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EC981 MSc Dissertation

“Assessing the impact of the Euro on trade and output: the Gravity Model approach”
- Acknowledgments -
In this paper, I estimate the impact of the European Monetary Union (EMU) on trade and output. I use a panel dataset that includes observations of 15 members of the European Union (EU) in the period from years 1991 to 2002. By using the Gravity Model of international trade, I find a positive and statistically significant relationship between the introduction of the Euro and the volume of trade between the EU members. I also find a positive and significant correspondence between trade and output. On the contrary, no significant influence of the per se introduction of the euro on output is found, indicating that the beneficial effect of the Euro on output arises through the trade channel rather than though the central bank credibility and monetary stability channel.
1. Introduction

The introduction of the Euro is certainly the most important monetary event of the century. January 1\textsuperscript{st} 1999 marked the appearance of the Euro and a group of 12 European states\cite{1} relinquished their national currencies and adopted it.

A common currency is expected to positively affect the economic performance of countries participating in the monetary union. In the literature, several studies on this topic have been conducted. Tenreyro (2001), Alesina and Barro (2002) argue that the introduction of a common currency entails gains in terms of central bank credibility and monetary stability, which will eventually boost output. Levine (1997) provides empirical evidence supporting a positive relationship between financial development and economic growth. The introduction of a common currency plays an important role because by eliminating the exchange rate risk it removes an obstacle to the free flow of financial assets and it consequently speeds up financial market integration. Engel and Rose (2000) argue that a single currency makes the country members’ markets more integrated and it thus allows for a more efficient allocation of resources. The increased market integration is reflected in the increase of trade and investment flows, which, in the end, positively affect output.

This paper draws upon the above ideas and examines if the introduction of the Euro has created a more appropriate environment for trade and hence, via this channel, for growth. To do so, I apply the Gravity Model of International Trade and test whether the Euro has indeed boosted the economic growth in the European Union (EU). In its basic specification,

\footnote{i.e. Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain.}
the Gravity Model mainly predicts that the flow of bilateral trade is proportional to the two countries’ national income and inversely proportional to the distance between them.

The paper is organized as follows. Section 2 critically examines the advantages and disadvantages of adopting a common currency. It also offers a survey of the empirical literature, which will be the benchmark for comparing my empirical results. Section 3 describes the main features of the Gravity Model, which will provide the theoretical framework of the study. Section 4 represents the core of the paper and conducts the empirical analysis. The Section is divided into four parts, which correspond to different stages of the study. The first part applies the Gravity Model to a sample of the 15 EU members\(^2\) for the period from 1991 to 2002 and aims to estimate the impact of the Euro on trade. The second part estimates the effect of trade on GDP per capita by employing an augmented classical growth theory output equation. A sub-section is devoted to calculate the estimates when the likely endogeneity of trade is taken into account. The third part more accurately tests whether the Euro regardless of the trading partners forming the EU directly affects output. The forth and last part combines the estimates found in the former parts and gives an overall estimation of the impact of the Euro on the EU output. A conclusion and a summary are provided in Section 5.

\(^2\) i.e. the 12 EMU countries (see footnote 1) plus Denmark, Sweden and United Kingdom. Henceforth when I mention EU and EU members I consider these 15 countries and neglect the ten new members of the EU.
2. Does one common currency help?

This section aims to critically analyse the advantages and disadvantages of a currency union in terms of its effect on the economic performance of the country members.

2.1 Theoretical literature review

Although this paper will provide significant empirical evidence in favour of the Euro, it cannot neglect to mention the main drawbacks that a common currency entails. As De Grauwe (2003) points out, the costs of a currency union mostly descend from the fact that when a country relinquishes its national currency, it loses the possibility of carrying its own monetary policy. In other words, a country joining a currency union will no longer be able to change the price of its currency through revaluations or devaluations and will no longer be able to change the short-term interest rate. The loss of independence in conducting the monetary policy may become overwhelming when a country needs to stabilise its economy (Obstfeld 1997). If a member of a currency union falls into recession while growth remains strong elsewhere, it cannot depreciate or lower interest rates to stimulate the demand. Moreover, in the case of the European Monetary Union (EMU), the fiscal policy of each country member is bound to respect the rules imposed by the Stability and Growth Pact\(^3\) and thus the EMU members have limited discretion in potential fiscal expansions. As an overall

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\(^3\) The budget deficit of each EMU members must be kept below 3 per cent of their respective GDP and the gross general government debt should either be below 60% of GDP or be making good progress down towards this reference value.
result, the adjustment of an individual economy may become very painful and slow\(^4\) and the country could suffer protracted periods of high unemployment relative to the EMU average.\(^5\)

On the contrary, the European Commission argues that the introduction of the Euro accelerates the process of integration among the EMU members. As a consequence, their business cycles tend to be more synchronized, which means that asymmetric shocks should occur less frequently and hence the worries expressed by Obstfeld should not arise.

These two different views are poles apart and contribute to sustain the current debate whether or not EMU is an Optimum Currency Area (OCA). Frankel and Rose (1998) identify 4 inter-relationships between members of a potential OCA, namely:

- Extent of trade,
- Symmetry of shocks and synchronized business cycles,
- Degree of labour mobility,
- System of risk-sharing, usually based on fiscal transfers.

