Anticipated macroeconomic fundamentals, sovereign spreads and regime-switching: the case of the euro area*

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Abstract

The impact of the anticipated macroeconomic fundamentals on the euro area sovereign spreads is shown to be subject to regime-switching dynamics. The estimated model performs well in explaining the observed break in the spread data corresponding to the year 2005. We propose an abstract model to interpret our finding: the probability of default is itself subject to changes in regimes because the anticipated fundamentals are characterized by multiple equilibria. The model allows time-varying probabilities to account for the influence of global financial conditions in the determination of "sunspot"– or stochastic – equilibria. The regime-changing dynamics is interpreted as the result of the implementation of the Basel II framework.

Keywords: Sovereign spreads; Time varying Markov-Switching; Euro area; anticipated fundamentals

JEL classification: C51; F36; H39

*The views expressed in this papers are only the authors' and do not necessarily reflect the opinion of the Banque de France and CEPII.

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1.- Introduction

The question as whether forecasts of macroeconomic fundamentals affect the sovereign bond spreads in the Euro area is still an unresolved issue. Though recent academic papers document a close correlation between both, there seems not to be a consensus because papers on the topics are still few (Some recent papers are Attinasi et al. (2009), Barrios et al. (2009), Sgherri and Zoli (2009)).. This paper adds to the empirical literature by documenting that the strength with which changes in market expectations of economic fundamentals are factored in the determination of the Euro area bond market spreads is regime-dependent. Such dependence implies multiple “equilibrium relationships” between spreads and macroeconomic variables, and switches between the equilibria. The factors causing the switches are not necessarily sunspots or self-fulfilling expectations, but variables that are publicly available. Specifically, the impact of the anticipated macroeconomic variables on sovereign spreads depends upon the global conditions prevailing in the financial markets (appetite for risk, market liquidity, health of the banking sector). We use a nonlinear model of sovereign spreads, namely a time-varying probability Markov switching model. We model the probabilities associated with narrowing and widening spreads as a result of changes in anticipated public deficits, debt ratios and inflation. These probabilities vary across time as the result of changed attitude to risk, debt market liquidity or stock price changes of banking institutions.

The contributions of the paper are the following. To our knowledge, there are no previous studies applying time-varying Markov-switching regime models to study the dynamics of sovereign spreads in the euro area. Such a study is interesting because the dynamics of spreads in Europe are subject to structural changes regarding the influence of the macroeconomic fundamentals. We interpret the structural changes as the results of institutional reforms in 2005 corresponding to the implementation of the Basel II rule. This led the investors to modify their opinion about the way they evaluated the probability of default on sovereign debts by governments. We contribute to the literature by first proposing a simple analytical model in which some sources of regime switches are described. In particular, spreads are affected by the investors’ perceived probability of default on debt servicing by governments and this probability varies across time because investors anticipate the future outcome of macroeconomic fundamentals influencing sovereign debts. The uncertainty on the expectations on the fundamentals is modeled by a Markov process. We then consider a reduced-form of the analytical model to illustrate the empirical performance of time-varying Markov switching model in describing the experience of the euro area spread between 2003 and 2009. To this end, we estimate an extension of a Filardo-type model.

The paper is organized as follows. Section 2 introduces the theoretical framework of analysis. Section 3 presents the data and some stylized facts. Section 4 contains the empirical estimation. Finally, Section 5 concludes.

2.- Framework of analysis

The framework we propose is an adaptation of the so-called "escape clause models" in the literature on currency crises to sovereign bond market when a risk of default exists[1]. The perceived probability of default by bond holders is reflected in the sovereign spreads.

