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Does Fiscal Policy Affect Interest Rates? Evidence From A Factor-Augmented Panel

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Does Fiscal Policy Affect Interest Rates? Evidence From A Factor-Augmented Panel

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Abstract

This paper reconsiders the effects of fiscal policy on long-term interest rates employing a *Factor Augmented Panel (FAP)* to control for the presence of common unobservable factors. We construct a real-time dataset of macroeconomic and fiscal variables for a panel of OECD countries for the period 1989-2012. We find that two global factors—the global monetary and fiscal policy stances—explain more than 60 percent of the variance in the long-term interest rates. Compared to the estimates from models which do not account for global factors, we find that the importance of domestic variables in explaining long-term interest rates is weakened. Moreover, the propagation of global fiscal shocks is larger in economies characterized by macroeconomic and institutional weaknesses.

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Keywords: Fiscal Policy; Interest rates; Real time data; Cross-sectional dependence; Heterogeneous panels

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I. INTRODUCTION[1]

The global financial crisis and its adverse effects on the budget deficits of advanced economies have revived the debate on the link between fiscal policy and interest rates. The strong convergence observed among advanced countries' interest rates before the crisis came to a halt when the global recession provoked a substantial deterioration of sovereigns' fiscal positions. Financial markets then suddenly started to discriminate between borrowers. These developments seem to suggest that: (1) under increased capital market integration, interest rates and risk premia tend to follow global factors rather than domestic variables; (2) nonetheless, the effects stemming from fiscal policy can be large and substantial when sovereigns face a common adverse budgetary shock. The objective of this paper is thus to analyze the impact of fiscal policy on sovereign interest rates in a broad panel of OECD countries, using a framework which can accommodate both the existence of common sources of fluctuations as well as heterogeneous responses to global shocks. In particular, we want to answer the following questions: In a context of high financial integration, do global factors matter more than domestic factors? And how do global factors affect the cost of borrowing?

In this paper we consider the effects of fiscal policy on long-term interest rates. We follow and expand the existing literature along two dimensions. Starting from the result according to which the relationship between fiscal policy and interest rates becomes statistically significant when using fiscal projections rather than actual data (Reinhart and Sack, 2000; Canzoneri et al., 2002; Gale and Orszag, 2004; Laubach, 2009; Afonso, 2010) we construct a real-time dataset based on macroeconomic projections collected from several vintages of the OECD economic outlook. The use of real time data serves two different purposes: (i) it takes into account the forward looking behavior of financial markets; (ii) it avoids the possible reverse causality problem from interest rates to fiscal policy decisions which arise from the use of actual data. Collecting fiscal projections from an independent agency like the OECD rather than official government plans presents also a further advantage. As shown by Beetsma and Giuliodori (2010) and Cimadomo (2008) governments' released budget plans tend to be overly optimistic in terms of expected fiscal outcome; on the other hand, the forecasts released by an independent body such as the OECD are less prone to this 'optimistic bias'.

Given the evidence of strong cross-country correlation in interest rates, we implement an estimation method called *Factor Augmented Panel* (FAP)—originally developed by Giannone and Lenza (2008)—which explicitly accounts for the presence of unobserved global factors that affect interest rates simultaneously in all countries. By controlling for the presence of global factors this method allows us to estimate the effects of the idiosyncratic components of fiscal policy on interest rates. Moreover, it ensures unbiased estimates in case the effects of global shocks are heterogeneous across countries. Finally, it has the desirable property of allowing us to identify the global factors with observable data, and analyze the

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determinants of the cross-country differences of their effects on interest rates. Overall, we find that using standard panel techniques provides results that are similar to those found in previous literature. However, once we implement the FAP method to account for the presence of global factors, we find that the estimated effect of budget deficits on long-term interest rates becomes smaller in magnitude and insignificant, while the effect of public debt remains significant and of about 1 basis points for a 1 percent increase in the debt to GDP ratio.

The FAP technique also allows us to analyze in more detail the nature and the quantitative importance of the common factors. Our results show that long-term interest rates are mainly driven by two global factors, which explain more than 60 percent of their variance and can be interpreted as the aggregate fiscal and monetary policy stances of the countries in the sample. This suggests that the fiscal consolidations and the reductions of monetary policy rates which took place almost simultaneously across advanced economies in the nineties can explain the observed decline and convergence of long-term interest rates. However we also show that long-term interest rates respond heterogeneously to the aggregate fiscal stance. In particular, after an increase in the aggregate deficit long-term interest rates increase more in small peripheral countries or countries characterized by a low initial level of financial integration, and macroeconomic or institutional weaknesses.

The paper proceeds as follows. In Section II, we provide a brief review of the literature. In Section III we discuss our dataset and its properties, which justify our estimation technique. In Section IV we derive the estimating equations and explain the FAP methodology. In Section V we present and discuss results. In Section VI we analyze the heterogeneity in the country specific responses to global shocks, while in Section VII we report results from using different specification. In Section VIII we do some robustness checks. Section IX concludes.

II. Literature Review

There is a vast empirical literature on the effects of fiscal policy on long-term interest rates and sovereign spreads but, despite the large production, the results are still mixed. In spite of the mixed results, we can identify few areas of consensus: (1) studies that employ measures of expected rather than actual budget deficits as explanatory variables tend to find a significant effect of fiscal policy on long-term interest rates (Feldstein, 1986; Reinhart and Sack, 2000; Canzoneri et al. 2002; Thomas and Wu 2006; Laubach, 2009); (2) the effect of public debt appears to be non-linear (Faini, 2006; Ardagna et al. 2007); (3) the effects of public debt are quantitatively smaller than those of public deficit (Faini, 2006; Laubach, 2009); (4) the effects of global shocks and in particular “global fiscal policy” seem larger than the effects of domestic shocks (Faini, 2006; Ardagna et al. 2007; Baldacci and Kumar 2010; Alper and Forni 2011); (5) as for sovereign spreads, they are found to respond strongly to “global risk aversion” both in advanced countries (Codogno et al., 2003, Geyer et al., 2004; Bernoth et al., 2004 and Favero et al., 2009) and in emerging markets (Gonzalez-Rosada and Levy-Yeyati, 2008; Ciarlone et al., 2009).

This paper estimates the effects of fiscal policy on interest rates in panel of 17 OECD countries. The papers more closely related to our work are Reinhart and Sack (2000), Chinn and Frankel (2007), Ardagna et al. (2007). As Reinhart and Sack (2000) and Chinn and

Frankel (2007) we use fiscal projections instead of actual data. The choice of the regressors, instead, closely follows Ardagna et al. (2007).

Reinhart and Sack (2000) estimate the effects of fiscal policy in a panel of 19 OECD countries using annual fiscal projections from the OECD. They find that a one percentage increase in the budget deficit to GDP increases interest rates by 9 basis points in the OECD and by 12 basis points in the G7. The authors, however, do not consider the level of debt and do not control for global factors. Chinn and Frankel (2007) focus on Germany, France, Italy and Spain, while also considering evidence for UK, U.S. and Japan. They focus on the effect of public debt and also use fiscal projections from the OECD. They find that the effect of public debt is significant only when they include the US interest rate as a proxy for the "world" interest rate. Ardagna et al. (2007) estimate the effects of fiscal policy in a panel of 16 OECD countries using yearly data, from 1960 to 2002, but do not use fiscal projections. They find that a one percentage increase in the primary fiscal deficit to GDP increases long-term interest rates by 10 basis points, a result similar to the one in Reinhart and Sack (2000). Contrary to Reinhart and Sack (2000), Ardagna et al. (2007) also control for the level of debt, finding evidence of non-linearity: interest rates increase if the level of debt to GDP is higher than 60 percent. They also include cross-sectional averages of the fiscal variables to control for the presence of global factors. They find that average debt and average deficit have statistically significant effects on long-term interest rates, with magnitudes between 20 and 60 basis points.

Our main difference from the literature lies in the empirical strategy. We argue that to properly identify the effects of fiscal policy we need a robust framework that allows us to isolate idiosyncratic effects from common factors. While the previous literature has acknowledged the relevance of global shocks as a driver of national interest rates, they have constrained their effects to be homogeneous across countries. We show that this assumption might lead to biased and inconsistent estimates. Our empirical model follows the insights of recent literature that analyzes cross-sectional dependence in large panel. Cross-sectional dependence[2] arises whenever the units of observations are simultaneously and heterogeneously affected by common unobserved shocks. The recent econometric literature provides different methodologies to deal with this type of structure in the data (Bai, 2009; Pesaran, 2006). In this paper, we follow the methodology proposed originally by Giannone and Lenza (2008) in their study of the Feldstein-Horioka puzzle. They show that the high correlation between domestic savings and investments found in previous studies vanishes once the panel takes into account global shocks with heterogeneous transmission. In Section IV we provide a more detailed explanation of the methodology.

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[2] Following the terminology of Chudik, Pesaran and Tosetti (2011), we deal with *strong* instead of *weak* cross-sectional dependence.

III. Data Description and Properties

A. Data

Our database contains real-time semi-annual forecasts of macroeconomic and fiscal variables taken from the December and June issues of the OECD's Economic Outlook, (EO), and covering the period from 1989 to 2012. The countries included are 17: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Norway, Netherlands, Spain, Sweden, United Kingdom and United States.

In our dataset, the projected horizon of the forecast is always one year ahead. So for example, for the June and the December issue of each year t, we collect the projections for year $t + 1$.[3] The June and the December issues of the EO release forecasts with different information sets. Following the terminology of Beetsma and Giuliodori (2008), the December issue contains a forecast related to the planning phase of the budget law, while the June issue contains a forecast related to its implementation phase. In spite of this difference, we pool them together to achieve higher degrees of freedom. However we checked that splitting the sample according to the June or December issue does not affect our main results.[4]

As for the dependent variable we use the realized ten years yield on sovereign bonds (r_{it}). We construct this variable using the value of the interest rates observed in the month after the release of the forecast: January for the December issue and July for the June issue. This approach is useful because the forecasts on fiscal variables are likely to take into account current market conditions and the level of interest rates. Under the assumption that financial markets are forward looking and are able to incorporate rapidly all the available information, sampling interest rates after the release of the forecasts reduces the issue of reverse causality. Data on interest rates are taken from Datastream (Appendix B).

