (4) to (6) are obtained using real GDP. The first point to note, is that the use of nominal versus real controls does not change the qualitative result: both the sign and the magnitude of estimated coefficients remain roughly the same. The currency union dummy, short-term volatility ($CV3_t$) and $EMU1_{ijt}$ display significant coefficients and, above all, the expected sign. $CV10_t$, which measures, misalignments, is not significant, but still shows the expected negative sign. The value of the CU_{ijt} coefficient suggests that currency unions generate an increase in cross-border investment flows of the order of 110-230%. The OLS model implies the loss of all information contained in observations for which FDI are negative (implying a disinvestment); by applying a Tobit model, on the contrary, it is possible to partly exploit this additional information. Attention has to be paid not to confuse estimated coefficients with marginal effects. In these kind of models, in fact, the two are not the same, and they will be reported separately in the paper. Tables 3 and 4 present relevant results for the Tobit specification: again both nominal (Table 3) and real regressors (4) are used. Column (1) reports estimated coefficients for equation 6, in columns (2) and (3) only short-term volatility is taken into account, while the last two columns show results for equations 7 and 8. Countries characteristics are not significant in all specification: in particular, country2 (the source country) population seems not to give a valuable contribution. This suggests that host-country features are more important in that they signal the potential profitability of the investment. More importantly, however, the currency union dummy and the exchange rate volatility index display the expected sign and are significantly different from zero, though misalignments appear to have larger impact. This is consistent with a world of irreversible investments in which long-term variability plays an important role. $EMU1$ is positive and significant, indicating no FDI diversion following the introduction of the euro and corroborating the intuition about deep integration. The inclusion of this additional control sensibly increases both the marginal effects of CU and its t-statistics, while it has a limited effect on $CV3$ and $CV10$. Column (4) rises some concern in that the inclusion of controls for exchange rate volatility not only lowers the marginal effect of the currency union dummy, but also sensibly affect its significance, thus instilling the doubt whether using the same legal tender merely eliminates exchange rate volatility. When $EMU1$ is introduced —as column (5) shows— CU regains both significance and an appreciable marginal effect. Using real GDP yields basically the same results. The currency union dummy in particular displays a fair degree of robustness to this change; marginal effects tell that using the same currency may increase cross border investment flows by 50 to 170Tables 5 6 repeat the exercise employing a different measure of short-term volatility. The KR3 index, based on the rate of change rather than on the level of bilateral exchange rates, is never significant, while the other controls do not suffer any deterioration. The currency union effect is pretty robust to different specifications and always significant at 1% level. This strengthen the impression that what really matters are long term misalignments rather than short lived fluctuations that are more easily edged in financial markets. A further check is performed using only 1990–2001 data, even though the shorter time span poses serious limitations to the time-series approach of the paper. Results are presented in Tables 7 and 8: the main point to note here is the loss of significance of the exchange rate volatility indexes and of the currency union dummy (except when $EMU1$ is also included), though all relevant variables display the expected sign and marginal effects have the same order of magnitude as before. Overall the robustness of the results seems well established[40]. A potential problem plaguing this kind of studies is the

[39] FDI's, on the contrary, are only taken in their real values.

[40] Yet another regression is run limiting the sample to industrial countries only: results —not presented in the paper and available upon request— confirm previous findings.

presence of endogeneity between explanatory and dependent variables. If in fact FDI's concur to generate economic growth[41], then a bias would affect estimation results and the regressors should be replaced by instruments. A straightforward instrument is lagged GDP: despite all the thaumaturgic properties usually attached to FDI's, it is in fact difficult to maintain that they can affect past economic performance. Regression results (not reported) obtained with lagged GDP show no qualitative change in the conclusions of the paper. Endogeneity thus seems neither to play a relevant role, nor to introduce a significant bias.

As anticipated before, the paper allows one to test the implication of the model presented in Mody et al. (2003): in particular, one can test the hypothesis that joining a currency union has an effect comparable to an increase in host country transparency. If this is the case, then, the ratio of FDI's over trade should decrease because agent will substitute away from direct ownership. Estimating equation 9 using a Tobit model yields the results presented in Tables 9 and 10. The currency union dummy is not significant, but when $EMU1$ is introduced; in this case, however, the effect is positive contrary to expectations. The theoretical discussion of the first paragraphs did not take explicitly in consideration the impact of exchange rate volatility on the choice between trade and direct investment. However, the option value paradigm can still offer a plausible explanation. Investing abroad, in fact, can legitimately be considered more "irreversible" than investing at home, and hence uncertainty is more likely to affect international investment flows rather than commercial links, even if one admits the possibility that, in order to export, a firm has to increase its productive capacity and thus to incur in some sunk costs. The proximity-concentration trade-off, the benchmark explanation for the choice between trade and FDI, is consistent with this view: the duplication of activities associated with an FDI makes this form of international transaction more costly than an increase in productive capacity aimed at serving the foreign market. Hence, *ceteris paribus*, lower exchange rate uncertainty makes FDI more competitive than before with respect to trade. Using real rather than nominal GDP makes coefficients more significant, and marginal effects larger.