2.1.- The model

2.1.1.- Sovereign spreads and perceived probability of default

Consider a government that has issued a sovereign bond for which it has committed to pay an interest rate very date t, r_t to the holders of the domestic bond. In time t-1, investors think that the government can default at time t with a probability π_t. We assume that, in case of default, the investors receive no payment. There is a riskless bond whose interest rate is R_t. The expected rate of return is given by the following relationship:

$$1 + R_t = (1 + r_t) \times (1 - \pi_t) + \pi_t \times \ 0, \ \ 0 < \pi_t < 1 \qquad (1)$$

Denoting the spread $SP_t = r_t - R_t$, we have

$$SP_t = (1 + R_t)\frac{\pi_t}{1-\pi_t} \qquad (2)$$

An increase in the perceived probability of default at time t yields an increase in the spreads:

$$\frac{\partial SP_t}{\partial \pi_t} = \frac{1+R_t}{(1-\pi_t)^2} > 0 \qquad (3)$$

π_t is assumed to be the average of the perceived probability of default occurring at time t by a continuum of individual bond holders k:

$$\pi_t = \int_0^1 \pi_t^k dk, \ \ k \epsilon [0,1] \qquad (4)$$

[1] For examples of such escape clause models, see Jeanne (1997), Jeanne and Masson (2000).

2.1.2.- Government's loss function

We define the projected loss function of the government as follows:

$$L_t = -(\tau_t - \tau_t^*),\ \tau_t = \frac{r_t D_t}{REV_t} \tag{5}$$

where D_t denotes the expected stock of sovereign debt at time t, REV_t denotes the expected fiscal revenues at time t by the government. We assume that at time t-1 the government has to choose its expenditures and revenues for time t. τ_t is thus the projected ratio of debt service over fiscal revenues at time t. τ_t^* is a threshold value above which the government defaults (if $\tau_t > \tau_t^*$). We assume that a default implies a loss for a government in the sense that the induced cost of defaulting is a difficulty to raise funds to finance public expenditure in the future. Dividing the numerator and the denominator by the nominal GDP, the loss function can also be expressed in terms of the projected debt ratio to GDP, d_t, and projected fiscal revenues as share of GDP, rev_t:

$$L_t = -(\tau_t - \tau_t^*),\ \tau_t = \frac{r_t d_t}{rev_t},\ \ d_t = \frac{D_t}{GDP_t},\ rev_t = REV_t/GDP_t \tag{6}$$

From a standard equation of debt dynamics, the evolution of debt ratio can be represented in terms of the nominal growth rate, γ_t, and the primary balance as share of GDP, pb_t:

$$d_t = \frac{1+r_t}{1+\gamma_t} d_{t-1} - pb_t \tag{7}$$

This equation summarizes the influence of the macroeconomic fundamentals on the debt ratio. This can be motivated by several arguments. For instance, the current account may influence the dynamics of debt through the fiscal approach of the balance of payment. Real growth has an impact through automatic stabilizers or government fiscal reaction function. Also, equation (7) shows that inflation influences the debt ratio through nominal GDP.

As a consequence, the projected debt ratio is a function of the projected level of fundamental variables and of the probability of default (through the influence of the interest rate). Denoting $\boldsymbol{\Omega}$ a vector containing the fundamentals and the riskless interest rate R_t, and noting that r_t is a function of R_t and π_t ,we can rewrite the government's loss function as follows:

$$L_t = -(\tau_t - \tau_t^*) = \psi(\Omega_t, \pi_t, \Omega_t^*) \tag{8}$$

where Ω_t^* is the value of the projected fundamentals and riskless interest rate for which $\tau_t = \tau_t^*$.

An increase in the perceived probability of default increases the government's loss while the impact of an increase in the projected fundamentals depends upon the nature of the correlation between the debt service ratio and these fundamentals:

$$sign\left(\frac{\partial\psi(.)}{\partial\Omega}\right) = sign\left(\frac{\partial\tau(.)}{\partial\Omega}\right), \quad \frac{\partial\psi(.)}{\partial \mathrm{r}} > 0 \tag{9}$$

2.1.3.- Dynamics of the fundamental variables and Markov-switching regimes

At time t-1, governments need predicting the value of the fundamental variables in order to make projections of their debt service for time t. Also, bond holders need to anticipate the fundamentals in order to evaluate the probability of default for time t.

