The currency union effect on trade and the FDI channel

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Abstract

The positive effect of a common currency on trade is empirically well-documented, but the reason of this effect remains unclear. In this paper, we argue that part of the currency union effect on trade is indirect. Currency unions foster foreign direct investment (FDI), which promotes trade due to complementary effects between trade and FDI. Using data for 22 OECD countries, we find that half of the euro impact on trade is driven by additional FDI.

Keywords : Currency Union, Trade, FDI
JEL classification : F15, F21, F33

Résumé

L'effet positif de la monnaie commune sur le commerce est bien établi, mais les causes de cet effet sont peu connues. Dans cet article, nous proposons une explication originale : l'union monétaire renforce les investissements directs étrangers (IDE) qui, en raison d'effets de complémentarité, créent du commerce. En utilisant des données sur 22 pays de l'OCDE, nous montrons que l'accroissement des IDE explique environ la moitié de l'effet de l'euro sur le commerce.

Mots clés : Union monétaire, Commerce, IDE
Classification JEL : F15, F21, F33

1 Introduction

In 2000, Andrew Rose published a stimulating paper estimating the effect of currency unions on international trade. Members of a currency union trade three times more than similar countries with separate currencies, other things being equal (Rose, 2000). This surprising large positive effect raises harsh debates and criticisms. Subsequent papers confirm this positive impact but generally report lower estimates. Using meta-analysis to combine 754 disparate point estimates of common currency trade effects, Rose (2004) finds that "a currency union increases bilateral trade by between 30% and 90%".

The effect of a common currency on trade is now well established, but as acknowledged by Anderson and van Wincoop (2004), "it remains unclear exactly why a currency union raises trade levels so much". Some potential explanations emphasize direct effects of adopting a common currency, such as the reduction of exchange rate transaction costs and volatility. However, they are not totally convincing and rarely investigated. Moreover, they only hold to explain additional intra-currency union trade flows, whereas empirical evidence suggests that a monetary union also boosts trade between member and non-member countries (Rose, 2000; Micco et al., 2003). In this paper, we argue that part of the effect of monetary unions on trade is indirect, coming from additional foreign direct investments (FDI). This argument raises several issues concerning the interrelations between (i) FDI and currency unions and (ii) FDI and trade.

(i) Recent empirical studies find a positive relationship between monetary integration and FDI (Wei and Choi, 2002; De Sousa and Lochard, 2004). First, a currency board or a complete dollarization entails a large effect on FDI (Wei and Choi, 2002). But this result is subject to several biases as it rests on a limited number of peculiar experiences (Hong Kong, Argentina and Panama). Second, the adoption of the euro by 11 European countries in 1999 seems to have significantly increased FDI inside the euro zone (De Sousa and Lochard, 2004).

(ii) Trade and FDI are strongly related. Even if this relation depends mainly on the motive of FDI (see below), literature generally documents a relationship of complementarity (a.o. Lipsey and Weiss 1981, 1984; Svensson, 1996; Clausing, 2000).

As a result, a monetary union may induce additional foreign investments, which could in turn generate more trade.

Focusing on the recent Economic and monetary union (EMU), we assess whether some trade effects related to the creation of the euro occur through an increase in FDI. Our basic framework is a gravity equation, which is the traditional empirical tool to explain trade flows. We find that approximately half of the EMU effect

on trade is indirect, coming from an increase in FDI following the creation of the single currency.

The remainder of the paper is organized as follows. In the next section, we set out more deeply the interrelations between FDI, trade and monetary integration. Then, in section 3, we describe the empirical methodology and data. In section 4, we present our main results. Some sensitivity tests are provided in section 5, and in the final section, we draw some conclusions.

2 The currency union effect on trade: the FDI channel

As stated above, the effect of a common currency on trade is empirically well-documented, but there is still very little literature trying to explain this effect. Some potential explanations are put forward, but rarely fully investigated.

The first classical argument lies in the reduction of exchange rate transaction costs following the creation of a single currency, such as currency conversion costs and in-house costs of maintaining separate foreign currency expertise[1]. However, the range of savings varies widely across countries. Small countries without traded currencies face a higher exchange rate barrier. Besides, the reduction of exchange rate transaction costs holds only to explain additional intra-currency union trade flows and not additional trade between member and non-member countries.

A second argument is that a monetary union removes exchange rate volatility between member countries and should incite member's firms to trade. However, empirical and theoretical literature does not point a clear-cut relationship between exchange rate volatility and trade flows. A recent in-depth IMF study on the topic finds a negative relationship between exchange rate volatility and trade, but this result is "fairly small and is by no means a robust, universal finding" (IMF, 2004). Besides, in many cases, forward exchange markets allow hedging against currency risk, even if hedging may be quite expensive and inaccessible for some firms. In those respects, the benefits of a common currency are not so obvious.

Finally, the effect of currency unions on trade may be indirect. A currency union may affect trade through business cycle synchronisation and current account constraints (Flandreau and Maurel, 2001).