The main concern with previous results is the presence of only three years in which the currency union dummy equals 1. To alleviate this problem, the present paragraph investigates whether participation in the Exchange Rate Mechanism (ERM) yielded results comparable to those of a currency union. If, in fact, the main mechanism through which a single currency affects international investment flows is the reduction in exchange rate fluctuations, then a good deal of volatility had already been removed by ERM through the introduction of a narrow fluctuation band around a central parity. It is then possible to think about ERM as a "softer" version of EMU that should still have some positive effects on FDI's. The main advantage of using ERM is the amount of data available: created in 1979 to link the currencies of 8 countries, the system lasted until the introduction of the euro in 1999 when it counted 13 members. Tensions on the exchange rate markets lead to a famous crisis in September 1992, but the system was overall successful. A similar mechanism —ERM2— is currently operating for countries that are not yet part of EMU, though at the moment only Denmark has joined. Table 11 reports regression results when a new indicator for ERM participation is included. ERM_{ijt} takes value 1 when country i and country j are both part of the system at time t or when one country belongs to EMU while the other to ERM2. The new dummy presents a slightly positive coefficient that is significant at 5% level when controls are in real terms (columns 3 and 4), slightly below the threshold value otherwise. Since Table 11 basically replicates columns (1) and (4) of Table 3 and Table 4, a comparison with previous results is instructive and interesting. Leaving aside the more traditional "gravity" variables that basically display no change, it is interesting to note how the estimated coefficient of the currency union dummy becomes both larger and more significant, while the exchange rate volatility indexes moves only slightly. Table 11 presents only mild evidence of a small positive effect of ERM on cross-border investments, whereas the introduction

[41] This is a much debated point: most recent empirical evidence, especially studies based on firm level data, seems to reject this causation. See for instance Aitken and Harrison (1999).

of a single currency spurred FDI flows far more. This is consistent with irreversibility playing an important role in investment decisions. While in fact ERM did not shield investors from realignments and discrete jumps in the exchange rates, EMU not only eliminates volatility, but assures permanent stability. By eliminating present and future uncertainty about exchange rate fluctuations a common currency is thus able to mitigate the impact of irreversibility far beyond what a mere pegged rate can do. Estimated marginal effects, in fact, imply that EMU has more than doubled intra-European FDI flows; on the other hand, the significance of the coefficient suggests that eliminating exchange rate volatility is not the only channel through which EMU affects cross-border investments.

