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REGULAR ARTICLE

Adopt the euro? The GME approach

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Abstract The objective of this paper is to evaluate the degree of financial integration achieved in the European Union based on covered interest parity and using Generalized Maximum Entropy. EU countries are divided into two groups according to their current situation with respect to the adoption of the euro. Financial integration before the adoption of the euro is analyzed for the countries that adopted the euro in 1999. Similarly, current financial integration is evaluated for non-euro EU countries. Besides the importance of comparing the situation of the non-euro EU countries with the situation of the euro EU countries previous to the euro adoption, which may be useful to evaluate an eventual decision of the non-euro members to adopt the euro, it is interesting to analyze the performance of Generalized Maximum Entropy. Generalized Maximum Entropy has the ability to estimate the parameters of a regression model without imposing any constrains on the probability distribution of errors and it is robust even when we have ill-posed problems. Overall our results suggest that the degree of financial integration on non-euro countries is lower than the degree of financial integration that existed among euro adopting countries before the adoption of the euro.

Keywords Financial integration · Generalized maximum entropy · Timeseries analysis · Ill-posed problems

JEL Classification C15 · C61 · G15

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1 Introduction

The evaluation of financial integration in the European Union (EU) is an important question especially in the event of entry of new countries to the common currency. Adopting the euro, when financial integration is not complete, could result in the increase of disparities between countries. The adoption of the euro by a country leads to the loss of monetary authority for that country and thus it leads to the loss of an instrument to combat possible asymmetric shocks in the country's economy.

With the advance of the integration process, where the introduction of the common currency was an important step, we expect that full financial integration occurs between the different countries, giving them the capacity of similar responses. But countries do not have the same conditions to verify the full financial integration. In the specific case of EU financial markets, the abolishment of capital controls had been done progressively, a process that was completed in 1995. In this scenario, theory indicates that the abolishment of capital controls should conduct to a high level of financial integration in the member states. However, there are other factors which prevent complete financial integration, such as the risk of reinserting controls, the existence of asymmetric information, transaction costs and the existence of legal barriers and different fiscal treatment of returns in the different countries.

The existence of other type of barriers, besides affecting capital mobility, implies that countries do not fully explore the potential benefits of financial integration. In these benefits we can count a better saving allocation that will conduct to better investment returns. With better returns, investors expect better economic performance and the increase of the consumption level. We also expect that financial integration leads to the decrease of borrowing costs (due to more competition), the decrease of intermediation costs (the same motive) and the harmonization of product prices and financial services. In the end, we expect higher market efficiency. But financial integration is presented as an institutional challenge, because the rapid integration of financial markets (noted by the increase in the volume of capital flows between countries) could increase exposition of currencies to risk, facilitating the appearance of global scale crises. In this situation, financial integration was (and it continues to be) a challenge for the euro countries. In addition, it is a challenge also for other EU countries which may decide to adopt the common currency sometime in the future. Since the evidence of financial integration is a good signal to understand if the countries are ready to answer to asymmetric shocks, it is interesting and actual to study the financial integration in non-euro EU countries. The objective of this study is to compare the recent financial integration of these countries with the financial integration, before 1999, of the countries who adopted the euro. This comparison is relevant to evaluate the conditions for a future decision of adopting the euro. There are many types of empirical studies analyzing the financial integration between countries. In this paper we investigate the financial integration in EU countries. One novelty in our paper is the application of the *Generalized Maximum Entropy* (GME from hereon), an econometric methodology which presents advantages over *Ordinary Least Squares* (OLS from hereon), since it is not so restrictive in terms of the main assumptions, estimators are more efficient than OLS ones in small samples and it works good not just with well-posed but also with ill-posed problems. We apply GME to study covered interest parity (CIP from hereafter). According to Lemmen (1996), capital mobility is one of the essential concepts in the study of financial integration. The usage of a more recent sample and the application of a new methodology to analyze CIP are the extensions of this paper.

The set of EU countries that do not have the common currency, can be divided into two groups: the old EU members who did not adopt the euro in 1999 (Denmark, Sweden and United Kingdom) and the new EU members who joined the EU in 2004 and 2007.[1] Before 1999, there were some studies including the three countries that decided not to adopt the common currency in 1999. For the newest countries, the few studies that use these countries prefer to use the stock markets (see, for example, Scheicher 2001). The results point to the increase of financial integration with the other EU countries. Another example, using parity conditions, is the study of Herrmann and Jochem (2003), which do not find evidence of financial integration, although the differentials decrease in time. On the other hand, Mansori (2003) concludes that there exists some degree of financial integration with other EU members. This author uses a test of stationarity in panel data. The difference in the results of these two studies may be due to differences in the methodology used.

This paper is organized as follows: Section 2 contains a literature review about covered interest parity and financial integration; Sect. 3 presents the data and methodology; in Sect. 4 we present the empirical analysis; finally, Sect. 5 concludes.