[1] Transaction cost savings following the adoption of the Euro were estimated between 0.4 percent (Emerson et al. 1992) and 1 percent of the GDP of the first 12 members of the European Community (Gros and Thygesen, 1998).

In this paper, we investigate another indirect channel. We argue that a currency union tends to raise FDI and that additional FDI create trade. Both assumptions need discussion.

We first motivate the link between trade and FDI. This relationship can be theoretically negative (substitution) or positive (complementarity). Empirical studies generally document a relationship of complementarity between FDI and trade (a.o. Lipsey and Weiss 1981, 1984; Svensson, 1996; Clausing, 2000). However, some recent studies, using disaggregated data, qualify this relationship in discerning between horizontal and vertical FDI. Horizontal FDI refers to the duplication of the same stage of the production process in a foreign country. In this case, horizontal FDI is a substitute for exports in order to serve the foreign market. Vertical FDI refers to the breaking of the value-added chain, leading to a geographical fragmentation of the production process (Blomström and Kokko, 1997). In this case, vertical investments complement trade. Empirically, such a distinction between different motives of FDI leads to confirm theoretical predictions: complementary effects occur when firms are vertically integrated and substitution effects occur when foreign affiliates serve local markets (Head and Ries, 2001; Blonigen, 2001). However, even in the case of horizontal FDI, trade can be expanded if foreign affiliates require imported inputs from the home country. Hence, complementarity can also emerge because of trade in intermediate goods (Head and Ries, 2001).

We now turn to the link between currency unions and FDI. Whereas theoretical literature on the impact of monetary integration on FDI is rather scarce, empirical evidence points to a positive relationship (Wei and Choi, 2002; De Sousa and Lochard, 2004). Wei and Choi (2002) find that a currency board or a complete dollarization has a large effect on FDI. Belonging to the "dollar bloc", *via* the adoption of a currency board (Hong Kong, Argentine) or the US dollar as the official currency (Panama) tends to increase FDI from the United States as much as 185%. Moreover, De Sousa and Lochard (2004) show that the creation of the euro in 1999 generates increasing FDI inside the euro zone and between EMU members and other OECD countries.

Indeed, monetary integration may affect FDI through different channels. First, it reduces uncertainty related to price variables and changes in policies and rules. Uncertainty about future returns may deter partially irreversible investments as there is an 'option value' of waiting (Dixit and Pyndick, 1994). The greater the economic and political uncertainty, the more likely the firm will wait before entering the market. Second, monetary integration removes exchange rate volatility. This removal increases the certainty-equivalence value of expected profits of risk averse firms and fosters FDI[2] . Moreover, a decrease of exchange rate volatility may favor

[2]The possibility of hedging against currency risk is reduced for FDI since hedging over

vertical FDI as a complement to trade. However, it may also decrease horizontal foreign investments and increase trade as a substitute (Bénassy-Quéré et al., 1999).

Finally, a single currency could foster FDI by easing comparison of international costs and price decisions and by reducing transaction costs.

3 Methodology and data

In this section, we present the empirical model, describe our sample and discuss the estimation techniques.

3.1 The model

The gravity model is a well-known empirical tool which basically relates the volume of trade between two countries to their economic size and bilateral distance. We extend this model with a set of additional variables. First, we introduce a dummy variable (EMU) measuring the impact of the single currency on trade. Then, we include two control variables (EU and FTA) to isolate this impact from the effect of various economic integration processes. Finally, we control for the volatility of exchange rate to capture the single currency effect beyond the stabilization of exchange rates.

Thus, our model is:

$$\begin{aligned} \ln(Trade_{ijt}) &= \alpha + \beta_1 \ln(Y_{it}Y_{jt}) + \beta_2 \ln(Distance)_{ij} + \beta_3(FTA)_{ijt} \\ &+ \beta_4(EU)_{ijt} + \beta_5(Volatility)_{ijt} + \gamma(EMU)_{ijt} \\ &+ \nu \ln(FDI)_{ijt} + \phi_i + \phi_j + \lambda_t + \epsilon_{ijt} \end{aligned} \tag{1}$$

where $Trade_{ijt}$ is the value of bilateral trade between i and j at time t[3]. Y_{it} is the GDP of country i. $Distance_{ij}$ is the bilateral distance between i and j, computed as the great circle distance between the major cities of the two countries. FTA_{ijt} is a dummy variable which is one if the two countries belong to the same Free Trade Agreement[4], excluding EU, which is estimated using a specific dummy variable EU_{ijt} that is one if i and j belong to the European Union at time t.

long horizons is problematic.

[3]Bilateral trade is computed as the average of imports and exports as reported by each country.

[4]Given our sample, this dummy accounts for membership in the European Free Trade Association (EFTA) and the North American Free Trade Area (NAFTA) (see appendix 1).