The last exercise presented here addresses whether countries that chose to opt-out of EMU (Denmark, UK, Sweden) suffered a significant FDI diversion due to their decision not to adopt the single currency. To do this, the paper re-estimates the relevant equation without the currency union dummy and then analyzes the residuals. Arguably, a negative impact of the decision to opt-out should result in negative residuals or, to say it better, in the distribution of residuals having more mass in the negative area. Figure 7 plots the distributions of estimated residuals for the three aforementioned countries, EMU members and the rest of the world (RoW). The column labeled EMU plots the distribution of estimated residuals relative to all the country pairs for which $CU_t = 1$ in at least once. Den, on the other hand, shows the residuals for all the 24 pairs involving Denmark: the same applies to Swe and UK, while RoW aggregates estimated residuals for all other countries. Residuals are obtained from Tobit estimation of equation 8 using the full sample (1980–2001) and real GDP's. Residuals obtained using nominal GDP's look very similar and are not reported. The figure shows that most of the probability mass is concentrated around zero; the median of the distributions are reported in Table 12. Visual inspection suggests that residuals related to EMU member countries have more probability mass on the positive orthant, consistently with previous results that indicate a positive effect of the CU dummy. Somehow surprisingly, the median for the UK is just slightly smaller. Hence the UK seems not to have suffered any FDI diversion after the introduction of the euro. Figure 2 restricts the above investigation to those years (in the sample) for which EMU was actually implemented (1999, 2000 and 2001). It is now more evident that EMU members display residuals larger that other groups (luckily enough the median for RoW equals zero, thus facilitating comparisons): the UK still displays a positive median as well as Denmark, while Sweden seems the only country for which non-EMU status has had a negative impact on FDI flows. With the help of a simple non-parametric test (the sign-test) it is possible to investigate the hypothesis that the actual median equals zero for all groups. Table 12 reports both a two-sided version of this test (where the null hypothesis H0: median=0 is confronted with a general alternative H1: median¡0) and a one-tailed version that specifically takes into consideration the alternative of a negative median (H0: median=0 Vs H1: median¡0). To better understand Table 12, it is useful to start from the residuals of EMU members: consistently with a positive median (otherwise there would be no CU effect), the null is rejected in a two-tailed test and accepted when the only alternative is a negative value. The values taken by the residuals of pairs involving the UK display a very similar pattern, thus indicating that the decision to opt out of the monetary union has not led to any substantial FDI diversion. The picture is less clear cut for Denmark and Sweden. Here, in fact, while the null is supported in both tests when the whole sample period is considered, the result is reversed when the focus is restricted to 1999–2001. This suggests that residuals of the two countries may in fact have a negative median, i.e. more probability mass concentrated in the negative area. Overall, both visual inspection and the sign test indicate that refusing to join the EMU has had a negative effect on FDI flows for Sweden (and less clearly Denmark), while nothing of this sort has happened in the case of the UK[42].

[42]Given the low power of the test, and the short length of time for which EMU data are available, caution should be put in analyzing these data.

7 Conclusions

The paper has investigated the impact of currency unions on international direct investment flows employing a gravity model with a limited number of explanatory variables, time dummies and country-pair fixed effects. Concentrating on the time-series variation in the data, the analysis bypasses, at least partially, potential endogeneity issues, while time dummies should reduce the noise in the data. Drawing from the option value approach to investment decisions, the paper explains how a reduction in exchange rate uncertainty due to the introduction of a single currency can spur cross-country investment flows. Empirical analysis, conducted using a Tobit model, supports the theoretical prediction but also suggests that elimination of exchange rate volatility is not the only channel through which currency unions work. In fact, when an additional control for ERM participation is introduced, the CU dummy retains a significant positive effect.

Further research is needed in this area aiming at extending the dataset in order to increase the number of observations for which the currency union dummy is equal to 1 and, possibly, at incorporating interest rate volatility into the picture. This is in fact another potential channel through which a common currency can influence investment decisions. The short length of time for which EMU data are available (1999–2001) suggests point estimates should not be taken too seriously. The traditional high variability of FDI flows, in fact, implies that the three years for which the currency union dummy equals 1 may not be very informative, despite time dummies should take care of idiosyncratic shocks. A second limitation of the dataset consists in the inability to distinguish among short- and long-term effects. Arguably, one could conclude that the currency union effects found in the paper are the one-time result of portfolio reallocation by multinationals, so that in the longer-term FDI flows will revert to their pre-shock levels. Nonetheless, the sign and significance of the CU coefficient are quite robust to different specifications and support economic intuition. As a final remark, it is worth noting that the paper takes no stand on the issue of the impact of FDI flows on economic performance. This work in fact is not interested in the potential growth-enhancing effect of currency unions (via FDI's), but is rather part of a broader research agenda that aims at unveiling the potential endogenous mechanisms at work in a currency area.

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Table 1: Expected Sign of Key Coefficients

Equation	LHS Variable	Relevant RHS Variables	Coefficient	Expected Sign
(6)	$\ln FDI_{ijt}$	CU_{ijt}	γ	positive
(7)	$\ln FDI_{ijt}$	CU_{ijt}	γ	positive
		$RERV_t$	δ_1	negative
		MIS_t	δ_2	negative
(8)	$\ln FDI_{ijt}$	CU_{ijt}	γ	positive
		$RERV_t$	δ_1	negative
		MIS_t	δ_2	negative
		$EMU1_{ijt}$	ϕ	positive
(9)	$\ln FDI_{ijt}/Trade_{ijt}$	CU_{ijt}	γ	negative