2 Covered interest parity and empirical evidence

Covered interest parity (CIP) is considered as a pure criterion of economic mobility, as it is referred, for example, in Frankel (1992). With instruments that cover exchange risks, investors make arbitrage operations and eliminate differentials between returns of similar assets (similar in maturity, political risks, and sovereign risks, among others) except in currency denomination. With capital mobility between countries, arbitrage assures that differentials, which represent riskless profits, are eliminated. Frankel (1993) shows that we just need the abolition of capital controls to have a reduction of profit opportunities.

Since the instruments to cover risks are different for different maturities (forward contracts for short maturities and swaps for longer maturities—those which have a maturity longer that 12 months), we can formalize CIP for each type of maturity. In this work we will test only CIP for short maturities.

The equation of CIP is:

$$\frac{F_{t+1}}{S_t} = \frac{1+i_t^*}{1+i_t} \tag{1}$$

where i is the nominal interest rate, S the spot exchange rate,[2] F the forward exchange rate and the symbol * is used for foreign variables. Taking the logarithm of the previous

[1] Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia; Bulgary and Romania.

[2] Units of foreign currency per unity of domestic currency.

equation we get:[3]

$$f_{t+1} - s_t = i_t^* - i_t \tag{2}$$

Rearranging the previous equation, and isolating the national rate, we have:

$$i_t = i_t^* - (f_{t+1} - s_t) \tag{3}$$

defining $ic_t^* = i_t^* - (f_{t+1} - s_t)$ as the covered foreign rate and including an error term, we have the equation $i_t = ic_t^* + \varepsilon_t$, where ε_t is a Gaussian error. In order to test empirically the CIP, we need to estimate the following equation:

$$i_t = \alpha + \beta ic_t^* + \varepsilon_t \tag{4}$$

If CIP holds then $\alpha = 0$ and $\beta = 1$, thus testing CIP is equivalent to test these two conditions. Transaction costs, obstacles that prevent capital mobility like government restrictions to capital circulation and political risk[4] are detected in the constant term, with this showing a non zero value. On the other hand, the trend detects differentials due to differences in fiscal treatment of returns, financial restrictions imposed by governments or data imperfections.

Some studies, like those from Holmes and Pentecost (1996) and Holmes (2003) find differentials that are eliminated over time, showing evidence in favour of financial integration in EU. There are only few cases that, reporting to main EU countries in recent years, show evidence against CIP. One of these cases is the study of Holmes and Wu (1997), authors that find significant covered interest differentials. Exchange rate turbulence and the German unification in 1990, an asymmetric shock, are the reasons advanced for these results.

In the absence of transaction costs, and if assets are really similar, CIP differentials are expected to be null as differential will decrease till all profitable opportunities are eliminated. However there may exist some frictions that provoke differentials but that do not mean riskless profit opportunities. In the presence of transaction costs, CIP differential do not necessarily mean the existence of profit opportunities. If the differentials are smaller than the transaction costs, they do not generate profit opportunities. Based on this assumption, Frenkel and Levich (1975, 1977) elaborate a neutral band for parity, within which differentials are not synonymous of riskless profit opportunities. Out of this band differentials could mean different tax treatment, sovereign risk, government controls, non-infinite demand and supply elasticities, transaction costs, information costs, capital controls, imperfect assets substitutability or even measure errors. Rejection of CIP could be also a sign of monetary autonomy.

Typically, studies before 1999 testing CIP for EU countries find evidence in favour of financial integration. After this, because of the adoption of the euro, CIP cannot

[3] We assume that $\ln(1 + z) = z$, assumption usually used when z is a small value in relation to 1.

[4] See Aliber (1973). Political risk is the probability of future intervention of government in financial markets. It tells us that if an investor anticipates the intention of the government of imposing obstacles to capital mobility, he will demand an extra premium for his investment.

be used to measure financial integration among euro EU countries. With the entrance of 10 new countries in EU in 2004, the interest of some researchers turned to these countries. Mansori (2003) studies financial integration for the three more important economies of the 10 countries that entered in EU: the Czech Republic, Hungary and Poland, concluding that these three new members present similar conditions to those verified by EU countries in the pre-European Monetary Union period. Herrmann and Jochem (2003) make a study where they add Slovakia to these countries and find contrary evidence, rejecting CIP. As possible explanations for the violation of CIP they advance with the incomplete integration of monetary markets, premium risk, transaction costs, capital controls, inefficiency and underdevelopment of financial systems and lack of liquidity of the markets. In absolute terms, average differentials decrease over time, probably due to the attempt to abolish barriers (the Czech Republic withdraws controls in 1999, Slovakia and Hungary in 2001 and Poland in 2002). They conclude that, from these countries, the Czech Republic is the country which presents smaller differentials.