$Volatility_{ijt}$ is the volatility of nominal bilateral exchange rates (see appendix 1). Finally, EMU_{ijt} is a dummy variable which is one if the two countries belong to the Economic and monetary union at time t[5].

In this paper, we intend to estimate the impact of monetary integration on trade, controlling for the FDI channel. Our intuition is that a common currency encourages FDI which, in turn, induces larger trade flows between member countries. Hence, we introduce a FDI variable, FDI_{ijt}, measuring the value of bilateral FDI outward stocks between i and j at time t.

Providing theoretical foundations for the gravity model, Anderson and van Wincoop (2003) advocate for the introduction of "multilateral resistance" variables. These additional factors should account for the fact that "the more resistant to trade with all others a region is, the more it is pushed to trade with a given bilateral partner" [Anderson and van Wincoop, 2003: 3]. A solution to control for these unobserved terms is to introduce country specific dummies (ϕ_i and ϕ_j) in the estimated equation. Our model also includes a vector of time dummies (λ_t).

3.2 Data

We estimate equation (1) on a sample of 22 OECD countries: 14 European countries (Austria, Belgium-Luxembourg, Germany, Denmark, Spain, Finland, France, Great-Britain, Greece, Ireland, Italy, the Netherlands, Portugal, Sweden) and 8 non-European countries (Australia, Canada, Iceland, Japan, Korea, Norway, Switzerland, the United States) on the time period 1982-2002[6]. Bilateral trade data come from OECD. Our FDI outward stocks data are taken from *International Direct Investment Statistics Yearbook 2003* (OECD). GDP data come from the World Bank (*World Development Indicators*, 2003). Other data come from various sources (see appendix 1).

3.3 Estimation techniques

We first pool the data and estimate equation (1) using the ordinary least squares (OLS) estimator. However, we potentially face a simultaneity problem, leading to the inconsistency of the OLS estimator. As being argued, trade and FDI are strongly related and we do not know whether trade causes FDI or FDI causes trade.

[5]Since its creation in 1999, EMU comprises Germany, Austria, Belgium, Spain, Finland, France, Ireland, Italy, Luxembourg, the Netherlands, Portugal. Greece joined the euro zone more recently, in 2001.

[6]This represents a potential of 9,702 observations [=(22 countries * 21 partners * 21 years)] observations. However, many FDI observations are missing (see appendix 2).

To overcome this problem, there are broadly two methods. The simplest one is to use the lagged value of FDI instead of its present value. But as recognized by Frankel (1997), this method is not satisfactory, since "precedence does not ensure causality" (p. 132). In fact, firms can engage in international investments because they rationally anticipate further trade. The second method consists in using an instrumental variable (IV) or two-stage least squares (2SLS) method of estimation. This method seems relevant for our purpose, since the idea of the 2SLS approach is to replace $\ln(FDI)_{ijt}$ by a linear combination of exogenous variables, including EMU_{ijt}, and use it as an explanatory variable of $\ln(Trade_{ijt})$.

In the next section, we first present our econometric results using the traditional OLS estimator on pooled data, and then the IV estimates in order to account for the potential endogeneity of the FDI variable.

4 Results

4.1 Least-squares results

We run two regressions. First, we estimate a benchmark model to measure the "gross" impact of monetary union on trade, as it is done in the literature (Rose, 2000; Micco *et al*, 2003), by dropping the FDI variable. Then, in a second step, we estimate equation (1) to account for the "FDI channel".

Our first results using the OLS estimator are given in table 1. In the benchmark model (column 1), all coefficients are significant ($p<0.01$) and have the expected sign. Country size, membership in a FTA or in EU are found to favor trade, while distance (a proxy for transaction costs) and exchange rate volatility are found to be detrimental to trade. Belonging to the euro zone seems to influence positively trade. The estimated EMU coefficient indicates that two euro zone members trade 27% $[= exp\ (0.24) - 1]$ more with each other than a similar pair of countries with separate currencies, other things being equal.

In column (2), we restrict our sample to observations for which FDI data are available. The estimation is based on a much smaller sample[7]. In this way, we ease the comparison of the coefficients with the estimation including the FDI variable. It is worth noting that results in columns (1) and (2) differ slightly. The coefficient on the EMU variable now indicates that countries belonging to the euro zone trade 21% $[= exp\ (0.19) - 1]$ more than otherwise (column 2).

[7] Our sample contains 9,701 observations, but only 5,264 observations for FDI. See appendix 2 for further details on missing FDI data.