Table 2: OLS Regression with Country-Pair and Year Fixed Effects

	Nominal GDP			Real GDP		
	(1)	(2)	(3)	(4)	(5)	(6)
GDP country1	0.87	0.77	0.85	0.58	0.56	0.56
	(4.59)**	(3.91)**	(4.27)**	(9.30)**	(8.93)**	(8.93)**
GDP country2	0.82	0.87	0.90	-0.07	-0.04	-0.01
	(3.97)**	(4.19)**	(4.32)**	(0.62)	(0.33)	(0.05)
Population country1	-13.31	-13.64	-13.16	-9.06	-9.41	-9.07
	(15.66)**	(15.93)**	(15.26)**	(9.13)**	(9.38)**	(9.02)**
Population country2	-1.84	-2.21	-1.89	-1.73	-2.12	-1.86
	(1.60)	(1.91)	(1.63)	(1.52)	(1.85)	(1.62)
CU	0.93	0.80	1.19	0.87	0.76	1.10
	(6.16)**	(5.00)**	(6.38)**	(5.82)**	(4.83)**	(5.99)**
CV3[a]		-1.76	-1.70		-2.23	-2.23
		(2.25)*	(2.18)*		(2.91)**	(2.92)**
CV10[b]		-0.96	-0.95		-0.67	-0.69
		(1.20)	(1.19)		(0.85)	(0.87)
EMU1			0.57			0.50
			(4.04)**			(3.56)**
Observations	3594	3528	3528	3594	3528	3528
CU members	110	110	110	110	110	110
Number of groups	280	280	280	280	280	280
R-squared	0.46	0.46	0.47	0.47	0.47	0.47

Absolute value of t statistics in parentheses: * significant a 5%; ** significant at 10%
Year dummies and constant not reported
[a] 3 year coefficient of variation of real exchange rate
[b] 10 year coefficient of variation of real exchange rate

Table 3: Tobit Model with Country-Pair and Year Fixed Effects (1980–2001): Nominal GDP

	(1)		(2)		(3)		(4)		(5)	
	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect
GDP country1	0.98	*0.76*	0.57	*0.43*	0.69	*0.54*	0.46	*0.34*	0.58	*0.45*
	(3.45) **		(1.93)		(2.33)**		(1.56)		(1.97)*	
GDP country2	0.98	*0.76*	0.94	*0.71*	0.97	*0.76*	0.86	*0.64*	0.88	*0.68*
	(3.34) **		(3.19) **		(3.29) **		(2.90) **		(2.99) **	
Population country1	-15.14	*-11.73*	-14.66	*-11.11*	-13.73	*-10.82*	-14.84	*-10.99*	-13.89	*-10.76*
	(11.85)**		(11.46)**		(10.65)**		(11.61)**		(10.78)**	
Population country2	-1.28	*-0.99*	-1.21	*-0.92*	-0.69	*-0.54*	-1.35	*-1*	-0.83	*-0.65*
	(0.78)		(0.74)		(0.42)		(0.83)		(0.51)	
CU	0.65	*0.51*	0.63	*0.48*	1.28	*1.01*	0.41	*0.3*	1.06	*0.82*
	(2.86) **		(2.78) **		(4.85) **		(1.73)		(3.88) **	
CV3[a]			-2.89	*-2.19*	-2.77	*-2.19*	-2.53	*-1.87*	-2.43	*-1.88*
			(2.53)**		(2.43)**		(2.20)*		(2.12)*	
CV10[b]							-3.45	*-2.56*	-3.34	*-2.58*
							(2.96)**		(2.87)**	
EMU1					0.97	*0.77*			0.96	*0.74*
					(4.82) **				(4.73)**	
Observations	4698		4599		4599		4568		4568	
of which censored	683		683		683		682		682	
CU members	133		133		133		133		133	
Log-L	-8677.66		-8550.81		-8539.37		-8492.49		-8481.56	

Absolute value of t statistics in parentheses: * significant a 5%; ** significant at 10%
Year dummies and constant not reported
[a] 3 year coefficient of variation of real exchange rate
[b] 10 year coefficient of variation of real exchange rate

Table 4: Tobit Model with Country-Pair and Year Fixed Effects (1980–2001): Real GDP