As indicators of fiscal stance, we use the expected primary deficit ($pdef$) and the expected public debt ($debt$) all measured as shares of previous period GDP.[5] We use primary the deficit instead of total deficit to avoid the problem of reverse causality (since total deficit contains also the total interest payments), while debt is measured as the total gross financial liabilities of the general government.[6] Table 1 reports the descriptive statistics of the variables of interest.

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[3]Starting from 1996, the OECD publishes also projections for year $t + 2$ in the December issue; for internal consistency, we only keep the one year ahead projection.

[4]Results are available upon request.

[5]We also used current period GDP and trend GDP measured with a Hodrick-Prescott filter as a scaling variable obtaining similar results.

[6]A better measure could be the Net Financial Liabilities of the General Government. However, this measure is still subject to substantial harmonization problems since it is not yet established how to compare the value of governments' assets across countries. An even better measure would include contingent liabilities. However, there is an ever bigger issue on how to compare these items across countries. This is though an interesting area of future research.

B. Properties

The importance of the cross-sectional correlation among our variables of interest can be observed when looking at the behavior of long-term interest rates in our sample (Figure 1). We have grouped the countries from the right in the following way: first are the Scandinavian countries (Norway, Sweden, Denmark); then the EMU countries (Finland, Ireland, Italy, Spain, Austria, Belgium, Netherlands, France, Germany); then the Anglo-Saxon countries (Australia, Canada, the UK) and finally Japan and the U.S. Long-term interest rates are higher at the beginning of the sample in all countries. Starting from 1994, there appears to be a strong convergence, with an especially marked reduction of the interest rates in the peripheral EMU countries (Ireland, Italy, Spain). Nevertheless, the convergence is observed also outside the EMU. Interest rates remain low throughout the 2000 particularly so in Japan, and they begin to diverge only during the crisis.

This evidence is in line with the hypothesis that countries might be subject to the same shocks causing a co-movement in interest rates. To verify the importance of common factors, we test for the presence of cross-sectional dependence in long-term interest rates and the macroeconomic variables of interest using Pesaran's (2004) CD test. For a panel of N countries, the test statistic is constructed from the combinations of estimated correlation coefficients. Under the null of cross-sectional independence the statistic is distributed as a standard Normal. For all the variables in our sample we find strong evidence of cross-sectional dependence (Table 2).[7]

We also conducted standard stationarity tests (Table 3). We first implement the Pesaran's (2007) test for panel unit root and we find indication that almost all the variables can be treated as stationary. There is mixed evidence with respect to the fiscal variables. We therefore implement the Moon and Perron's test (2004) which accounts for multifactor structure, which gives evidence of stationarity for all the variables.[8] We thus conclude that all the variables in our panel can be treated as stationary.

IV. Econometric Specification and Estimation Strategy

In this section we describe the FAP technique and discuss its properties and estimation procedure. We derive the estimating equation starting from a data generating process in which a set of global unobservable factors simultaneously determine interest rates and macroeconomic variables. This feature generates the pattern of cross-sectional dependence

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[7]This test is based on the following set of hypotheses: $\begin{cases} H_0: \rho_{ij} = \rho_{ji} = corr(u_{it}, u_{jt}) = 0 \quad \text{for } i \neq j \\ H_1: \rho_{ij} = \rho_{ji} \neq 0 \quad \text{for some } i \neq j \end{cases}$ Given the estimated pairwise correlation coefficients of the residuals: $\hat{\rho}_{ij} = \hat{\rho}_{ji} = \frac{\sum_{t=1}^{T} \hat{u}_{it}\hat{u}_{jt}}{\left(\sum_{t=1}^{T} \hat{u}_{it}^2\right)^{1/2}\left(\sum_{t=1}^{T} \hat{u}_{jt}^2\right)^{1/2}}$ Pesaran (2006) showed that the following statistic: $CSD = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N} \hat{\rho}_{ij}\right)$ is distributed as a *Standard Normal.* The asymptotic distribution of the test statistic is however developed for $N > T$.

[8]We were unable to implement the Pesaran, Smith and Yamagata (2008) test, given that our time series is too small.

observed in the data (see Section III). In the next section we discuss the econometric model and show—as in Giannone and Lenza (2008)—that standard estimation techniques are likely to yield biased estimates whenever the effects of global factors are truly heterogeneous across countries. In Section IV.B we discuss the estimation of the unobserved factors and refer the reader to Appendix A for more details.

A. The Econometric Model

Let r_{it} and x_{it} be respectively the long-term interest rate and a set of observable variables, with $(i = 1, \dots, N; t = 1, \dots, T)$. When looking for the determinants of interest rates the natural starting point is a linear model of thetype:

$$r_{it} = \alpha_i + \beta x_{it} + \varepsilon_{it} \tag{1}$$

where the country intercepts α_i capture time invariant heterogeneity across countries. This is the equation estimated for example by Reinhart and Sack (2000) in a panel of 20 OECD countries. The estimates of the β coefficients are however unlikely to be informative of the effect of x_{it} on y_{it} if these are simultaneously determined by a set of unobserved global factors. This is the case for open and integrated economies where there exist common sources of fluctuations - such as common business cycle shocks. A common shock would in fact jointly determine the reaction of monetary and fiscal authorities across countries and hence the level of interest rates. Following Giannone and Lenza (2008) we therefore assume a factor structure of the type:

$$\begin{cases} r_{it} = \sum_{k=1}^{q} \lambda_{ki}^{r} f_{kt} + r_{it}^{ID} \\ x_{it} = \sum_{k=1}^{q} \lambda_{ki}^{X} f_{kt} + x_{it}^{ID} \end{cases} \tag{2}$$

in which observable quantities $\{r_{it}, x_{it}\}$ are a function of a set of q unobservable global factors $\{f_t^k\}_{k=1}^{q}$ with heterogeneous impact in each country $\{\lambda_{ki}^{r}, \lambda_{ki}^{X}\}_{k=1}^{q}$, $\forall i: 1, \dots, N$.

Given this data generating process, an accurate estimate of the effect of macroeconomic and fiscal policy variables on interest rates should be based on the idiosyncratic components only:

$$r_{it}^{ID} = \alpha_i + \tau_t + \beta x_{it}^{ID} + u_{it} \tag{3}$$

Equation (3) cannot be estimated because the idiosyncratic components $\{r_{it}^{ID}, x_{it}^{ID}\}$ are unobservable, but we can use (2) to substitute the idiosyncratic component in (3) and rewrite the equation in terms of observable quantities and global factors:

$$r_{it} = \alpha_i + \tau_t + \sum_{k=1}^{q} (\lambda_{ki}^{r} - \beta\lambda_{ki}^{X})\, f_{kt} + \beta x_{it} + u_{it}$$
$$r_{it} = \alpha_i + \tau_t + \sum_{k=1}^{q} \delta_{ki}\, f_{kt} + \beta x_{it} + u_{it} \qquad (4)$$

By taking explicitly into account the global factors $\{f_t^k\}_{k=1}^{q}$, (4) allows us to estimate the relationship between the idiosyncratic components of the variables of interest.

Consistent estimates of the common factors, allow an estimation of the β by standard panel techniques. In Section 4.2 we show that these can be obtained extracting principal components from the set of observable variables of equation (4), $\{r_{it}, x_{it}\}_{i=1,\ldots,N;t=1,\ldots,T}$. This estimation technique goes under the name of *Factor Augmented Panel* (FAP).

When the data generating process is represented by the system in (2), we can obtain unbiased estimates of the coefficients β only if we allow the factors to have heterogeneous impact across countries ($\delta_{ki} \neq \delta_{kj}$). This aspect has been often ignored in previous studies. In fact, when tackling the issue of common unobserved factors the literature has mainly pursued different paths. The first approach (Chinn and Frankel, 2007) consists of finding an a priori observable variable (or a subset of variables) which might affect contemporaneously the interest rates across countries, and introduce it directly in the panel:

$$r_{it} = \alpha_i + \beta x_{it} + \gamma z_t + \xi_{it} \qquad (5)$$

where the variable (z_t) is the vector (or matrix) of identified common factors. Alternatively, unobserved factors have been accounted for by introducing time effects. This would lead to the estimation of the following model (Ardagna et al. 2007):

$$r_{it} = \alpha_i + \tau_t + \beta x_{it} + \xi_{it} \qquad (6)$$

This is equivalent to assuming that in each time period there is a common shock which affects homogeneously countries' interest rates.

Differently from the FAP specification in (4), equations (5) and (6) impose homogeneous effects of the global factors, represented either by the common regressors z_t or by the time effects τ_t. If however the unobserved factors have truly a heterogeneous effect across countries, then the country specific components will become part of the error terms of (5) and (6). Therefore, if the factors are correlated with the observable variables—as implied by (2)—equations (5) and (6) will suffer from endogeneity and produce biased estimates.

B. Estimation Strategy

To obtain consistent estimates of the sets of unobservable factors we follow Giannone and Lenza (2008) and use principal components. This is a general procedure that can be applied whenever in a linear regression the variables have a factor structure. It consists of taking the entire set of dependent and independent variables for all the N cross sections and, after stacking them together in a single matrix, apply principal components.

Hence to estimate the unobserved factors of equation (4), we collect all the variables $\{r_{it}, x_{it}\}_{i=1,..,N;t=1,...T}$ in a matrix W^r:

$$W^r = [r_{it}^1, \dots, r_{it}^N; x_{it}^1, \dots, x_{it}^N]$$

If the elements x_{it}^j have dimension $T * k$, the matrix W^r will be of dimension $T * (N(k+1))$.[9]

The Principal Component Analysis (PCA) of W^r produces set of $N(k+1)$ orthogonal vectors which are the eigenvectors obtained from the eigenvalue-eigenvector decomposition of the covariance matrix of W^r. The eigenvectors are linear combinations of the columns of W^r. However, under the assumptions that common factors are pervasive and that idiosyncratic shocks are not pervasive, the eigenvectors are a consistent estimate of the common factors, with consistency achieved as the dimensions of W^r increase. Of all the $N(k+1)$ eigenvectors extracted from W^r we keep the first q, which are the ones associated with the highest proportion of explained variance. This procedure ensures that the q factors are indeed those elements which explain the bulk of the correlation among all of our data series and are therefore responsible for their observed co-movements.
The first two eigenvectors explain 68 percent of the panel variance with the third one contributing for less than 10 percent (see Table 4).

