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Which combination of fiscal and external imbalances to determine the long-run dynamics of sovereign bond yields ?

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Résumé : Pendant la crise financière de 2009, les primes de risque souverain se sont écartées de manière significative entre les pays développés. Bien que le risque perçu pour les pays cœur de la Zone euro reste relativement faible, les marchés financiers semblent discriminer les économies périphériques, qui voient augmenter les primes au-delà de ce que justifieraient les seuls facteurs budgétaires. Nous testons donc l'idée que la montée des taux d'intérêt souverains dans les pays périphériques n'est pas seulement le résultat d'une fragilité budgétaire, mais de la combinaison de déséquilibres internes et externes significatifs. La dynamique annuelle jointe des rendements souverains et de leurs déterminants de long terme dans l'OCDE, après 1980, est évaluée à l'aide de modèles économétriques à correction d'erreurs en panel. Les résultats des différentes estimations indiquent l'existence d'un "double déficit", à la fois des comptes publics et externes, qui a exercé une pression à la hausse sur les rendements souverains dans de nombreuses économies.

Mots-clés : Rendements souverains, dette publique, position extérieure nette, modèle à correction d'erreur en panel.
Codes JEL : C23, E43, G12.

Abstract : In the aftermath of the crisis, sovereign risk premium differentials have been increasingly widening. Although the perceived risk for core countries remains relatively low, financial markets seem to discriminate among peripheral economies requiring higher risk premia than what is justified by fiscal factors only. Our hypothesis in this study is that in peripheral countries this is not simply the result of fiscal indiscipline but the combination of both internal and external imbalances. We use a yearly post-1980 OECD-country panel data to estimate the joint dynamics of sovereign bond yields and their long-run determinants. We find that a net foreign position that is considered highly deteriorated can be a differentiating factor for investors. Indeed, the existence of a "twin deficit" put substantial upward pressures on sovereign bond yields in many advanced economies over the medium term.

Keywords : Sovereign bond yields, Public Debt, Net Foreign Assets, Panel error-correction models.
JEL classification : C23, E43, G12.

Non-technical summary : In the aftermath of the crisis, sovereign risk premium differentials have been increasingly widening. Although the perceived risk for core countries of the Euro area remains relatively low, financial markets seem to discriminate among peripheral economies requiring higher risk premium than what is justified by fiscal factors only. This observation opens the way for considering the combination of both internal and external imbalances as a potential explanation of the raise of sovereign bond yields and not only fiscal indiscipline in peripheral countries of the European monetary union. In particular, this paper addresses three related questions. First, what role do fiscal variables play in sovereign yields' dynamics ? Second, how does the net international investment position fill in the observed gap between fiscal variables and sovereign bond yields ? Finally, how does the combination of fiscal and external position explain the different behavior of sovereign yields among developed countries ?

A large empirical literature has addressed the determinants of sovereign bond yields by, on the one hand, focusing on the evolution of national fiscal conditions and, on the other hand, by relaxing the closed-economy assumption. The first type of literature provides heterogeneous findings. For example, Laubach [2009] and Gruber and Kamin [2011] show that fiscal variables have, on average, a significant impact on sovereign bond rates, whereas Codogno, Favero and Missale [2003] find that they play a role only for Italy and Spain. The second type of literature has introduced non-domestic variables in order to account for financial globalization. For instance, De Grauwe and Ji [2013] and Pogoshyan [2014] assign the recent uncoupling between fiscal variables and sovereign bond to the over-reaction of financial markets, whereas Costantini, Fragetta and Melina [2014] include the competitiveness differentials as a long term determinant of sovereign yields.

Our contribution is twofold. First, we take into account the recent episode of the financial crisis to assess the effect of fiscal variables on long-term interest rates. Our model tracks quite closely the pattern of observed movements in the series when we simulate the estimated model over a period including unusual movements on sovereign yields, which literature had difficulties to explain. Second, in addition to the standard determinants in the literature as the debt-to-GDP ratio, external imbalances are introduced as explanatory variables in order to capture the effect of competitiveness deterioration on the rise

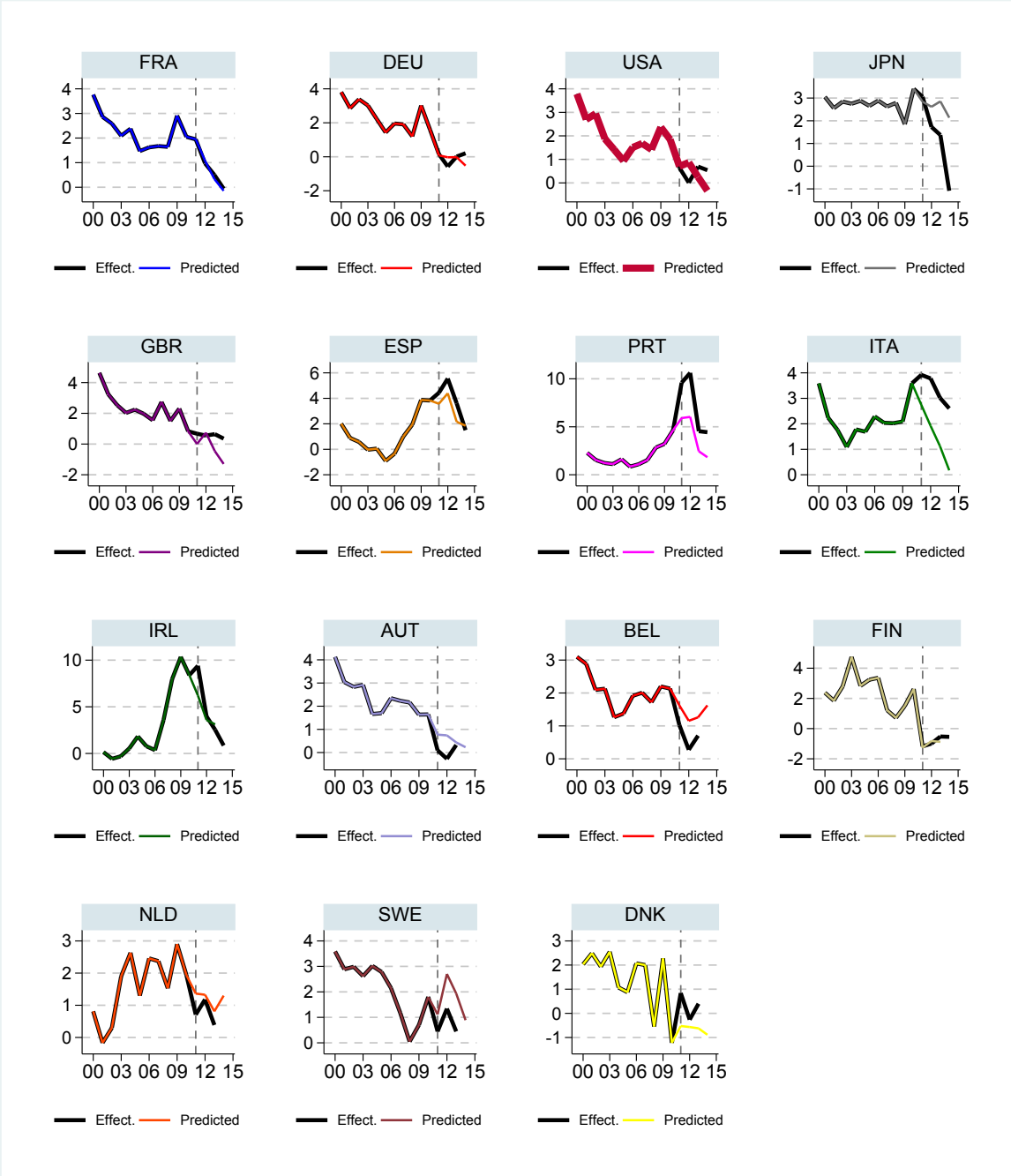
of country risk. The idea is that a favorable investment position keeps interest rates at a lower level than what is implied by fiscal variables only. Indeed we explore the threshold effects in the link between net foreign assets and public debt on sovereign bond yields, using the Macroeconomic Imbalance Procedure (MIP) of the European Commission as a starting point.

We conduct an empirical yearly analysis for OECD countries over the period 1980 to 2014 with a particular focus on Euro area countries. We estimate the joint dynamics of sovereign bond yields and their long-run determinants by using panel econometric techniques.

