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Mr. Wicksell and the global economy: What drives real interest rates?

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Editorial

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Mr. Wicksell and the global economy: What drives real interest rates?*

Michał Brzoza-Brzezina[†] Jesus Crespo Cuaresma[‡]

Abstract

We use a Bayesian dynamic latent factor model to extract world, regional and country factors of real interest rate series for 22 OECD economies. We find that the world factor plays a privileged role in explaining the variance of real rates for most countries in the sample, and accounts for the steady decrease in interest rates in the last decades. Moreover, the relative contribution of the world factor is rising over time. We also find relevant differences between the group of countries that follow fixed exchange rate strategies and those with flexible regimes.

Keywords: Real interest rates, natural rate of interest, Bayesian dynamic factor models.

JEL Classifications: E43, C11, E58

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1 Introduction

In this study we examine the nature of the determinants of short-term real interest rates in open economies. To what extent do domestic conditions matter and to what extent are international factors responsible for the behaviour of interest rates? Does the ongoing process of globalization, characterized in particular by increased capital mobility, change the relative role of domestic and international forces? What is the role of regional exchange rate arrangements? Does the size of the economy matter? How far are we today from the traditional approach to real interest rate determination laid down over a hundred years ago by Knut Wicksell?[1] These questions appear important both for theory and policymaking.

From the theoretical perspective, we still miss a satisfactory theory of interest rate determination in open economies. The literature on microfounded open economy models[2] has advanced substantially over the recent years, so that current models have standard features of the New Keynesian literature like monopolistic competition and nominal rigidities as well as specific open economy factors like home bias in consumption. Nevertheless contemporaneous open economy models still seem far from ready to analyze such detailed issues as capital flows and impediments to international interest rate equalization as important determinants of interest rates. Although our paper is not a direct contribution to this stream of theoretical literature, our results can be used as an input for the construction of models that aim at explaining the behaviour of real interest rates in open economies.

From the policy perspective, the question of whether interest rates are determined by domestic fundamentals or foreign factors seems important as well. In particular in small economies with floating exchange rates it contributes to the discussion of how "independent" monetary policy really is. However, the increasing role of world

[1]The Swedish economist Knut Wicksell (1851-1926) presented a theory of real interest rate determination that still shapes the way most economists think about interest rates. According to Wicksell (1898, 1907) the real rate of interest fluctuates around an unobservable equilibrium level called natural rate of interest. The natural rate equilibrates ex ante savings and investment and equals the marginal product of capital (in a closed economy setting). If the real rate equals the natural rate, prices are stable, if it goes above (below), the economy contracts (expands) and prices fall (rise).

[2]This literature started with the pathbreaking study of Obsfeld and Rogoff (1995). Recent contributions include Clarida et al (2002), Gali and Monacelli (2005), McCallum and Nelson (2000) and Faia and Monacelli (2006).

factors in shaping yield curves and the resulting implications for monetary policy are taken into consideration even by big central banks like the ECB (2007) or the FED (Humpage (2005)). Our contribution quantifies the relative importance of domestic developments (like loosening of the fiscal stance) versus international developments in determining domestic monetary conditions.

Although the literature shows that international forces play a significant role in determining real interest rates in open economies, most empirical contributions do not explicitly quantify the relative strength of international, regional and country-specific factors in the dynamics of the real interest rate. Our study aims at filling this gap. For the first time in this application we use a dynamic factor model[3], which allows us estimating the changing role of world and EMU factors in shaping real short-term interest rates. The factor model approach allows us using a much wider set of explanatory variables than it was the case in most previous studies. Our results are based on a sample of 22 OECD countries over the period 1983-2005 and a wide range of variables that can potentially explain short and long-term movements of real interest rates. We find convincing evidence for an important role of international factors in shaping real interest rates in open economies. In particular the world factor explains almost 48% of the variance of the real short-term interest rate. Moreover world developments lead to a decline of real rates of about 4 percentage points over the period 1983-2005. In our view the low short-term variability of the world factor shows that it describes movements of the underlying natural rate of interest rather than common cyclical developments. We also find an important role for an EMU factor (loaded for EMU members plus Iceland and Denmark). This factor leads to a hike in real interest rates in the 1980's, peaks during the EMS crisis in 1992 and falls somewhat since then. Nevertheless, domestic developments (country factors and idiosyncratic components) still play an important role in shaping real interest rates, especially in economies with floating exchange rates.

A variance decomposition exercise in a rolling time window shows a substantial increase of the variance share of the world factor until the mid 1990's, which probably reflects the steady progress of capital flows liberalization in the OECD countries in the 1980's and early 1990's. The behaviour of the variance share of the EMU factor

[3]Dynamic factor models have been recently used in applications that, as ours, investigate the relative role of domestic and international developments. Kose et al. (2003) extract world, regional and domestic factors to test for the presence of a world business cycle. Mumtaz and Surico (2006) use a similar model to investigate inflation developments in small, open economies.

shows a decreasing importance through time. We find some evidence that the EMU factor mattered more for poor EMS/ EMU members, which shows its importance for cohesion countries. Finally, we aim at verifying the hypothesis whether the role of the world factor is smaller for large economies. Our results give only very limited support for this claim. We find some evidence of a negative relationship between size of the economy and the proportion of the variance of real rates explained by the world factor only in a very small subsample of countries that had liberalized capital flows since 1983.

Our paper is structured as follows. Section 2 briefly reviews the related liteature on the determinants of real interest rates in open economies. Section 3 explains the econometric details of our dynamic factor model and presents the data used. In section 4 we show the empirical results and conclusions are given in section 5.