We assume that the fundamentals are stochastic and evolve according to a two-state Markov-switching process. This assumption can be motivated by the huge empirical literature showing that macroeconomic variables in the industrialized countries are influenced by the business cycle, which is characterized by strong nonlinearities in terms of the asymmetric dynamics of the expansion and recession phases, the occurrence of turning points, the length of the transitional dynamics[2]. To mimic the nonlinear dynamics, different types of econometric models have been proposed among which the Markov-switching models. Such models are the empirical equivalence of the so-called "sunspot equilibrium models" in the theoretical literature. They capture the idea that market equilibria are not necessarily deterministic but can be stochastic if the economies are characterized by a high degree of uncertainty.

We assume that the government and the investors base their forecasts on the same set of information and use the same "technology" to make their predictions. The assumption is retained for purpose of simplicity, in order to avoid introducing heterogeneous expectations which would lead us to discuss problems of coordination. This is out of the scope of this paper.

The stochastic nature of the economic dynamics is introduced by assuming that, at time t, the fundamentals are "unobservable", or not known with certainty because the economy is subject to permanent shocks causing them to switch between different regimes. These regimes are identified by a latent variable $S_t = \{1,2\}$. The fundamentals evolve according to the following equation:

[2] For and example, see Clements and Krolzig (2004).

$$\Omega_t = \mu(S_t) + \alpha(S_t)\Omega_{t-1} + \varepsilon_t \quad (10)$$

where $\varepsilon_t \sim N(0, \sigma_\varepsilon^2)$ and $E[\varepsilon_t, \varepsilon_{t'}] = 0$ for $t \neq t'$. The transitional dynamics between regimes 1 and 2 is described by the following transition matrix:

$$\prod = \begin{bmatrix} p_{11}(z_t) & 1 - p_{11}(z_t) \\ 1 - p_{22}(z_t) & p_{22}(z_t) \end{bmatrix}, \; p_{ij}(z_t) = Pr[S_t = j \,/ S_t = j, z_t], \; i,j = 1,2 \quad (11)$$

z_t is a "transition" variable that governs the switching between regimes. In the empirical part of the paper below, these are variables related to the global financial environment.

2.1.4.- Perceived probability of default

The perceived probability of default is a key variable influencing the dynamics of sovereign spreads. At time t-1 a representative investor estimates that, at time t, a default will occur if $\tau_t > \tau_t^*$, that is :

$$\pi_t \; = Pr[\psi(\Omega_t, \pi_t) < 0/\Omega_{t-1}] = Pr(\tau_t > \tau_t^*/\Omega_{t-1}) \quad (12)$$

(12) is a closed loop equation because there are feedback effects between the left- and right-hand sides of the equation. There may be multiple values of π_t satisfying this equation since both sides are increasing functions of π_t . More precisely, since τ_t and Ω_t describe the same dynamics, the cumulative distribution function of Ω_t is a sigmoid function (because $\varepsilon_t \sim N(0, \sigma_\varepsilon^2)$). This implies that the maximum number of π_t is equal to 3.

In this simple model, the nonlinearity in the default probability is thus a potential source of multiple values of the sovereign spreads.

2.2.- Characterization of the stationary (steady-state) equilibrium

2.2.1.- The equilibrium under certainty (deterministic equilibrium)

We consider the equilibrium under certainty, that is when the transition matrix degenerates to the identity matrix (once the economy enter a given regime j at the initial date, it continues to visit this regime in the subsequent periods).

The first step is to determine τ_t^*. Because we have assumed that the government and the investors share the same set of information to make their predictions of the fundamentals, the level of the debt service ratio above which investors anticipate a default is the level above which the government effectively chooses to default.

It is optimal for the government to choose τ_t^* such that

$$L_t = -(\tau_t - \tau_t^*) = \psi(\Omega_t, \pi_t, \Omega_t^*) = 0 \quad (13)$$

Indeed, if $\tau_t < \tau_t^*$, the government defaults but this choice is not optimal because defaulting implies a cost: it becomes difficult to borrow in the capital markets to finance future expenditures. If $\tau_t > \tau_t^*$ it does not default, but pay an interest rate on public debt higher than the minimum level it could pay and still avoid defaulting. Thus, the optimum is $\tau_t = \tau_t^*$.