Our empirical results suggest that government bond yields can be determined in the long run not only by domestic factors but also by net foreign assets. Indeed, we find that a net foreign position that is considered highly deteriorated can be a differentiating factor for investors in many advanced economies over the medium term. Whereas core countries seem to have benefitted from a flight-to-quality effect, during the 2008 financial crisis, peripheral countries in the Euro area have suffered from the abrupt revision of market expectations, showing sovereign bond yields on average significantly higher than what is justified by their fiscal deterioration. The relevance of our specification is confirmed by the forecast exercises (in-sample and out-of-sample) conducted after 2007. Indeed, our model succeeds in capturing the sharp increase of sovereign bond yields experimented by the European peripheral countries and reproduces fairly well the trajectory of core economies, as shown in figure 1.

Policy implications that can be derived from this include that the improvement of international competitiveness might be a valid mechanism to public finances' sustainability in some countries. The analysis of the determinants of interest rates dynamics is of particular interest regarding fiscal sustainability. Indeed, the simulations performed on the basis of our estimations allow evaluating a benchmark level for long term interest rates. In such a setting, a difference between this benchmark and the observed interest rates could give some quantitative assessment about the risk of a positive interest rate shock.

FIGURE 1 – Actual and out-of-sample fitted values of sovereign yields
(Forecast starting on 2011, regression ends on 2010)



1 Introduction

Many theoretical and empirical studies have been devoted to explain the long-run dynamics of real interest rates. Bernanke [2013] himself has asked "why the long-term interest rates are so low in the United States and in other major industrial countries". Nevertheless, the debate is not yet clear-cut regarding the determinants - and the role they play - of such dynamics.

Economic theory indicates potential GDP, the rate of return on investment, households' time preference and investors' behavior towards risk as directly influencing bond yields whereas the relationship with fiscal policy variables, as debt or fiscal balance, remain an open issue. As Ardagna, Caselli and Lane [2007] notice, "the focus now is on empirical evidence". Sovereign bond yields have been declining since the 1980s, casting doubts to their reaction to the deterioration of budget deficits in OECD countries as underlined by Ahrend, Catte and Price [2006]. Indeed, a large but inconclusive empirical literature has been dealing with the effects of fiscal imbalances on interests rates.

Nevertheless, from a policy perspective it is important, as pointed out by Orr, Edey and Kennedy [1995], to identify if the sources of trends describing sovereign bond yields' evolution may be driven by policy-related factors. It seems, then, useful to disentangle short-run and long-run determinants, the former being typically associated to cyclical and monetary policy features, whereas the latter to structural shifts in the rate of return on capital, risk and fiscal sustainability.

Another way to think of the difference between these two kinds of determinants, is that long-run variables allow to proxy the shifts in expectations about the fundamentals. This implies that open economies with a high degree of financial integration share common transmission mechanisms for their real interest rates. On the contrary, expectations could differ in the short-run. These two features explain the choice of the empirical specification in a panel framework, in which the relationship describing the long-run of sovereign bond yields is homogenous between countries, whereas the short-run dynamics can differ across countries.

In this paper, we introduce a new determinant in the long-run dynamics of sovereign bond yields : the net international investment position. Indeed, as underlined by D'Auria, Veld and Kuenzel [2012], this variable has long been regarded as an indicator of default risk, as well as affecting growth in a nonlinear way.

The idea that net foreign assets play a role on macroeconomic performance and stability is at the heart of the paper. Actually, our results indicate that a deteriorated net foreign position can be a differentiating factor for investors. It seems they doubly penalize countries with a "twin deficit" : the combination of both deteriorated budgetary and negative external positions. Furthermore, we test the nature of that impact on sovereign bond yields, either linear or not. Indeed, we follow the European Commission which monitors "macroeconomic imbalances" of its members by introducing thresholds on several macroeconomic variables, and especially net international investment position. Our analysis yields a key finding : net foreign assets combined with government debt do explain the long-run dynamics of sovereign bond yields.

The paper is organized as follows. Section 2 briefly discusses the different determinants and their effect on sovereign bond yields as presented in the major brands of literature. Section 3 describes the different empirical specifications and the methodology used. Section 4 provides the estimation results and the fit of the model. Section 5 concludes.

2 Sovereign bond yields' determinants in existing studies and stylized facts

2.1 Conceptual framework

Several theoretical models explain directly or indirectly the behavior of long-term real interest rates and propose potential different factors to this behavior, which include fiscal variables. On the one hand, financial theory explains sovereign bond yields' dynamics by the expected future path of short-term rates, once taking into account the term,

liquidity and credit risk premia. Assuming the time-constancy of these premia leads to the "Expectations Hypothesis". The following equation expresses this view, which is the general model for the term structure of bond yields, as presented in Caporale and Williams [2002] :

$$r_t^l = \delta r_t^s + \gamma p_t \Rightarrow i_t = \beta \pi_t + \delta r_t^s + \gamma p_t \tag{1}$$

with r^l being the real sovereign bond yield, i the nominal long-term interest rate, π the expected inflation rate, r^s the short-term interest rate, and p the function defining the impact of different variables associated to risk's perception. The "Expectations Hypothesis" implies the restrictions $\beta = \delta = 1$ and $\gamma = 0$, in which case "the Fisher Hypothesis" also holds. However, as the restrictions on γ tend to be rejected in practice as in Caporale and Williams [2002], a proxy that may better reflect prospective risks is the ratio of government debt to GDP. In fact, Howe and Pigott [1991/1992] argue that the future value of public debt could decrease with economic environment deterioration due to a high and rising government debt. Hence Caporale and Williams [2002] advocated that long-term rates are not only determined by financial market activity but also by budgetary positions, which catch the country risk.

On the other hand, the conventional macroeconomic view for understanding the government debt impact on interest rates is based on the aggregate constant-return production function [4] as detailed by Engen and Hubbard [2004] among others. Hence public debt completely replaces productive physical capital [5], which allows to understand the potential effect of budgetary variables on the interest rate.

$$r = \alpha A \frac{Y}{K} \Longrightarrow \frac{\partial r}{\partial D} = \alpha(1-\alpha) A \frac{Y}{K^2} > 0$$

In that simple economic model, the level of the interest rate will be determined by the stock of public debt, whereas the variation of the yield will depend on the debt flow counterpart (i.e. public deficit). This corollary suggests as well that, in empirical analysis,

4. In the Cobb-Douglas setup, $Y = AK^{\alpha}L^{1-\alpha}$ where Y, A, K and L denote respectively production, productivity, capital and labor.

5. Then it implies that $\frac{\partial K}{\partial D} = -1$ where D denotes government debt.

public debt would affect the long-run determinants of sovereign bond yields whereas the fiscal balance would only influence the short-run dynamics. As the assumption of complete crowding-out of capital by public debt is strong, the authors suggest that deficits (by stimulating aggregate demand) lead to an increase in interest rates in the short-run. Nevertheless, even if the two mechanisms are very different, they could be equivalent in their result. Moreover, determinants other than public debt are involved in the demand and supply of loanable funds in credit markets making the quantitative evaluation of the own effect of fiscal variables harder. Laubach [2009] points out this identification issue. For example, during recessions, fiscal deficits increase due to automatic stabilizers, whereas long-term interest rates decrease due to a loose monetary policy. In this case, their correlation would be negative even if theory predicts a positive one. A way to address this issue is to distinguish long-run from short-run dynamics, as cyclical variations vanish in the former component.

Finally, a bulk of recent studies, as Pogoshyan [2014] for example, refer to the Ramsey model of optimal growth to provide some guidance on the determinants of the long-term interest rates. The deterministic steady state value of the real rate of return on capital, denoted r, is defined by :

$$r = \frac{1}{\sigma} g + \theta \tag{2}$$

where σ denotes the intertemporal elasticity of substitution, g the growth rate of consumption, and θ the time preference. At first sight, there are no fiscal variables (government debt or balance) involved in equation (2). However, there is room for such variables if the Ricardian equivalence is violated. Whether it is deficit or debt that matters for the determination of interest rates is not theoretically clear cut. It may depend on the reasons of the failure of the Ricardian equivalence. The impact of these variables on the interest rate should differ if deficits show time dependence. Considering intergenerational redistribution is another way to give debt back the role in the determination of interest rates, as pointed out by Elmendorf and Mankiw [1999] who reviewed several

explanations for the Ricardian equivalence violation. Indeed in basic overlapping models, the steady state value for the rate of return on capital depends now explicitly on debt (denoted d).

$$r = R(\sigma, \theta, \lambda_0, \lambda_1; d)$$

where λ_0 is the birth rate of a new generation, and λ_1 its constant probability of death. Hence, when the government cuts taxes and issues government bonds today, the tax increase required in the future from the budget constraint might fall on taxpayers who are not yet living. The key issue in these models for explaining why debt matters is not that life is considered finite but the debt non-neutrality relies on the introduction of new taxpayers without links to the past. It provides then the conventional positive correlation between debt and interest rates, even if there is some degree of intergenerational altruism.