The larger each of them, the more suitable is a common currency.

Frankel and Rose focus their analysis on the first two linkages and argue that more integration should encompass more trade and more international trade should result in higher correlated business cycles. However, the advantages of adopting a common currency positively depend on the extent of trade integration between the members of the union.

Expanding the study of Frankel and Rose (1998) with respect to the symmetry of shocks and synchronized business cycles, Engel and Rose (2000) find that countries participating in a currency union are more integrated than countries with their sovereign

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\(^4\) Since EMU members have limited discretion in the use the main economic tools to offset economic shocks (i.e. monetary policy, fiscal policy, exchange rate policy), the only remaining way to adjust is via structural reforms (such as labour market reforms) which are not easy to implement and only have long run benefits.

\(^5\) For a more detailed comparison between costs and benefits of a currency union, see Obstfeld and Rogoff (1996).
currencies, but are less integrated than regions within a country. The concept of integration moves along with the theory that currency unions benefit trade and output. In fact, Engel and Rose (2000) find that members of a currency union trade more than countries with their own currencies, but less than regions within a single country. Similar pattern exist for the degree of synchronization of business cycles: members of a currency union tend to exhibit more synchronized business cycles than countries with their own currencies, but these cycles are not as synchronised as those in regions of a single currencies.

The linkage between the extent of integration and currency union can be summarized more systematically using the graph device depicted in Fig. 2.1, which ranks the extent of integration (trade and synchronization of business cycles). Countries participating in a currency union lie among regions within an individual country and countries with sovereign money.
However, note that the debate about the positive association between the degree of integration and synchronization of the business cycles is still ongoing. Indeed Krugman (1991) arrives at opposite conclusions. He argues that economic integration might lead to regional concentration of industrial activities and hence it might increase, rather than decrease, the likelihood of asymmetric shocks.

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2.2 Empirical literature review

Being a promoter of the Euro, the European Commission strongly sustains that the positive effects stemming from the introduction of the common currency more than offset the negative effects. Thus, according to the European Commission, the Euro sensibly helps to create the favourable environment to boost the growth in the EMU.

De Grauwe (2003) proposes two channels through which a currency union may affect economic growth. The first channel is trade. By fostering trade a currency union also boots the output potential of the country members. The second channel is the exchange rate. By eliminating the exchange rate uncertainty a currency union reduces the financial risk and accordingly it reduces the interest rate, which eventually stimulates the economic growth. Empirical evidence has been tested for the trade channel, whilst no similar results have been achieved with respect to the exchange rate channel.

Using cross-section economic and geographic data for over 200 countries, Frankel and Rose (2000) estimate the effect of currency unions, via trade, on output per capita. They pursue a two-stage approach: first they estimate the effect of currency unions on trade and then they estimate the effect of trade on income. At the first stage, they find that a currency union more than triples trade with the members. Moreover, no evidence is observed for trade diversion. At the second stage, they found that every one per cent increase in trade between countries of a currency union leads to 1/3 per cent increase in income per capita over twenty years. These results support the theory that currency unions have a significant and positive effect on the economic performance of the union’s members.

Rose (1999) draws similar conclusions to Frankel and Rose (2000). He uses a panel data set of 186 countries with 33,903 observations, spanning five different years (1970,
1975, 1980, 1985 and 1990). Again, countries sharing the same currency trade significantly more than those countries with their own currencies.

By symmetry, using a panel data set including 217 countries from 1948 to 1997, Glick and Rose (2001) find that countries that quit the currency union suffer economically and significant –in statistical terms- declines in bilateral trade. They also estimate the impact of the currency union on trade and find that those countries sharing a common currencies trade about four times more than those countries with own national currencies.

Rose (2004) provides an excellent review and further references on the topic of the impact of currency unions on trade. Combining the estimates of 34 recent empirical studies, he finds that a bilateral currency union increases trade between 30% and 90%.

In summary, the theory predicts that countries joining a currency union will increase the volume of intra-union trade. Empirical evidence demonstrates that this relationship is strong and statistically significant. The most important consequence of the raise in trade is the increased gains from trade. As the deadweight loss of using different currencies vanishes, competitive pressures arise and consumers gain. The size of these gains may be large and moreover, this dynamic process may lead to higher economic growth rates.
3. The Gravity Model of International Trade

Most of the empirical studies referred to in the previous chapter apply the Gravity Model of international trade. The Gravity Model in economics stems from Newton’s Gravity Law in physics. Newton discovered that the attraction between two objects is proportional to their mass and inversely proportional to their respective distance. By analogy, the flow of bilateral trade is proportional to the two countries’ national income and inversely proportional to the distance between them.

The basic standard gravity equation is the following:

\[ \text{TRADE}_{ij} = \lambda \frac{Y_i Y_j}{\text{DIST}_{ij}} \]  

where:

- \( \text{TRADE}_{ij} \) represents the flows of bilateral trade between country \( i \) and country \( j \),
- \( Y_i \) and \( Y_j \) are country \( i \)’s and country \( j \)’s GDPs respectively,
- \( \text{DIST}_{ij} \) stands for distance between country \( i \) and country \( j \),
- \( \lambda \) is a constant of proportionality.