3 Data and econometric methodology

The main objective of this paper is to study the financial integration of non-euro EU countries, comparing it with the pre-adoption financial integration of the countries who adopted the euro in 1999. Among the non-euro EU countries we include in our study the ones for whom there is available data: Denmark, Sweden and United Kingdom who decided not to adopt the euro in 1999; the Czech Republic and Hungary who entered for EU in 2004. We study these countries to evaluate if they have conditions to capture all potential benefits of financial integration. We test CIP using assets with maturity until 12 months, made with onshore assets: interbank interest rates, denominated in currency of each country.[5] To study financial integration of the euro EU countries in the period before they adopted a common currency we should use spot and forward exchange rates for each country relatively to the German mark. Since exchange rates in relation to German mark are not available, we recovered those of each country relatively to the American dollar. Then, we calculated the corresponding exchange rate with respect to the German mark using triangular parity. Due to the existence of transaction costs, there may exist some differences between the real values of the true exchange rates in relation to the German mark and the values calculated by triangular parity. However the deviations are minimal since the currency used in the calculations—American dollar—is largely used in international markets, so transaction costs are small and do not show significant effect on the tests. We use monthly data from DataStream. Choice of this database is due to relatively homogeneity within data. Samples for euro EU countries were recovered according to data availability. Longer samples start in January 1991 and end in December 1998 (Austria, Finland, Spain, Greece and Portugal have smaller samples).

[5] Because data is not available in DataStream, we do not analyze Austria and Finland for maturity of 2 months and the Netherlands for 12 month maturity.

To study financial integration of the non-euro EU countries we recovered exchange rates with respect to euro. The samples for these countries start in January 1999 and end in December 2008.

In a first step, we analyze the behaviour of our time series according to stationarity and cointegration tests. Firstly we study the existence of unit roots in each individual series. If both series are integrated of order 0, we can apply OLS to study CIP. However, if they are integrated of order 1 we can study financial integration with cointegration to check the existence of a long run relationship between variables. If there exists a relation between pairs of series it means that there is a long run relationship between them and parity is verified, at least, in its weak form. Parity is verified in the strong form if, besides the existence of cointegration, regression parameters are those we test (0 and 1, respectively). However, in the presence of cointegration, normal tests of hypotheses can not be applied.

We used Augmented Dickey Fuller (ADF) test to analyze the stationarity of the series (see Dickey and Fuller 1979). There are some criteria to choose the number of lags. We adopted the criterion of starting from a high number of lags, doing the habitual t test for each lag until we found the first significant lag. This procedure is referred as having equal results than other criteria, namely AIC and BIC, in terms of limit distribution (Said and Dickey 1984). In this study we start with 12 lags.[6] To study cointegration we adopted the univariate approach, proposed by Engle and Granger (1987) to detect the existence (or non existence) of a long-range linear relation between two variables. It happens if the estimated residual of a regression between those two variables is (or it is not) stationary. The stationarity analysis is made with an ADF test. The difference is in the critical values, which are larger.

After this we use GME to estimate the CIP relation (Eq. 4) and compute confidence intervals for α and β. To satisfy CIP the confidence interval for α should include the value 0 whereas the confidence interval for β should include the value 1. GME derives from the principle of maximum entropy (ME).[7] Following Jaynes (1957), in any inference problem, probabilities should be recovered according to the ME principle, using all the available and relevant information. Associated with minimal information, ME principle allows to find the best probability distribution to data minimizing the inadvertent use of non-available information. With a problem like this, the solution is the value of probability distribution p_i which maximizes entropy subject to the identified constraints. This principle is based in the fact that entropy raises to reach its maximum value, with any a prior constraint. The introduction of more constraints will not bias the results, once that if constraints are not fully respected by empirical data, there is not a possible solution (Zellner 1996). Furthermore, since all the statistical moments are included, this is a more efficient method to find probability distributions (Golan 2002).

Generalized Maximum Entropy (GME) was proposed by Golan and Judge (1996) and it constitutes a specific area of ME application. In a traditional problem given by$y = X\beta$, the objective is to find values for the parameters β in a more efficient way, even when we have misspecification and small samples.

[6] When we have samples with just 24 observations, as for Portugal, Finland or Greece, we start with 6 lags.

[7] For an overview of ME principle see, for example, Golan (2002).

The GME approach has the advantage of increasing the number of possible applications in economics, especially when we are in the presence of linear *ill-posed* problems. Following Golan et al. (1996), this kind of problems could occur due to several factors: (1) bad specification of models that result in problems with many parameters to estimate in relation to the number of data points available (lack of information for the estimation of parameters or, for example, problems of non-stationarity); (2) data inconsistency; (3) collinearity between variables (caused by bad specification or by using non-experimental data). The problem is the fact that the use of traditional methodologies (as the ordinary least squares) could cause bias and also inefficiency in the estimators (caused by instable solutions and with high variance and lack of precision), arbitrary values for parameters of even undefined solutions.