2.2 Literature review

A large empirical literature has tried to fill in the theoretical gaps by, on the one hand, addressing the issue of the potential impact of budget variables on sovereign bond yields and, on the other hand, by relaxing the closed-economy assumption. As surveyed in Brook [2003] or Engen and Hubbard [2004], the first issue provides heterogeneous findings, given the different model specifications, explanatory variables and sample. Table 1 focuses on recent papers mostly using panel data and reports the impact of public debt on long-term interest rates. Most studies do not take into account the recent episode of the financial crisis to assess the effect of fiscal variables on long-term interest rates.

The second type of literature introduces non domestic variables in order to account for financial globalization [6] and its impact on the pricing of sovereign credit risk. Indeed, larger capital inflows allow keeping long-term sovereign bond yields low despite a higher bond supply. In line with Costantini et al. [2014], who measure competitiveness differentials by cumulated inflation differential as another long-run driver of the sovereign spreads along with the debt-to-GDP ratio, we introduce net international investment

6. The evolution of net international investment position among industrial countries, as a consequence of financial globalization, has been well-documented by Lane and Milesi-Ferretti [2005].

TABLE 1 – Effect of 1% point increase in public debt on long-term interest rate in the recent empirical literature

Reference	**Countries (OECD)**	**Sample**	**Result in basis points (bps)**
Costantini et al. [2014]	9 EMU	2001 :1-2011 :12	7.5 bps
Pogoshyan [2014]	22	1980-2010	1.4-2.5 bps
Gruber and Kamin [2011]	19	1988-2007	0.6-1.8 bps
Baldacci and Kumar [2010]	31	1980-2008	2-5 bps
Laubach [2009]	United States	1976-2006	3-4 bps
Ardagna et al. [2007]	16	1960-2002	non linear
Kinoshita [2006]	19	1971-2004	2-5 bps
Engen and Hubbard [2004]	United States	1976-2013	3 bps

position to play this role. Moreover Baldacci and Kumar [2010] show that if sovereign bond yields have become more dependent on global conditions, national fiscal variables are not totally pushed out. Finally public debt and net foreign assets are included in our empirical framework as potential long-run drivers of the sovereign bond yields.

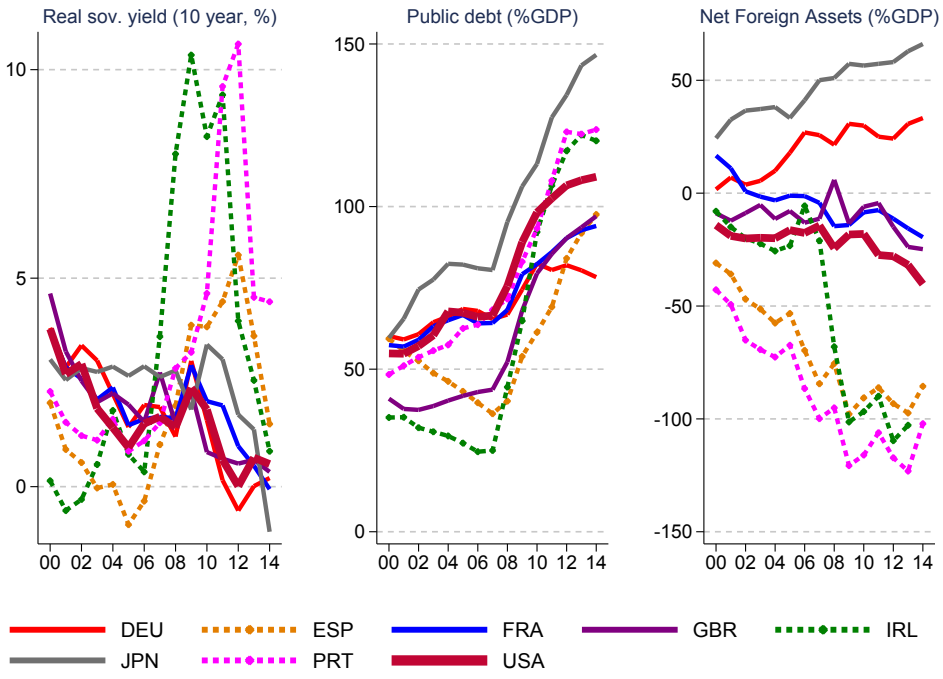
The issue now is the way external debt affects macroeconomic variables. When looking at the literature about the debt overhang, which is a key issue for developing/emerging countries, its impact is considered to be nonlinear. Indeed, beyond a certain threshold in terms of GDP, estimated at 35-40% by Patillon, Poirson and Ricci [2011], and also found by Imbs and Rancière [2005], external debt has a negative effect on the growth rate. The threshold is found to be higher in developed economies than in developing ones as pointed out by Reinhart, Reinhart and Rogoff [2012]. They found a value of 90% but this negative correlation between external debt and growth does not systemically translate to interest rates. Investigation of a non-linear impact of the public debt on the interest rates is not so common in the literature, and is rather found for emerging countries in Ardagna et al. [2007] or Perovic [2015] among others. Our intuition is then that net foreign assets play a role in the dynamics of interest rate even for developed countries, but in an indirect way. The mechanism would be the following : below a certain level, net international investment position helps deteriorating macroeconomic

stability, increasing the likelihood of crisis. This issue is developed in the next section.

2.3 Stylized facts : The role of public debt and net foreign assets

In order to detect whether or not internal and external imbalances in our data capture the dynamics of sovereign bond yields, we illustrate in figure 2 the evolution of real long term sovereign yields, public debt and net foreign assets for selected countries in our sample. As documented in section 2.1, we would expect from a theoretical point of view, a positive long-run relationship between the real sovereign bond yields and the level of government debt and a negative correlation with net foreign assets.

FIGURE 2 – Evolution of sovereign bond yields, public debt and net foreign assets (2000-14)



However, when analysing these correlations, some "decoupling" is observed between the sovereign yield and its usual fundamentals. For instance, some big economies exhibit

decreasing sovereign yields, whereas both their internal and external imbalances have deteriorated over time. This is the case, for instance, for the United States, the United Kingdom and France. Actually, whereas core countries seem to have benefitted from a flight-to-quality effect, peripheral countries have suffered from the abrupt revision of market expectations, showing sovereign bond yields on average significantly higher than what justified by fiscal factors only.

Our hypothesis in this study is that external imbalances that are considered "abnormal" by the investors may provide the answer for this puzzling behaviour. Indeed, peripheral economies characterized by a very high and rapid deterioration of their external imbalances at the end of the period, increase considerably their default risk premium. On the contrary, in core countries, where net foreign assets are either positive or negative but relatively stable, interest rates tend to decrease. In this sense, we postulate that highly deteriorated net foreign assets, beyond a certain level, are considered as a differentiating factor in which a higher yield would be necessary to attract investors in order to compensate them for a higher risk. When this risk is not present, traditional macroeconomic fundamentals will explain the behaviour of sovereign rates.

From the point of view of sovereign yields, the behaviour of NFA is particularly relevant. In effect, if a country uses its borrowed foreign funds to finance consumption rather than investment which would generate long-term income, then its ability to repay might come into question. This situation may have an impact on sovereign issuers even if this behaviour is circumscribed to the private sector only. In fact, during a financial crisis, sovereign credit risk can rise significantly through private-sector bailouts which increase public sector liabilities and the inherent risk of a public debt overhang.

Moreover, even if a country is intertemporally solvent, during a financial crisis it can be exposed to sharp reversals of its current account when facing higher external financing constraints. Such reversals can be highly disruptive because aggregate demand (including government consumption) must be curtailed abruptly when foreign financing is no longer available.

Actually, net foreign assets are an indicator of the long-run saving-investment balance

of an economy vis-à-vis the rest of the world, referring to its net borrowing needs or net wealth position. In this regard, a solvent country might be able to generate sufficient current account surpluses in the future to repay what it has borrowed to finance their deficits in the past. In other words, whether a country should run a current account deficit depends on the extent of its foreign liabilities and on whether this borrowing will finance productive investment.

Along these lines, our contribution assesses the nonlinear impact of debt through the net international investment position. Indeed, when net foreign assets are positive, the impact of debt on sovereign yields is expected to be reduced. On the contrary, when very negative, they are expected to increase the impact of debt and we show that this increase appears only for values of net foreign assets below a certain threshold. Following Pogoshyan [2014], we estimate panel data heterogeneous error-correction models from a long historical span in order to circumvent the endogeneity issue. Their specifications are presented in section 3.