The direct relationship between \( \text{TRADE}_{ij} \) and \( Y_i Y_j \) is linked to the economic size of a country: the larger the country’s GDP, the larger is the amount of trade. In other words, unless the country is a pure re-exporter, the size of the country puts the limit to the volume

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7 Tinbergen (1962) and Pöyhönen (1963) are the pioneers by doing the first econometric studies based on the Gravity Model. Linnemann(1966) expanded the analysis by introducing further variables.
of trade and hence small countries are assumed to trade less in absolute terms than big countries (Frankel 1998).

The inverse relationship between \( \text{TRADE}_{ij} \) and \( \text{DIST}_{ij} \) hinges on the transportation costs. The Gravity Model assumes that the closer the countries, the cheaper the transport of goods becomes and thus the more convenient it is to trade. Frankel (1998) prefers a broader definition of transportation costs that does not merely include physical shipping, but also transaction costs. Such costs are explained by communication costs and by the idea that each country tends to have a better understanding of its closest neighbours and of their institutions.

Taking logs, equation (1) becomes:

\[
\log(\text{TRADE}_{ij}) = \log(\lambda) + \log(Y_iY_j) - \log(\text{DIST}_{ij})
\]  

(2)

Empirical studies applying the Gravity Model use this log-linearised equation as a basic equation of the analysis. Equation (2) is often expanded by introducing other constants and other variables. It is common usage\(^8\) to include the log of the product of per-capita incomes (i.e. \( \log(Y_iY_j / \text{Pop}_i \text{Pop}_j) \)) as to measure how a more developed country tends to specialise more and thus trade more.

Frankel (1998) uses the Gravity Model to estimate a pooled time-series-cross-section regression over the period from 1979 to 1990. Besides the usual gravity variables, he augments equation (2) by including dummy variables, such as countries sharing a common language, countries belonging to a regional grouping (such as European Community,

Western Hemisphere and East Asia), countries sharing a common land border. If countries share the same colonial history, it may be useful to introduce a dummy variable to account for a possible effect on trade (Rose 1999).

Engel and Rose (2000) apply the Gravity Model to test, *ceteris paribus*, whether trade between two countries is higher if both use the same currency. To test the model, they include a “currency union dummy”, which takes the value of one if countries adopt the same currency and which scores zero otherwise. Next, I proceed in similar fashion and test for the effects of the Euro on trade and output in the EU.
4. Empirical analysis

This section represents the core of the paper. It is divided into four sub sections, each corresponding to a different stage of the analysis: the effect of Euro on bilateral trade, the effect of trade and Euro on output, the direct effect of the Euro on output and finally the overall estimate the impact of the Euro on output in the EU.

4.1 The effect of Euro on Bilateral Trade in a Gravity framework

4.1.1 The Gravity equation

The first step of the empirical study is to estimate the effect of the Euro on the bilateral trade between the countries of the EU. The decision of including Denmark, Sweden and United Kingdom and thus considering the sample of the EU countries rather than EMU countries, draws upon the idea that Denmark, Sweden and United Kingdom also benefit from the introduction of the Euro. In fact, all the EU members have established free movements of good, capitals and persons within the Union. It is reasonable to assume that the introduction of the Euro fosters these movements within the entire EU and not merely within the EMU.

The equation applied to test the impact of the Euro on bilateral trade is:

\[
\log(TRADE)_{ijt} = \alpha_0 + \alpha_1 \log(DIST)_{ij} + \beta_1 \log(Y_iY_j)_{it} + \beta_2 \log(Y_iY_j/Pop_iPop_j)_{it} + \gamma_1 \text{LANG}_{ij} \\
+ \gamma_2 \text{BORDER}_{ij} + \gamma_3 \text{LANDLOCK}_i + \lambda \text{EURO}_{ijt} + u_{ijt}
\]  

(3)

Equation (3) is an augmented version of equation (2), where:

- \(TRADE_{ij}\) denotes the value of bilateral trade between country \(i\) and \(j\), and it is measured as exports plus imports,
• DIST$_{ij}$ represents the great-circle distance between the European capitals as the crow flies,

• $Y_i$ is the real GDP in 1995 for country $i$,

• $Y/\text{Pop}$ stands for real GDP in 1995 per capita and hence $Y_iY_j/\text{Pop}_i\text{Pop}_j$ represents the product of GDP per capita of country $i$ with country $j$,

• LANG$_{ij}$ is a binary variable which is unity if both countries $i$ and $j$ share the same language. The criteria used gives the value of 1 not only if the entire country $i$ speaks the same language of country $j$ or vice versa (such as English for UK and Ireland), but also if a sub area of country $i$ speaks the same language of country $j$ (such as Swedish for Sweden and Finland, French for France and Belgium, Dutch for Netherlands and Belgium),

• BORDER$_i$ is a binary variable, which is unity if countries $i$ and $j$ share the same land border,

• LANDLOCK$_i$ is a binary variable, which is unity if country $i$ is landlocked,

• EURO$_{ij}$ is the EMU binary variable, which is unity if both countries $i$ and $j$ have adopted the Euro at time $t$,\footnote{It is worth to mention that all the 12 EMU countries but Greece adopted the Euro in January 1999. For budget deficit reasons, Greece was admitted in January 2001.}

• $u_{ij}$ denotes the myriad other influences on bilateral trade and is assumed to be well behaved.