Briefly, GME generalizes the concept of ME with the reparametrization of the linear model transforming the unknown elements (parameters and errors) in the form of probabilities. After reparametrizing, GME estimates the probability distribution of the parameters and the errors. Consider the traditional model given by

$$\mathbf{y} = \mathbf{X}\boldsymbol{\beta} + \mathbf{e}$$

where y is a vector of dimension $(T \times 1)$ which represents one of the problems referred before, $\mathbf{X}$ a $(T \times K)$ matrix, $\boldsymbol{\beta}$ a $(K \times 1)$ vector and e an error vector of dimension $(T \times 1)$. Having limited information to parameter signals and for error components ($\boldsymbol{\beta}$ and $\mathbf{e}$), such as knowing the expected signals and values for the magnitude of variable effects, it is possible to assume, that each parameter β_k could be seen as a discrete random variable with M possible results where $2 \leq M \leq \infty$ (Golan et al. 1996). Considering these possible results as a z_k vector of dimension $(M \times 1)$, and being z_{k1} and z_{kM}, respectively, the minimum and the maximum, it is possible to write β_k as a combination of z_k and p_k, as:

$$\beta_k = \begin{bmatrix} z_{k1} \ldots z_{kM} \end{bmatrix} \begin{bmatrix} p_{k1} \\ \vdots \\ p_{kM} \end{bmatrix}.$$

The vector z_k should be constructed based on the sample/experimental information or according to economic theory (see the examples of Fraser 2000 or Campbell and Hill 2005, 2006). If we generalize for all the parameters $(k = 1, \ldots, K)$, it is possible to define β as follows:

$$\boldsymbol{\beta} = \mathbf{Zp} = \begin{bmatrix} z_1' & 0 & \ldots & 0 \\ 0 & z_2' & \ldots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \ldots & z_K' \end{bmatrix} \cdot \begin{bmatrix} p_1 \\ p_2 \\ \vdots \\ p_K \end{bmatrix}.$$

In this case, $\mathbf{Z}$ is a matrix of support values for parameters, with $(K \times KM)$ dimension, and $\mathbf{p}$ is a $(KM \times 1)$ vector for the unknown probabilities and that $p_{km} > 0$ and $p_k' i_M = 1$ for all k.

Besides the reparametrization of parameters it is possible to do the same with errors. Assuming that we have $\mathbf{J} \geq 2$ support points, that $\mathbf{V}$ is a matrix of those support points (with $(T \times TJ)$ dimension) and that w is a $(TJ \times 1)$vector of probabilities for the same support points, we can define the following matrix:

$$\mathbf{e} = \mathbf{V}\mathbf{w} = \begin{bmatrix} v_1' & 0 & \dots & 0 \\ 0 & v_2' & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & v_T' \end{bmatrix} \cdot \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_T \end{bmatrix}.$$

By the same reason it is necessary that probabilities should be $w_{tj} > 0$ and $w'_t i_J = 1$, for all the values of *t*.

Using the previous elements, it is possible to write the reparametrized model in its matricial form as:

$$\mathbf{y} = \mathbf{XZp} + \mathbf{Vw}$$

In this case, the values of $\mathbf{y}$, $\mathbf{X}$, $\mathbf{Z}$ and V are known and we want to estimate the unknown parameters of vectors $\mathbf{p}$ and $\mathbf{w}$ using the principle of ME (see Golan et al. 1996).

The GME solution, according to Golan et al. (1996), is given by:

$$\hat{p}_{km} = \frac{\exp\left(z_{km} x_k' \hat{\lambda}\right)}{\sum_{m=1}^{M} \exp\left(z_{km} x_k' \hat{\lambda}\right)} \qquad m = 1, \dots, M \quad \text{and} \quad k = 1, \dots, K$$

and

$$\hat{w}_{tj} = \frac{\exp\left(v_{tj} \hat{\lambda}\right)}{\sum_{j=1}^{J} \exp\left(v_{tj} \hat{\lambda}\right)}, \qquad j = 1, \dots, J \quad \text{and } t = 1, \dots, T$$

where $\hat{\lambda}$ are the Lagrangian multipliers for the identified constraints.

An issue in the application of GME is the choice of the support vectors for parameters and errors. This choice has to take into account the trade-off between precision and computational capacity, because support vectors of higher dimension require more computational capacity that sometimes could be excessive. However, in empirical work, some authors refer that using higher support vectors does not change significantly the results (see for example Shen and Perloff 2001 and Golan et al. 1998). After some experiences, we use $M = 5$.

For the error support vector, normally is chosen a symmetric distribution in relation to zero. Pukelsheim (1994) argues that the support points for errors should be between $v_{t1}' = -3\sigma$ and $v_{tJ}' = 3\sigma$ (being σ the standard deviation of e). If σ is unknown, it could be substituted by an estimate. Campbell and Hill (2006) consider two different possibilities: (1) $\hat{\sigma}$ estimated by the OLS regression and (2) calculating the sample standard deviation for the dependent variable y (according to the same authors, this alternative shows better results). In this paper we apply that 3σ rule, using both estimates for the parameter σ.