2 Related literature

The issue of interest rate determination has been taken up in the empirical literature frequently. While most studies concentrate on the role of fiscal developments in the determination of real interest rates, here we concentrate on the part of the literature which explicitly deals with the issue of domestic and international determinants of interest rates. An important contribution from the early literature is Blanchard et al. (1984). The authors seek to explain the high levels of real interest rates in the US in the late 1970's and early 1980's. They note that interest rates are substantially determined worldwide and explain US interest rates with international factors (tight monetary policies and increased productivity). Another important contribution by Barro and Sala-i-Martin (1990) deals explicitly with the world real interest rate. Aggregate data of ten OECD economies are considered as a proxy to the world economy and the role of shocks to desired saving and investment demand is estimated. The results point at a significant role of monetary policy as well as stock returns (proxy for profitability of investment) and oil prices (proxy for desired national savings) in driving world real interest rates. The authors also find that world variables play a dominant role in determining domestic real interest rates. Ford and Laxton (1995) estimate a model for nine OECD countries, where individual real interest rates are regressed on a set of country specific variables and aggregate net public debt-GDP ratio. The authors conclude that the increase of world public debt-GDP ratio substantially boosts real interest rates. At the same time own country debt variables are in most cases insignificant. Orr et al (1995) estimate a panel cointegration model for 17 OECD countries. The coefficients in the long-term (cointegrating) equation show a significant impact of domestic variables (e.g. government deficit, current account balance) as well as of the foreign (G3) real rate. The significance of the latter for many countries is interpreted as showing the impact of international factors on domestic interest rates. Christiansen and Piggot (1997) show that long-term interest rates in ten OECD economies are, to some degree, affected by foreign interest rates. Moreover, the evidence from estimating their models in two subsamples shows that the role of foreign factors increased somewhat over time. Nevertheless, domestic economic fundamentals are found to be key factors shaping movements in long-term interest rates among the countries with floating exchange rates. Spillovers between interest rates between the US and euro area are documented by Chinn and Frankel (2003). They also confirm and important role of domestic fiscal variables on interest rates, but fail to prove the significance of foreign developments. Finally, Desroches and Francis (2006), use a similar methodology to Barro and Sala-i-Martin (1990) and confirm a significant impact of several factors (e.g. labour force growth, economic liberalization, demographic structure and goverment deficits) on savings and investment and, as a consequence, on the world real interest rate.

Another stream of relevant literature relates to testing the real interest rate parity hypothesis. In brief, the hypothesis states that in absence of restrictions to goods and capital flows, real interest rates should converge internationally. Most recent studies (e.g. Chinn and Frankel (1995), Gagnon and Unferth (1995), Ong et al. (1999), Goodwin and Grennes (1994) and Manusco et al. (2003)) find some support for real interest convergence, especially if endogenous structural breaks are allowed for. These studies, however, are based exclusively on interest rate data and ignore fundamental determinants of real interest rates.

3 Econometric methodology: The dynamic latent factor model

3.1 A latent factor model for real interest rates

The proposed model explains the dynamics of the observable variable y_{it} as being determined by k unobservable factors f_{jt}, so that

$$y_{it} = \beta_0 + \sum_{j=1}^{k} \beta_j f_{jt} + \mu_{it}, \tag{1}$$

where μ_{it} follows an AR(p) process, assumed uncorrelated with μ_{gt} for $g \neq i$,

$$\mu_{it} = \sum_{f=1}^{p} \theta_f \mu_{it-f} + \rho_{it}, \tag{2}$$

where ρ_{it} is white noise, uncorrelated with ρ_{nt} for $i \neq n$. The dynamics of the factors are also assumed to be governed by an autoregressive process, so that

$$\begin{aligned} f_{jt} &= u_{jt}, & (3) \\ u_{jt} &= \sum_{i=1}^{q} \phi_i u_{jt-i} + \nu_{jt}, & (4) \end{aligned}$$

where ν_{jt} is assumed to be a serially uncorrelated innovation with constant variance for each factor (a necessary assumption for identification), uncorrelated with ν_{lt} for $l \neq j$.

For illustration (anticipating the empirical application below), assume that there are three factors, a country-specific factor (factor 1) a region-specific factor (factor 2) and a world factor (factor 3). Assume that there are V variables, C countries and R regions, each one containing C/R countries. The matrix of factor loadings corresponding to the model put forward above has therefore the following structure,

$$B = \begin{pmatrix} \beta_1^{1,1} & 0 & \dots & 0 & \beta_2^{1,1} & 0 & \dots & 0 & \beta_3^{1} \\ \beta_1^{2,1} & 0 & \dots & 0 & \beta_2^{2,1} & 0 & \dots & 0 & \beta_3^{2} \\ \vdots & \vdots & \dots & \vdots & \vdots & \vdots & \dots & \vdots & \vdots \\ \beta_1^{V,1} & 0 & \dots & 0 & \beta_2^{V,1} & 0 & \dots & 0 & \beta_3^{V,1} \\ 0 & \beta_1^{1,2} & \dots & 0 & \beta_2^{1,2} & 0 & \dots & 0 & \beta_3^{1,2} \\ 0 & \beta_1^{2,2} & \dots & 0 & \beta_2^{2,2} & 0 & \dots & 0 & \beta_3^{2,2} \\ \vdots & \vdots & \dots & \vdots & \vdots & \vdots & \dots & \vdots & \vdots \\ 0 & \beta_2^{V,2} & \dots & 0 & \beta_2^{V,2} & 0 & \dots & 0 & \beta_3^{V,2} \\ \vdots & \vdots & \dots & \vdots & \vdots & \vdots & \dots & \vdots & \vdots \\ 0 & 0 & \dots & 0 & \beta_2^{V,C/R} & 0 & \dots & 0 & \beta_3^{V,C/R} \\ 0 & 0 & \dots & 0 & 0 & \beta_2^{1,1+(C/R)} & \dots & 0 & \beta_3^{V,1+(C/R)} \\ \vdots & \vdots & \dots & \vdots & \vdots & \vdots & \dots & \vdots & \vdots \\ 0 & 0 & \dots & \beta_1^{V,C} & 0 & 0 & \dots & \beta_2^{V,C} & \beta_3^{V,C} \end{pmatrix},$$

where $\beta_a^{b,c}$ is to be read as "factor loading for factor a in variable b of country c".

It should be noticed that the signs of the loadings and the factors are not separately identified. Geweke and Zhou (1996) and Kose et al. (2004) present alternative identification schemes based on imposing restrictions on the loadings in (1). To identify the signs we follow Kose et al. (2004) by imposing positive loadings on the country factor for each corresponding country, positive loadings for Germany in the world factor and positive loadings for Germany and the UK in each one of the two regional factors included.