Table 1: Trade, FDI and monetary union: OLS estimates

	Dependent variable: $\ln(Trade_{ij})$		
	'Benchmark' Model	Sample Restricted	With FDI
Ln GDP	0.70^a	0.52^a	0.42^a
	(0.03)	(0.05)	(0.05)
Ln Distance	-0.93^a	-0.87^a	-0.77^a
	(0.01)	(0.01)	(0.01)
FTA	0.39^a	0.37^a	0.32^a
	(0.03)	(0.05)	(0.05)
EU	0.12^a	0.18^a	0.18^a
	(0.02)	(0.03)	(0.02)
Exchange rate volatility	-0.02^b	-0.07^a	-0.05^a
	(0.01)	(0.01)	(0.01)
EMU	0.24^a	0.19^a	0.10^a
	(0.03)	(0.04)	(0.03)
Ln FDI outstock			0.14^a
			(0.01)
Adj. R-sq	0.93	0.93	0.94
# of observations	9249	5055	5055
Country dummies	yes	yes	yes
Year dummies	yes	yes	yes

Notes: Dependent variable: log of bilateral trade between countries i and j. Heteroscedastic-consistent (White-robust) standard errors in parentheses with ^{a} denoting significance at the 1% level, and ^{b} at the 5% level. The constant, the country and year dummies are not reported. Column (1): 'Benchmark' model; Column (2): 'Benchmark' model with the sample restricted to FDI stock available data; Column (3): 'Benchmark' model with FDI stock. See text for more details.

In column (3), we simply estimate equation (1) with the FDI outstock variable. The FDI coefficient is positive and significant, pointing to a seemingly complementary relationship between foreign investments and trade. The introduction of this additional variable affects all coefficients, but the most important change concerns the EMU coefficient, which is reduced by half compared to column (2)[8]. The FDI variable "captures" much of the single currency effect and the net EMU effect, after introducing the FDI channel, is about 11% $[= exp\ (0.10) - 1]$.

Hence, these first results seem to provide some evidence for an indirect effect of monetary integration on trade, going through an increase in foreign investments.

4.2 Endogeneity issue

If the FDI variable is an endogenous regressor, the OLS estimator may be inconsistent and our main result may not hold. Hence, to account for this potential bias, we perform new estimations using the IV estimator. The current problem and most difficult task is to find appropriate instruments, correlated with the endogenous variable but strictly exogenous, i.e. non correlated with the error term.

We suggest to use country characteristics as excluded instruments for the FDI variable. More precisely, we employ as instruments a measure of labour tax wedge in the investor country [*tax wedge (investor)*] and in the partner country [*tax wedge (host)*], the level of employment protection in the partner country [*legislation (host)*] and the union density in the investor country [*union density (investor)*][9]. These variables are likely to be highly correlated with FDI[10]. Indeed, as indicated by the first stage regression they are significant determinants of bilateral FDI outstocks (see table 7 in appendix 3). Furthermore, the tax wedge and legislation on employment protection are generally driven by policy objectives and unrelated to bilateral trade flows.

In table 2 we estimate equation (1) using the IV method and three sets of instruments. Firstly, we employ all four instruments (column 2). We compute a Sargan test of overidentifying restrictions and the Chi2 statistic indicates that we

[8]Note that our results do not seem to suffer from severe multicollinearity problems, since the standard errors are quite small and do not increase when the FDI variable is added in the estimated equation.

[9]See appendix 1 for a description of these variables and data sources.

[10]Nicoletti *et al.* (2003) emphasize that "the tax wedge on labour income appears to influence FDI in much the same way as anti-competitive regulation" (p. 55). Moreover, employment protection in the host country may dissuade vertical FDI, as it represents potential costs for investors, and union density in the investor country may encourage foreign investment (see De Sousa and Lochard, 2004).

cannot reject the null hypothesis that the excluded instruments are valid instruments, i.e., uncorrelated with the error term. Then, in column (4), we drop the less exogenous instrument [*tax wedge (investor)*] and the Chi2 statistic is now much lower. Finally, in column (6), we keep only two instruments [*tax wedge (host)* and *union density (investor)*][11]. These two instruments appear to be highly correlated with FDI (see table 7 in appendix 3) and the partial F-test of joint significance is about 16, which is reasonable[12]. Note that the hypothesis of endogeneity of the FDI variable is rejected by the Durbin-Wu-Hausman (DWH) test in the first two specifications. However, in the last column, the DWH test confirms the endogeneity of the FDI outstock variable and rejects, at the 5% level of significance, the OLS estimator. As in table 1, to ease comparisons, we reproduce the OLS estimates obtained by dropping the FDI variable on the same sample (columns 1, 3 and 5).

In all cases, the FDI coefficient is significant and larger than in table 1, indicating that trade may induce more FDI. The instrumental variable estimation also confirms our main result: the EMU coefficient is considerably reduced compared to the OLS estimates excluding the FDI variable (columns 1, 3 and 5). It is even not significantly different from zero in columns (4) and (6). This is not surprising since the instrumental variable method tends to increase the variance of the estimator and the correlation between regressors (Wooldridge, 2003: 490, 502). Hence, using the IV estimator, we may face a problem of multicollinearity, inducing larger standard errors.