Following Giannone and Lenza (2008), we therefore take into consideration only the first two factors. Using these two estimated vectors we can rewrite equation (4) as:

$$r_{it} = \alpha_i + \tau_t + \beta x_{it} + \delta_{1i}\hat{f}_{1t} + \delta_{2i}\hat{f}_{2t} + \omega_{it} \qquad (7)$$

Notice that, while we allow the response to the common factors (δ_{ik}) to vary across country, we impose the coefficients β to be common to keep the results consistent with those obtained in previous studies. The economic interpretation of the estimated factors $\hat{f}_{1t}$ and $\hat{f}_{2t}$ is important for the scope of our analysis. In Appendix A we show that these two elements can be interpreted as the average monetary policy and the average fiscal policy stances of the countries in our sample.

Although having estimated elements in the regression introduces a further source of uncertainty, which normally requires to bootstrap the standard errors, we rely on the result by Giannone and Lenza (2008), Bai (2004) and Bai and Ng (2006) who show that with a relatively large number of countries there is no generated regressor problem.[10]

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[9] See *Appendix A* for more details on the elements of W^r.

[10] Bai (2003) and Bai and Ng (2006) show that factors can be treated as known if the number of countries is larger than the square root of the sample size.

The FAP is however not the only methodology proposed in the literature. Other types of estimator developed to tackle the issue of common unobservable factors and cross-sectional dependence are e Pesaran's (2006) Common Correlated Effect CCE, and Bai's (2009) Interactive Fixed Effects (IFE). In Section VIII we show that our main results are preserved if we employ these two alternative estimation techniques.

V. Estimation Results

A. Baseline Model

In this section we present the results from the estimation of equation (7). The set of regressors x_{it} contains the OECD forecasts of public debt, primary deficit, real GDP growth. We also include the expected short term interest rate[11] and the expected inflation rate - to net out of the long-term interest rate the expectations on future monetary policy stance and the inflation premium.
The results are reported in Table 5. In the table, columns 1 and 2 use standard panel techniques, while column 3 presents the results of the FAP estimation. In particular, we first estimate equation (7) using only country fixed effects α_i (column 1-FE), then we include also time fixed effects τ_t (column 2-2FE) and finally we include both fixed effects and estimated factors (column 3-FAP).[12]
At the bottom of each table we include, as a further specification test, the value of the CSD statistic, which is Pesaran's (2006) test for cross-sectional dependence[13] applied to the residuals of the estimated equation.

Our results show that the positive correlation between fiscal variables and long-term interest rates previously found in the literature is not robust to the introduction of general equilibrium effects. A standard FE estimator shows that a one percentage point increase in the expected primary deficit to GDP ratio increases interest rates by around 9.8 basis points, while a 1 percent increase in the expected debt to GDP ratio increases interest rates by around 1.3 basis points (column 1). However, the large value of the CSD statistic (43.51) for the residual, indicates that the regression is misspecified.

Looking at columns 2 and 3 we first notice the importance of accounting for common factors. For both estimators, the CSD statistic falls markedly compared to the FE, but the FAP performs better against the 2FE (-1.80 vs. -0.87). The response of long-term interest rates to

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[11]We also tried using the actual 3 months interest rate from Datastream obtaining very similar results.

[12]The country and time fixed effects are eliminated by means of a standard within transformation applied to the left hand side and *observable* right hand side variables - See Bai (2009).

[13]We report the value of the statistic instead of the *p-value* because the asymptotic for this test is developed for $N > T$ and to our knowledge there is no test of residual cross-sectional dependence which does not rely on this assumption. Hence, because in our panel we have $T > N$ we prefer to report the value of the statistic and interpret the changes in its values across different specifications as the marginal impact of the introduction of common factors in correcting cross-sectional dependence.

idiosyncratic factors diminishes in both cases. When we allow for heterogeneous response to global shocks with the FAP (column 3) primary deficit becomes statistically insignificant, while the effect of public debt becomes significant. As for the magnitude, the effect is similar to the standard FE estimator (column 1): a 1 percent increase in public debt increases long-term interest rates by 1.3 basis points. The coefficient on the short-term interest rate also decreases significantly when using the FAP, indicating that, accounting for general equilibrium effects, long-term interest rates are less responsive to domestic monetary policy. The coefficient on GDP growth is negatively signed but the effect is insignificant. Finally, we find a positive but not significant relation with expected inflation.

B. Time Variation in the Idiosyncratic Components

In this section we check whether the importance of the idiosyncratic components has been changing over time. We expect that, with the progressive financial and economic integration among advanced economies, global factors become more important and thus reduce the impact of idiosyncratic policies. We are primarily interested in the time varying effect of public debt and primary deficits. However we also analyze the coefficient on the short term interest rate, to assess whether financial integration affects the sensitivity to own monetary policy as suggested by the results presented in the previous section. We re-estimate (7) using rolling regressions with a window of 24 periods.[14] We can therefore follow the evolution over time of the coefficients on primary deficit, public debt and short-term interest rates (Figure 2).

As expected, there is a clear downward trend in the coefficients, indicating a progressive loss of importance of domestic policy variables. This is the case for both fiscal and monetary policy. The coefficient on the short term interest rate shows that central banks have been progressively losing effectiveness in stirring long-term rates. This evidence is consistent with that presented by Giannone et al (2009), who show how in the recent decades long-term interest rates have become more disconnected from country-specific monetary policy stances. The importance of idiosyncratic fiscal factors stays flat for most of the sample and then increases for the last period. While fiscal deficits do not have any impact through the more recent period, the coefficient on public debt increases but the uncertainties around its estimates also increases due to the large variation observed in debt during this period. This evidence suggests a possible repricing of risk in the aftermath of the global financial crisis (see Sgherri and Zoli (2009) and Poghosyan (2012) for evidence on the EMU).[15]

C. Discussion

The results so far indicate that, when we account for heterogeneous response to global shocks: (1) long-term interest rates remain positively related only to public debt; (2) there is

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[14]Having 49 time periods, the size of the window is determined by having an equal split of the sample in the first regression.

[15]A stronger evidence of increase in the importance of the idiosyncratic components of debt and deficit is visible when looking at sovereign risk rather than long-term interest rates. See Dell'Erba and Sola (2013).

mild evidence of increased importance of idiosyncratic fiscal policy in the last crisis. Our results stand partly in contrast with previous literature. In particular, past studies have found a significant effect of public deficits on long-term interest rates (Ardagna et al. (2007)). The effect of public debt on long-term interest rates is also smaller compared to previous estimates. Laubach (2009) for example, finds that a 1 percent increase in public debt to GDP leads to an increase in long-term interest rates by 3 to 4 basis points, while we find that the effects are less than 1 basis point. While our results cannot be strictly comparable due to differences in the sample and in the data, we argue that our results are consistent with the implications of standard neoclassical models if we change the assumption on the degree of crowding-out. Laubach (2009) shows that, within the neoclassical growth model, under the assumption that roughly two-thirds of the increase in public debt is offset by domestic savings, a 1 percent increase in public debt to GDP leads to an increase in real interest rates by 2.1 basis points.[16] However, recent evidence on the Feldstein-Horioka regression by Giannone and Lenza (2008), show that less than one-fifth of savings in developed countries are retained for domestic investment. This evidence on the lower degree of crowding-out reconcile our estimates with theory, and generate effects of public debt on real interest rates in the range of 1 basis points (Table 5, Column 3).[17]

VI. Effects of Global Shocks

The fact that, after accounting for global factors, the idiosyncratic component of fiscal policy plays a smaller role compared with earlier literature does not necessarily mean that fiscal policy is unimportant. We have seen so far that nominal interest rates are driven by factors which closely resemble global monetary and global fiscal policy stances. In this section we use the FAP estimator to focus on how shocks to the aggregate fiscal stance transmit to domestic long-term rates. In terms of our estimating equations, we analyze the magnitude and the cross-country differences in the coefficients δ_{1i} in equation (7).

This exercise can help to shed some light on the dynamics of the interest rates observed during the recent crisis, which was characterized by a simultaneous increase in advanced countries' budget deficits. From a theoretical point of view, in a group of financially integrated economies a shock in the global fiscal stance will affect countries' interest rates through its effect on the 'world interest rate.' If all governments increase spending together, this affects the aggregate savings schedule whenever governments' actions are not perfectly compensated by an equal and opposite reaction from the private sector. Therefore the equilibrium 'world interest rate' increases and, because of capital markets integration, interest rates in all countries adjust accordingly.

The existing literature has already recognized the importance of these global effects. Faini (2006) for example, analyzes the effect of a 'global fiscal expansion' for EMU countries; Ardagna et al. (2007) extend their sample to the OECD while Claeys et al. (2008) used a

[16] Following the discussion in Laubach (2009) , the effect of 1 percent increase in public debt to GDP on interest rates is given by the formula: $(1-s)cs/k^2$where $s=0.33$ is the capital share on national income; $k=2.5$ is the capital-output ration; $c=0.6$ is the degree of crowding out.

[17] Assuming the parameter is $c=0.2$ the estimated effect is 0.7 basis points.

panel of 100 countries. Similarly, Alper and Forni (2011) used a panel of advanced and emerging countries. In all cases, the effects are found to be statistically significant and much larger than those of domestic fiscal shocks.[18] One important advantage of our approach is that we can analyze not only the relative magnitudes of the effects of idiosyncratic versus global shocks, but we can also study how the effects of global shocks differ across the countries in our sample. For instance, when global deficits increase we would expect interest rates to respond more in countries with relatively closer capital account, as they can only draw from the smaller pool of national savings instead that from the world market. Alternatively, interest rates might increase more in countries with large macroeconomic or fiscal vulnerabilities.

To estimate the effects of these global factors we re-estimate equations (7) replacing the estimated factors with their economic interpretation. As discussed in Appendix A we use the average expected primary deficit[19] and the average expected short term rate of the countries in our sample. The estimated effects of a fiscal increase in global deficit are indeed quantitatively important and highly heterogeneous across countries (see Table 6 and Figure 3).

There seems to be a clustering of countries, with Ireland, Italy and Spain displaying the highest coefficients. For them, a one percentage point increase in average deficit increases nominal interest rates between 43 and 51 basis points. Positive effects are also observed for the group of the core EMU members (Austria, Belgium, Netherlands, France), the Nordic countries (Finland, Denmark, Sweden), and the Anglo-Saxons (UK and Australia). For these groups, however, the coefficients are about 50 percent smaller, ranging between 10 and 25 basis points, with Finland displaying the highest coefficient. The group of countries for which the estimated coefficients are the lowest is composed of the U.S., Norway and Germany, for which they are also not statistically significant. These are countries that are either relatively "large" (U.S., and Germany) and – at least in the case of the U.S. - more likely to behave as closed economies; or for which availability of capital is more driven by the exogenous variation in the price of oil and natural gas (Norway). Quantitatively, average deficit is by far more important than the idiosyncratic fiscal components. Its average effect is in fact around 20 basis points, which is more than ten times larger than the effect of an increase in idiosyncratic primary deficit. A one standard deviation in the increase in global fiscal stance can have effects as large as 1 percentage point.