Markov-Chain Monte Carlo (MCMC) methods can be used in order to obtain the joint posterior distribution of the parameters and factors in the model given by (1)-(4). Let $\varphi(\Upsilon, F|Y)$ be the posterior distribution of interest, where Υ is the set of parameters in (1)-(4) and F is the set of factors. The posterior can be written as

$$\varphi(\Upsilon, F|Y) = \varphi(Y|\Upsilon, F)\varphi(\Upsilon)\varphi(F), \tag{5}$$

where $\varphi(Y|\Upsilon, F)$ is the likelihood function and $\varphi(\Upsilon)$ and $\varphi(F)$ are the priors on the parameters and the factors, respectively. A Markov chain can be set up by drawing from the conditional densities $\varphi(\Upsilon|F, Y)$ and $\varphi(F|\Upsilon, Y)$, which are significantly simpler than the joint posterior distribution. Otrok and Whiteman (1996) show that, under conjugate prior densities, the parameters in Υ have the usual Normal-inverse Gamma conditional posterior distributions which can be sampled in a straightforward manner, with the exception of the autoregressive parameters of the idiosynchratic factor, whose conditional posterior distribution needs to be sampled using a Metropolis-Hastings algorithm. On the other hand, conditioning on Υ, the posterior of the factors can be computed through the product of the marginal likelihood of the factors and the likelihood given the factors (see Otrok and Whiteman, 1996).

The Markov chain is then built by starting with a draw Υ_1 from $\varphi(\Upsilon|F_0, Y)$ for a given starting value F_0. F_1 is then drawn from $\varphi(F|\Upsilon_1, Y)$ and subsequently Υ_2 is draw from $\varphi(\Upsilon|F_1, Y)$. This process is repeated, leading to realizations of the joint posterior distribution, which is the stationary distribution of the Markov chain.

3.2 Data

Factor models were designed to derive common patterns (factors) from big data sets. Given this feature, applications of factor models do not treat economic theory too restrictively with respect to the choice of data series. In this sense factor models are closer to unrestricted VARs than to structural models, especially those derived from first principles. Since, as mentioned in the introduction, we still miss a good, microfounded theory of interest rate determination in open economies, this feature of factor models seems convenient. It allows us to draw relatively freely both from various theories and from previous empirical studies in determining the data set.

We start by noting that the observed real interest rate can be thought of as consisting of a "fundamental" component (sometimes referred to as the natural rate of interest) and a cyclical component, determined primarily by active monetary policy in the sense that the central bank uses the level of the (nominal) short-term interest rate as their primary policy instrument. Given that prices react sluggishly to changes in the policy rate, in practice the central bank also steers the short-term real interest rate at business cycle frequencies. As to the cyclical component, it is relatively uncontroversial to model it as a function of inflation (or deviation from target) and the output gap (e.g. Taylor (1993)). Since we have data neither on inflation targets nor on potential output for all countries, we use CPI inflation and real GDP growth as approximations.

Turning to the domestic determinants of the "fundamental" component of real interest rates in open economies, the theoretical literature shows several determinants of the natural rate of interest. For instance Woodford (2003) derives the natural rate of interest in a closed economy setting and shows, that it depends among others on government purchases, productivity growth and the rate of time preference. Similar results can be easily derived in a Ramsey or OLG setting (Goodfriend and King (1998)). Several empirical studies confirm the relationship between fiscal variables and real interest rates.[4] Similarly, the relationship between productivity growth and the natural rate was confirmed by Laubach and Williams (2001). We use general government financial balances - GDP ratio and general government gross financial liabilities - GDP ratio as proxies for the fiscal stance, the dependency ratio as proxy for the rate of time preference of the society. Concerning this last variable, the importance of demographic developments in the dynamics of the natural rate of interest has been highlighted recently by several authors. Saarenheimo (2005), for instance, quantifies a decline of real interest rates of the order of 70 basis points due to ageing-related developments. Moreover, we add labour productivity and two other variables that can help track changes in the natural rate: gross national savings - GDP ratio and long-term nominal interest rates.

We also add to our specification factors, which go beyond theoretical, closed economy models, but can be thought of as potential determinants of interest rates and are primarily determined domestically. These factors reflect impediments to international capital flows and prevent interest rates from equalizing worldwide. We augment our data set by the current account-GDP ratio and the conditional standard deviation of the nominal effective exchange rate. These variables can be thought of as proxies for risk carried by foreign investors.

We measure the real interest rate as the short-term (mostly 3-month) money market rate deflated by the current year GDP deflator. We choose the GDP deflator instead of the CPI in order to avoid spurious correlation of the real rate with CPI, which is present in our data set as a separate variable.

Summing up, our data set consists of 11 variables: real short-term interest rate, real GDP growth rate, CPI inflation, current account balance, dependency ratio, general government deficit, general government debt, gross national savings, variability

[4] E.g. Ford and Laxton (1995), Paesani et al (2006), Laubach (2003) and Ardagna et al. (2004). There are, however notable exceptions as well, e.g. Evans (1985) and Evans and Marshall (2001).

of the nominal effective exchange rate, nominal long-term interest rate and labour productivity. None of the series reflects the size of the underlying economy, they are expressed either in growth rates or in relative terms (e.g. as percent of GDP). This means that in our specification small and big countries matter the same. To the extent that country size does not affect capital flows aimed at arbitraging out differences in real interest rates, this specification would be preferred to one where size matters.

The series are collected on annual basis over the period 1983-2005 for 22 OECD countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and the United States. Details on the definitions and sources can be found in the Appendix.

4 Empirical results: world, regional and country factors in real rates

We estimated[5] (1)-(4) in a model with three factors: a world factor, a regional factor aimed at modelling differential dynamics in the group of countries with fixed exchange rates (EMU factor)[6] and flexible regimes and a country factor for each one of our 22 countries in our sample. The results presented below correspond to a design with two lags in the autoregressive processes specified above, a relatively diffuse prior on the variance of the idiosyncratic shock (an inverse-Gamma distribution with shape parameter equal to 5 and scale parameter equal to 0.001), and standard normal priors on the loadings. The priors on the autoregressive parameters are $N(0, 1)$ for the first autoregressive term and $N(0, 0.5)$ for the second autoregressive term (as in Kose et al. (2004)). The results presented are based on 10000 draws of the Markov chain after a burn-in phase of 1000 draws. Several robustness

[5]The estimation codes were written in GAUSS and were based on programmes provided by C. Otrok to accompany the paper Kose et al. (2003).