	(1)		(2)		(3)		(4)		(5)	
	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect
GDP country1	0.41	*0.3*	0.5	*0.38*	0.5	*0.39*	0.46	*0.34*	0.46	*0.35*
	(4.30) **		(5.26) **		(5.25)**		(4.77) **		(4.78)**	
GDP country2	-0.11	*-0.08*	-0.06	*-0.05*	-0.02	*-0.01*	-0.08	*-0.06*	-0.04	*-0.03*
	(0.76)		(0.44)		(0.13)		(0.57)		(0.26)	
Population country1	-12.99	*-9.59*	-11.24	*-8.56*	-10.51	*-8.26*	-11.64	*-8.71*	-10.88	*-8.43*
	(8.95)**		(7.69)**		(7.16)**		(7.95)**		(7.40)**	
Population country2	-1.61	*-1.19*	-1.39	*-1.05*	-0.9	*-0.7*	-1.52	*-1.13*	-1.02	*-0.79*
	(0.99)		(0.85)		(0.55)		(0.93)		(0.63)	
CU	0.58	*0.43*	0.6	*0.45*	1.2	*0.94*	0.39	*0.3*	1	*0.78*
	(2.55) **		(2.63) **		(4.58) **		(1.68)		(3.71) **	
CV3[a]			-3.22	*-2.45*	-3.2	*-2.51*	-2.81	*-2.1*	-2.8	*-2.17*
			(2.86)**		(2.85)**		(2.47)**		(2.47)**	
CV10[b]							-3.22	*-2.41*	-3.15	*-2.44*
							(2.77)**		(2.72)**	
EMU1					0.92	*0.72*			0.92	*0.71*
					(4.57) **				(4.53)**	
Observations	4698		4599		4599		4568		4568	
of which censored	683		683		683		682		682	
CU members	133		133		133		133		133	
Log-L	-8679.37		-8543.89		-8533.64		-8486.5		-8476.51	

Absolute value of t statistics in parentheses: * significant a 5%; ** significant at 10%
Year dummies and constant not reported
[a] 3 year coefficient of variation of real exchange rate
[b] 10 year coefficient of variation of real exchange rate

Table 5: Tobit Model Using the KR Volatility Index: Nominal GDP

	(1)		(2)		(3)	
	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect
GDP country1	0.69	*0.53*	0.80	*0.64*	0.66	*0.51*
	(2.38)**		(2.76) **		(2.24)*	
GDP country2	0.97	*0.75*	0.99	*0.79*	0.90	*0.70*
	(3.29) **		(3.38) **		(3.03) **	
Population country1	-14.41	*-11.07*	-13.47	*-10.76*	-13.69	*-10.70*
	(11.29)**		(10.48)**		(10.65)**	
Population country2	-1.01	*-0.78*	-0.50	*-0.40*	-0.73	*-0.57*
	(0.62)		(0.31)		(0.45)	
CU	0.71	*0.55*	1.36	*1.09*	1.1	*0.86*
	(3.14) **		(5.19) **		(4.06) **	
KR3[a]	0.22	*0.17*	0.11	*0.08*	-0.86	*-0.67*
	(0.31)		(0.15)		(0.71)	
CV10[b]					-3.52	*-2.75*
					(3.04)**	
EMU1			0.98	*0.78*	0.97	*0.76*
			(4.87)**		(4.78) **	
Observations	4599		4599		4568	
of which censored	683		683		682	
CU members	133		133		133	
Log-L	-8553.92		-8542.28		-8483.51	

Absolute value of t statistics in parentheses: * significant a 5%; ** significant at 10%
Year dummies and constant not reported
[a] Volatility measured proposed in Kenen and Rodrick (1986); see page 9 above for an exact definition
[b] 10 year coefficient of variation of real exchange rate

Table 6: Tobit Model Using the KR Volatility Index: Real GDP

	(1)		(2)		(3)	
	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect
GDP country1	0.51	*0.39*	0.50	*0.40*	0.46	*0.36*
	(5.30) **		(5.30)**		(4.81) **	
GDP country2	-0.09	*-0.07*	-0.04	*-0.03*	-0.05	*-0.04*
	(0.59)		(0.27)		(0.34)	
Population country1	-11.02	*-8.45*	-10.28	*-8.13*	-10.7	*-8.33*
	(7.53)**		(7.00)**		(7.28)**	
Population country2	-1.2	*-0.92*	-0.72	*-0.57*	-0.94	*-0.73*
	(0.74)		(0.44)		(0.58)	
CU	0.67	*0.52*	1.27	*1.01*	1.04	*0.81*
	(2.99)**		(4.90) **		(3.86) **	
KR3	-0.04	*-0.03*	-0.17	*-0.13*	-1.29	*-1.00*
	(0.05)		(0.23)		(1.05)	
CV10					-3.38	*-2.63*
					(2.92)**	
EMU1			0.92	*0.73*	0.92	*0.72*
			(4.58)**		(4.55)**	
Observations	4599		4599		4568	
of which censored	683		683		682	
CU members	133		133		133	
Log-L	-8547.92		-8537.62		-8478.95	