Shore and Johnson (1980) show that ME and GME are correct principles, with an axiomatic derivation of them. Also Csiszár (1991) makes an axiomatic approach concluding in favour of the validity of ME. Extending the work of Shore and Johnson, Golan (2002) conclude that, with the objective of making inference with finite data, GME is the only method which verifies all the five axioms identified in their work, when compared with other extensions of GME. Recently, Campbell and Hill (2005, 2006) show how to include inequality constraints in the support matrix of parameters, in GME problems. ME and GME have been used in economics, especially to estimate utilities and in finance. However, it has some other applications in economics, such as in agricultural and industrial economics. Other information measures could be applied to analyze financial integration. As financial integration is given by Eq. 4, it could be analyzed the distance between those two variables. It could be done, for example, with mutual information (Kullback 1968). This is a measure is analogous to the linear correlation coefficient which can be extended to non-linear dependence. Cross entropy and joint entropy are also another information measures that could be used to analyse dependence between variables. For a review of these concepts see, for example, Golan (2004). However, for the purpose of this study, we chose GME which allow us to evaluate financial integration with confidence intervals for covered interest parity parameters.

4 Empirical results

Firstly, we analyze the stationarity of i_t and ic_t^* using the unit root test proposed by Dickey and Fuller (1979). In almost the cases, the series were integrated of order 1. The exception was Hungary, which has stationary time series. After this, we performed the cointegration tests to evaluate the existence of a long run relationship between these two variables. Austria, Belgium, France, the Netherlands and the Czech Republic show evidence in favour of cointegration for all maturities. Portugal and Greece have evidence of cointegration for 6 and 12 months maturities while for Spain cointegration just holds for the 12 months maturity. The remaining pairs of series are not cointegrated.[8] In all cases where series were integrated of the same order, we used GME to estimated parameters α and β. We used GAUSS 8.0 to estimate both the values of the parameters α and β, and also to estimate confidence intervals. Based on the predictions of economic theory under CIP, the following support vectors were used: $\{-1.5, -0.75, 0, 0.75, 1.5\}$ for α and $\{0.5, 0.75, 1, 1.25, 1.5\}$ for β. Following previous studies, we used the 3σ rule for the support vector for errors, centering it in zero and using $J = 5$. For the value of σ we used both the estimates of $\hat{\sigma}$ from OLS or from the standard deviation of y. Results were mixed regarding to the best of these two possibilities in terms of efficiency. In the estimation of confidence intervals we used 2,000 boots to obtain intervals with 90, 95 and 99% of confidence, using the same

[8] Results are not shown due to space constraints. The authors will make them available upon request.

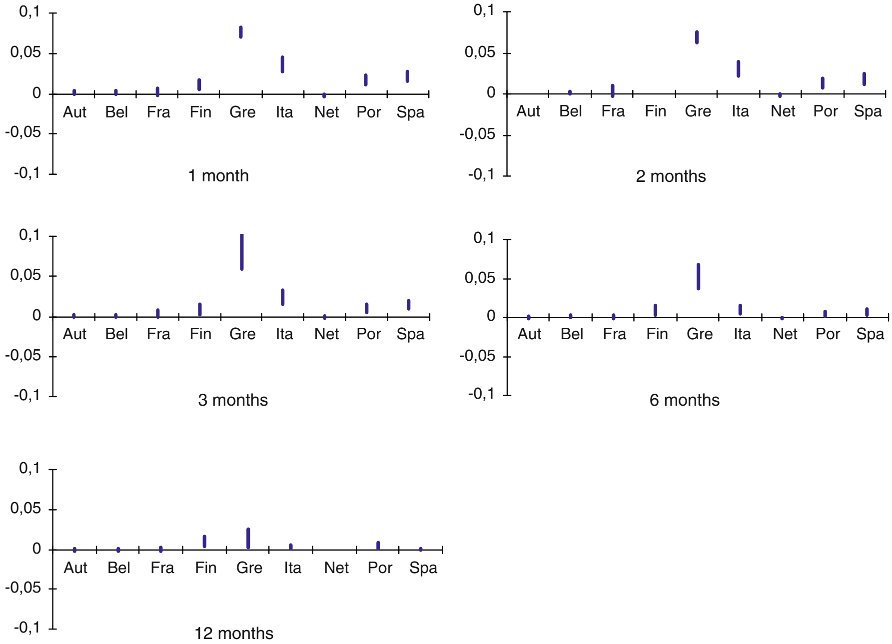

Fig. 1 Confidence intervals (99%) for α for euro countries

priors. In what follows we only present the results for the 99% confidence intervals as the remaining intervals are included in this one. We start by discussing the results regarding the financial integration of the euro EU countries in the pre-adoption period. Next we present results concerning the financial integration of non-euro countries in the recent past.