[6]This factor is loaded by the 11 countries that form EMU at the end of our sample, as well as for Denmark, Iceland and Sweden. The latter countries had exchange rate arrangements oriented to the ECU/ Euro over more than half of our sample (Reinhart and Rogoff 2002). Moving these three countries to the non-EMU group does not substantially alter our results. Alternative specifications with two world factors were also estimated, but did not lead to different results from those shown below.

checks were performed changing the prior design. In particular, allowing for higher autoregressive structures and changing the prior on the idiosyncratic shock variance and on the loadings do not affect the results presented in this section qualitatively.

Figure 1 presents the estimate of the world factor of real interest rates for the period considered,[7] together with the corresponding 33th and 66th percentiles of the posterior distribution. The world factor is estimated with high accuracy and presents a global downward trend which is only interrupted in 1989 by a slight increase in global real rates. This brief change in the overall trend can been attributed to the process of German unification. Owen (1991) summarizes the macroeconomic effects of German reunification and includes estimates of the increase in world interest rates which are attributable to the setting up of the German monetary union. It should be noticed that this global trend in world real interest rates masks marked differences in the differential dynamics of nominal interest rates and inflation. While there is ample evidence of convergence in nominal interest rates in EMU prior to the set up of the monetary union, the evidence is less clear for the rest of OECD countries (see for example Chinn and Frankel, 2003), where stronger differentials in inflation rates and exchange rate changes caused nominal rates to differ substantially across countries in the period studied. A convergence trend in *real* interest rates is however also observable for the group of non-EMU OECD countries in the period considered, which justifies the existence of a world factor driving the global dynamics of real rates.

[INCLUDE FIGURE 1 ABOUT HERE]

Real interest rate differentials across countries can be decomposed in a straightforward manner into differences in the covered interest rate differential, differences in exchange risk premia and expected real depreciation of the national currency (see for example Frankel, 1992). While the first factor is mostly related to national policies concerning barriers to financial integration, the second and third factor (currency premia) have been removed within the group of EMU countries in the process leading to the birth of the monetary union. These structural theoretical differences in the behaviour of real interest rate differentials between the two groups of countries lead us to include an EMU factor in the dynamic factor model. Figure 2 compares the contribution of the world and EMU factor to the change in real rates by plotting

[7] All figures reflect deviations from the mean.

these two components[8]. Interpreting changes in the world factor as being caused by convergence and global dynamics of the natural rate of interest, the estimates imply a decrease in this variable of slightly over 4 percentage points in the last two decades. On the other hand the contribution of the EMU component to real interest rate change is much smaller. It leads to a hike in real rates in the 1980's, peaks during the EMS crisis in 1992 and declines somewhat since then. While the shape of the non-EMU regional factor is similar to that of the EMU factor, the loading for this regional factor is quantitatively irrelevant for the group of non-EMU economies. This implies that the regional factor is picking up differences which are exclusive to the EMU group, which are quantitatively small (compared to the effect of the world factor) and whose importance, as will be shown below, has been decreasing in time.

[INCLUDE FIGURE 2 ABOUT HERE]

Figure 3 presents the decomposition of the real rate into world and country components (the median value of the respective factor multiplied by the corresponding median loading for each country) for six representative economies of the sample.[9] The heterogeneity in the relative importance of each one of the factors for the different economies is exemplified in this decomposition. The volatility of the country component in the real rate series of the US, Japan, Switzerland and Germany contrasts with the minimal importance that this factor has for the dynamics of interest rates in Spain and Greece. In Greece, the EMU factor (not shown in the graph) accounts for the increase of real rates in the first part of the sample, and partly (adding its effect to the world factor) for the decrease in the second part of the sample. In the Spanish case, on the other hand, most of the interest rate dynamics are driven by the world factor.

[INCLUDE FIGURE 3 ABOUT HERE]

Table 1 presents the variance decomposition for the real rates of the countries in the sample. The total variance is decomposed into the part which is explained by

[8]It should be noted that the scale of the factor itself has no direct interpretation. In order to make it interpretable it must be multiplied by the respective loading. In what follows the term "component" will be used to mean a factor multiplied by a loading (median loading in case of several countries).

[9]For the sake of readability of the graphs, we excluded the regional component. Similar graphs for the 22 countries studied can be obtained from the authors upon request.

the world, EMU, country factor and the idiosyncratic shock μ_{it} in (1). On average, the variance of the world factor explains almost 48% of the variation in real rates for OECD countries, and the regional factor accounts for 11% of the variance. A significant part of the variation in real rates is however determined on average by the idiosyncratic shock. The average contribution of around 9% by the country factor hides huge differences in the importance of this factor for explaining the dynamics of real interest rates. The country factor appears very important exclusively for four countries in the sample: Germany, Finland, Iceland and the US (with proportions of the variance of real interest rates explained by this factor over 20%), but is relatively unimportant for the remaining 18 countries, with an average proportion below 5% of the variance explained by the country factor in this subsample. It should be, however noted that almost 32% of the variance remains unexplained (idiosynchratic component). In economic terms we prefer to interpret this part of variance together with the country factor as the variance share of domestic dedvelopments. The importance of domestic developments, as measured by the joint variance share of the country and idiosyncratic components, is substantially higher in countries with floating exchange rates (50%) than in EMU countries (35% including Denmark, Sweden and Iceland).

The regional factor appears relatively more important for the group of countries that formed the monetary union, and in particular it explains a high proportion of the variance in real rates for most of them (over 14% on average including Denmark, Sweden and Iceland, versus less than 5% for the non-EMU group). There are substantial differences in terms of the importance of the regional factor within the sample of EMU countries. In particular, there exists a significant negative relationship between the level of GDP per capita and the proportion of the variance of real rates explained by the EMU factor (see Figure 4, where a scatterplot relating these two variables is presented)[10], which implies that the factor was of special importance for cohesion countries. This result is a natural one taking into account that the reduction in exchange risk premia and stabilization of inflation expectations implied by the run-up to EMU was quantitatively more important for this subgroup of economies.