In the next section, we test the sensitivity of our results to the model specification (section 5.1) and sample modifications (section 5.2), using the OLS estimator with country and time dummies[13]. Finally, to further establish the robustness of our results, we use a fixed effect method of estimation to account for the time-series dimension and reduce the potential endogeneity of the the EMU variable (section 5.3).

[11] The results are broadly the same with other subsets of the two instruments [*legislation (host)* and *union density (investor)* or *legislation (host)* and *tax wedge (host)*] and are available upon request.

[12] Staiger and Stock (1997) show that an F-statistic below 10 means that there is possibly a weak instrument problem.

[13] The results with the IV estimator are broadly the same and are available upon request.

Table 2: Trade, FDI and monetary union: IV estimates

	Dependent variable: $\ln(Trade_{ij})$					
Model	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Ln GDP	0.53^a	0.40^a	0.53^a	0.38^a	0.53^a	0.33^a
	(0.05)	(0.06)	(0.05)	(0.06)	(0.05)	(0.07)
Ln Distance	-0.91^a	-0.79^a	-0.90^a	-0.76^a	-0.90^a	-0.72^a
	(0.02)	(0.03)	(0.01)	(0.04)	(0.01)	(0.04)
FTA	0.27^a	0.26^a	0.28^a	0.27^a	0.34^a	0.26^a
	(0.06)	(0.06)	(0.06)	(0.06)	(0.05)	(0.06)
EU	0.21^a	0.20^a	0.21^a	0.20^a	0.19^a	0.19^a
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Exchange rate volatility	-0.05^a	-0.02^b	-0.05^a	-0.02^c	-0.05^a	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
EMU	0.19^a	0.08^c	0.18^a	0.05	0.19^a	0.02
	(0.04)	(0.04)	(0.04)	(0.05)	(0.04)	(0.05)
Ln FDI outstock		0.17^a		0.21^a		0.26^a
		(0.04)		(0.05)		(0.06)
Adj. R-sq	0.93	0.94	0.93	0.94	0.93	0.93
# of observations	4392	4392	4537	4537	4640	4640
Country dummies	yes	yes	yes	yes	yes	yes
Year dummies	yes	yes	yes	yes	yes	yes
Durbin-Wu-Hausman test		0.30		1.35		4.65^b
Sargan test		3.05		0.23		0.30

Notes: Dependent variable: log of bilateral trade between countries i and j. Heteroscedastic-consistent (White-robust) standard errors in parentheses with ^{a} and ^{c} denoting respectively the significance at the 1% and 10% level. The constant, country and time dummies are not reported. Instrumental variable estimations (columns 2, 4, 6) and OLS estimations of the 'benchmark' model (columns 1, 3, 5). Column (2): FDI instrumented by *tax wedge (investor)*, *tax wedge (host)*, *legislation (host)* and *union density (investor)*; Column (4): FDI instrumented by *tax wedge (host)*, *legislation (host)* and *union density (investor)*; Column (6): FDI is instrumented by *tax wedge (host)* and *union density (investor)*. See text for more details.

5 Sensitivity tests

5.1 Sensitivity tests related to the specification

We first perform some sensitivity tests related to the specification of the model. To control for the possible endogeneity of the GDP term we impose, in the first two columns of table 3, a unitary coefficient for the GDP variable consistently with the theory (see for example Anderson and van Wincoop, 2003). This increases slightly the coefficient on the EMU variable compared to prior estimations. However, it is still reduced when we account for the FDI channel (column 2 vs. column 1).

In column (3) and (4), we replace the FDI outstock variable by an instock variable. Our findings are little changed. Finally, in column (5) and (6), we estimate an "augmented" gravity equation, including two additional dummies to account for the fact that countries with a common border or a common language trade more than otherwise. The coefficients of these two variables appear consistently positive and significant. The EMU and FDI outstock coefficients are close to the OLS estimates of equation 1 (table 1, columns 2 and 3).

5.2 Sensitivity tests related to the sample

We perform other sensitivity tests related to the modification of our sample. As the FDI variable contains many missing values, it seems important to check that our results do not hold only for a particular period, zone or sub-sample.

As regards the time period, we first run an estimation over the period 1990-2002, excluding the 80s from the sample (line A of table 4) and then over the period 1982-2001, dropping the year 2002 for which we have many missing FDI observations (line B).

As regards the robustness to a particular zone, we run our estimation excluding respectively the EU 6 original members (Belgium, France, Germany, the Netherlands, Italy, Luxembourg) (line C), the Nordic countries (Denmark, Finland, Iceland, Norway, Sweden) (line D) and the "Deutsche Mark bloc countries" (line E) (Austria, Belgium, Luxembourg, the Netherlands, Denmark, France).

Finally, we also drop from the original sample countries with a FDI missing data ratio above 0.5 (line F)[14], countries for which GDP per capita is below 15,000 US$ on average on the period 1982-2002[15] (line G) and countries for which GDP

[14] Accordingly, we drop Australia, Belgium-Luxembourg, Denmark, Finland, Greece, Ireland, Iceland, Norway, Portugal, Spain, Sweden and Switzerland. See appendix 2.