3 Econometric models

3.1 Specification

In order to explore the relevance of net foreign assets as a long-run determinant of sovereign bond yields (r), we must take into account the cointegration between this variable and their determinants, such as public debt (D) and net foreign assets (A). We introduce the short-term real rate (denoted r^s) in the cointegration relationship, in order to take into account other structural effects in the economy. We then specify error-correction models as :

$$\Delta r_{it} = \varphi_i \beta_i' Z_{i,t-1} + \delta_i' X_{it} + \mu_i + \varepsilon_{it} \tag{3}$$

where r_{it} is the real sovereign bond yield at date t and for country i, Z_{it} the vector of variables included in the cointegration space, β_i the cointegrating vector of coefficients,

X_{it} the variables describing the short-run dynamics with δ_i. In addition, we adopt the following generic specification for the cointegration equation :

$$\beta' Z_{it} = r_{it} - \beta_1 D_{it} - \beta_2 A_{it} - \beta_3 D_{it} \times \mathbb{1}_{A_{it}>0} - \beta_4 D_{it} \times \mathbb{1}_{A_{it}<\lambda} - \beta_5 r^s_{it} \quad (4)$$

where the dummies are defined as :

$$\mathbb{1}_{A_{it}>0} = \begin{cases} 1 & \text{if } A_{it} > 0 \\ 0 & \text{otherwise} \end{cases} \quad ; \quad \mathbb{1}_{A_{it}<\lambda} = \begin{cases} 1 & \text{if } A_{it} < \lambda \\ 0 & \text{otherwise} \end{cases} \quad (5)$$

The introduction of dummies and the threshold λ, are founded in the *Macroeconomic Imbalance Procedure* (MIP) of the European Commission. The MIP was adopted in December 2011 and aimed at preventing and correcting macroeconomic imbalances by establishing a scoreboard. The former consists of a set of 11 indicators with indicative thresholds. Among these indicators, the thresholds of public debt and net international investment position are set, respectively, to -60% and -35% [7].

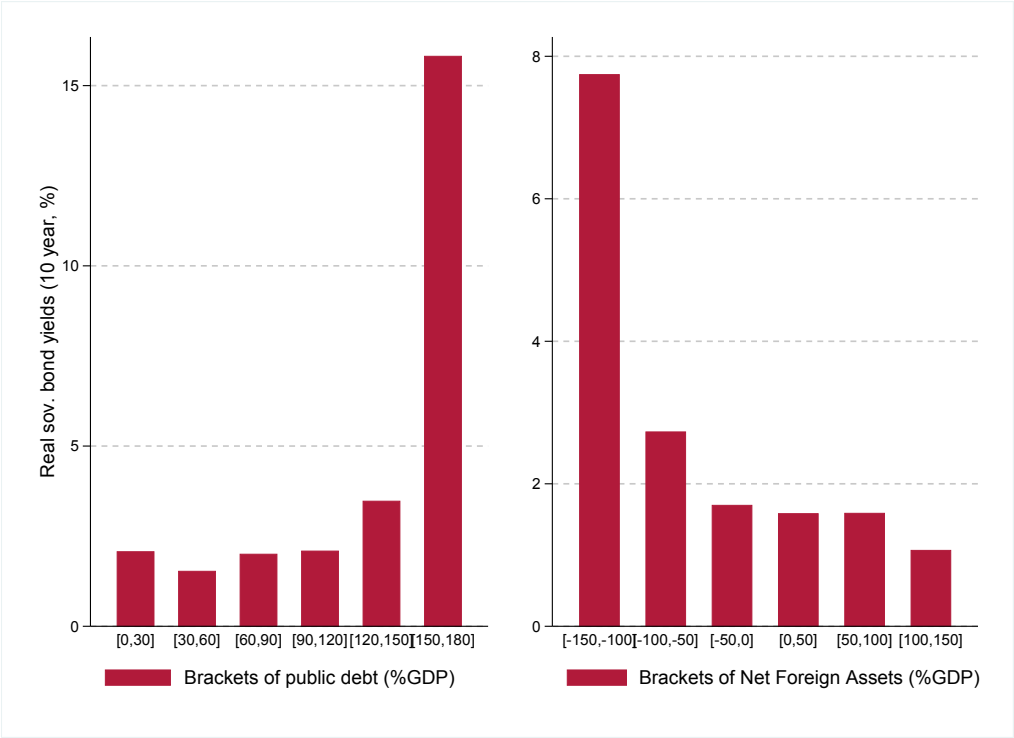
By looking at the data, however, sovereign yields seem to react to much higher values of public debt and net foreign assets than what is considered in the MIP. Actually, as depicted in figure 3, the mean of interest rates increases considerably only when the level of public debt and net foreign assets are very deteriorated, exceeding the values of 150 and -50%, respectively. Of course, this simple metric provides only guide values, but empirical evidence seems to also favour these magnitudes. For instance, Catao and Milesi-Ferretti [2013] found that the ratio of net foreign liabilities to GDP is a significant crisis predictor when it exceeds 50 percent in absolute terms. The previous section has reviewed other papers providing estimated thresholds closed to these values.

Our approach for the choice of the parameter λ in baseline estimations correspond to a threshold of -50% for net foreign assets. We also perform robustness checks with

7. The -35% threshold corresponds to the lower quartile of this variable over the period 1990-2007. Nevertheless, net foreign assets have deteriorated considerably in recent years with an average equal to -75% over the period 2008-2013.

the normative threshold of -35% in the appendix but the associated dummies lead to estimated coefficients of β_4 which are never significant (see table 11) [8].

FIGURE 3 – Sovereign bond yields mean by brackets of public debt and net foreign assets
(2000-14)



We are interested in several error-correction models, differing only in their specification of the long-run equilibrium given by equation (4). The short-run dynamics, in all models, is always described by inflation growth, short-term real rates growth, GDP growth and Debt-to-GDP growth [9].

– Model 0 is the baseline error-correction model. Only debt-to-GDP ratio (D) is

8. We did not specify an equivalent threshold for public debt since in our data, interest rates increase only when the level of public debt is beyond 150% and this applies to very few cases.

9. Fiscal balance-to-GDP growth has been introduced instead of debt-to-GDP growth but generally it is not significant. Current account-to-GDP ratio has also been taken into account as the short-run counterpart of net foreign assets-to-GDP ratio, but again it is never significant.

included in the long-run dynamics. This is equivalent to equation (4) when $\beta_2 = \beta_3 = \beta_4 = 0$.

- Model 1 : compared to model 0, the long-run dynamics considers also the direct impact of net foreign assets to GDP ratio (A). This is equivalent to equation (4) when $\beta_3 = \beta_4 = 0$.
- Model 2 : compared to model 0, direct and indirect impacts of net foreign assets are both included. This is equivalent to equation (4).
- Model 3 : compared to model 0, only the indirect impact of net foreign assets is studied. This is equivalent to equation (4) when $\beta_2 = 0$.
- Model 4 : compared to model 0, only the positive form of the interactive net foreign assets is studied. This is equivalent to equation (4) when $\beta_2 = \beta_4 = 0$.
- Model 5 : Since the coefficient β_3 is generally statistically insignificant, we also provide estimates of the regression excluding the positive form of the interactive net foreign assets, denoted model 5 (see section 4.2). This is equivalent to equation (4) when $\beta_2 = \beta_3 = 0$.

The idea behind models 2, 3 and 5 is that when net foreign assets are beyond -50%, it is expected they reinforce the impact of government debt on long-term yield and therefore $|\beta_1 + \beta_4| > |\beta_1|$. Conversely, in models 2, 3 and 4, the effect on sovereign yields of an increase in government debt is expected to be partially counterbalanced when the net foreign asset balance is positive. In that case, it is assumed that $|\beta_1 + \beta_3| < |\beta_1|$. It is expected then that $\beta_2 < 0$ and $\beta_3 < 0$ and $\beta_4 > 0$.

It must be pointed out, however, that net foreign assets are rarely positive and then the dummy $\mathbb{1}_{A_{it}>0}$ corresponds to few observations. Indeed, over the period, the external position is always positive only for three countries (Germany, Japan and Switzerland). On the contrary, eight countries (Australia, Greece, Italy, Korea, New Zealand, Portugal, Spain and Sweden) present a negative external position for all years but only for six of them there is a predominance of very negative net foreign assets. Finally, the remaining economies experiment successive periods of positive and negative external position.

In model 5, we systematically test the equality to 1 of the coefficient of the short-term

interest rate, β_5, in the long-run dynamics, in order to avoid misspecification. Actually, the pure expectation hypothesis implies that this coefficient must be equal to 1 when the other ones (β_1 to β_4) are equal to zero, which is systematically rejected by the tests (see section 4.2).