[INCLUDE TABLE 1 AND FIGURE 4 ABOUT HERE]

[10]Regardless of the statistical significance of the relationship, the result is of course to be taken with care due to the reduced sample size.

We can gain interesting insights on the relative importance of the factors through time by performing the variance decomposition exercise using a ten-year moving window. Figures 5 and 6 present the (median) proportion of variance in real rates explained by the world and EMU factors in overlapping windows of ten years. The results show an increasing importance of the world factor, coupled with a decreasing importance of the regional factor. This reinforces the intuition that the regional factor is capturing the convergence process within EMU countries prior to the formation of the union, and thus proxies the effects of the exchange rate arrangements and inflation stabilization trend on real rates that took place on the way to EMU. Its high role in the early 1990's can be also related to the EMS crisis. One would expect that in such periods of turbulence, co-movements in fundamentals across EMU countries increase, raising therefore the percentage of variance explained by the underlying factor. Starting with the birth of EMU, the world factor appears as the main driving force in real interest rates for OECD economies. Figure 7 illustrates tentatively the fact that the driving force behind the increase in importance of the world factor for the dynamics of interest rate is the degree of financial openness of the economies analyzed. In Figure 7 we present the average financial openness index for the OECD sample proposed by Ito and Chinn (2002, 2007), which summarizes information on the existence of multiple exchange rates and restrictions on current and capital account transactions.[11] The common dynamics of the financial openness index and the importance of the world factor as a driving force in national real interest rates (with a correlation of both series of 0.95 in levels and 0.50 in growth rates) leads us to conclude that the completion of financial liberalization in the early 1990's can be the reason for a stable role of the world factor since the mid 1990's. If this explanation is correct, it may mean that the globalization of real interest rate movements has already come to a barrier formed by factors like home bias or exchange rate volatility.

[INCLUDE FIGURES 5, 6 AND 7 ABOUT HERE]

A relevant question that can be posed in the framework of our analysis is whether the size of the economy plays a role concerning the relative importance of the different factors in explaining developments of the real rate. The results of a simple regression of the proportion of interest rate variance explained by world and regional factors on size of the economy (as proxied by (log) GDP) does not reveal any significant relationship between these variables. Some minor evidence (due to the small

[11] Notice that this index therefore concentrates on *de jure* measures of financial openness.

sample size) can be reported if we constrain the sample to those economies that have fully liberalized capital accounts for the whole period under study (Germany, Netherlands, United Kingdom, Japan, Canada and the US), as can be seen in the scatterplot in Figure 8. This preliminary result deserves further scrutiny in a theoretical setting where structural relationships are modelled explicitly, which is not in the scope of this study.

[INCLUDE FIGURE 8 ABOUT HERE]

5 Conclusions

In this paper we employ a Bayesian dynamic factor model to investigate the relative role of domestic and international factors in determining real interest rates in open economies. Our model is applied to a panel of 22 OECD economies over the period 1983-2005. Our specification allows for a common (world), regional (EMU) and country specific factors to influence real short-term interest rates.

We find an important role of the world factor in shaping real interest rates. The factor accounts for almost 48% of the variance of real rates and contributes to an overall decline of real rates of approximately 4 percentage points between 1983 and 2005. Moreover, as evidenced by the variance decomposition in a rolling time window, the role of the world factor is also increasing over time, at least until the mid 1990's. Our preferred explanation for the stabilization of the variance share in the last decade is the finalization of capital flows liberalization in our sample economies in the early 1990's. If this explanation is correct, it may mean that the globalization of real interest rate movements has already come to a barrier formed by factors like home bias or exchange rate volatility.

We also find a significant role for the EMU factor, which explains 14% of the variance in real rates. However we find its role decreasing over time, with only a slight hike since creation of the monetary union. In our view, this shows the importance of the factor in the run-up to the euro, especially in cohesion countries, where its relative importance is highest.

Despite the leading role of the world factor, country specific developments still play a significant role in shaping real interest rates. The average share of the country and idiosyncratic components is 40% and it is substantially higher in floating countries

(50%) than in EMU countries (35%). This shows that despite increased capital mobility, monetary authorities in floating exchange rate countries still have the possibility to shape real short-term interest rates.

Finally, we ask the question whether the relative role of international and domestic factors changes with the country size. There is no evidence of such relationship in the whole sample. If we restrict the sample to countries that had fully liberalized capital flows since 1983 we find a clear negative relationship, but this evidence should be taken very cautiously, since it is based only on a six country sample. We think that this issue deserves deeper investigation in further studies.

Appendix: Data definitions and sources

Folowing data series were used in the dynamic factor model.

Name	**Definition**	**Source**
Real interest rate	3 month money market rate deflated by the GDP deflator	OECD
GDP	Annual growth rate of real gross domestic product	OECD
CPI	Annual growth rate of the consumer price index	OECD
Current account	Current account balance as percent of GDP	OECD
Dependency ratio	For Australia, Canada, Italy, Japan, New Zealand and United States dependency ratio = ((population - working age population)/ population). For other countries age dependency ratio 2nd variant (population aged 0-19 or 60 and more to total population).	Population, working age population - OECD; age dependency ratio - Eurostat;
Government deficit	General government financial balances as percent of GDP	OECD; New Zealand - IMF; Switzerland - KOF
Government debt	General government gross financial liabilities as percent of GDP	OECD; Australia - own estimates based on Treasury data; New Zealand - Treasury; Switzerland - KOF
Gross national savings	Gross national savings as percent of GDP	OECD; Germany - IMF
Variability of exchange rate	Conditional standard deviation of the nominal effective trade-weighted exchange rate. Estimates obtained from GARCH(1,1) models on monthly data.	Own estimates based on IMF data
Nominal interest rate	Interest rate on 10-year government bonds	OECD; Portugal and Ireland - Eurostat; Greece - own estimates based on Eurostat data
Labour productivity	Annual growth rate of real GDP over employment	1983-1989: own calculations based on OECD data, 1990-2005: OECD