Absolute value of t statistics in parentheses: * significant a 5%; ** significant at 10%

Year dummies and constant not reported

[a] Volatility measured proposed in Kenen and Rodrick (1986); see page 9 above for an exact definition

[b] 10 year coefficient of variation of real exchange rate

Table 7: Tobit Model with Country-Pair and Year Fixed Effects (1990–2001): Nominal GDP

	(1)		(2)		(3)		(4)		(5)	
	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect
GDP country1	1.35	*1.08*	0.41	*0.34*	0.66	*0.56*	0.39	*0.32*	0.63	*0.53*
	(3.14)**		(0.86)		(1.37)		(0.82)		(1.31)	
GDP country2	1.09	*0.88*	0.99	*0.83*	1.05	*0.89*	0.91	*0.74*	0.96	*0.81*
	(2.44)**		(2.15)*		(2.29)*		(1.96)*		(2.09)*	
Population country1	-15.67	*-12.55*	-9.13	*-7.62*	-7.76	*-6.64*	-10.97	*-8.96*	-9.38	*-7.89*
	(5.15)**		(2.78)**		(2.36)**		(3.27)**		(2.78)**	
Population country2	-10.70	*-8.56*	-9.84	*-8.22*	-8.89	*-7.61*	-10.54	*-8.61*	-9.49	*-7.98*
	(3.18)**		(2.85)**		(2.58)**		(3.03)**		(2.73)**	
CU	0.38	*0.30*	0.40	*0.34*	1.04	*0.89*	0.22	*0.18*	0.87	*0.73*
	(1.46)		(1.56)		(3.49)**		(0.79)		(2.74)**	
CV3[a]			-1.22	*-1.02*	-1.18	*-1.01*	-0.75	*-0.62*	-0.79	*-0.66*
			(0.71)		(0.69)		(0.44)		(0.46)	
CV10[b]							-2.44	*-2.00*	-2.11	*-1.78*
							(1.52)		(1.32)	
EMU1					0.96	*0.82*			0.94	*0.79*
					(4.23)**				(4.11)**	
Observations	3132		3042		3042		3011		3011	
of which censored	495		495		495		494		494	
CU members	133		133		133		133		133	
Log-L	-5810.92		-5699.69		-5690.91		-5643.57		-5635.36	

Absolute value of t statistics in parentheses: * significant a 5%; ** significant at 10%
Year dummies and constant not reported
[a] 3 year coefficient of variation of real exchange rate
[b] 10 year coefficient of variation of real exchange rate

Table 8: Tobit Model with Country-Pair and Year Fixed Effects (1990–2001): Real GDP

	(1)		(2)		(3)		(4)		(5)	
	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect
GDP country1	0.17	*0.13*	0.45	*0.38*	0.36	*0.31*	0.51	*0.42*	0.41	*0.35*
	(0.54)		(1.46)		(1.16)		(1.62)		(1.31)	
GDP country2	-0.4	*-0.32*	-0.39	*-0.33*	-0.25	*-0.21*	-0.32	*-0.26*	-0.18	*-0.16*
	(1.12)		(1.09)		(0.68)		(0.87)		(0.5)	
Population country1	-15.09	*-12.04*	-9.11	*-7.68*	-7.44	*-6.38*	-11.25	*-9.25*	-9.39	*-7.9*
	(4.92)**		(2.84)**		(2.30)**		(3.40)**		(2.82)**	
Population country2	-7.67	*-6.12*	-6.59	*-5.55*	-6.01	*-5.16*	-7.79	*-6.4*	-7.1	*-5.97*
	(2.25)*		(1.90)		(1.74)		(2.21)*		(2.02)*	
CU	0.23	*0.18*	0.31	*0.26*	0.88	*0.76*	0.10	*0.08*	0.68	*0.57*
	(0.90)		(1.20)		(2.97) **		(0.36)		(2.16) *	
CV3[a]			-1.57	*-1.32*	-1.73	*-1.49*	-0.96	*-0.79*	-1.18	*-1*
			(0.94)		(1.04)		(0.56)		(0.70)	
CV10[b]							-2.92	*-2.4*	-2.69	*-2.26*
							(1.79)		(1.65)	
EMU1					0.87	*0.75*			0.86	*0.72*
					(3.84) **				(3.74)**	
Observations	3132		3042		3042		3011		3011	
of which censored	495		495		495		494		494	
CU members	133		133		133		133		133	
Log-L	-5817.62		-5700.56		-5693.31		-5643.97		-5637.17	