3.2 Panel estimation

The pooled mean group estimator (PMG) developed by Pesaran, Shin and Smith [1999] is used to estimate the error-correction model given by equation (3). We assume that the cointegrating vector of coefficients β is homogenous, whereas the short-run dynamics described by the coefficients δ_i's and the residual variances ($V(\varepsilon_{it})$) are country-specific. Indeed, the PMG estimator relies on a combination of pooling and averaging the coefficients for the long-run and short-run dynamics, respectively. It results from iterated likelihood maximization as country-specific error-correction models are non-linear in the parameters φ_i and β.

The long-run homogeneity could be tested by implementing the Hausman's test [10], which compares the difference between the PMG estimator and the Mean Group estimator, the latter being computed with country-specific coefficients for all variables. Moreover, the specification of the error-correction model is not necessarily symmetric as the variables explaining the long-run dynamics (X) could be different from the variables defining the long-run equilibrium (Z).

4 Empirical Analysis

4.1 Data

Our dataset is an unbalanced panel in annual basis composed of 22 OECD economies for the 1980-2014 period. A complete description of the variables and their source can

10. The distribution of the statistic is $\chi^2(k)$ where k is the number of variables included in the long-run relationship : without the short-term rate, 1 for model 0, 2 for models 1 and 4, 4 for model 2, 3 for model 3.

be found in table 2.

TABLE 2 – Description of variables and sources

Variable	**Description**	**Source**
Long term rate	Ten year real gov. bond yield	Datastream and OECD
Government debt	General gov. net debt, % of GDP	WEO and Eurostat
Net foreign asset	Net foreign asset position, % of GDP	External Wealth of Nations dataset[a] and author's calculations
GDP growth	Real GDP growth	WEO
Net lending or borrowing	General gov. net lending or borrowing, % of GDP	WEO and Eurostat
Current account balance	Current account balance, % of GDP	WEO
Short term rate	Three months real gov. bond yield	Datastream and OECD
Inflation	Inflation rate CPI	WEO

The sample covers Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and the United States.
[a] Lane and Milesi-Ferretti [2007].

The dependent variable is the long term real sovereign interest rate. We rely on daily and monthly observations of 10 year bond yields provided by Datastream and the OECD, from which we compute a yearly average. Regarding the choice for explanatory variables, the credit risk of a country is influenced by macroeconomic or political factors that affect the sustainability of debt and its likelihood of repayment. Among others, they are determined by the internal and external positions of a country. The former is described by debt-to-GDP ratios and fiscal deficits, and the latter by Net Foreign Assets and the current account balance to GDP. Fiscal position series are constructed on the basis of IMF and Eurostat publications.

To improve our understanding of the effect of the investment position on sovereign

yields, we also rely on the dataset of foreign assets and liabilities developed by Lane and Milesi-Ferretti [2007] for the period 1970-2011 and we update this figures up to 2014 by using available estimates from Eurostat and IMF on NIIP. The difficulty we face with this choice is the possible correlation between this variable and public debt. One possibility to overcome this problem would be to exclude the amount of public debt from category Debt assets and liabilities. However, this is not possible given data constraints. We consider this should not bias our results in a significant manner since the simple mean correlation between the two variables is limited (less than 5 per cent in absolute terms over the whole sample).

Overall, our sample includes a maximum of 747 observations but, due to missing values in the explanatory variables, we only use around 550 data points. Table 3 reports usual descriptive statistics about the different variables in the model.

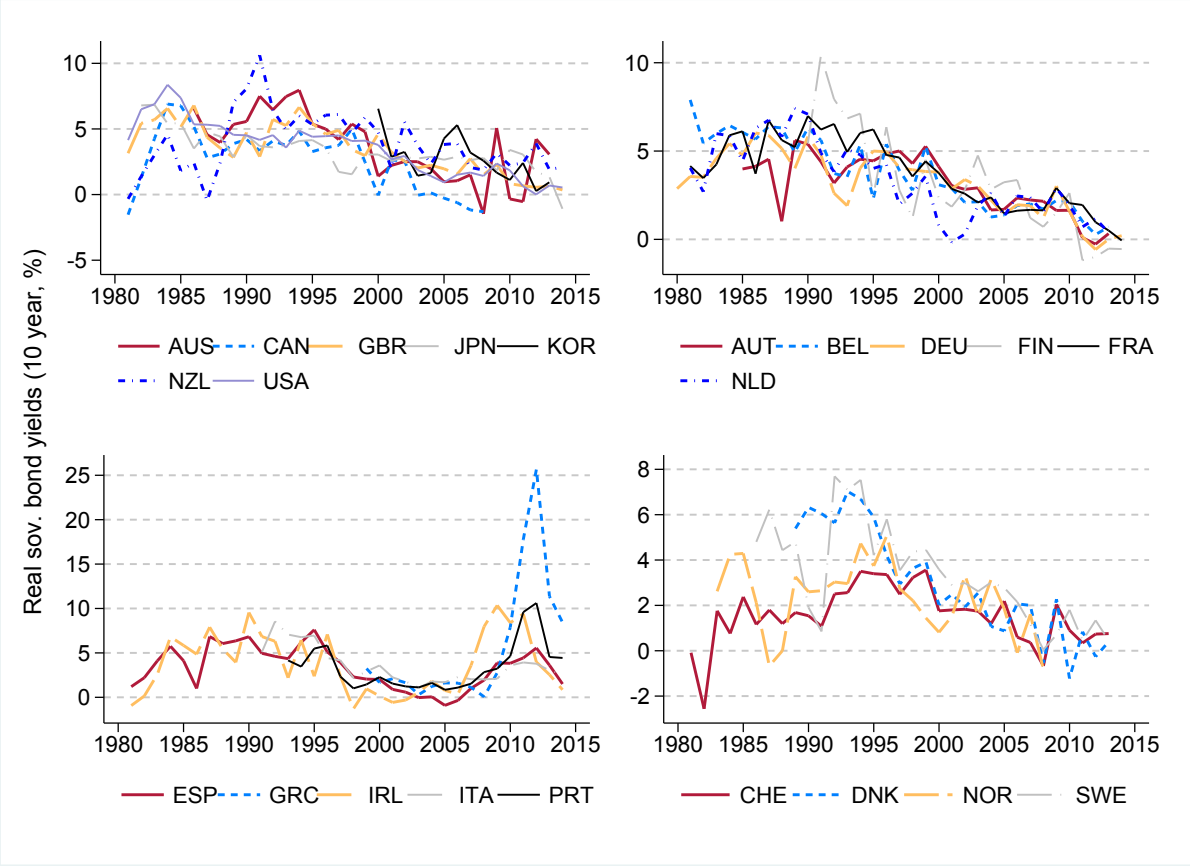
TABLE 3 – Descriptive statistics

Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Long term rate	624	3.4	2.5	-2.6	25.7
Government debt	708	56.6	29.7	6.5	179.5
Net foreign asset	748	-11.8	42.6	-165.5	146.6
Short term rate	653	2.8	2.8	-2.8	12.2
Net lending/borrowing	669	-2.5	4.8	-30.9	18.8
Current account balance	747	0.1	4.8	-14.9	16.5
Inflation	747	4.1	4.4	-1.7	29.3
GDP growth	726	2.4	2.6	-8.5	12.3

The average long term rate amounts to 3.4 percent. Nevertheless, there is a wide difference between countries, with a minimum of -2.6 and a maximum of 25.7 percent. Moreover, interest rates present, in general, a decreasing pattern over time until the 2009 financial crisis (see figure 4). This trend is also confirmed by a number of papers such as Shiller [2007]. In addition, it is also observed a dichotomy between core and periphery EMU countries following the global credit crunch. The long term rates of the core group

have been relatively stable whereas the ones of the periphery group have experienced a considerable ascending path.

FIGURE 4 – Evolution of sovereign bond yields
(1980-2014)



4.2 Results

Before estimation, we perform various panel unit root and panel cointegration tests, without neglecting the cross-section dependence issue. The results reported in appendix A.1 indicate that most of our variables have a unit root, and that there exists at least one cointegration relationship between sovereign bond yields and their long-run determinants.

From table 4, estimation results indicate that we obtain the expected relationship between sovereign bond yields and debt. Specifically, a 1 percentage point increase in the government debt-to-GDP ratio results in a rise of 5.2 basis points in the yield. This feature is in line with the estimates found in other studies, as reported by Haugh, Ollivaud and Turner [2009] and in table 1 for more recent papers. Concerning net foreign assets, its role on the long-run dynamics of sovereign bond yields is not a clear-cut issue. The negative coefficient associated to the direct metric of net foreign assets in model 1 suggests that countries with a more advantageous external position would pay lower interest rates. Indeed, a 1 percentage point increase in the external position leads to a decrease of around 2 basis points in the yield as provided by the estimation of model 1, but it is less significant.