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	Proportion of variance in real rates explained by			
	World factor	Regional factor	Country factor	Idiosyncratic shocks
Australia	0.534	0.006	0.119	0.336
Austria	0.411	0.193	0.025	0.355
Belgium	0.769	0.010	0.020	0.195
Canada	0.599	0.009	0.006	0.376
Denmark	0.782	0.030	0.042	0.140
Finland	0.543	0.016	0.138	0.296
France	0.618	0.094	0.046	0.235
Germany	0.222	0.032	0.350	0.391
Greece	0.071	0.707	0.008	0.201
Iceland	0.078	0.254	0.243	0.425
Ireland	0.673	0.009	0.005	0.302
Italy	0.742	0.069	0.013	0.171
Japan	0.558	0.197	0.047	0.193
Netherlands	0.741	0.010	0.004	0.235
New Zealand	0.372	0.018	0.014	0.587
Norway	0.424	0.006	0.164	0.400
Portugal	0.168	0.453	0.005	0.365
Spain	0.716	0.014	0.026	0.235
Sweden	0.406	0.130	0.030	0.426
Switzerland	0.295	0.119	0.183	0.393
United Kingdom	0.510	0.029	0.013	0.438
United States	0.270	0.015	0.462	0.248
Average	0.477	0.110	0.089	0.316