[15] This condition amounts to drop 4 countries from the original sample (Greece, Korea, Portugal and Spain).

Table 3: Sensitivity tests related to the specification

	Dependent variable: $\ln(Trade_{ij})$					
Model	Unitary GDP		FDI Instock		Augmented equation	
	(1)	(2)	(3)	(4)	(5)	(6)
Ln GDP	1	1	0.45^a	0.30^a	0.54^a	0.45^a
			(0.05)	(0.02)	(0.04)	(0.04)
Ln Distance	-0.88^a	-0.78^a	-0.92^a	-0.79^a	-0.73^a	-0.66^a
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
FTA	0.36^a	0.31^a	0.22^a	0.12^a	0.28^a	0.25^a
	(0.05)	(0.05)	(0.05)	(0.04)	(0.05)	(0.05)
EU	0.19^a	0.19^a	0.15^a	0.16^a	0.27^a	0.25^a
	(0.03)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)
Exchange rate volatility	-0.06^a	-0.04^a	-0.06^a	-0.05^a	-0.05^a	-0.04^a
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
EMU	0.21^a	0.13^a	0.24^a	0.12^b	0.19^a	0.11^a
	(0.04)	(0.03)	(0.06)	(0.05)	(0.03)	(0.03)
Ln FDI outstock		0.14^a				0.12^a
		(0.01)				(0.01)
Ln FDI instock				0.16^a		
				(0.01)		
Adjacency					0.32^a	0.29^a
					(0.03)	(0.02)
Language					0.46^a	0.35^a
					(0.03)	(0.02)
Adj. R-sq	0.87	0.88	0.93	0.94	0.94	0.95
# of observations	5055	5055	4377	4377	5055	5055
Country dummies	yes	yes	yes	yes	yes	yes
Year dummies	yes	yes	yes	yes	yes	yes

Notes: Dependent variable: log of bilateral trade between countries i and j. Heteroscedastic-consistent (White-robust) standard errors in parentheses with ^{a} and ^{b} denoting respectively the significance at the 1% and 5% level. The constant, country and year dummies are not reported. Columns (1) and (2): Unit elasticity for GDP; Columns (3) and (4): FDI instock instead of FDI outstock. Columns (5) and (6): Augmented gravity equation with adjacency and a common language dummy. See text for more details.

Table 4: Sensitivity tests related to the sample

Group excluded	Model	Estimated coefficients		Statistics	
		EMU	FDI outstock	Adj. R-sq	Obs.
A. 80s	(1)	0.15^{a}		0.93	3882
		(0.04)			
	(2)	0.08^{b}	0.13^{a}	0.94	3882
		(0.03)	(0.01)		
B. 2002	(1)	0.19^{a}		0.93	4951
		(0.04)			
	(2)	0.10^{a}	0.14^{a}	0.94	4951
		(0.03)	(0.01)		
C. Original EU 6 countries	(1)	0.23^{a}		0.93	2977
		(0.06)			
	(2)	0.12^{b}	0.12^{a}	0.93	2977
		(0.06)	(0.01)		
D. Nordic countries	(1)	0.15^{a}		0.93	3427
		(0.04)			
	(2)	0.01	0.16^{a}	0.94	3427
		(0.04)	(0.01)		
E. DM bloc countries	(1)	0.17^{a}		0.93	2439
		(0.06)			
	(2)	0.08	0.10^{a}	0.94	2439
		(0.06)	(0.01)		
F. Countries with missing ratio>0.5	(1)	0.14^{b}		0.93	1422
		(0.07)			
	(2)	0.02	0.18^{a}	0.94	1422
		(0.06)	(0.02)		
G. Less developed countries	(1)	0.21^{a}		0.94	3818
		(0.04)			
	(2)	0.14^{a}	0.16^{a}	0.95	3818
		(0.04)	(0.01)		
H. More developed countries	(1)	0.14^{a}		0.93	1684
		(0.05)			
	(2)	0.02	0.14^{a}	0.94	1684
		(0.05)	(0.01)		

Notes: Dependent variable: log of bilateral trade between i and j. Heteroscedastic-consistent (White-robust) standard errors in parentheses. ^{a} and ^{b} denote resp. the significance at the 1% and 5% level. (1) corresponds to the 'benchmark' model (without the FDI variable) and (2) corresponds to equation (1). Estimations are carried with the OLS estimator including country and year dummies. All other coefficients are not reported (available upon request).

is above 20,000 US$[16] (line H).

Our results appear quite robust to sample modifications. When we introduce the FDI variable in the 'benchmark' model, the EMU coefficient is always considerably reduced and sometimes even less significant. Thus, part of the effect of the monetary union on trade goes through an increase in FDI.