In spite of the conclusions that can be drawn from table 4, the reported short-run coefficients are unweighted averages of country-specific coefficients and it could be interesting to have a look at individual results. Indeed, the speed of adjustment when significantly positive or not significant, implies that there is no long-run effect of debt or net foreign assets on sovereign bond yields. Actually, we find no evidence of a tendency of the 10-year bond yield to revert to its long-run determinants in half of the countries. This could be possibly related to the fact that our sample covers a relatively long period. Thus, the underlying factors of the dynamics could go beyond the macroeconomic variables present in our model and, for instance, be related to other structural changes. As documented in figure 4, sovereign bond yields have been subject to substantial changes over time. A single structural factor could not provide a clear-cut explanation for this, but several elements put together might play a role. A non-exhaustive list of such elements is provided in what follows.

First of all, the decline in inflation rates since the 1980s might imply a fall in risk premia on nominal assets demanded by investors given the lesser uncertainty about future inflation. In addition, other factors such as the Maastricht Treaty and, subsequently, the introduction of the euro currency in 1999 could also play a role. Actually, up to the 2009 financial crisis, it was observed a converging pattern across the euro zone bond yields

TABLE 4 – Preliminary regressions - No short-term rate in cointegration equation
(Average short-run coefficients)

	Model 0	Model 1
Long-run coefficients		
Debt ratio	0.056***	0.052***
Net Foreign Asset		-0.016*
Short-run coefficients		
Error correction residual	-0.224***	-0.232***
ΔDebt ratio	0.071***	0.070***
ΔInflation	-0.365***	-0.359***
ΔShort-term real rate	0.475***	0.468***
ΔGDP	0.000	0.000
Constant	-0.312**	-0.351**
BIC	1400.8	1405.8
Hausman test[a]	0.505	0.750
Observations	561	561
Countries	22	22

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

[a] p-value.

to that of Germany. However, since the eruption of the sovereign debt crisis, peripheral countries of the euro area have experienced a substantial rise in the spread against the core economies. On the other hand, core countries have benefited from a flight-to-quality effect, leading to a considerable reduction of their government bond yields, as pointed out by Costantini et al. [2014].

More recently, in order to stimulate the economy, non-conventional monetary policy has been implemented in major advanced countries, thus impacting the yield. Such policies have been used by Japan, the United States, the United Kingdom, and the Eurozone, among others. One possibility to overcome the difficulty of including several structural factors in the econometric specification is to introduce the short term yield

directly in the long-run dynamics instead of placing it in the error correction residual only. Indeed, when included in the cointegration relationship, the short term yield would integrate the downward expectations of future real rates of return given the structural changes experienced since the 1980s. In contrast, since longer term bonds imply a greater risk, the differential between the two could be explained by the fiscal and external position of one country [11].

Table 5 reports the estimated parameters from our error-correction model when the short-term rate is included in the cointegration equation. Since the coefficient of the interactive term is generally statistically insignificant when net foreign assets are positive, we also provide estimates of the regression excluding this variable in Model 5.

As in previous analysis, the debt-to-GDP ratio remains significant and with the expected sign. Nevertheless, the impact of debt-to-GDP ratio is lowered and varies between 0.012 and 0.017. The main difference in the results is that now net foreign assets, in their direct form, are not significant. Looking at the models where net foreign assets are specified as acting indirectly, the sign of their coefficient, when the threshold of -50% is crossed (models 2, 3 and 5), is the expected one. Actually, a 1 percentage point fall in the external position increases the risk of the country in around two additional points in the yield when the variable has significantly worsened. The results highlight the fact that a worsened net foreign position can be a differentiating factor for investors. In this sense, public finance variables are not sufficient to explain the dynamics of sovereign rates. Rather, investors further penalize countries with a "twin deficit" : the combination of both worsened budgetary and net external positions.

Actually, if we refer to model 5, the rise of 1 point in the debt-to-GDP ratio induces a long-term increase of only 1.6 basis points in the yield if the external position of the country is favorable. Nevertheless, if the competitiveness of the country is highly deteriorated, the same increase in the public debt will push the yield up in 3.2 basis points.

11. Long-term bonds yields can be decomposed into the expected short-term bond yields during the same period plus a premium that investors require for bearing the risk of a long-term bond investment as expressed in equation (1)

It is worthy of note that both variables come into consideration in the Macroeconomic Imbalance Procedure scoreboard of the European Commission.

The misspecification in table 4 can then be associated to the lack of the short-term interest rate, which plays a major role in the long-run dynamics. Indeed our panel estimation suggests that this variable accounts for about 70% of the changes in the long-term yield. This is roughly in line with the theoretical prediction of a one-for-one movement between these two variables [12]. Moreover, the specification in table 5 is more suitable as only Austria and Norway do not present a significant estimate of the error correction residual [13] and the adjustment to long-run equilibrium occurs more rapidly than the one reported in table 4. In addition, the models with the short-term interest rates outperform those without them in terms of fitting, as indicated by the Bayes Information Criteria (BIC). Long-run homogeneity is again validated by the Hausman test as the p-values are greater than 30% except for model 4, whose information criteria is yet among the highest.

All the specifications are robust to outliers as estimates remain quite stable when modifying the time or country sample. Indeed, beginning the time sample at 1986 instead of 1980 (loosing 36 observations) in order to exclude the early 1980s, characterized by long-term interest rate peak, provides similar estimates for the long-run or the short-run dynamics (see table 9 of appendix A.2).

4.3 Model Simulations

In order to investigate how well our models explain the current evolution of sovereign bond yields, we calculate the fitted values of our regressions and compare them to observed data. In what follows, we refer to model 5 in table 5 as our main specification.

12. Although the test shows that this parameter is significantly lesser than one, the fact that short-term rates are not fully reflected in long-term yields may be explained by the term premium and any other sources of deviation from the expectations hypothesis. Actually, some studies (such as Sarno, Thornton and Valente [2007]) suggest the rejection of the expectation hypothesis throughout the maturity spectrum.

13. The same models are estimated for countries for which the speed of adjustment is significantly negative and the results are reported in table 10 of appendix A.2.

We perform dynamic simulations [14] for the period that goes from 2008 to 2013 using the country coefficients estimated over the whole sample (in-sample simulations). We also construct the out-of-sample simulations between 2011 and 2013 using the country coefficients estimated up to 2010 to check the performance of the model during the economic crisis. The results are displayed in figures 5 and 6, respectively.

In general, our model tracks quite closely the pattern of observed movements in the series when we use the in-sample forecast techniques. This is particularly relevant since the simulations cover a period characterized by unusual movements on sovereign yields, which literature had difficulties to explain. For instance, the model succeeds in capturing the rapid increase of yields experimented by the European peripheral countries such as Greece, Ireland, Portugal and Spain. Our model also captures relatively well the downward trend of yields in core economies that benefitted from a flight-to-quality effect. Indeed, despite a slight disconnection at the end of the period, the predicted value follows closely the observed trend of the yield in France, Germany, Japan, the United Kingdom and the United States.

Overall, our out-of-sample forecast is able to roughly replicate the interest rate path. However, given the lesser information captured by the coefficients, its performance is lower than in the in-sample case. Indeed, there are some sizeable errors in the case of Italy and Japan.

14. The predicted value of the bond yield for one period is used for the value of the lagged dependent variable in the subsequent period.

FIGURE 5 – Actual and in-sample fitted values of sovereign yields
(Forecast starting on 2007, regression ends on 2013)