4.1.2 The data set

Most of the series are downloaded from Ameco (Annual macroeconomic database) provided by the European Union.\footnote{http://www.europa.eu.int/comm/economy_finance/indicators/annual_macro_economic_database/ameco_applet.htm}
Data on bilateral trade are downloaded for the World Trade Database of the United Nations Statistical Office.\textsuperscript{11} Firstly, the nominal trade values, which are recorded in thousands US dollars, are deflated by the American GDP chain index\textsuperscript{12} and then converted into Euro according to the International Financial Statistics tables provided by the International Monetary Fund (IMF). Data on distance are expressed in kilometres (km).\textsuperscript{13}

Because with respect to Belgium and Luxembourg the data on bilateral trade until 1998 are recorded as a whole, I have no choice but to combine the observations for the year 1999 onwards. Thus, I treat Belgium and Luxembourg like they were a single, unique country that I will refer as “Belux”. For this reason, the reader should be aware that the regression of equation (3) considers a group of 14 subjects, although it encompasses 15 countries.

It is also worth to mention that the dataset does not include any observations with zero trade and thus there is no need to worry about the potential problems that arise when the argument of a logarithmic function is equal to zero\textsuperscript{14}.

\subsection*{4.1.3 The results}

Equation (3) is estimated by using a panel data set with 2,184 bilateral trade observations, spanning the years between 1991 and 2002. The outcome of this pooled-time-series-cross-section regression is reported in the forth and fifth columns of Table 1. Equation (3) appears to fit the data very well, explaining 94 per cent of the variation in trade. I account for unobserved heterogeneity and apply a fixed effect and also a random effect model. However, the estimates are nearly identical. The most relevant result is that in both cases the

\begin{itemize}
\item[\textsuperscript{11}]\url{http://unstats.un.org/unsd}
\item[\textsuperscript{12}]\url{http://www.bea.gov}
\item[\textsuperscript{13}]The data are obtained from the website \url{http://www.indo.com/distance}
\item[\textsuperscript{14}]In fact $\log (x)$ does not exists when $x = 0$: only in the limit as $x \rightarrow 0$ $\log (x) \rightarrow -\infty$, which would not make any economic sense in equation (3).
\end{itemize}
predictions of the Gravity Model are strongly confirmed. All the variables are statistically significant even at the level of one per cent and have the sign that the theory predicts.

The richer the countries, the higher is the trade flow. The coefficient on the (log of) real GDP is 0.761, which conforms to the standard estimates and which is close to the value of 0.80 estimated by Frankel and Rose (2000), who apply a similar methodology to a different sample of over 200 countries worldwide. The coefficient 0.761 suggests that, holding GDP per capita constant, bilateral trade increases as the size of the country increases, but less than proportionate. The ratio of trade to GDP falls by 0.239 (= 1 - 0.761) per cent for every one per cent rise of GDP, because larger countries tend to become more self-sufficient.

The coefficient on (log of) GDP per capita confirms the theory that rich countries proportionally trade more than poor countries. A different illustration of this estimate is the following: holding GDP constant, an increase in size of population by one per cent\textsuperscript{15} reduces the trade flow by 0.112 per cent. The magnitude of this effect does not seem very large, but the reason is more likely to be found in the fact that the sample includes only the 15 EU members, which are a group of developed countries and which, with the exception of Greece and Portugal, do not differ much with one another in terms of GDP per capita.

The variable for distance has its correct sign and is statistically significant, indicating that trade between two non-adjacent countries shrinks by about 0.678 per cent for every one per cent increase in distance between them. This result falls within the bands found in the literature, whose usual estimate ranges from 0.60 to 0.80, as surveyed by Frankel (1997).

\textsuperscript{15} In other words, a shrinkage of GDP per capita by one per cent.
Sharing a common land border has a remarkable influence on bilateral trade. By being neighbours, countries trade 62 per cent more.\footnote{exp (0.487) \approx 1.62 , where 0.487 is the coefficient estimating the effect of sharing a common land border on trade (See Table 1).} A similar effect, but lower magnitude, arises when countries have the same language: the flows of trade between them are 37 per cent more than with countries speaking different languages.\footnote{Likewise the previous footnote: exp (0.319) \approx 1.37 , where 0.319 is the coefficient estimating the effect of speaking the same language on trade (See Table 1).} Being landlocked is a considerable threat to bilateral trade. The coefficient 0.655 indicates that Austria, the only landlocked country in the sample, would almost double\footnote{exp (0.655) \approx 1.93} the flows of its bilateral trade with the EU members if the country were not landlocked.

More important and centre of my analysis is the estimated coefficient assessing the impact of the Euro on bilateral trade flows. The estimate indicates that the introduction of the common currency indeed boosts bilateral trade within the EU countries. The effect can be measured taking the exponential of the coefficient on the EMU dummy: exp (0.232) \approx 1.26. \textit{Ceteris paribus}, the introduction of the Euro has raised the flows of bilateral trade by approximately 26 per cent. This result is statistically different from zero at one per cent level of significance and confirms what the theory predicts: national money is a barrier to international trade, currency unions remove this barrier and accordingly favour more trade (Rose and van Wincoop 2001).