Absolute value of t statistics in parentheses: * significant a 5%; ** significant at 10%
Year dummies and constant not reported
[a] 3 year coefficient of variation of real exchange rate
[b] 10 year coefficient of variation of real exchange rate

Table 9: FDI/Trade: Tobit Model with Country-Pair and Year Fixed Effects: Nominal GDP

	(1)		(2)		(3)	
	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect
GDP country1	0.25	*0.09*	0.22	*0.06*	0.24	*0.08*
	(4.98)**		(4.18)**		(4.63)**	
GDP country2	0.05	*0.02*	0.03	*0.01*	0.03	*0.01*
	(0.96)		(0.49)		(0.58)	
Population country1	-3.65	*-1.31*	-3.75	*-1.08*	-3.58	*-1.17*
	(16.28)**		(16.71)**		(15.78)**	
Population country2	0.34	*0.12*	0.25	*0.07*	0.35	*0.12*
	(1.19)		(0.88)		(1.23)	
CU	0.07	*0.03*	-0.01	*0.00*	0.12	*0.04*
	(1.76)		(0.13)		(2.46)**	
CV3[a]			-0.32	*-0.09*	-0.30	*-0.10*
			(1.56)		(1.47)	
CV10[b]			-0.96	*-0.28*	-0.94	*-0.31*
			(4.65)**		(4.58)**	
EMU1					0.18	*0.06*
					(5.10)**	
Observations	4640		4568		4639	
of which censored	683		682		682	
CU members	133		133		133	
Log-L	-1986.76		-1961.33		-1950.14	

Absolute value of t statistics in parentheses: * significant a 5%; ** significant at 10%
Year dummies and constant not reported
[a] 3 year coefficient of variation of real exchange rate
[b] 10 year coefficient of variation of real exchange rate

Table 10: FDI/Trade: Tobit Model with Country-Pair and Year Fixed Effects: Real GDP

	(1)		(2)		(3)	
	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect
GDP country1	0.34	*0.21*	0.33	*0.20*	0.33	*0.21*
	(21.57)**		(21.02)**		(21.07)**	
GDP country2	0.02	*0.01*	0.02	*0.01*	0.03	*0.02*
	(0.78)		(0.89)		(1.23)	
Population country1	-1.10	*-0.69*	-1.22	*-0.74*	-1.09	*-0.69*
	(4.54)**		(5.02)**		(4.45)**	
Population country2	0.51	*0.32*	0.43	*0.26*	0.52	*0.33*
	(1.86)		(1.57)		(1.92)	
CU	0.06	*0.04*	0.01	*0.01*	0.12	*0.08*
	(1.56)		(0.28)		(2.71)**	
CV3[a]			-0.45	*-0.27*	-0.46	*-0.29*
			(2.39)**		(2.40)**	
CV10[b]			-0.54	*-0.33*	-0.53	*-0.34*
			(2.78)**		(2.73)**	
EMU1					0.17	*0.11*
					(4.97)**	
Observations	4640		4639		4639	
of which censored	683		682		682	
CU members	133		133		133	
Log-L	-1812.07		-1794.05		-1784.06	

Absolute value of t statistics in parentheses: * significant a 5%; ** significant at 10%
Year dummies and constant not reported
[a] 3 year coefficient of variation of real exchange rate
[b] 10 year coefficient of variation of real exchange rate

Table 11: Tobit Model with ERM dummy (1980–2001)