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[18]Faini (2006) finds that the effects on interest rates of domestic fiscal policy shocks are rather small compared to those caused by a global fiscal expansion: a change in domestic surplus leads to a 5 basis points reduction of interest rates, while a change in the EMU surplus leads to a 41 basis points decrease in interest rates. Ardagna et al. (2007) obtain similar results for the OECD. They analyze the world fiscal stance as both the aggregate primary deficit and the aggregate debt. They find that, depending on the specification, the world deficit leads to increase in interest rates between 28 and 66 basis points, while world debt increases interest rates between 3 and 21 basis points. In both papers, the effects of global shocks are supposed to be homogeneous across countries.

[19]The theory would suggest to use the *world* fiscal stance as control. Here, we use instead the average fiscal stance in 17 advanced economies. We believe this provides a reasonable approximation (see also Ardagne et al. (2007) on the point).

Besides recognizing the quantitative importance of the effects of global fiscal stance, our framework allows us to investigate the driving factors behind their cross-sectional dispersion. Our evidence shows that there exists a relationship between the estimated coefficients and: (i) the initial level of capital markets integration, measured by the initial level of the long-term interest rate, or the initial level of the Chinn and Ito Index[20] (top left and bottom left panels of Figure 4); (ii) the size of the current account imbalances (top right panel of Figure 4) and (iii) an indicator of fiscal and political risk (bottom right panel of Figure 4).

This descriptive evidence provides an interesting explanation of the behavior of long-term interest rates in the recent decades. The progressive fiscal retrenchment which took place among industrialized countries at the beginning of the nineties, by increasing aggregate savings, has caused long-term interest rates to decline. This movement has been facilitated by the progressive economic and especially financial integration which, consistently with theoretical models, has induced interest rates to converge to the "world interest rate." The convergence forces have obviously influenced more those countries which were characterized by low initial financial integration.[21] In these countries, however, the compression of long-term interest rates went hand in hand with the build-up of large external imbalances, which eventually caused larger increases in interest rates as soon as the global deficit started expanding. The drain of savings caused by the global fiscal expansion experienced since the onset of the crisis has in fact put upward pressure to the "world interest rate," and as a result of higher need for savings, investors have repatriate capital from abroad, making capital scarcer in countries with large current account deficits (see Arslanap and Tsuda 2012).[22]

Finally, the increase in long-term interest rates can also be associated with an increase in risk premia. Hence, we would expect that, as capital becomes scarcer due to the expansion in global deficit, countries with weak institutions or weak fiscal positions would suffer proportionately more. In the bottom panel of Figure 4 we show that the dispersion in the country-specific effect global fiscal policy is positively related with an indicator of fiscal and political vulnerability. This indicator has been constructed as the simple average of the

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[20]Chinn and Ito (2009).

[21]While the Chinn and Ito (2009) index measures *de Jure* financial integration, the level of long-term nominal interest rates can be interpreted as a measure of *de Facto* financial integration.

[22]In terms of our theoretical model - equation (4) - the responsiveness of the domestic interest rates to the global factors are given by $\delta_{ki} = \lambda_{ki}^{r} - \beta\lambda_{ki}^{X}$. This means that they are directly proportional to the responsiveness of the domestic interest rates to the global factors and inversely related to the responsiveness of the regressors x_{it}. A close capital account translates into a higher value of the coefficients λ_{ki}^{r} because an expansion of aggregate budget deficits would mean relatively higher excess demand of capital for countries that can only access their domestic capital markets. A large share of foreign capital, instead, can translate again into high values of the λ_{ki}^{r} coefficients. If in fact global fiscal expansions take place in periods of recessions when investors also pull out capital from abroad, then running a high current account deficit might aggravate capital scarcity and induce higher increase in interest rates.

countries' debt to GDP ratio and the index of political risk constructed by the International Country Risk Guide.[23]

Overall, these results give us a key of interpretation for the observed behavior of interest rates in the recent decades. The common move of the governments of most advanced countries towards fiscal discipline has played a major role in explaining the convergence of long-term interest rates. The excess savings generated by fiscal retrenchment, however, in some countries contributed to create macroeconomic and fiscal vulnerabilities which eventually stroke back as the global deficit began to increase during the financial crisis (Giavazzi and Spaventa 2010).

VII. Results From Different Specifications

In this section we report the results from using different left-hand side variables. We first measure the impact of fiscal policy on the real interest rate. Since the ex-ante real long term yield is unobservable, as in Ardagna et al. (2007) we construct it from the data. Since the Outlook provides forecast only for inflation in period *t+1*, we proxy inflation expectations in t+10 with the "trend inflation" calculated with the help of a Kalman Filter applied recursively on the series of inflation expectations for the year *t+1*. As a second exercise, we measure the impact of fiscal policy on the yield spreads measured as the difference between the ten years yield and the yield on a risk-free asset of the same maturity ($r - r^B$).[24] To correct for the presence of exchange rate risk, we follow Codogno et al. (2003) and before computing the spreads we subtract from the long-term interest rates the yield on the interest rate swaps of the same maturity. However, because of the availability of data on interest rate swaps, the sample covers the period 1997-2012.

Before estimating the FAP equations for the real interest rate and the spreads equation we have to re-estimate the global factors for each of these two specifications. In the first case the results are very similar to the ones obtained for the equation for long-term nominal rates: two global factors account for more than two thirds of the variance and they can be interpreted as the global monetary and the global fiscal policy stances. For the spreads equation, instead, the relevant factors seem to be three: besides global monetary and fiscal policy stances a third factor which mimics global risk aversion is very relevant.[25] More details on the

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[23]To make the debt to GDP ratio and the political instability index comparable with each other, they have been first standardized to have zero mean and unit variance.

[24]To measure the yield spreads we need to define a benchmark. In general the literature on EMU countries uses the interest rate on German government Bunds as a benchmark. After the introduction of the common currency, the exchange rate risk among EMU countries has disappeared and Germany has acquired the "status" of safe haven (see von Hagen et al. (20011)). Outside the EMU area, instead, it is generally the U.S. Treasury which is considered the risk free asset.

[25]This third factor tracks very closely the Chicago Board Options Exchange Market Volatility Index (VIX), which is commonly considered an indicator of global risk aversion.

extraction of the common factors are available in Appendix A. The results are reported in Table 7.

If we look at the FAP, we see that the effect of domestic deficits on the real interest rate is still statistically insignificant and the value of the coefficient is of 3 basis points. As for the level of public debt, instead its effect stays significant and it is about one and a half basis points. The expected short term interest rate is positive and significant, with a magnitude comparable to what found when examining the effect on long-term nominal rates (Table 5). The coefficient on GDP growth is negatively signed but not statistically significant. Finally, we find a negative relation with the expected inflation. This is a direct consequence of allowing for an open economy setting. In open economies, in fact, nominal rates are equalized on the world capital markets and therefore higher expected inflation rate reduces the measured ex-ante real interest rate (the "Mundell-effect", Mundell (1963)).

When estimating the equation for sovereign yield spreads, we include also a measure of liquidity (the ratio of the stock of public debt over the total debt of OECD countries)[26] and a dummy variable for the introduction of the Euro to control for the flattening of sovereign spreads after the introduction of the single currency (as in von Hagen et al. (2011)). The fiscal variables turn out to be correctly signed but only the coefficient on public debt is statistically significant. Its effect is however very small and lower than a basis point. The sign and significance of the EMU dummy variable are consistent with the empirical evidence of a strong convergence of sovereign spreads in the Euro area after the introduction of the single currency. Although not statistically significant, the negative sign of the interest rate of the benchmark country shows the safe haven status of the U.S. and German bonds and is consistent with the evidence in von Hagen et al. (2011). The results differ from the ones using the nominal rates but the two cannot be directly compared since the estimation is performed over different sample periods.

VIII. Robustness Checks

In this section we present the results of a series of robustness checks. As a first check we re-estimated equation (7) replacing the factors estimated from principal components with what we found to be their economic interpretation. That is, we replicate the results of the third column in Table 5 but instead of the estimated factors we use the average expected deficit and the average expected short term interest rate. The results (column 2, Table 8) are remarkably similar to those obtained with the estimated factors (column 1, Table 8). The test statistic of cross-sectional dependence on the residuals is also remarkably similar. We interpret these results as a further validation of our interpretation for the estimated factors. The second robustness check we perform is a cross-validation. We check whether the results from our baseline specifications are confirmed if we exclude from the estimation one country at a time. We notice that the results are remarkably stable, with the expected short-term interest rate and the debt to GDP ratio being consistently significant and of similar magnitude. Expected inflation becomes marginally significant when Spain is excluded from the sample (Table 9).

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[26] See Gomez-Puig (2006).

As a third robustness check we re-estimate our baseline equation using different techniques: Pesaran's (2006) Common Correlated Effect (CCE) and Mean Group (MG) estimators and Bai's (2009) Interactive Fixed Effects (IFE) estimator. The (CCE) estimator consists of introducing cross-sectional averages of the dependent and the independent variables in the equation. Since cross-country aggregates average out idiosyncratic components, for large cross-sectional dimensions they tend to approximate the common factors. Contrary to the FAP this method does not provide us with a direct estimate of the unobserved factors, which is something we are interested in. Bai (2009) instead, has recently suggested the use of an estimator called Interactive Fixed Effects (IFE) which combines standard OLS and principal components, and allows to specify the number of unobservable factors which one wants to control for. Results are reported in Table 10.

When using the MG estimator both the coefficients of debt and deficit are statistically significant and larger than those obtained with other techniques (including the FAP). When the MG estimator is applied to the spreads equation only the deficit to GDP turns out significant but with the wrong sign. The high values of the test statistic for cross-sectional dependence however show that the MG estimator does not help in correcting for cross-sectional dependence, with the possibility that these results might suffer from model mis-specification. The results obtained with the IFE estimator seem more in line with the results from the FAP. The results obtained with the CCE are very similar but the debt to GDP ratio turns out statistically significant only in the equation for sovereign spreads.