Euro-sceptics argue that the introduction of the Euro would have a very low impact on intra-EMU trade, because the exchange rate volatility has been low prior to the establishment of the EMU\footnote{See the model implemented by Anderson and van Wincoop (2000). See also Rose (2001) for a critical survey.}. To test whether the argument is correct, I exclude Denmark, Sweden and United Kingdom from the sample. The estimates are reported in the forth and fifth columns of Table 1. Similarly to the case of the 15 EU members, all the variables are economically and
statistically significant. The EMU dummy slightly dwindles, although its impact is still more than proportionate. The coefficient is now 0.144, indicating that, *ceteris paribus*, the introduction of the Euro has raised intra-EMU trade by approximately 16 per cent.\(^{20}\)

I also test the argument made by Frankel (1998), who applies a broader definition of transportation costs based on the existence of transaction costs. If Frankel’s argument is correct, after dropping all variables that measure the affinity between countries,\(^{21}\) the coefficient on (log of) distance should rise because it now encompasses both the effect of physical shipping costs and the effect of transaction costs. In other words, the coefficient on (log of) distance should bear almost all the consequences of the exclusion of the affinity variables. On the contrary, when all variables are included, the coefficient on (log of) distance only measures the effect of physical distance (read physical transportation costs), because the effect of the transactions costs (e.g. communication costs and the better understanding neighbouring countries) is measured by the affinity variables. The last two columns of Table 1 report the estimates after the exclusion of the affinity variables. These results are to be compared with the estimates of the second and third columns and lend support to Frankel. The coefficient on (log of) distance is statistically significant and bounces up from 0.678 to 0.976. On the contrary, the coefficients on the remaining variables do not vary much: the (log of) product GDP remains statistically significant and slightly increases from 0.761 to 0.795; the (log of) product GDP per capita remains statistically significant and slightly increase from 0.112 to 0.121.

\(^{20}\) \(\exp (0.144) \approx 1.16\)

\(^{21}\) i.e. LANG, BORDER, LLOCK and EURO. Henceforth, I will refer to these variables as Affinity variables.
4.2 The effect of Trade on GDP per capita

4.2.1 The Output equation

The second step of the analysis is to estimate the effect of trade on GDP per capita. I use a neoclassical growth theory approach, which assumes that the level of output at the end of a period is positively related to the quantity of investment in physical and in human capital, to the population growth, and to the level of output at the beginning of the period. I will refer to these variables as Control variables. As a proxy of investment in human capital, I use the gross primary and secondary school enrolment. Physical investment is computed as the annual change of gross capital formation at 1995 prices.

This basic neoclassical model is augmented by the inclusion of variables that account for the size and the openness of the country. As a proxy of the size I use population and territory. Openness is measured by constructing an index, which is the sum of the exports and imports of a given country divided by its GDP. The inclusion of these variables in an output equation is suggested by trade theory, which in its classical version assumes that trade positively affects output. Modern trade theory has become more concrete, explaining the positive effect of trade on output with concepts of specialization according to comparative advantage, exploitation of economies of scale from larger markets, exchange of ideas through communication and travel, spill over of technology through investment and exposure to new goods.

Using a convenient form in logs, the augmented output equation to be estimated is the following:

\[
\log\left(\frac{Y}{\text{Pop}}\right)_{it} = \alpha_0 + \alpha_1 \left(\frac{I}{Y}\right)_{it} + \alpha_2 \text{SCHOOL1}_{it} + \alpha_3 \text{SCHOOL2}_{it} + \alpha_4 n_{it} + \alpha_5 \log\left(\frac{Y}{\text{Pop}}\right)_{91, i} + \mu_1 \log(\text{Pop})_{it} + \mu_2 \log(\text{AREA})_i + \gamma \left(\frac{X+M}{Y}\right)_{it} + \lambda \text{EURO}_{it} + \varepsilon_{it}
\]

(4)

where:

- \((Y/\text{Pop})_i\) is the GDP at 1995 market prices per head of population of country \(i\); and thus the term \((Y/\text{Pop})_{91,i}\) represents country’s \(i\) GDP per capita for the year 1991, which corresponds to the initial period of this empirical study,
- \(I\) stands for investment and the term \((I/Y)_i\) will be referred as the “investment ratio” of country \(i\),
- \(\text{SCHOOL1}\) and \(\text{SCHOOL2}\) respectively represent the gross primary and secondary school enrolment,
- \(n\) measures the growth rate of population,
- \(\text{Pop}\) stands for population,
- \(\text{AREA}_i\) is the land surface of the country, measured in squared km,
- \([(X+M)/Y]_i\) is the aforementioned index of openness, where \(X\) stands for exports and \(M\) stands for imports,
- \(\text{EURO}_i\) represents the EMU dummy, which takes the value of 1 if country \(i\) has adopted the Euro and which is 0 otherwise,
- \(\epsilon_i\) is the unobservable error, hopefully well behaved.

4.2.2 The data set

Like equation (3), the series are mainly downloaded from Ameco. The only non-Ameco source series are \(\text{AREA}, \text{SCHOOL1}\) and \(\text{SCHOOL2}\), which come from the World Development Indicator database. The national account base year for school enrolment is 1995. The series \(\text{SCHOOL1}\) and \(\text{SCHOOL2}\) respectively contain three and six missing values. Physical investment is computed as the annual change of gross capital formation at
1995 prices. All the pecuniary data are expressed in 1995 market prices and are available in Euro with the exception of Denmark, Sweden and UK, whose data are expressed in their respective national currencies. If needed Danish Kroner, Swedish Kronor and British Pound are converted into Euro according to the International Financial Statistics tables of the IMF.