Denoting $\tilde{R}$ the riskless interest rate at the steady state (which is exogenous), we characterize a stationary equilibrium of the expected fundamentals, under certainty, by a vector $(\tilde{\Omega}\ ,\tilde{\Omega}^*)$ that satisfies:

$$\tilde{\Omega} \ = \left(\frac{\mu}{1-\alpha}, \tilde{R}\right) \quad (14)$$

using equation (10) and

$$\psi(\tilde{\Omega}\ , \pi_t, \tilde{\Omega}^*\ ) = 0 \quad (15)$$

The equilibrium values are then used to compute the perceived probability of default and the sovereign spreads:

$$\tilde{\pi} \ = Pr[\psi(\tilde{\Omega}\ , \tilde{\pi}\ ) < 0], \quad \widetilde{SP} \ = (1+\tilde{R})\frac{\tilde{\pi}}{1-\tilde{\pi}} \quad (16)$$

Even is the steady-state value of the fundamentals is unique, we may have multiple steady state values of the sovereign spreads because of the nonlinearity in the default probability.

2.2.2.- The equilibrium under uncertainty (stochastic equilibrium)

As we have assumed that the economy is not observable with certainty, both the government and investors cannot anticipate the stationary value of the fundamentals but only their distribution (or some values in the distribution) in the steady state. Considering the Markov model introduced before, we need further assumptions about the way $p_{ij}(z_t)$ is determined. We assume the following simple linear specifications for S_t:

$$S_t = \begin{cases} 1, & if\ \eta_t < a(S_{t-1}) + z_t b(s_{t-1}) \\ 2, & if\ \eta_t \geq a(S_{t-1}) + z_t b(s_{t-1}) \end{cases} \quad (17)$$

where $\eta_t \sim iid$ with cumulative distribution function Φ . The transition probabilities are accordingly defined as:

$$p_{1j} = \Phi(a_j + z_t b_j)\ and\ p_{2j} = 1 - \Phi(a_j + z_t b_j),\ \ j = 1,2 \quad (18)$$

Denoting f the density function of ε_t in Equation (10) and using Bayes' rule, we can compute the posterior probability of being in sate j at time t as follows:

$$\upsilon_{jt} = \frac{p_{1j}\upsilon_{1t-1}\eta_{jt} + p_{2j}\upsilon_{2t-1}\eta_{jt}}{f(\Omega_t/\Omega_{t-1})},\ \ j = 1,2 \quad (19)$$

where $\eta_{jt} = f(\Omega_t/\Omega_{t-1}, s_t = j)$ is the density of Ω_t conditional on the realization of state $S_t = j$ and $f(\Omega_t/\Omega_{t-1})$ is the unconditional density of Ω_t.

Therefore, for each t, the expected fundamentals take two values Ω_t^1 and Ω_t^2 with respective probabilities υ_{1t} and υ_{2t}.

Let us first consider the case of constant probabilities (z_t is a constant). A stochastic steady-state equilibrium is then defined by a vector $\left(\widehat{\Omega}^1, \widehat{\Omega}^2, \widehat{\Omega}^{*1}, \widehat{\Omega}^{*2}, \upsilon_1, \upsilon_2\right)$ that satisfies

$$\widehat{\Omega}^j = \left(\frac{\mu^j}{1-\alpha^j}, \hat{R}^j\right),\ \ j = 1,2 \quad (20)$$

$$\hat{\upsilon}_j = \frac{p_{1j}\hat{\upsilon}_1\eta_j + p_{2j}\hat{\upsilon}_{2t-1}\eta_j}{f(\widehat{\Omega}^j)},\ \ \eta_j = f\left(\widehat{\Omega}^j/S_t = j\right),\ j = 1,2 \quad (21)$$

$$\psi\left(\widehat{\Omega}^j, \widehat{\Omega}^{*j}\right) = 0, j = 1,2 \quad (22)$$