The existing literature (see Sgherri and Zoli (2009) among others) have pointed out that countries' fiscal variables might have stronger impact in determining interest rates during crisis periods. We have found some mild evidence that this might be the case when performing the estimates with rolling windows (see Section 5.2). Here we implement a more formal test by re-estimating equation (7) and checking for structural breaks in the coefficients. In the first three columns of Table 11 we interact the coefficients of deficit and debt with two dummy variables: one which takes value 1 before the second half of 2008 and another which takes value 1 from that moment onwards. The results show only mild evidence that the coefficient on the debt to GDP ratio might have increased during the crisis period. The last column of Table 11 includes a new variable, the deficit gap which is computed as in Faini (2006)[27] to check whether the structural break could be pertinent to variables which are more directly linked to expected fiscal sustainability. The results in column 4 of Table 11 support this hypothesis as the value of the coefficient on the deficit gap more than doubles after 2007.[28]

We also check whether, as suggested by Ardagna et al. (2007), the effect of public debt is non-linear carrying stronger effects after a given level. We re-estimate equation (7) including

[27] The deficit gap is the product between the debt to GDP ratio and the difference between expected deficit and the deficit which would stabilize the debt to GDP ratio (see *Appendix B*).

[28] Non-linear effects of crisis periods are stronger when looking at sovereign spreads rather than long-term interest rates. See Dell'Erba and Sola (2013).

first a quadratic term for the debt to GDP ratio and then including a spline for the coefficient on public debt at 50 percent and 75 percent of GDP. Our results show that the coefficient on the debt is statistically different when it is higher than 75 percent of GDP. However the difference in the effect is of about 0.3 basis points only and therefore not economically significant.

We conducted several other robustness checks. We repeated the estimations splitting the sample to consider separately data belonging to the June and to the December issues of the OECD forecasts and obtained similar results. We also repeated the estimation for long-term interest rates checking for the presence of structural breaks after the introduction of the Euro. We used a spline regression where all the regressors entered the equation also interacted with a dummy variable for the introduction of the Euro. We found evidence of a break in the coefficient on the inflation rate, which is positive and significant only for countries and periods not belonging to the EMU. We interpret this result as the "credibility effect" due to the presence of an inflation averse Central Bank.

IX. Concluding Remarks

In this paper we tackled the issue of identifying the effects of fiscal policy on long-term interest rates for a panel of OECD countries. We use real time data on forecasts to limit issues of reverse causality and to better take into account the forward looking nature of the responses of financial markets. The strong correlation observed across interest rates in different countries justifies the use of an estimator which takes into account the presence of unobservable global factors. We use a Factor Augmented Panel (FAP), an estimation procedure originally developed by Giannone and Lenza (2008). This methodology allows us to obtain consistent estimates of the parameters and to study the heterogeneity of the cross-country propagation of global shocks. We show that in general two unobserved factors can explain almost 70 percent of the variance in the data. We identified these factors to be the aggregate monetary policy and the aggregate fiscal policy stances. Our results show that global factors are not only quantitatively relevant determinants of long-term interest rates, but once introduced in the analysis, they also affect the importance of the idiosyncratic components. When using the FAP estimation method, the role of domestic fiscal policy variables is largely reduced: public debt is still significant, but contributes by only 1 basis point.

We show that the importance of the idiosyncratic factors is time-varying. We show that the role of idiosyncratic factors has been declining over time, as it would be expected due to the increase in financial and economic integration. However, the results point also to an increase in the sensitivity of interest rates to idiosyncratic factors after the global crisis. As for the role played by global factors we find that global supply of funds, represented by global monetary and fiscal policy stances plays a relevant role in affecting long-term interest rates. In particular the effects of a global fiscal expansion are by far quantitatively more important than domestic fiscal policy alone, and are significantly heterogeneous across countries. The magnitude of these effects ranges between 5 and 51 basis points with stronger effects for countries that were relatively less financially integrated at the beginning of the sample, and that are characterized by external, fiscal or institutional fragilities.

Our results provide an interpretation of the recent behavior of interest rates in advanced economies. While during the nineties the general movement towards fiscal consolidation and low monetary policy rates has contributed to low long-term interest rates and low sovereign spreads, during these last years the increase in countries' budget deficits have reversed this process. These shocks have triggered a heterogeneous increase in borrowing costs with larger effects for those countries which, while benefiting from the capital markets integration, had also accumulated larger imbalances. Countries' fiscal and macroeconomic policies therefore, affect interest rates not so much directly, but rather indirectly by influencing the magnitude of the spillover effects from global factors. Hence, even if on one hand financial integration reduces the impact of national policies on borrowing costs, on the other hand changes in global conditions expose more vulnerable countries to a sudden reversal of fortunes.

APPENDIX A. EXTRACTION OF THE FACTORS

The aim of this appendix is to provide more details on the extraction of the factors and present the evidence for their economic interpretation. As mentioned in Section IV.B we follow Giannone and Lenza (2010) and we estimate the unobserved factors of equation (7) by means of principal components. The principal components are extracted from the variance covariance matrix of W^r, which contains the observable left-hand side and right-hand side variables of equation (7):

$$W^r = [r \quad stnr \quad infl \quad g \quad pdef \quad debt]$$

where *r* is the (*T x N*) matrix of long-term interest rates, *stnr* the matrix of expected short-term rates, *inf l* is the matrix of expected inflation rates, *g* that of expected real GDP growth rates and *pdef* and *debt* those of expected primary deficits and public debts respectively.

A first important decision in our analysis is the determination of the number of factors to include in the regression. In the empirical literature on factor models, the determination of the number of factors has been a subject of intense research. For example, Forni and Reichlin (1998) propose a rule of thumb according to which one should retain the number of principal components that explains more than a certain fraction of the variance, while Bai and Ng (2006) present a formal test based on information criteria. In our case Table 4 shows that the first two components extracted from W^r explain about 68 percent of the total variance, with third factor contributing for about 7.8 percent. Following the rule of thumb proposed by Giannone and Lenza (2010) we decide therefore to include two factors in the estimating equation.

A second important point is the economic interpretation of the common factors. To find it we follow economic intuition. It is plausible to think that in integrated capital markets the global factors driving the interest rates must be related to the global availability of funds. Aggregate supply of savings is in turn affected by the aggregate fiscal stance - which is the "public" component of savings – and by aggregate monetary policy stance, which drives the availability of liquidity in the market. This intuition is well supported by the data. In fact the first two factors extracted from W^r are very much correlated with the average expected short term interest rate and with the average expected primary deficit (Figure 5).[29]

To give quantitative support to our interpretation, we then try to regress our estimated factors on the average short term rate and on the average deficit respectively. Table 13 reports the results of this exercise. In both cases the constant term is close to zero and never significant, while the coefficient on the estimated factor is close to one and strongly significant. The R^2 also indicates a good fit. Given that the extracted factors are standardized, we also standardize the short term interest rates and the deficits before computing the averages across countries.

The extraction of the factors is done in an analogous manner for the specifications for the real interest rate and the sovereign spreads (see Section VII and Table 7). In particular, for the

[29] Given that the extracted factors are standardized, we also standardize the short term interest rates and the deficits before computing the averages across countries.

specification with the real interest rates, we extract the factors from the variance covariance matrix of W^{real}, which contains:

$$W^{real} = [\, r(real) \quad stnr \quad infl \quad g \quad pdef \quad debt]$$

where *r(real)* is our measure of long-term real interest rate (see Appendix B). When we estimate the specification for the sovereign spreads, instead, we extract the factors from a matrix$W^{spreads}$ which is constructed as:

$$W^{spreads} = [\, r - r^B \quad stnr \quad infl \quad g \quad pdef \quad debt \quad r^B \quad VIX \quad liq]$$

The long-term interest rates *r* have been replaced by the sovereign spreads and the expected long-term interest rate of the benchmark country r^B. The VIX is the Chicago Board Options Exchange Market Volatility Index. Additionally we introduced a measure of liquidity (the ratio of government debt over the total debt of the OECD countries as in Gomez-Puig (2006)), which is usually included as a control in an equation for the spreads.

In terms of the importance of the global factors, in the first case the results are very similar to those for the long-term nominal rate: two factors explain more than two thirds of the panel variance and are interpretable as global fiscal and monetary policy stance as they track very closely the average expected deficit and the average expected short-term interest rate. In the second case, a third factor becomes relevant and it tracks very closely the dynamics of the VIX index. We interpret this factor as the "global risk aversion" factor (as in Sgherri and Zoli (2009)).[30]

[30] Results available upon request.

APPENDIX B. VARIABLES

Variable	Description	Source
r	Long-term Nominal rate	Datastream
r(real)	Difference between *r* and the trend of expected inflation (*infl*)	Datastream
$r - r^B$	$(r - r^B) - (sw - sw^B)$ Interest rate spread minus the difference in interest rate swaps over the same maturity	Datastream
stnr	One year ahead short-term (3-Month) interest rate	OECD
r^B	One year ahead long-term nominal interest rate of the benchmark country	OECD
infl	One year ahead GDP deflator inflation rate (ln(*PGDP*_t+1/*PGDP*_t))	OECD
g	One year ahead Growth rate of Real GDP	OECD
pdef	Government lending net of interest payments (NLG+YPEPG)	OECD
debt	Gross Government Financial Liabilities (GGFL)	OECD
liq	Ratio of government debt over the total government debt of OECD countries	OECD
VIX	Chicago Board Options Exchange Market Volatility Index	Datastream
def gap	$(gbal^* - gbal)$ with: $gbal^*$ = *(rltr-g)debt*, and *gbal* = *-pde f* and *rltr* = *ltr-inf* , and *ltr* is the one year ahead forecast for long-term rate	OECD

APPENDIX C. TABLES AND FIGURES

Table 1. Summary Statistics

Variable	mean	sd	min	max
Long-term Int Rates	5.72	2.56	0.78	14.25
Exp Int Rates - Short	4.72	3.05	0.01	8.41
Exp Inflation	2.22	1.23	-1.85	17.73
Exp Growth	2.54	1.04	-1.46	7.73
Exp Def/GDP(-1)	-2.4	4.23	-21.36	11.09
Exp Debr/GDP(-1)	72.62	33.76	3.25	222.64

Note: The table reports the summary statistics of the dependent variables and the regressors used in the analysis.