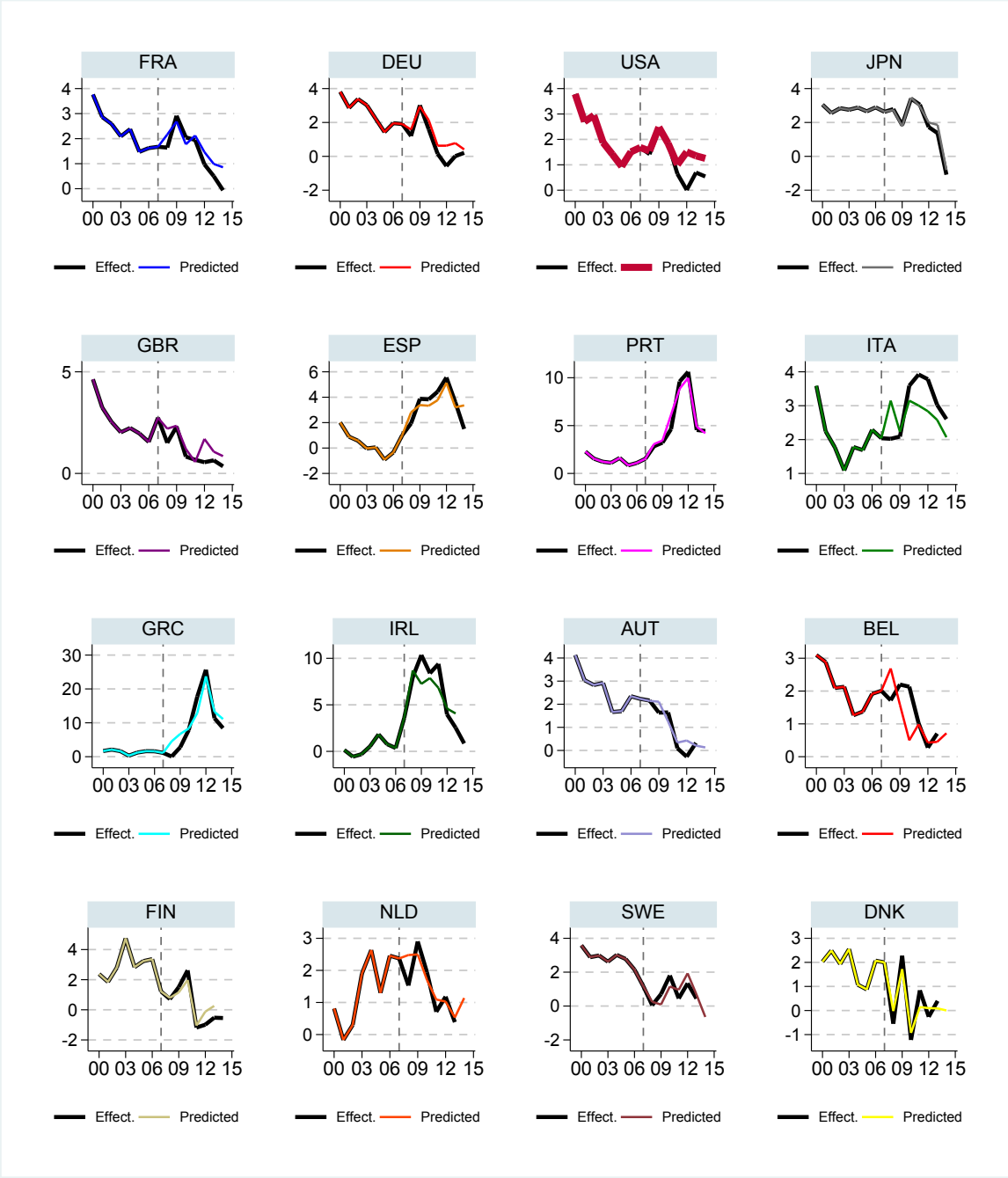
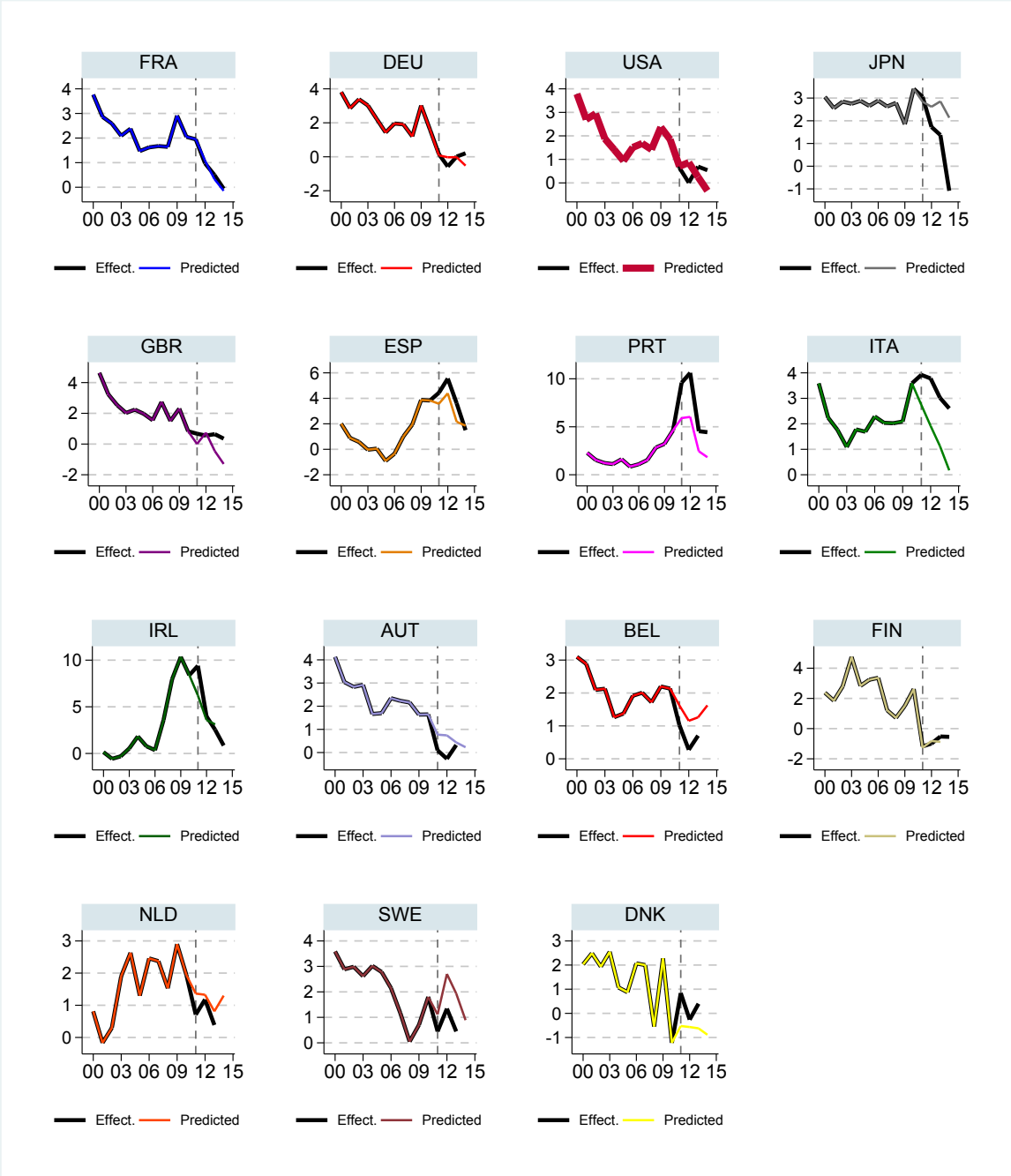


FIGURE 6 – Actual and out-of-sample fitted values of sovereign yields
(Forecast starting on 2011, regression ends on 2010)



5 Conclusion

This paper analyses the long-run dynamics of sovereign bond yields in developed countries. The objective is to disentangle the role played by net foreign assets, when taking into account the debt behaviour. When applied to a post-1980 yearly OECD country panel, we find evidence for a nonlinear effect of net foreign assets once a certain threshold is crossed, combined to the debt-to-GDP ratio. The relevance of our specification of the long-run dynamics of the sovereign bond yields is confirmed by the in-sample and out-of-sample forecast exercises conducted after 2007. In fact, it succeeds in capturing the rapid increase of sovereign bond yields experimented by the European peripheral countries and reproduces fairly well the trajectory of core economies which have benefitted from a flight-to-quality effect.

Our results suggest that fiscal imbalances of peripheral countries have certainly contributed to increase their sovereign risk, but this is not the only factor that comes into play. Actually, external imbalances are also identified as an important driver of the interest rates surge after the 2008 economic crisis. This alternative interpretation is not necessarily inconsistent with the fiscal fragility vein but may also reflect concerns about the solvency of private sector. Actually, we show that investors doubly penalize countries with a "twin deficit" : the combination of both deteriorated budgetary and net external positions. This is more apparent when we observe results at country level during the 2008 financial crisis. Whereas core countries seem to have benefitted from a flight-to-quality effect, peripheral countries have suffered from the abrupt revision of market expectations, showing sovereign bond yields on average significantly higher than what justified by fiscal factors only. Actually, for most of the peripheral countries, the deterioration of competitiveness has a role comparable to fiscal fundamentals in explaining the level of the yields.

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A Appendices

A.1 Testing unit roots and cointegration

We first test cross-sectional dependence in our data as this feature creates considerable difficulties when testing the null hypothesis that all units in a panel are non-stationary. Indeed, power gains in panel unit root tests developed under the assumption of cross-section independence over individual unit root tests are in fact the consequence of nontrivial size distortions. The results of Pesaran [2004a]'s test, based on the pair-wise correlation of coefficients, are reported in table 6 and indicate cross-section dependence.