Opposite to the case in equation (3), separate data are available for Belgium and Luxembourg and thus the analysis can be more accurate. Unfortunately, this gain is offset by the lack of data on school enrolment for the years 2001 and 2002. For this reason, I am compelled to restrict the study to the period from 1991 to 2000 and thus allow the effect of the currency union to hold only for the years 1999 and 2000. An implicit shortcoming is that two years may not be a sufficient length of time to make an assessment, but these series are the latest available.

4.2.3 The results

Equation (4) is estimated using a panel dataset composed by the 15 EU members for the period from 1991 to 2000. I account for unobserved heterogeneity and apply a fixed effect and also a random effect model. The Hausman’s specification test\(^{23}\) suggests that the random effect estimator is the most appropriate. Indeed accounting for random effects gives a better fit, as can be checked by looking at \(R^2\) in Table 2.

The first estimation applies Ordinary Least Squares (OLS) and use openness and (log of) population as explanatory variables. The estimates are reported in the third and forth columns of Table 2. Then, I include the control variables suggested by neoclassical growth theory, namely investment in physical and in human capital, population growth, and output at the beginning of the period. The results are reported in the seventh and eighth columns of

\[\text{If } E(X_u) = 0, \text{ then fixed effects are unbiased but less efficient than random effects.}\]
Despite the discontinuous significance and unexpected signs of the other explanatory variables, in all cases, the estimated coefficient on openness has its correct positive sign and is statistically significant. This result demonstrates that trade has a positive impact on the level of income per capita. With OLS estimation, the magnitude of this effect ranges between 0.312 and 0.406. In other words, holding the income value for 1991 constant, in 2002 income is 0.312 - 0.406 per cent higher for every one per cent point increase in the trade/GDP ratio. As expected this effect is smaller when I control for initial level of output.

The coefficient on the investment ratio is always statistically significant and, as growth theory predicts, it has a relevant impact on output. When I account for random effects, the estimated coefficient on population (the proxy for size) is small and insignificant, indicating a negligible, although positive influence of population on output. Similarly, the estimated coefficient on the population growth rate is positive, but extremely small. This result is most likely due to the fact that the population growth rate in Western Europe is very low, which ultimately might explain the small impact of population on the EU output.

Surprisingly, both estimated coefficients on primary and secondary school enrolment are negative. Moreover, the primary school coefficient is even significant. However, firstly note that for both variables the estimated coefficient is very small, indicating a low impact of school enrolment on GDP per capita. Secondly, note that my sample is composed of 15 developed countries, in which a very high share of population has a secondary school degree. Therefore, the impact of primary and secondary school education on output is not very relevant. Future studies could control for a higher level of education and probably obtain a better estimate of the effect of human capita on output.

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24 Such as university enrolment rate, percentage of graduated people over the entire population, etc.
The EMU dummy is negative, but the smallness of its coefficient entails a negligible magnitude of the effect. Moreover, in all cases the coefficient is not statistically different from zero. These results suggest that the introduction of the Euro does not have a direct impact on the level of GDP per capita. As I have argued in Section 2, the channel through which the Euro has had an effect is through trade.

4.2.4 Endogeneity and Instrumental Variables

I estimate equation (4) with Instrumental Variables (IV) to address the endogeneity problem nested in estimating the effect of exchange rate regimes on economic variables, such as trade volume, capital flows and synchronization of business cycles\textsuperscript{25}. A single currency may be the result of policies fostering trade, but similarly the presence or potential for massive trade may spur the formation of a currency union.\textsuperscript{26} In this case, applying OLS leads to biased estimates, whilst unbiased estimates are obtained with IV.

As instruments I use gravity variables that are exogenous, but correlated with trade and that hence fulfil the assumptions to be good IV. Such variables are (log of) distance, (log of) partner country population, (log of) area, and dummy variables for common land border, common language, landlocked status, and Euro. The IV technique is a two-stage least squares approach and encompasses the following steps:

1. obtain the fitted values of log (Bilateral Trade) from the familiar Gravity Model equation,


\textsuperscript{26} In the case of Europe, the EMU is indeed the final outcome of policies of promoting trade and integration. The first ancestor of the EMU is in fact the European Coal and Steel Community (ECSC), established in 1952. The ECSC is founded to promote the trade in the Coal and Steel sector. In 1958 the ECSC is extended to all economic sectors, creating the European Community. This process of integration strengthens with the creation of the European Union in 1992 and starts a new era with the introduction of the Euro in 1999.
2. take the exponential of these fitted value in order to neutralise the log and obtain the fitted values for Bilateral Trade,
3. aggregate these value for each country and obtain an estimate of the Total Trade of each country,
4. divide Total Trade by the respective country’s GDP and obtain an estimate of the variable Openness, which represents \((X+M)/Y\) in equation (4),
5. estimate equation (4) using the ratio computed in step 4 as an instrument for the variable Openness.