Table 2. Cross Sectional Dependence Test

Variable	CD-test	P-value	Corr	Abs(corr)
Long-term Int Rates	72.95	0	0.918	0.918
Exp Int Rates - Short	71.19	0	0.896	0.896
Exp Inflation	46.03	0	0.581	0.581
Exp Growth	37.25	0	0.473	0.491
Exp Def/GDP(-1)	47.77	0	0.601	0.614
Exp Debr/GDP(-1)	21.44	0	0.271	0.391

Note: Cross sectional correlation test. Under the null hypothesis of cross-section independence the statistic $CD\ N(0,1)$. The table shows the value of the test statistic, the p-value associated to the test and the value and absolute value of the estimated cross-sectional correlation.

Table 3. Panel Unit Root Tests

	CIPS	0 lag p-val	CIPS	1 lag p-val	CIPS	2 lag p-val	MP	p-val
Long-term Int Rates	-5.31	0	-3.4	0	-2.94	0	-3.515	0
Int Rate - Short	-5.12	0	-2.72	0	-2.21	0.01	-3.137	0
Inflation	-5.4	0	-3.52	0	-1.98	0.02	-4.878	0
GDP Growth	-9.81	0	-4.59	0	-4.21	0	-14.49	0
Def/GDP(-1)	-1.16	0.12	0.97	0.83	1.28	0.9	-1.81	0.03
Debt/GDP(-1)	0.6	0.72	1.6	0.94	1.96	0.97	-1.867	0.03

Note: CIPS is the t-test for unit roots in heterogeneous panels with cross-section dependence, proposed by Pesaran (2007). The lag refers to the order of the ADF regression. Null hypothesis assumes that all series are non-stationary. MP is the Moon and Perron (2004) panel unit root test based on two extracted factors from the variable. The lag order is selected automatically. Null hypothesis assumes all series are non-stationary.

Table 4. Principal Component Analysis

		1st	2nd	3rd	4th	5th
Long-term Interest Rate	Marginal	0.5097	0.1706	0.0784	0.0564	0.0314
	Cumulative	0.5097	0.6803	0.7506	0.8151	0.8465

Note: The table reports the marginal and cumulative proportions of the explained variance by the first 5 principal components. The principal components are extracted from the matrix W^r - see Appendix A for details.

Table 5. Baseline Estimation - Long-term Interest Rates

VARIABLES	(1) FE	(2) 2FE	(3) FAP
Int Rate - Short	0.784***	0.544***	0.368***
	[0.023]	[0.055]	[0.035]
Inflation	0.098	0.094	0.06
	[0.072]	[0.066]	[0.050]
GDP Growth	0.041	-0.185***	-0.041
	[0.082]	[0.059]	[0.089]
Def/GDP(-1)	0.098***	0.046*	-0.003
	[0.020]	[0.024]	[0.021]
Debt/GDP(-1)	0.013	0.005**	0.013**
	[0.009]	[0.002]	[0.005]
Observations	794	794	794
R-squared	0.83	0.934	0.961
Number of id	17	17	17
CSD	43.51	-1.8	-0.87
Country FE	Yes	Yes	Yes
Time FE	No	Yes	Yes
Factors	No	No	Yes

Note: The dependent variable is the long-term nominal interest rate. The independent variables are: expected short term interest rate; expected inflation; expected GDP growth; expected deficit as a share of previous period GDP; expected gross debt as a share of previous period GDP. CSD is the Pesaran's (2004) statistic to detect cross-sectional dependence; the statistic is distributed as a normal under the null of cross-sectional independence. Column 1 reports the results from the FE; Column 2 reports the results from the 2FE and Column 3 reports the results from the FAP.

Table 6. Effects of Global Deficit Shock - Long-term Interest Rates

COUNTRIES	Global Def
AUS	0.183***
	-0.062
AUT	0.096*
	-0.05
BEL	0.164***
	-0.054
CAN	0.09
	-0.059
DNK	0.106**
	-0.053
FIN	0.251***
	-0.061
FRA	0.135***
	-0.05
DEU	0.048
	-0.051
ESP	0.471***
	-0.084
GBR	0.212***
	-0.058
IRE	0.434***
	-0.104
ITA	0.516***
	-0.079
JPN	0.120**
	-0.058
NLD	0.079
	-0.051
NOR	0.06
	-0.059
SWE	0.176***
	-0.066
USA	0.071
	-0.06
Observations	794
F-Test	177.5***

Note: The table reports the country specific coefficients on the global deficit factor obtained from the estimation of equation (7). The factor is proxied by the average expected budget deficit of the countries in the sample. “F-test” is the value of the F-statistic for the test of equality of coefficients.

Table 7. Baseline Estimation - Real Interest Rates and Sovereign Spreads

	(1)	(2)
VARIABLES	Real Rates	Spreads
Int Rate - Short	0.314***	
	[0.042]	
Inflation	-0.441***	
	[0.077]	
Int Rate - Benchmark		-0.005
		[0.141]
Liquidity		0.002
		[0.005]
GDP Growth	-0.01	-0.02
	[0.090]	[0.048]
Def/GDP(-1)	0.028	0.01
	[0.027]	[0.009]
Debt/GDP(-1)	0.014**	0.003***
	[0.006]	[0.001]
D(EMU)		-1.100**
		[0.428]
Observations	794	434
R-squared	0.923	0.511
Number of id	17	15
CSD	-1.48	-1.98
Country FE	Yes	Yes
Time FE	Yes	Yes
Factors	Yes	Yes

Note: the table shows the results of estimating equation (7) using the real interest rate (Column 1) and sovereign spreads (Column 2) as dependent variables. The real interest rate is computed as the long-term interest rate minus the trend component of expected inflation which is computed applying a Kalman filter to the expected inflation. Spreads are computed with respect to the German long-term interest rate for EMU countries and to the US long-term interest rate for the other countries. They are adjusted for the exchange rate risk following Codogno et al. (2003). The independent variables from top to bottom are: expected short term interest rate; expected inflation; the expected long-term interest rate of the benchmark country (Germany for EMU countries and US for the rest); liquidity, measured as the ratio between the stock of sovereign debt and the total debt of OECD countries; expected GDP growth; expected deficit as a share of previous period GDP; expected gross debt as a share of previous period GDP; a dummy variable for the introduction of the EURO. CSD is the Pesaran's (2004) statistic to detect cross-sectional dependence; the statistic is distributed as a normal under the null of cross-sectional independence.

Table 8. Factors' Interpretation - Long-term Interest Rates

	(1)	(2)
VARIABLES	FAP	Macro F
Int Rate - Short	0.368***	0.389***
	[0.035]	[0.035]
Inflation	0.06	0.046
	[0.050]	[0.052]
GDP Growth	-0.041	-0.058
	[0.089]	[0.092]
Def/GDP(-1)	-0.003	-0.001
	[0.021]	[0.022]
Debt/GDP(-1)	0.013**	0.012**
	[0.005]	[0.005]
Observations	794	794
R-squared	0.961	0.96
Number of id	17	17
CSD	-0.87	-0.95
Country FE	Yes	Yes
Time FE	Yes	Yes
Factors	Yes	Yes

Note: The dependent variable is the long-term nominal interest rate. The independent variables from top to bottom are: expected short term interest rate; expected short-term interest rate; expected Inflation; expected GDP growth; expected deficit as a share of previous period GDP; expected gross debt as a share of previous period GDP. Column 1 repeats the results from the baseline specification. In Column 2 the common factors have been replaced by their interpretation: average short term interest rate and average deficit. CSD is the Pesaran's (2004) statistic to detect cross-sectional dependence; the statistic is distributed as a normal under the null of cross-sectional independence.

Table 9. Cross Validation - Long-Term Interest Rates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	All Sample	No AUS	No AUT	No BEL	No CAN	No DNK	No FIN	No FRA	No DEU
Int Rate - Short	0.368***	0.339***	0.367***	0.369***	0.385***	0.374***	0.357***	0.368***	0.370***
	[0.035]	[0.026]	[0.037]	[0.037]	[0.033]	[0.035]	[0.035]	[0.036]	[0.036]
Inflation	0.06	0.053	0.061	0.062	0.071	0.054	0.082	0.059	0.061
	[0.050]	[0.054]	[0.052]	[0.050]	[0.050]	[0.054]	[0.048]	[0.050]	[0.052]
GDP Growth	-0.041	-0.036	-0.038	-0.051	-0.045	-0.035	-0.093	-0.044	-0.032
	[0.089]	[0.090]	[0.093]	[0.091]	[0.095]	[0.093]	[0.084]	[0.091]	[0.090]
Def/GDP(-1)	-0.003	-0.005	-0.004	-0.006	0.007	0	-0.007	-0.004	-0.006
	[0.021]	[0.020]	[0.021]	[0.021]	[0.018]	[0.020]	[0.023]	[0.021]	[0.022]
Debt/GDP(-1)	0.013**	0.013**	0.012**	0.013**	0.012**	0.013**	0.013**	0.013**	0.013**
	[0.005]	[0.005]	[0.005]	[0.005]	[0.006]	[0.005]	[0.006]	[0.005]	[0.005]
Observations	794	747	748	747	747	747	747	747	747
R-squared	0.961	0.961	0.96	0.96	0.96	0.959	0.958	0.959	0.96
CSD	-0.87	-0.47	-1.64	-0.8	-0.89	-1.35	-0.75	-1.78	-1.51
Number of id	17	16	16	16	16	16	16	16	16
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Factors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 10 (continued)

	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
VARIABLES	No IRE	No ITA	No JPN	No NLD	No NOR	No ESP	No SWE	No GBR	No USA
Int Rate - Short	0.357***	0.366***	0.368***	0.367***	0.374***	0.371***	0.378***	0.365***	0.375***
	[0.033]	[0.036]	[0.039]	[0.037]	[0.039]	[0.035]	[0.035]	[0.038]	[0.038]
Inflation	0.071	0.056	0.042	0.061	0.041	0.081*	0.028	0.073	0.063
	[0.054]	[0.049]	[0.048]	[0.054]	[0.057]	[0.045]	[0.048]	[0.050]	[0.050]
GDP Growth	-0.049	-0.013	-0.059	-0.047	-0.039	0.025	-0.041	-0.061	-0.047
	[0.111]	[0.093]	[0.093]	[0.095]	[0.097]	[0.065]	[0.094]	[0.093]	[0.098]
Def/GDP(-1)	0	0.006	0.005	-0.004	-0.018	0.004	-0.012	-0.007	-0.001
	[0.021]	[0.019]	[0.021]	[0.021]	[0.030]	[0.019]	[0.022]	[0.022]	[0.021]
Debt/GDP(-1)	0.008**	0.013**	0.017**	0.013**	0.013**	0.012*	0.011*	0.013**	0.013**
	[0.003]	[0.006]	[0.007]	[0.005]	[0.006]	[0.006]	[0.005]	[0.005]	[0.005]
Observations	747	751	747	747	747	747	747	747	747
R-squared	0.97	0.963	0.962	0.96	0.961	0.962	0.959	0.96	0.962
CSD	-2.04	-1.37	-1.19	-1.49	-0.92	-1.62	-0.46	-0.96	-0.81
Number of id	16	16	16	16	16	16	16	16	16
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Factors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: In this exercise we repeat the estimation of the FAP for the baseline model (equation 7) excluding one country at the time.
The dependent variable is the long-term nominal interest rate. The results are obtained with the FAP.