4.1 Financial integration of euro countries in the pre-adoption period

We estimated the confidence intervals for the parameters α and β. As mentioned above, the CIP will be satisfied if the confidence intervals for α includes 0 and the confidence intervals for β includes 1. Figure 1 shows the results of the 99% confidence intervals for the parameter α, using the estimate of the standard deviation of y for σ.[9] We can see that the expected parameter is verified for Austria, Belgium, France and the Netherlands for all maturities. For the other countries, the confidence interval for α does not contain the value 0, except for Spain in the 12 months maturity. However the confidence intervals are not far from 0 for Portugal in 6 and 12 months and for Italy and Greece in 12 months maturity.

[9] Due to space constraints, we just show results for intervals of 99% of confidence and using the standard deviation of y as an estimate for σ. Upon requested, we will be happy to supply results for the other confidence levels as well as for the other estimate of σ.

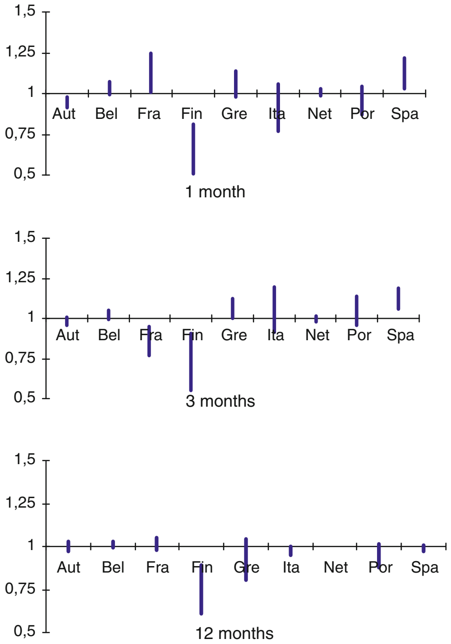

Fig. 2 Confidence intervals (99%) for β for euro countries

Figure 2 shows the results for parameterβ. For this parameter, there is more evidence of CIP. Finland is the only country where the confidence interval never contains 1. For the remaining countries, at least in one maturities the value 1 is included in the confidence interval. A possible surprising result is the fact that Greece and Portugal show more evidence of financial integration when compared, for example, with France. This may be explained by the fact that these two countries have smaller samples, that started later, while in France it could be because it faced some problems in the beginning of the period under analysis (like speculative exchange rate attacks).

The main purpose of this paper is to apply GME, a new methodology which is generally considered as providing better results than traditional methodologies. Moreover, GME also allows us to estimate confidence intervals and therefore to directly evaluate CIP. This is possible not only for cointegrated series but also for non-cointegrated series. It should be highlighted that in the case of cointegrated series OLS also allows the estimation of the parameters, however traditional tests are not valid. As a consequence GME has some advantages over OLS in the estimation of regressions involving integrated series.

Previous studies, namely those which study stationarity of differentials (an equivalent method to study CIP) refer that EU central countries are commonly those which have more evidence in favour of CIP. With the exception of France, this paper has similar results. Austria, Belgium and the Netherlands show ample evidence in favour of CIP, while France shows better results for the parameter α than for β. For South

European countries, CIP is just completely verified for Spain in the 12 month maturity. For Greece, Italy and Portugal the parameter β is according to CIP for some maturities and the confidence intervals for α are not far from 0 for longer maturities. As a consequence, although CIP is not verified in these three countries, results suggest that they are not very far from financial integration. Finland also does not verify CIP as the confidence intervals for β are all below 1.

The Netherlands has traditionally maintained a strong relationship with Germany, in which concerns to financial markets, at the stability of exchange rate level (Lemmen 1996). For example, De Haan et al. (1991) and Katsimbris and Miller (1993) present a strong relation between these two markets. On the other hand the Netherlands was the only country which had not suffered speculative attacks during European Monetary System (EMS) crisis. Also Austria presents evidence in favour of CIP, and it is also a country which presents a strong economic relation with Germany, as we can see in the interbank rates (since introduction of euro they are equal), also due to geographic proximity between these countries (see, for example, Helmenstein and Rünstler 1996). Belgium and France are countries that, in spite of evidence of CIP verification, present some problems, namely during part of 1992 and 1993, possibly due to the speculative attacks in the EMS crisis of September 1992. This could be the reason for the non-verification of CIP in France.

Southern countries present no evidence of verification in CIP, with exception to 12 month maturity in Spain. Greece and Portugal have in common the fact that their samples started just in 1997. In the case of Greece, besides of the non verification of CIP, the evolution of covered differential till 1999 did not show a decrease. Greece had problems in its economy, so much that it did not integrate the first group of countries that entered to unique currency. Portugal had a behaviour of approximation to CIP (visible in the graphical analysis for CIP differentials), when Portuguese economy had good performances (measured by the growth rate). Italy presents some moments with problems. Besides of similar problems to those countries (speculative EMS attacks), another possible reason is the high public debt and budget deficit, as well as the political instability of the country, with some government changes between 1992 and 1997. Finally, Finland does not present also verification in favour to CIP. It has too a small sample, but shows different behaviour, with differentials increasing in time.