5.3 Sensitivity tests related to the time series evidence

Finally, as our sample follows individuals (here countries) across time, we can exploit the time series properties of the data by using panel data methods of estimation. The fixed effect (FE) model or "within" estimator is a relevant method to capture the heterogeneity of the sample. It controls for any time-constant differences in characteristics (even unobservable) between EMU and non-EMU countries. Moreover, it limits the potential endogeneity bias related to the monetary union variable. Actually, countries may form a monetary union because of close trade relationships rather than the other way around. Time series evidence may deal with this problem since it enables to compare for each pair of countries the evolution of trade before and after the launching of the euro[17]. However, the within estimator may be inefficient, especially when the explanatory variables show a large variation across country pair and only little variation across time periods.

In columns (1) and (2), we estimate equation (1) with and without the FDI variable using the FE model[18]. Compared with the cross-section estimates (table 1), some differences are notable and expected. First, the magnitude of the EMU coefficient is reduced as we only capture the additional trade following the decision to join the currency union. This order of magnitude is certainly closer to the "true" effect of currency unions on trade. Second, the coefficient of the EMU variable does not experience a large drop after the introduction of the FDI variable (column 2 vs. column 1[19]). This result is due to the specificity of the panel data which give "more informative data, more variability [and] less colinearity among variables" (Baltagi, 2001). In that respect, the EMU coefficient in the first estimation (without FDI) already displays the "net" effect of currency unions on trade.

[16] This leads to drop Denmark, Finland, Germany, Iceland, Japan, Norway, Switzerland, Sweden, USA from the original sample.

[17] Technically, the simultaneity problem corresponds to a correlation between the EMU variable and the error term. The within estimator is robust to arbitrary correlation between explanatory variables and the time-invariant part of the error term.

[18] Note that this method of estimation does not allow to estimate the impact of time-constant variables, like the distance.

[19] As above, in column (1) we restrict our sample to observations for which FDI data are available to ease comparisons with column (2).

Table 5: Sensitivity tests related to the time series evidence

	Dependent variable: $\ln(Trade_{ij})$			
Model	Fixed effects		Fixed effects	IV-Fixed effects
	(1)	(2)	(3)	(4)
Ln GDP	0.57^a	0.56^a	0.54^a	0.44^a
	(0.02)	(0.02)	(0.02)	(0.03)
FTA	0.09^a	0.10^a	0.08^a	0.12^a
	(0.02)	(0.02)	(0.02)	(0.03)
EU	0.08^a	0.08^a	0.08^a	0.05^a
	(0.01)	(0.01)	(0.01)	(0.02)
Exchange rate volatility	-0.01^a	-0.01^b	-0.01^b	-0.01^b
	(0.00)	(0.00)	(0.00)	(0.00)
EMU	0.06^a	0.05^a	0.07^a	0.04^b
	(0.01)	(0.01)	(0.02)	(0.02)
Ln FDI outstock		0.02^a		0.13^a
		(0.00)		(0.03)
Within R-sq	0.82	0.83	0.84	0.83
# of observations	5055	5055	4237	4237
Sargan Test				0.73
Country-pair fixed effects	yes	yes	yes	yes
Year dummies	yes	yes	yes	yes

Notes: Dependent variable: log of bilateral trade between countries i and j. Standard errors in parentheses with ^{a} and ^{c} denoting respectively the significance at the 1% and 10% level. The constant, country and year dummies are not reported. Columns (1) and (3): 'Benchmark model'. Column (4): Instrumental variable estimation; FDI instrumented by *reform (investor)* and *tax wedge (investor)*. See text for more details.

To determine the indirect influence of currency unions on trade, through FDI, we therefore implement a two-stage least squares within estimator (hereafter IV-FE). We instrument the FDI variable with an index of regulatory reform in the investor country [*Reform (investor)*] and a variable measuring the tax wedge in the investor country [*tax wedge (investor)*][20].

Before proceeding to the IV-FE estimation (column 4), we reproduce in column (3) the FE estimation of the benchmark model without FDI, on the sample corresponding to column (4). As in table 1, we can now measure the size of the FDI channel by comparing columns (3) and (4). The "gross" impact of EMU on trade is 7.2% [$= exp\,(0.07) - 1$] (column 3) and the "net" impact is reduced to 4.1% [$= exp\,(0.04) - 1$] (column 4).

6 Concluding remarks

In this paper, we intend to explain the effect of monetary integration on trade. Some explanations are put forward in the literature but they are not totally convincing and rarely investigated. We argue instead that part of the currency union effect on trade is indirect, going through a rise in foreign direct investment.

Focusing on the recent EMU experience, we use a gravity model to estimate both the impact of monetary union and FDI on trade. We find that nearly half of the EMU effect on trade is indirect, coming from an increase in FDI. This seems quite robust to sensitivity tests.

Our results provide an explanation of the currency union effect on trade and could clear up the reason of the increase of both intra-EMU trade and trade with non-EMU countries. However, further investigations are needed to understand precisely the latter effect.