	Nominal GDP				Real GDP			
	(1)		(2)		(3)		(4)	
	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect	Estimated Coefficient	Marginal Effect
GDP country1	0.96	*0.75*	0.44	*0.33*	0.41	*0.30*	0.45	*0.35*
	(3.40)**		(1.51)		(4.27)**		(4.73)**	
GDP country2	0.93	*0.73*	0.80	*0.60*	-0.11	*-0.08*	-0.08	*-0.06*
	(3.15)**		(2.69)**		(0.73)		(0.55)	
Population country1	-15.01	*-11.74*	-14.66	*-11.02*	-12.83	*-9.64*	-11.45	*-8.74*
	(11.72)**		(11.45)**		(8.83)**		(7.80)**	
Population country2	-0.95	*-0.74*	-0.98	*-0.74*	-1.19	*-0.90*	-1.07	*-0.81*
	(0.58)		(0.60)		(0.73)		(0.65)	
CU	0.85	*0.66*	0.62	*0.46*	0.81	*0.61*	0.63	*0.48*
	(3.34)**		(2.37)**		(3.21)**		(2.43)**	
ERM	0.33	*0.25*	0.35	*0.26*	0.39	*0.29*	0.39	*0.30*
	(1.74)		(1.89)		(2.08)*		(2.14)*	
CV3[a]			-2.35	*-1.77*			-2.60	*-1.98*
			(2.04)*				(2.28)*	
CV10[b]			-3.58	*-2.69*			-3.35	*-2.55*
			(3.07)**				(2.88)**	
Observations	4698		4568		4698		4568	
of which censored	683		682		683		682	
CU members	133		133		133		133	
Log-L	-8676.15		-8490.73		-8677.20		-8484.24	

Absolute value of t statistics in parentheses: * significant a 5%; ** significant at 10%
Year dummies and constant not reported
[a] 3 year coefficient of variation of real exchange rate
[b] 10 year coefficient of variation of real exchange rate

Table 12: Median of Estimated Residuals from Tobit Regression without the CU dummy

		RoW	EMU	Denmark	Sweden	UK
All Years	Median	*0.12*	*0.89*	*-0.04*	*0.11*	*0.87*
	Two-Sided Sign test[a]	0.08	0	0.42	0.73	0
	One-Sided Sign Test[b]	0.96	1	0.96	0.67	1
Years: 1999-2001	Median	*0*	*1.81*	*0.69*	*-0.45*	*1.02*
	Two-Sided Sign test[a]	0.57	0.01	0.12	0.4	0.4
	One-Sided Sign Test[b]	0.28	1	0.21	0.2	0.86

Residuals obtained from Tobit estimation of equation (8)
The table reports the probabilities of H_0
[a] H_0: median$=0$ vs H_1: median$\neq 0$
[b] H_0: median$=0$ vs H_1: median<0

Figure 1: Distribution of Estimated Residuals: years 1980–2001

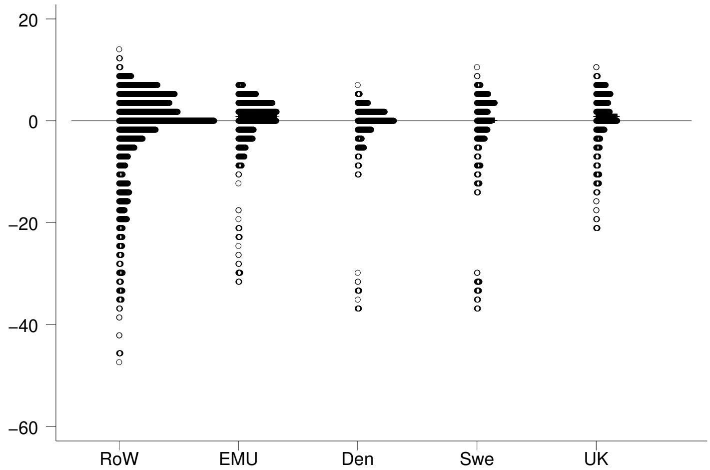
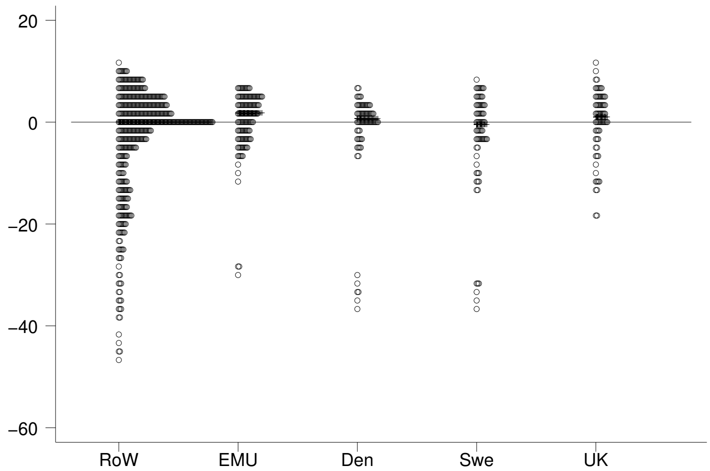


Figure 2: Distribution of Estimated Residuals: years 1999–2001



Residuals from Tobit estimation of equation (8) without the CU dummy.