Table 10. Baseline Estimation - Alternative Estimation Techniques: CCE-MG-IFE

	CCE			MG			IFE		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	LTR	RINT	SPREAD	LTR	RINT	SPREAD	LTR	RINT	SPREAD
Int Rate - Short	0.313***	0.233***		0.482***	0.433***		0.342***	0.289	
	[0.044]	[0.049]		[0.033]	[0.025]		[0.126]	[0.157]	
Inflation	0.131**	-0.331***		0.059	-0.489***		0.222	-0.412	
	[0.047]	[0.063]		[0.037]	[0.064]		[0.311]	[0.386]	
Int Rate - Benchmark			-0.517***			0.039***			-0.219
			[0.178]			[0.012]			[1.212]
Liquidity			0.003			-0.006			0.009***
			[0.005]			[0.008]			[0.002]
GDP Growth	-0.07	-0.049	-0.02	-0.088	-0.021	-0.036	0.041	0.016	0.052
	[0.086]	[0.100]	[0.043]	[0.061]	[0.063]	[0.045]	[0.255]	[0.316]	[0.117]
Def/GDP(-1)	0.008	0.042	0.013*	0.096***	0.085***	-0.069**	0.012	0.039	-0.002
	[0.022]	[0.029]	[0.007]	[0.020]	[0.022]	[0.034]	[0.019]	[0.024]	[0.013]
Debt/GDP(-1)	0.004	0.007	0.002***	0.018***	0.019***	0.007	0.006***	0.008***	0.003***
	[0.006]	[0.006]	[0.001]	[0.005]	[0.005]	[0.008]	[0.000]	[0.000]	[0.000]
Emu			-1.691***			-0.03			-0.957
			[0.644]			[0.023]			[1.633]
Observations	794	794	434	794	794	434	794	794	434
Number of ID	17	17	15	17	17	15	17	17	15
CSD	-1.49	-2.35	-2.82	44.06	44.22	12.42	16.13	13.77	-1.2

Note: Columns 1 to 3 report the results obtained with Pesaran's (2006) CCE estimator; Columns 3 to 6 report the results obtained with Pesaran's MG estimator; Columns 7 to 9 report the results obtained with Bai's (2009) IFE. The dependent variables are: the long-term nominal interest rate (Columns 1, 4 and 7); the long-term real interest rate (Columns 2, 5 and 8) and sovereign spreads (Columns 3, 6 and 9). The real interest rate is computed as long-term interest rate minus the trend component of expected inflation, which is obtained applying a Kalman filter to the expected inflation. Spreads are computed with respect to the German long-term interest rate for EMU countries and with respect to the US long-term interest rate for the other countries. They are adjusted for the exchange rate risk following Codogno et al. (2003). The independent variables from top to bottom are: expected short term interest rate; expected inflation; the expected long-term interest rate of the benchmark country (Germany for EMU countries and US for the rest); liquidity, measured as the ratio between the stock of sovereign debt and the total debt of OECD countries; expected GDP growth; expected deficit as a share of previous period GDP; expected gross debt as a share of previous period GDP; a dummy variable for the introduction of the EURO. CSD is the Pesaran's (2004) statistic to detect cross-sectional dependence; the statistic is distributed as a normal under the null of cross-sectional independence.

Table 11: Non-Linearity with Crises - Long-term Interest Rates

VARIABLES	(1) FAP	(2) FAP	(3) FAP	(4) FAP
Int Rate -Short	0.366***	0.369***	0.367***	0.379***
	[0.036]	[0.036]	[0.037]	[0.043]
Inflation	0.063	0.059	0.062	0.142**
	[0.049]	[0.051]	[0.051]	[0.051]
GDP Growth	-0.042	-0.040	-0.041	0.043
	[0.090]	[0.089]	[0.090]	[0.082]
Def/GDP(-1)		-0.003		
		[0.021]		
time>2008*(Def/GDP(-1))	-0.011		-0.012	
	[0.040]		[0.040]	
time<2008*(Def/GDP(-1))	-0.000		0.000	
	[0.018]		[0.018]	
Debt/GDP(-1)	0.013**			0.011**
	[0.005]			[0.005]
time<2008*(Debt/GDP(-1))		0.012**	0.012**	
		[0.004]	[0.004]	
time>2008*(Debt/GDP(-1))		0.013*	0.014*	
		[0.007]	[0.007]	
time<2008*(Def Gap)				0.053**
				[0.020]
time>2008*(Def Gap)				0.112*
				[0.060]
Observations	794	794	794	794
R-squared	0.961	0.961	0.961	0.964
Number of id	17	17	17	17
CSD	-0.87	-0.90	-0.91	-1.95
Country FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Factors	Yes	Yes	Yes	Yes

Note: The dependent variable is the long-term interest rate. The independent variables from top to bottom are: expected short term interest rate; expected short-term interest rate; expected inflation; expected GDP growth; expected deficit as a share of previous period GDP; expected gross debt as a share of previous period GDP. In Columns 1, 2 and 3 we test a specification with a spline on the fiscal variables according to weather or not they are measured after the second half of 2008. In Columns 4 we test a spline on the deficit gap (as defined in Appendix B) according to weather or not they are measured after the second half of 2008. CSD is the Pesaran's (2004) statistic to detect cross-sectional dependence; the statistic is distributed as a normal under the null of cross-sectional independence. All results are obtained using the FAP.

Table 12: Non-Linearity with Public Debt - Long-Term Interest Rates

VARIABLES	(1) FAP	(2) FAP	(3) FAP
Int Rate -Short	0.370***	0.367***	0.373***
	[0.035]	[0.034]	[0.035]
GDP Growth	-0.041	-0.04	-0.038
	[0.089]	[0.088]	[0.090]
Inflation	0.063	0.061	0.057
	[0.051]	[0.051]	[0.051]
Def/GDP(-1)	-0.002	-0.003	-0.003
	[0.020]	[0.021]	[0.019]
Debt/GDP(-1)	0.016		
	[0.010]		
(Debt/(GDP(-1))2	0		
	[0.000]		
Debt/(GDP(-1) < 50%		0.012*	
		[0.006]	
Debt/(GDP(-1) > 50%		0.012**	
		[0.005]	
Debt/(GDP(-1) < 75%			0.009*
			[0.005]
Debt/(GDP(-1) > 75%			0.012**
			[0.005]
Observations	794	794	794
R-squared	0.961	0.961	0.961
Number of id	17	17	17
CSD	-0.97	-0.92	-0.78
Test Debt		0.77	0.03
Country FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Factors	Yes	Yes	Yes

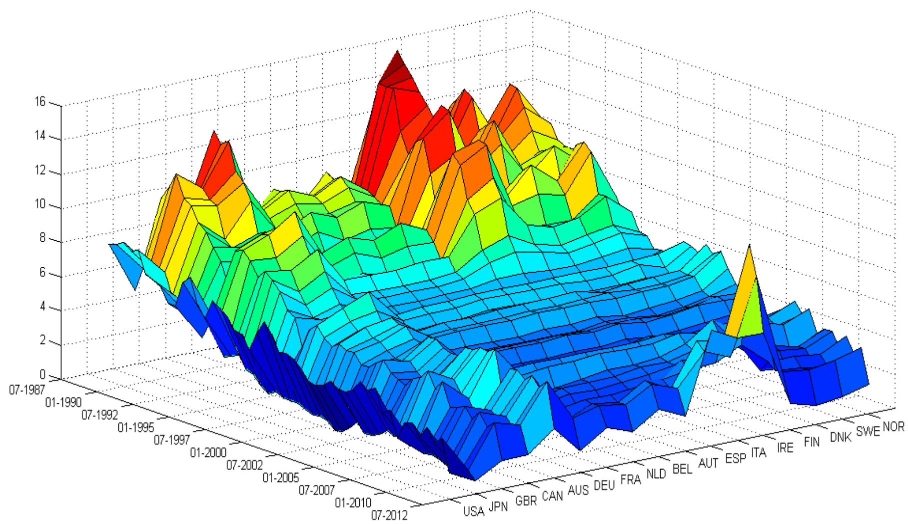
Note: The dependent variable is the long-term nominal interest rate. The independent variables are: expected short term interest rate; expected inflation; expected GDP growth; expected deficit as a share of previous period GDP; expected gross debt as a share of previous period GDP. We test different non linearities with respect to public debt: in Column 1 we introduced debt to GDP ratio squared; in Column 3 and 4 we splined the debt to GDP ratio according to whether it is larger or smaller than 50 percent and 75 percent. CSD is the Pesaran's (2004) statistic to detect cross-sectional dependence; the statistic is distributed as a normal under the null of cross-sectional independence. All results are obtained using the FAP. "Test Debt" reports the p-value of the t-test on the coefficients of the spline for the debt to GDP ratio.