The results obtained with IV are reported in the fifth, sixth, ninth and tenth columns of Table 2. Again, the Hausman test suggests that the random effect estimator is the most appropriate. The impact of trade on output is always positive and always statistically significant. When the classical growth theory control variables are excluded, the coefficient on openness is 1.15; when the classical growth theory control variables are included, the coefficient dwindles to 0.401. I again use Frankel and Rose (2000) as a benchmark to compare the results. Their estimates of the coefficient on openness are 1.22 and 0.33, when control variables are respectively excluded or included. My correspondent estimates are 1.15 and 0.401 and are in line with Frankel and Rose (2000) estimates.

With respect to the EMU dummy, estimating equation (4) with IV gives similar results to estimating with OLS: the direct impact of the Euro is small and statistically insignificant.

In summary, both OLS and IV estimations of equation (4) lead to two main conclusions:
• The more open the country (read the larger its flows of trade), the higher is the level of income per capita.
• The introduction of the Euro does not per se increase output of the EU.
4.3 Does the Euro directly influence EU output?

As previously mentioned, the estimation of equation (4) shows no direct significant effects of the Euro on GDP per capita. This section provides further analysis of this issue.

The theory that a common currency involves gains in terms of credibility and monetary discipline is a shared view in the literature (Tenreyro 2001, Alesina and Barro 2002). These features are highly desirable to those countries that lack internal discipline. Indeed, joining the EMU has compelled the Mediterranean members to more rigorous fiscal and monetary policies. The establishment of the European Central Bank moulding the German Bundesbank has been a clear sign of a serious commitment to sustained monetary stability.

To test whether the theory sustained by Tenreyro (2001), Alesina and Barro (2002) applies to my sample and thus whether the introduction of the Euro per se means more output in the EU, I follow a methodology suggested by Frankel and Rose (2000). The number of observations is 168 and covers the years from 1991 to 2002. The simplest formulation is to assume output (log of GDP per capita) to be in function of the size (log of population). The results are reported in the third and forth columns of Table 3. Then I include the EMU dummy (EURO), which takes the value of one if the country belongs to the EMU and zero otherwise. The Hausman test indicates that the fixed effect estimator is the most appropriate. The coefficient on EURO is negative, although not large (0.046) and moreover, it is statistically insignificant. (See Table 3 fifth column).

The analysis goes further, considering variables that measure the economic size of the EMU. The fifth and sixth columns of Table 3 reports the results after including the inner product of EMU membership and the real GDP of the bilateral trading partner (i.e. \( \Sigma_i \epsilon_{ij} Y_j \)). \( \epsilon_{ij} \) is a binary variable, which takes the value of one if country \( i \) and \( j \) have adopted the Euro and zero otherwise. High values of the inner product mean that the EMU is economically
large and that accordingly trade and output should increase. After controlling for the inner product, the coefficient on the EMU dummy is negative, but highly statistically insignificant.

I keep testing the *direct* impact of the Euro on output by controlling for other proxies of the economic size of the EMU. Model 4 in Table 3 includes the sum of the inner product weighted by the distance between country $i$ and $j$, like the Gravity Model would suggest, $\sum_j \epsilon_{ij} (Y_j / \text{Dist}_{ij})$. In this case, the coefficient on the EMU dummy is small and statistically insignificant, (see seventh and eighth columns in Table 3). Model 5 in Table 3 reports the estimates after considering the sum of the inner product weighted by distance multiplied by the square root of the aggregate per capita income of the EMU partners, that is $\sum_j \epsilon_{ij} (Y_j / \text{Dist}_{ij}) \sqrt{(Y/\text{Pop})_j}$. The results are virtually unchanged: the coefficient on the EMU dummy is small and statistically insignificant.

If the estimated coefficient for the EMU dummy were positive and statistically significant, then it could have been possible to argue that the Euro encompasses gains in terms of central bank credibility and monetary stability, regardless of the trading partners forming the EU. However, this seems not to be the case. Supported by empirical evidence, I rather argue that the impact of Euro on output comes through the trade channel.

### 4.5 Drawing the threads

In this section, I try to quantify the overall effect of the Euro on output by combining the estimates of the two stages: the effect of the Euro on trade, and the effect of trade on output.

For the year 2002, Eurostat reports the average export share of intra-EU exports to be 24% of the total EU exports and the average import share of intra-EU imports to be 22% of
the total EU imports. In the first step, I estimate the effect of the Euro on an average EU member’s trade to be 0.053.\footnote{This number is obtained by making an equal weighted average of intra-EU trade and then computing the effect of the Euro on trade by using the coefficient on EMU dummy of equation (3), see Table 1, third column. Thus 0.053 results from the calculation: \(0.053 \approx 0.23 \times 0.232\)}

Then I estimate the effect of this additional trade on an average EU member’s output. I need to multiply 0.053 by the coefficient measuring the elasticity of trade with respect to output in equation (4). From Table 2, my favoured coefficient for trade (read Openness in the table) is the surely unbiased IV estimate. The computation is straightforward: \((0.053 \times 0.401) \approx 0.021\) and thus the average effect of the Euro on EU output is estimated to be about 2.1%.
5. Summary and Conclusion

Since the Euro has been introduced, more than four years have passed. This paper aims to make an early assessment on how the introduction of the common currency has affected trade and output in the EU. By considering a sample of 15 EU countries for the period from 1991 to 2002 or from 1991 to 2000 if data are missing, I have obtained the following important results.