Next, we check for the stationarity of our variables by applying second-generation panel unit root tests developed by Pesaran [2004b] that relaxes the cross-sectional independence assumption. He considers a one-factor model with heterogeneous loading factors for residuals and suggests augmenting the standard ADF regression with the cross-section averages of lagged levels and first differences of the individual series. Another important feature of this panel unit root test is to take into account heterogeneity among the unit-root coefficient, which leads to the following test hypothesis :

$$\begin{aligned} H_0 &: \text{ All country-specific } \rho_i = 0 \\ H_a &: \text{ At least one or several panels are stationary } \rho_i < 0 \text{ for some } i \end{aligned}$$

The results, reported in table 7, are no so clear-cut. Overall, for the level of the government debt ratio, the net stock of foreign assets and their interactive term, the tests are unable to reject the null hypothesis that all panels contain unit roots against the panel stationarity alternative hypothesis. Mixed evidence is found, however, for the real long and short term interest rate.

In the case of interest rates variables, the aforementioned tests indicate that these series could be mean stationary for the panel as a whole. This conclusion is also supported by the unit root tests in time series framework for some countries where data are available in quarterly basis. In other countries, however, the evidence suggests that both series

have unit roots and therefore, looking for a cointegration relationship between interest rates variables and the other ones remains relevant.

In the line suggested by the results of Pesaran [2004a]'s test, the Westerlund [2007]'s tests of no-cointegration in a heterogeneous error-correction model are applied and the critical values are bootstrapped to take into account cross-section dependence. The group mean tests (G_a, G_t) consider cointegration for each country, and the corresponding null hypothesis is the following :

$$\begin{aligned} H_0 &: \text{All country-specific speeds of adjustment } \alpha_i = 0 \\ H_a &: \text{At least one panel exhibits cointegration } \alpha_{i_0} < 0 \end{aligned}$$

On the other hand, pooled mean tests P_a, P_t consider cointegration for the whole panel :

$$\begin{aligned} H_0 &: \text{All country-specific speeds of adjustment } \alpha_i = 0 \\ H_a &: \text{Every panel exhibits cointegration } \alpha_i < 0 \forall i \end{aligned}$$

Two versions of these tests could be computed depending on the way the parameters α_i or the test statistics t_{α_i} are weighted averaged or pooled. If the right hand side variables are not weakly exogenous, leads and lags must be added. The results are reported in table 8.

Note : The results indicate the presence of common factors affecting the cross sectional units. Therefore, the critical values for the test statistics are bootstrapped.

Again, the evidence is not clear cut due to group mean tests. As shown in table 8, the results in general reject the hypothesis that the series are not cointegrated.

TABLE 5 – Baseline regressions - Short-term rate in cointegration equation
(Average short-run coefficients)

	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5
Long-run coefficients						
Debt ratio	0.014***	0.012***	0.017***	0.016***	0.014***	0.016***
Net Foreign Asset		-0.005	0.003			
Short-term real rate	0.715***	0.698***	0.710***	0.706***	0.711***	0.707***
Debt ratio*(NFA>0)			-0.002	-0.000	-0.001	
Debt ratio*(NFA<-0.5)			0.021***	0.018***		0.018***
Short-run coefficients						
Error correction residual	-0.560***	-0.561***	-0.572***	-0.570***	-0.561***	-0.570***
ΔDebt ratio	0.055**	0.057**	0.053*	0.054**	0.055**	0.054**
ΔInflation	-0.307***	-0.306***	-0.302***	-0.302***	-0.307***	-0.302***
ΔShort-term real rate	0.184***	0.183***	0.162**	0.165**	0.184***	0.165**
ΔGDP	0.000	0.001	0.001	0.001	0.000	0.001
Constant	0.174	0.192	-0.090	-0.065	0.191	-0.066
BIC	1271.7	1276.4	1282.1	1276.1	1278.0	1269.8
Hausman test[a]	0.326	0.364	1.000	0.629	0.146	0.574
$\beta_5 = 1$[a]	0.00	0.00	0.00	0.00	0.00	0.00
Observations	561	561	561	561	561	561
Countries	22	22	22	22	22	22

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

[a] p-value.

TABLE 6 – Cross-sectional dependence

Variable	Test value	P value
Long-term rate	33.4	0.000
Debt ratio	18.3	0.000
NFA	-1.2	0.231
Short-term rate	45.1	0.000

TABLE 7 – Panel unit root test

Variable	Test value	P value
Long-term rate	-4.3	0.000
Debt ratio	2.9	0.998
NFA	7.3	1.000
Short-term rate	-5.9	0.000
Debt ratio*(NFA>0)	11.3	1.000
Debt ratio*(NFA<-0.5)	15.5	1.000

TABLE 8 – Panel cointegration test

	Group mean tests		Pooled mean tests	
Model	Gt	Ga	Pt	Pa
Constant + debt ratio	0.0	0.2	0.0	0.0
Constant + debt ratio + NFA	0.0	0.0	0.0	0.0
Constant + debt ratio + NFA + debt ratio*NFA	0.0	0.3	0.0	0.0

A.2 Robustness checks

TABLE 9 – Robustness regressions - Sample 1986-2013
(Average short-run coefficients)

	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5
Long-run coefficients						
Debt ratio	0.018***	0.023***	0.029***	0.025***	0.026***	0.025***
Net Foreign Asset		-0.003	0.008**			
Short-term real rate	0.699***	0.662***	0.669***	0.665***	0.651***	0.673***
Debt ratio*(NFA>0)			-0.007**	-0.002	-0.003	
Debt ratio*(NFA<-0.5)			0.023***	0.015***		0.015***
Short-run coefficients						
Error correction residual	-0.571***	-0.572***	-0.587***	-0.582***	-0.572***	-0.582***
ΔDebt ratio	0.051*	0.051*	0.046	0.049*	0.050*	0.049*
ΔInflation	-0.297***	-0.298***	-0.297***	-0.296***	-0.299***	-0.296***
ΔShort-term real rate	0.162**	0.173**	0.148**	0.154**	0.176***	0.152**
ΔGDP	0.001	0.001	0.001	0.001	0.001	0.001
Constant	0.032	-0.155	-0.413**	-0.327*	-0.167	-0.337*
BIC	1187.6	1183.5	1188.0	1184.1	1183.4	1178.0
Observations	523	523	523	523	523	523
Countries	22	22	22	22	22	22

* p < 0.10, ** p < 0.05, *** p < 0.01

TABLE 10 – Robustness regressions - 20 countries
(Average short-run coefficients)

	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5
Long-run coefficients						
Debt ratio	0.013***	0.010**	0.017***	0.015***	0.012***	0.015**
Net Foreign Asset		-0.005	0.003			
Short-term real rate	0.722***	0.706***	0.713***	0.710***	0.716***	0.712***
Debt ratio*(NFA>0)			-0.003	-0.001	-0.002	
Debt ratio*(NFA<-0.5)			0.022***	0.018***		0.018***
Short-run coefficients						
Error correction residual	-0.599***	-0.601***	-0.613***	-0.610***	-0.602***	-0.609***
ΔDebt ratio	0.057**	0.059**	0.055*	0.056*	0.057**	0.056**
ΔInflation	-0.263***	-0.261***	-0.258***	-0.257***	-0.263***	-0.257***
ΔShort-term real rate	0.203***	0.200***	0.178**	0.182**	0.201***	0.182**
ΔGDP	0.000	0.000	0.001	0.001	0.000	0.001
Constant	0.271	0.307	-0.014	0.022	0.306	0.009
BIC	1181.3	1185.8	1191.4	1185.6	1187.2	1179.4
Observations	513	513	513	513	513	513
Countries	20	20	20	20	20	20

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The sample covers Australia, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea, Netherlands, New Zealand, Portugal, Spain, Sweden, Switzerland, United Kingdom and the United States.

TABLE 11 – Robustness regressions - Official threshold for net foreign assets
(Average short-run coefficients, from and after 1985)

	Model 2	Model 3	Model 5
Long-run coefficients			
Debt ratio	0.014***	0.015***	0.015***
Net Foreign Asset	-0.007*		
Short-term real rate	0.703***	0.714***	0.718***
Debt ratio*(NFA>0)	0.004	-0.001	
Debt ratio*(NFA<-0.35)	-0.003	-0.001	-0.001
Short-run coefficients			
Error correction residual	-0.554***	-0.559***	-0.558***
ΔDebt ratio	0.057**	0.055**	0.055**
ΔInflation	-0.304***	-0.307***	-0.307***
ΔShort-term real rate	0.188***	0.185***	0.186***
ΔGDP	0.000	0.000	0.000
Constant	0.082	0.170	0.153
BIC	1288.4	1284.2	1277.9
Observations	561	561	561
Countries	22	22	22

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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