Why does CIP fail in some countries and maturities, if the abolishment of capital controls started in 1992 and ended in 1995? A condition for CIP verification is that assets have to be perfectly comparable. It is not credible, however, that international investors consider that less disciplined budget countries have the same risk level. So, investors demand a high risk premium to invest in some assets. This could be the reason for the failure of CIP in countries which have public debt countries, deficits or any type of political and economic instability (see, for example, Vieira 2003).

Exchange rate instability, verified for example in EMS crisis periods, is another problem that could affect CIP verification. Although we cannot speak directly in this question, since CIP has an instrument for covering exchange risk, the truth is that there may exist political risk, as mentioned by Aliber (1973). Investors, facing this political risk, are afraid to invest due to uncertainty and are afraid of not earning their investments. Additionally, the uncertainty periods could cause an increase in transaction costs (Fratianni and Wakeman 1982), and CIP could fail due this increasing costs.

The fact that interest rates and exchange rates serve in EU as instruments of economic policies is another possible source of CIP failure, since authorities affect interest rates not for market behaviour motives.

Another possible reason, referred by some authors, is data imperfections (see, for example, Taylor 1987). Using non contemporaneous data, that are averages and data which is not exactly the one used by financial agents, could generate inefficiencies at the results level. Another reason could be the different time span considered in the data sample obtained for each country. In spite of CIP failure, we cannot rule out that some convergence behaviour could have happened but that it have not been caught by sample data.

Besides, the violation of CIP, in spite of the absence of any barrier to capital movement, could also be geographically explained by the peripheral condition of Portugal, Spain or Greece. On the other hand, as we said before, it is possible that investors do not consider the assets of these countries as similar to German ones. If they do not trust those assets (because of the motives referred previously, namely speculative attacks or the fact that countries fail with budget discipline, for example), this could lead to less liquidity for these markets, which is another reason for CIP failure, which should not happen with Central European countries that have more liquid markets and that are fiscally more disciplined.

4.2 Financial integration of non-euro countries

In this subsection we analyze the financial integration of non-euro EU countries in the period after the adoption of the euro. Figure 3 shows the results for α. Denmark in all maturities and Sweden for 6 and 12 months maturities are the only countries which have confidence intervals containing the value 0. The confidence intervals for Czech Republic are close to 0. On the contrary, Hungary and United Kingdom have confidence intervals well above 0.

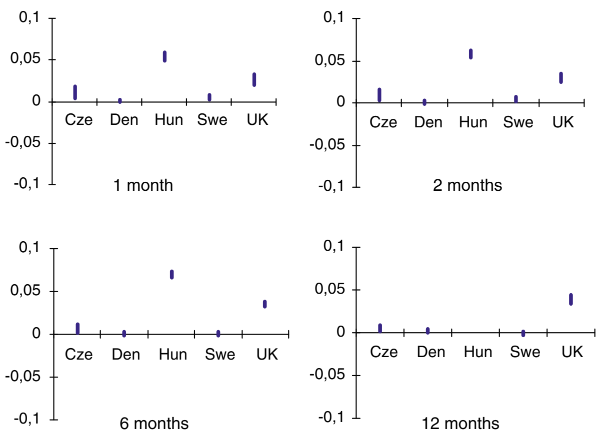

Fig. 3 Confidence intervals (99%) for α for non-euro countries

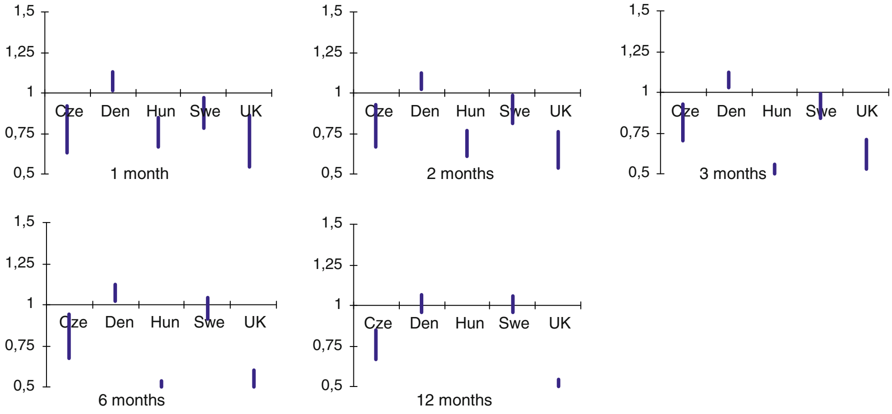

Fig. 4 Confidence intervals (99%) for β for non-euro countries

Figure 4 shows the evidence for β. Sweden (6 and 12 months maturities) and Denmark (12 months maturity) are the confidence intervals that contain the value 1. However, both countries have β close to one in the other maturities.