[20] The instruments for the IV-FE estimator are different from the preceding ones. Indeed, the cross-section instruments are correlated with the FDI variable "in level", but less in time variation. On the contrary, the index of regulatory reform and the tax wedge in the investor country seem to predict correctly the *evolution* of FDI. The F-test of joint significance is equal to 42 (see appendix 3 for the first stage regression). Moreover, the test of overidentifying restriction (Sargan test) indicates that they are exogenous.

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Appendix 1. Data

FTA	The Free Trade Agreement variable is a dummy which is one if the two countries participate in the same trade association. Given our sample, we account for two FTA: NAFTA (North American Free Trade Agreement) involving the US and Canada; EFTA (European Free Trade Association) involving Iceland, Norway, Switzerland, Portugal (until 1985) and Austria, Finland and Sweden (until 1995).
Volatility	Bilateral exchange rate volatility is measured as the standard error of the first difference in the log of the monthly nominal exchange rate in the five years preceding the current year. Bilateral exchange rate come from *International Financial Statistics* (IMF).
Tax wedge	This variable expresses the employees' and employers' social security contributions and personal income tax net of transfer payments as percentage of gross labour costs. Data come from the OECD *Taxing Wages* (2003).
Union density	The share of workers unionized in the host country is expressed in percentage. Data come from OECD *Labour Force Statistics database*.
Legislation	The employment protection legislation variable is an index constructed for 1990 and 1998 referring to both regulations concerning hiring (e.g. conditions for using fixed or temporary contracts, training requirements) and firing (e.g. redundancy procedures, severance payments). Data come from OECD *Labour Force Statistics database*.
Reform	This summary indicator (from 0 to 100) covers regulations and market conditions in seven energy and service industries: gas, electricity, post, telecommunications (mobile and fixed services), passenger air transport, railways (passenger and freight services) and road freight (see Nicoletti *et al.*, 2001).

Appendix 2. FDI missing values

Table 6: Missing observations for the FDI outstock variable

Year	Missing data ratio		country	Missing data ratio
1982	0.82		Australia	0.63
1983	0.81		Austria	0.29
1984	0.71		Belgium-Luxembourg	0.55
1985	0.69		Canada	0.14
1986	0.62		Denmark	0.72
1987	0.53		Germany	0.09
1988	0.49		Finland	0.54
1989	0.48		France	0.31
1990	0.45		Great Britain	0.29
1991	0.39		Greece	0.82
1992	0.39		Ireland	0.61
1993	0.32		Iceland	0.57
1994	0.25		Italy	0.35
1995	0.32		Japan	0.27
1996	0.27		the Netherlands	0.31
1997	0.25		Norway	0.51
1998	0.16		Portugal	0.69
1999	0.20		South Korea	0.43
2000	0.21		Spain	0.62
2001	0.26		Switzerland	0.57
2002	0.77		Sweden	0.51
			USA	0.02

Notes: Missing data ratio is calculated for each year or for each country as the number of missing observations divided by the total number of observations.

Appendix 3. IV estimator (first-stage)

Table 7: First stage estimations

	Dependent variable: $\ln(FDIoutstock_{ij})$			
	OLS	OLS	OLS	Fixed Effects
Ln GDP	0.71^a	0.82^a	0.78^a	0.87^a
	(0.13)	(0.13)	(0.13)	(0.07)
Ln Distance	-0.74^a	-0.75^a	-0.74^a	
	(0.04)	(0.04)	(0.04)	
FTA	-0.09	-0.10	0.12	-0.37^a
	(0.17)	(0.17)	(0.16)	(0.08)
EU	0.04	0.06	0.06	0.43^a
	(0.07)	(0.07)	(0.07)	(0.05)
EMU	0.58^a	0.57^a	0.63^a	0.19^a
	(0.10)	(0.10)	(0.10)	(0.06)
Exchange rate volatility	-0.13^a	-0.14^a	-0.13^a	0.00
	(0.03)	(0.03)	(0.03)	(0.02)
Tax wedge (host)	-0.03^a	-0.02^a	-0.03^a	
	(0.01)	(0.01)	(0.01)	
Ln Union density (investor)	1.20^a	1.13^a	1.06^a	
	(0.23)	(0.22)	(0.22)	
Ln Legislation (host)	-0.40^b	-0.50^a		
	(0.19)	(0.19)		
Tax wedge (investor)	-0.03^a			-0.02^a
	(0.01)			(0.00)
Ln Reform (investor)				0.78^a
				(0.09)
Adj. R-sq	0.81	0.82	0.81	0.60
# of observations	4495	4731	4834	4345

Notes: Dependent variable: log of FDI outstock. Heteroscedastic-consistent (White-robust) standard errors in parentheses with ^{a} and ^{b} denoting respectively the significance at the 1% and 5% level. OLS estimations include country and year dummies and the Fixed effects regression includes year and country pair dummies. Constant terms are not reported either.