Table 13. Interpretation of the Global Factors - Long-term Interest Rates

VARIABLES	(1) 1st PC	(2) 2nd PC
Average Int Rate	0.982***	
	-0.0278	
Average Def		0.743***
		-0.0998
Constant	-4.94E-09	3.06E-09
	-0.0275	-0.0987
Observations	47	47
R-squared	0.965	0.552

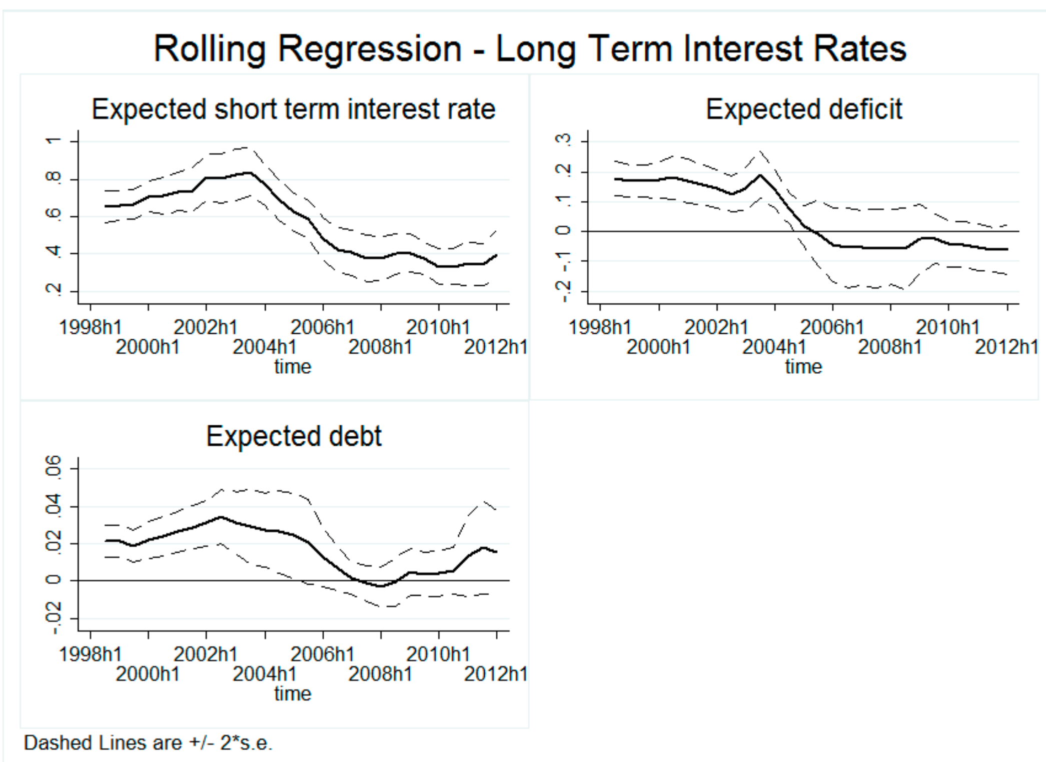
Note: In Column 1, the dependent variable is the first principal component extracted from W^r while the independent variable is the average expected short term interest rate of the countries in the sample. In Column 2, the dependent variable is the second principal component extracted from W^r while the independent variable is the average expected deficit of the countries in the sample.

Figure 1: Long-Term Interest Rates 1989-2012



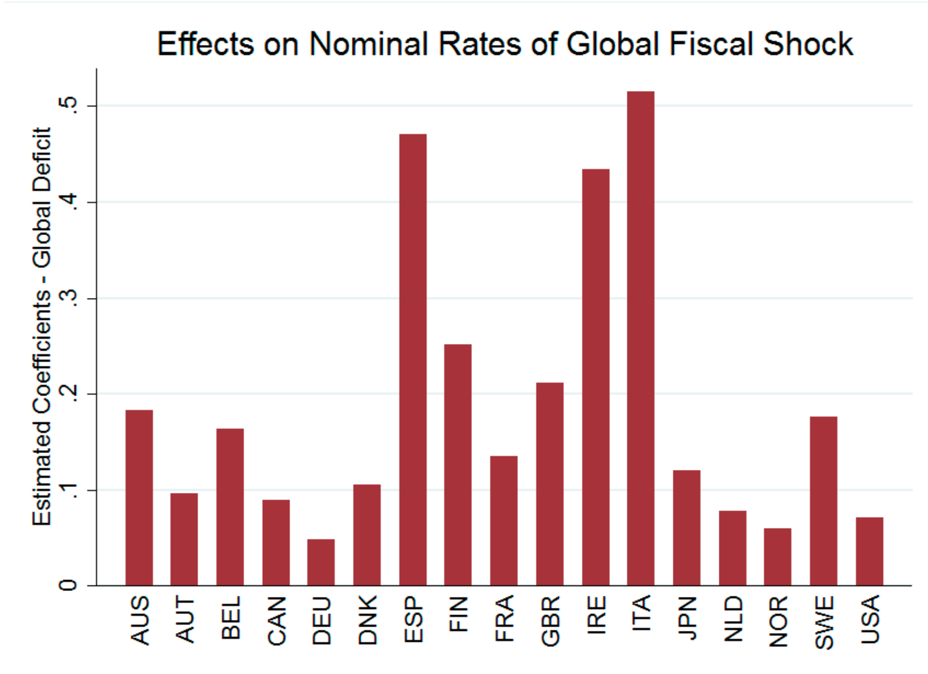
Note: Behavior of long-term nominal interest rates on 10 years government bonds for the countries in our sample. The sample runs from 1989 to 2012.

Figure 2: Rolling Window Estimates – Long-Term Interest Rates



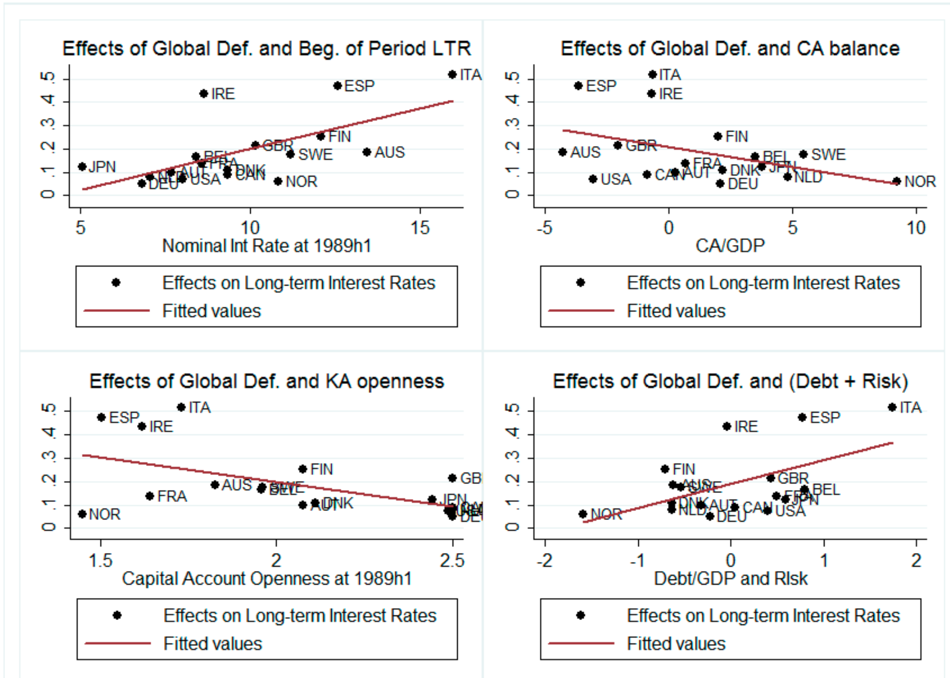
Note: The figures report the rolling window estimates for expected short term interest rate, expected deficit and expected debt obtained from estimating equation 7 with a 24 period rolling window. Dashed lines represent two standard deviation confidence bands.

Figure 3: Country Specific Effects of an Increase in Global Deficit



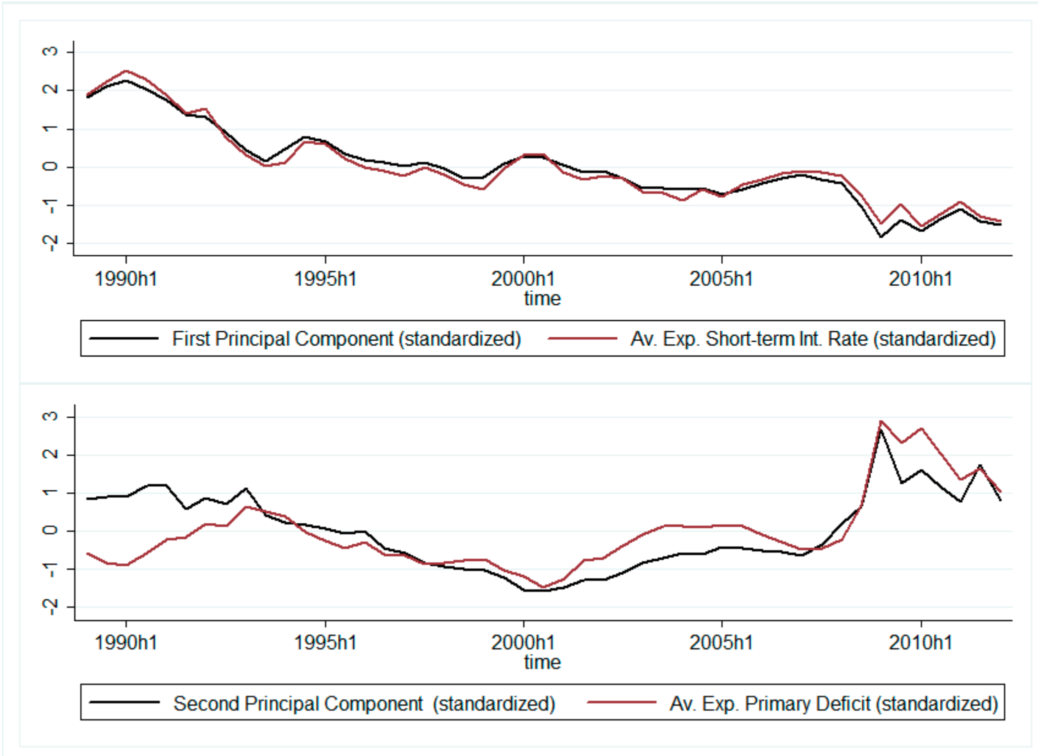
Note: The vertical bars represent the magnitude of the effects on each country's long-term interest rates of an increase in global deficit. They are obtained by estimating equation 7 and replacing the unobserved factors with their macroeconomic interpretation.

Figure 4. Determinants of the Cross-Country Dispersion of the Effects of Global Deficit



Note: The figures report the estimated country specific effect of global deficit. They are correlated with measures of initial capital markets integration, current account imbalances and fiscal and institutional fragility.

Figure 5. Global Factors and their Macroeconomic Interpretation



Note: The Figure shows the estimated unobserved factors plotted against their economic interpretation. The top panel shows the first factor plotted against the average expected short-term interest rate of the countries in the sample. The lower panel shows the second factor plotted against the average expected deficit of the countries in the sample.

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