Regarding the countries that did not adopt the common currency, none of them verifies CIP, except Denmark and Sweden for longer maturities. However, Denmark has values of α, in all maturities, which are according to CIP, meaning that in this country there are no obstacles to capital mobility. On the other hand, the confidence intervals for β only corroborate the CIP for 12 months maturity being slightly above one for the remaining maturities. This may be due to small differences in fiscal treatment. For Sweden, the value of α is meaningful in CIP terms just for longer maturities. The fact that these countries do not follow the same economic rules, because they are out of the common currency, could explain these results. Among the old EU countries the United Kingdom shows the most surprising results since all confidence intervals for α and β suggest the violation of CIP. This may arise from the fact that the economic policies in the UK are independent and differ completely from those which are performed in eurozone. For the new EU members, neither the Czech Republic nor Hungary verify CIP, in any maturity (in spite of the fact that the confidence interval for α is almost close to 0 for the Czech Republic). One first reason could be due to capital controls, which will be reflected in transaction costs, inhibiting the perfect capital allocation (in euro countries these problems do not happen). Effectively, investment barriers by residents in foreign currencies just were lifted in January 2001 for the Czech Republic and in June 2001 in Hungary (Herrmann and Jochem 2003). Another explanation could be the existence of a risk premium (assets are not considered similar): in order to choose these countries' assets, investors ask an additional premium because they do not consider these assets identical to German ones (reference assets). It could be important to study whether CIP is better verified after the control lifting, but results are similar. However, the Czech Republic is closer for the verification of CIP than Hungary. The changes that occurred in the political-economic regimes could explain the obtained results. The financial crisis of the latest months, with several interventions of monetary and policy authorities could also explain it.[10] Another possible explanation can be the underdevelopment of financial markets, for example in terms of lack of liquidity, which restricts the agents face to some possible arbitrage gains. It is expectable that, in the future the covered interest differential will decrease due to a more flexible markets in these countries.

5 Conclusions

In this paper we evaluated the degree of financial integration in EU countries, dividing them into two groups: a group of countries which adhered to euro in 1999 (Austria, Belgium, Finland, France, Greece, Italy, the Netherlands, Portugal and Spain), and a group of countries that do not have the common currency (Denmark, UK, Sweden, the Czech Republic and Hungary).

The motivation for this study is to analyze the capacity of countries to answer to asymmetric shocks, after loosing economic policy instruments, such as the monetary and exchange rate policy. This question is particularly important for EU members that adhered in 2004 and that are preparing to adopt the euro.

For this study we used data on onshore assets, with 1, 2, 3, 6 and 12 months maturities. This analysis used Germany as the reference country. The choice of Germany as the domestic market is due to the central role of this country in the European integration process. We tested covered interest parity using the GME approach. The main advantage of using this approach in our study is the fact that we can apply it to non-stationary and non-cointegrated data even for small samples. It is also important to refer that the possibility to make inference directly from the cointegrated series through the confidence intervals of the GME parameters allows us to draw more robust conclusions about the subject.

Our main results point to the verification of CIP in most of the Central European countries. The South of Europe countries show evidence of CIP only for longer maturities. Among the non-euro countries Sweden and Denmark satisfy CIP for longer maturities and are close to satisfying CIP for the remaining maturities. On the other hand, the UK, the Czech Republic and Hungary violate CIP (the violation is stronger for the UK and for Hungary). Unfortunately, the non availability of data for more countries that joined the EU in 2004 does not allow a better analysis of the condition of these countries in terms of financial integration.

As referred in the beginning, financial integration presents some potential benefits, including the increase of competition between financial institutions and better investment solutions due to the reduction of capital costs. All these factors will conduct, in theoretical terms, to the increase in the welfare of countries. However there are also potential loses, as for example a larger exposition to risk by currencies, which can end in exchange rate instability or even the appearance of crisis. But, in the particular case of EU, one of the important aspects of financial integration in terms of economic pol-

[10] For example, Herrmann and Jochem (2003) conclude, with an econometric analysis from of one linear regression, that differentials are explained by capital controls, by lack of liquidity, by the lack of openness markets to private loans and by real growth rates of loans.

icy is the loss of monetary authority when countries adhere to the common currency, loosing an instrument to face possible asymmetric shocks (although the harmonization of economic structures potentiates the decrease of shocks). In this context, economic revitalization has to be made with fiscal policies. However the power to use fiscal policy is limited due to the Stability Growth Pact.

The new EU members face a big challenge. If these countries decide to adhere to the common currency before the financial integration process is completed, they risk not having the capacity to face eventual asymmetric shocks, increasing the economic divergences in relation to other countries, in the case of East EU countries.

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