The creation of the EMU indeed favours trade between the EU members. Applying the Gravity Model of international trade, I have estimated that the Euro raises the flows of bilateral trade between the EU members by approximately 26 per cent. I have also restricted the estimate to the EMU sample and again found a positive and more than proportionate impact of the Euro on bilateral trade. This result opposes the theory of the euro-sceptics, who sustain that the introduction of the Euro would have very little impact on trade intra-EMU countries, because the exchange rate volatility has been low prior to the establishment of the EMU. I have also tested whether transaction costs are indeed a relevant component in the estimation of bilateral trade, as in Frankel (1998) and my empirical results support it.

Next, I have estimated different augmented neoclassical output specifications and estimated the elasticity of trade on output as ranging between 0.401 and 1.15. I have regressed the output equation including and excluding the neoclassical controls variables, I have accounted for fixed and for random effects, I have applied OLS and IV. In all cases the coefficient on trade is positive and statistically significant. Thus, the results of this paper suggest that the introduction of the Euro creates a more appropriate environment for trade and hence, via this channel, for growth.
Tenreyro (2001), Alesina and Barro (2002) argue that the introduction of a common currency entails gains in terms of central bank credibility and monetary stability, which in the end positively affect output. In theory this argument might be correct, but the empirical results of this paper do not support it for the EMU. In all the different cases in which I have estimated the output equation, the coefficient on the EMU dummy is small in magnitude and statistically insignificant, denying the theory that the Euro entails a direct positive effect on output, regardless of the trading partners. I have run further regressions to test this result, by controlling for variables measuring the economic size of the union. The EMU dummy assessing the direct impact of the Euro on output remains small and statistically insignificant.

By combining the estimate of the effect of the Euro on trade with the estimate of the effect of the additional trade flows on output, I have obtained an average effect of the Euro on output. This estimate is approximately 2.1%.

Because the used dataset only consists of 15 EU members, it is unfeasible to check for trade diversion. A possible extension of the paper could be to include the 15 EU countries in a wider sample and check whether the boost to trade among the EU members comes at the expense of diversion of trade with non-EU members. The conclusions of this paper would be less powerful if the additional trade between EU members were simply a shift from extra-EU partners to intra-EU partners. However, a recent empirical study by Frankel and Rose (2000) demonstrates that currency unions tend to generate trade creation rather than trade diversion and I am positive convinced that this finding applies to the EMU, too.

My results contribute to the Euro debate in two ways. Firstly, I contribute to the discussion about whether Denmark, Sweden and United Kingdom should or should not join

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28 Probably it would be wise to include the main extra-EU trade partners such as USA, Canada, Iceland, Norway, Switzerland, China, Japan, Australia, New Zealand, Argentina, Mexico, Brazil.
the Euro. Although it is not expected to solve the debate, this paper has provided significant empirical evidence in favour of the Euro and in favour of its beneficial consequences on trade and output.

Secondly, in terms of the recent EU enlargement, the estimates I have found can be a useful guideline to evaluate the possible economic gains of the ten new EU members\(^{29}\) if they adopt the Euro. Future studies could quantify the potential effects on trade and output that would arise if those ten countries were admitted in the EMU. The ten new EU members, and in particular the Eastern ones, are expected to exhibit increasing growth rates in the coming years. Once they meet all the economic criteria imposed by Brussels\(^{30}\), adopting the Euro could significantly accelerate their process of economic growth. As Eastern EU members become richer, Western EU members could increase the volume of trade with them. On one hand, products that are saturated on the Western European markets could find new spaces on the Eastern European markets. On the other hand, labour intensive products could be mainly manufactured in the Eastern European countries, taking advantage of cheap labour costs, and then these products could be easily traded in the entire EU, priced in the same currency.

As the EU market becomes larger and the process of integration continues, the enlargement of the EMU can be the next step to boost the economic growth in Europe. At present, this argument is only hypothetical and waits for future econometric studies to support it.

\(^{29}\) i.e. Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia.

\(^{30}\) A new Member State has to show that its economy has converged with the economy of the Euro zone. Article 121 (1) EC stipulates that convergence is assessed in terms of price stability, long-term interest rates, budget deficit, total government debt and stability in the exchange rate. Once met the convergence criteria and achieved a high degree of economic convergence with the Euro zone, the new Member State could join the new exchange-rate mechanism and then, after the two-year test phase, join the Euro. (Visit the website of the European Union at \url{http://www.europa.eu.int/scadplus/leg/en/lvb/l25066.htm} for a detailed explanation).
- References -


Frankel J. and S. Wei “Trade blocks and currency blocks” - NBER working paper No 4335


Linnemann R. (1966) “An econometric study of international trade flows” - Amsterdam, North Holland


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Panel, OLS estimation

Dependent variable is log of bilateral trade in real €

Intercept and year dummies were included but not reported

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Panel estimation
Dependent variable is log of real GDP per capita in € 1995
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Panel, OLS estimation
Dependent variable is log of real GDP per capita in € 1995
Intercept and year dummies were included but not reported
Standard errors recorded in parentheses, * statistically significant at 5% and ** at 10%