Table 1: Variance decomposition: Median proportions

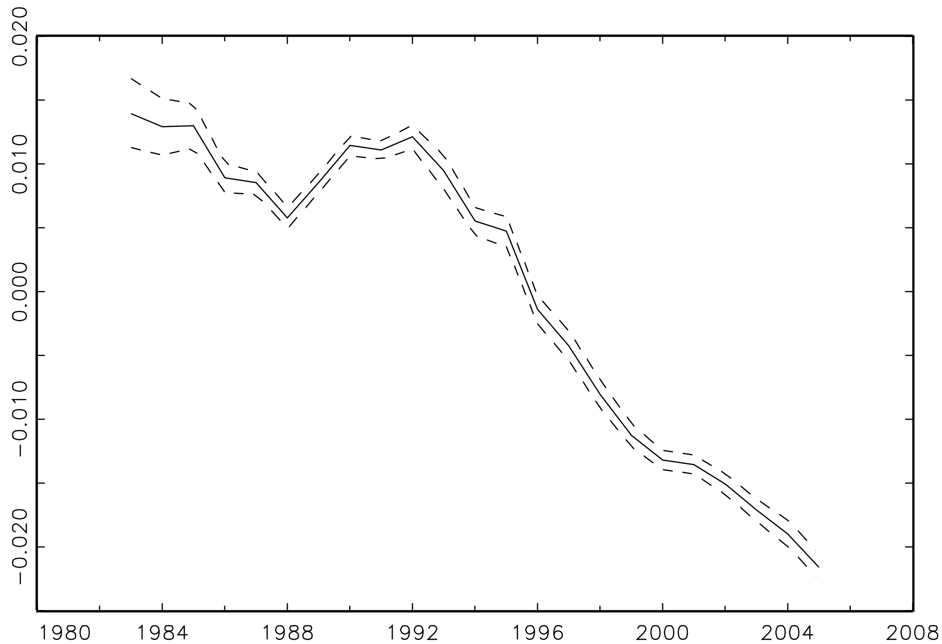

Figure 1: World factor of real interest rates

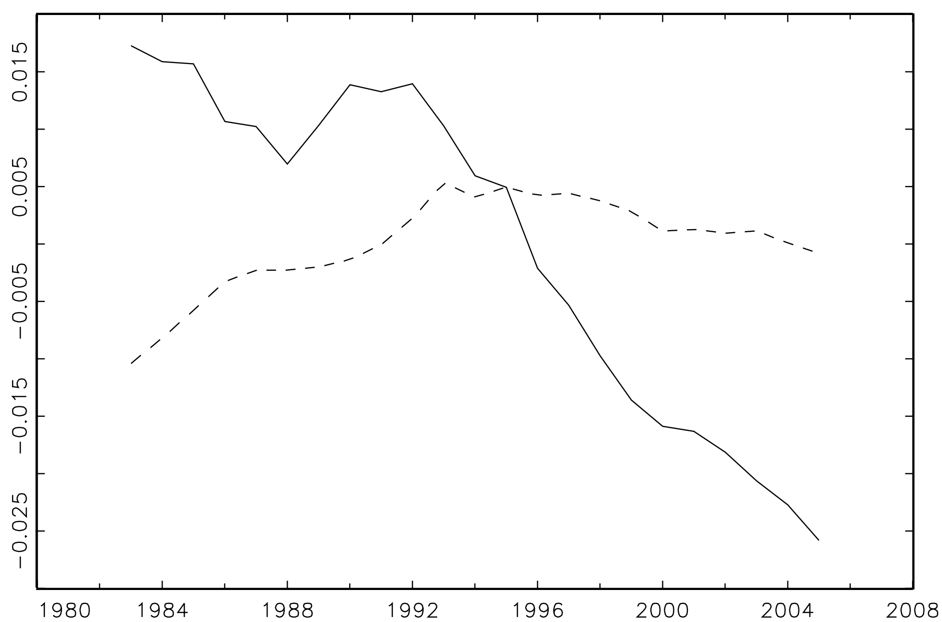

Figure 2: World and EMU components of real interest rates

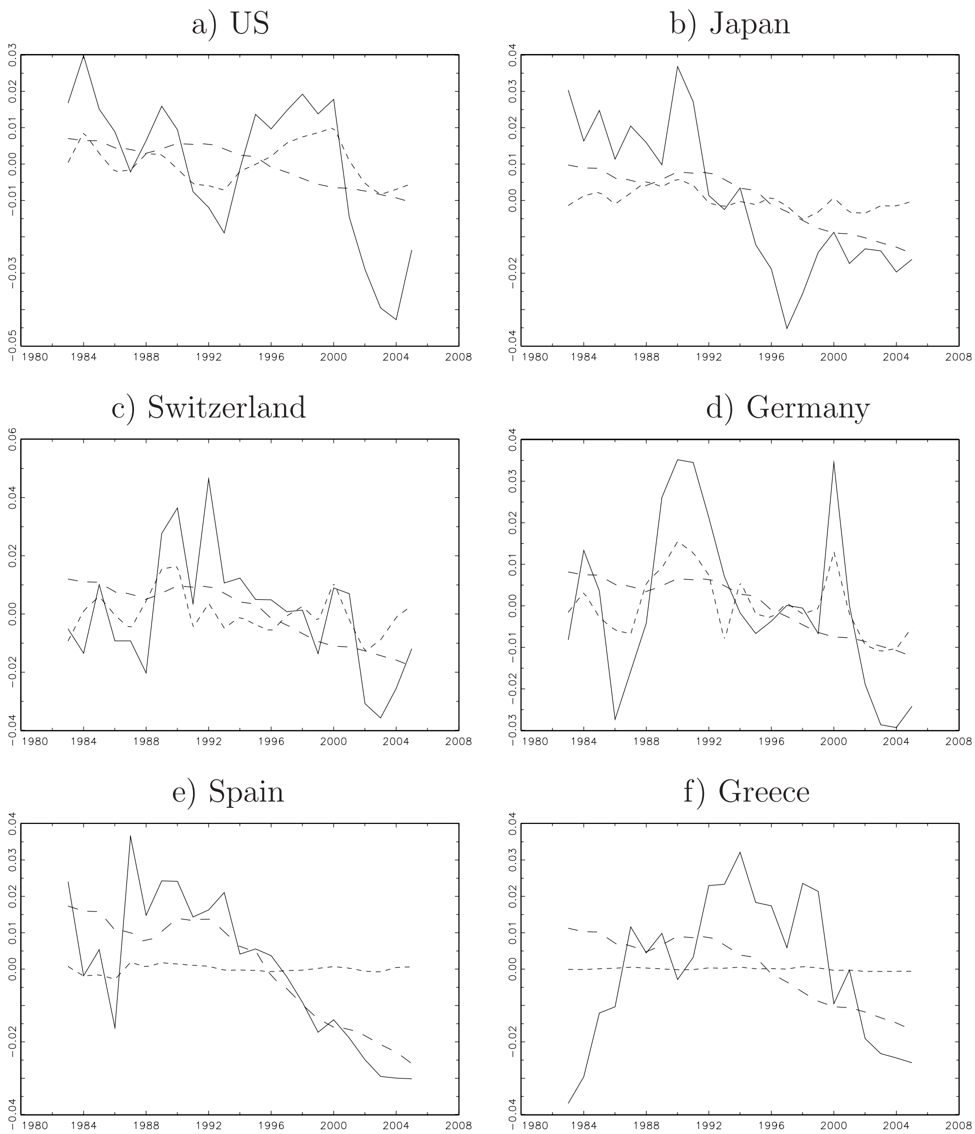

Figure 3: Real interest rates (bold line): Factor decomposition (world component: long dashed line, country component: short dashed line)

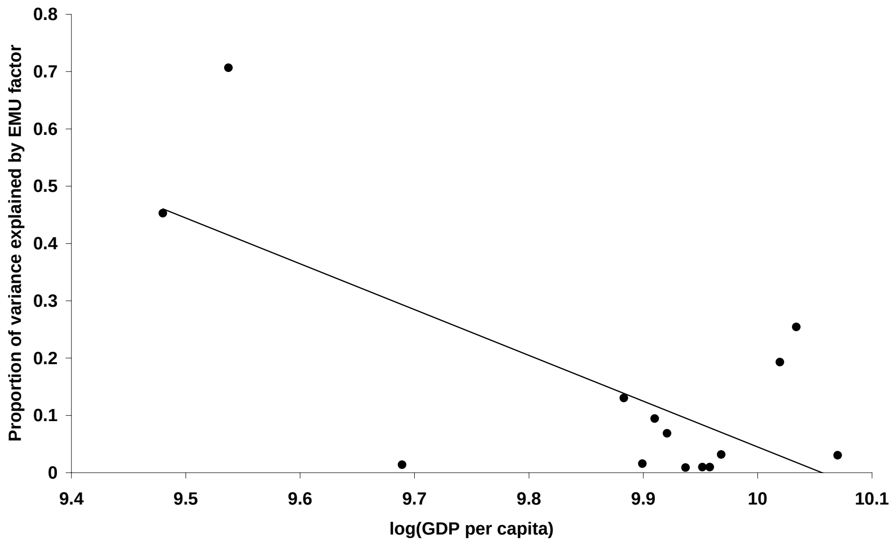

Figure 4: Proportion of variance explained by EMU factor versus GDP per capita

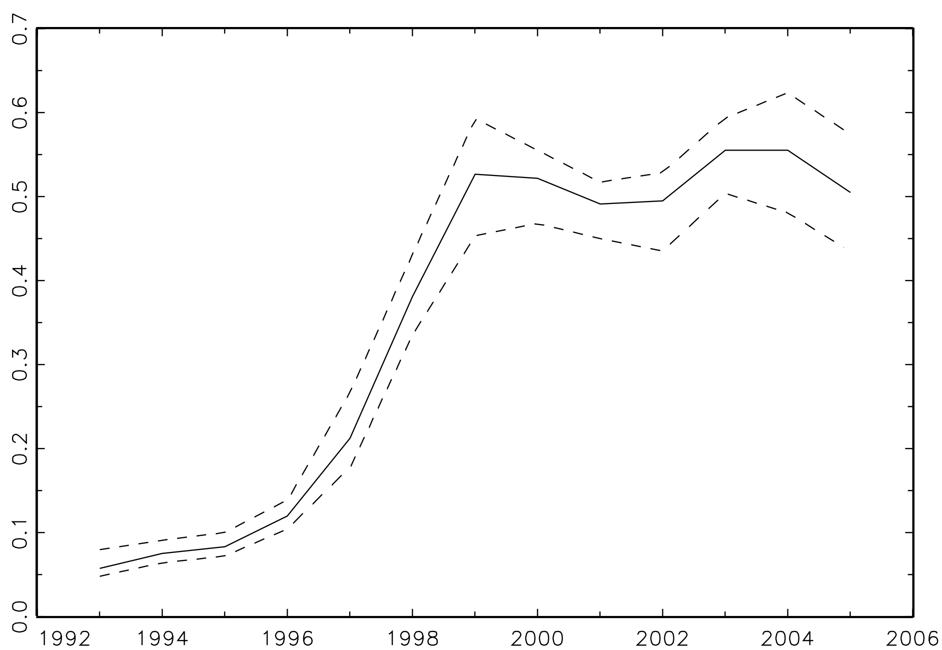

Figure 5: Proportion of variance explained by world factor: 10 year rolling window

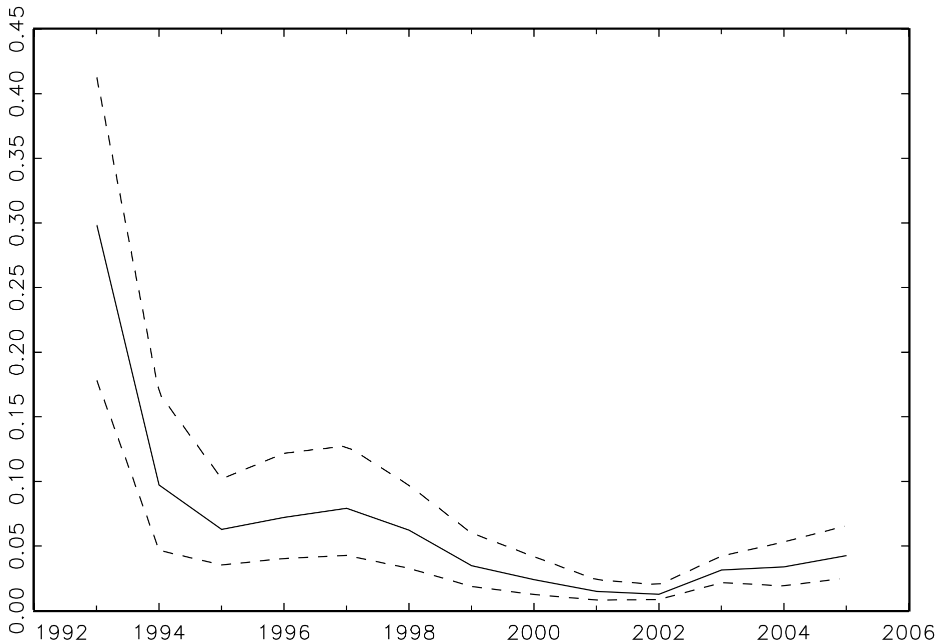

Figure 6: Proportion of variance explained by EMU factor:10-year rolling window

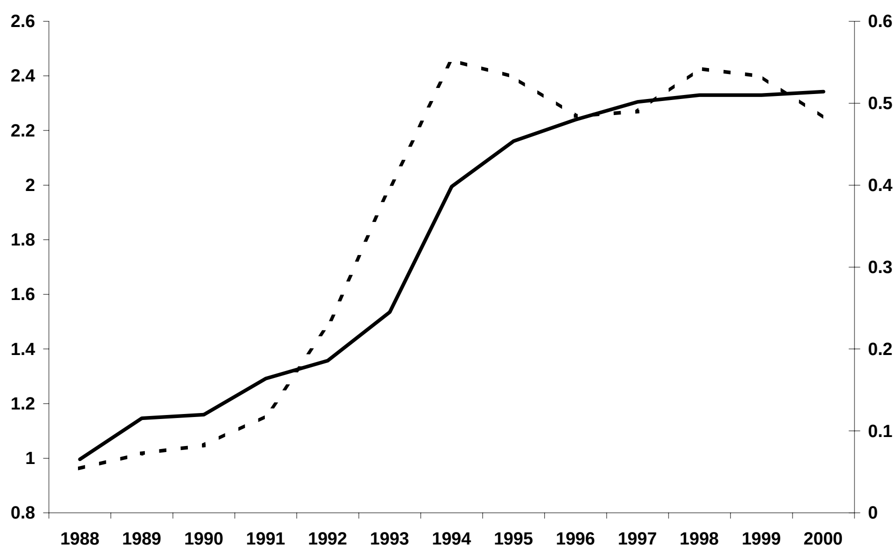

Figure 7: Financial liberalization index: OECD average (bold line, left axis) versus variance explained by world factor (dashed line, right axis)

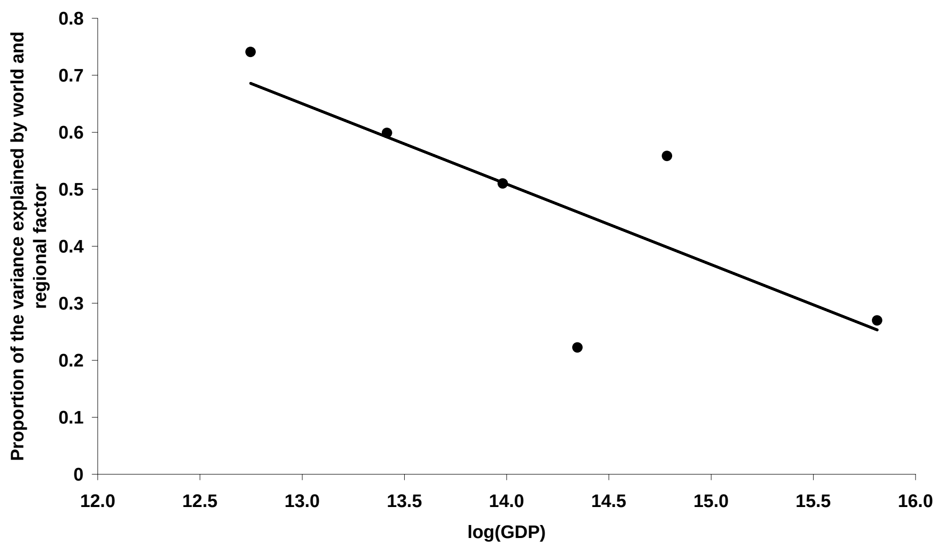

Figure 8: Proportion of variance explained by world and regional factor versus GDP: fully liberalized economies

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