The perceived probability of default and spreads are then given by

$$\hat{\pi}^j = Pr\left[\psi\left(\widehat{\Omega}^j, \hat{\pi}^j\right) < 0\right], \quad \widehat{SP}^j = \left(1 + \hat{R}^j\right)\frac{\hat{\pi}^j}{1-\hat{\pi}^j}\ , j = 1,2 \quad (23)$$

where $\hat{R}^j$ is the stationary value of the interest rate of the riskless asset in state j. Compared with the equilibrium under certainty.

If z_t is not constant, then the stochastic equilibrium is characterized by time-varying probabilities and (17) is replaced by

$$\upsilon_{jt} = \frac{p_{1j}\upsilon_{1t-1}\eta_{jt} + p_{2j}\upsilon_{2t-1}\eta_{jt}}{f(\widehat{\Omega}_t)},\ \ j = 1,2 \quad (24)$$

Compared with the case of deterministic equilibrium, the model now has a maximum of 2^3 stochastic equilibria. The aim of the model is only to show the plausibility of multiple levels of sovereign spreads in an economy even under simple assumptions concerning governments' loss function and the perceived probability of default. The message delivered by this stylized model can be summarized as follows.

First, the dynamics of sovereign spreads can be characterized by several regimes (for instance a regime of narrowing spreads as opposed to a regime of widening spreads, or a regime of high level of spreads as opposed to one of low levels of spreads). Governments pay attention to the existence of such regimes because the latter have an influence on their ability to service their debt. Also, the regimes influence the views of bond holders about the probability of default. Secondly, the fundamentals are subject to structural instabilities (due to shocks affecting the economies or the management of macroeconomic policies). Such instabilities give rise to multiple fundamental equilibria and thus to multiple levels of sovereign spreads. Which equilibria are chosen by the investors? The process of selection - or the switches between the different equilibria – depends upon the way investors use their anticipations of the macroeconomic fundamentals to determine the risk premium they ask on the sovereign debts they hold. There are third factors at play, such as investors' mood or market sentiment (which are captured in the empirical application below by an index of risk aversion), or the global financial environment (which we capture using indicators of debt market liquidity).

In Section 4 we illustrate the potential application of the model by considering the example of the euro area sovereign debt market. We consider a linearized reduced form equation linking sovereign spreads to some forecasted macroeconomic variables using the framework of a time-varying probability Markov-switching model. We address the question as whether changes in the anticipated macroeconomic fundamentals provide valuable information to say whether sovereign debts in the euro area are priced at high or low rate by investors.

3.- Data and stylized facts

3.1.- Period and countries

We consider monthly data from 2003:01 to 2009:06 and the following eleven euro area countries: Austria, Belgium, Finland, France, Germany, Greece Ireland, Italy, the Netherlands, Portugal and Spain.

3.2.- Endogenous variable : euro area sovereign spreads

The sovereign spreads are defined as the difference between the bond yield and a 10-year euro swap. A sovereign bond becomes a riskier asset when it is traded above the euro swap yield.

Figure 1 shows that the euro area bond yields to the 10-year euro swap have followed similar patterns in many countries. Following an initial stability (with a small spread) in 2003 up until the end-2005, there was a phase of decrease until the end 2008. After 2008 a pronounced reversal was observed with spreads increasing substantially.

INSERT FIGURE 1 ABOUT HERE

2.3.- The explanatory variables

2.3.1.- Anticipated macroeconomic variables

There are several papers in the empirical literature suggesting that *expected*, rather than observed, budgetary and current account balances matter for investment decisions in the bond markets. Among these papers, some specifically consider the case of the EMU countries. Using data from the Consensus Forecasts, Heppke-Falk and Hüfner (2004) find a significant effect of expected deficits on France and Germany's interest rate swap spreads. Haugh et al. (2009) suggest that higher expected future deficits were important in explaining movements in spreads (versus Germany), when future fiscal deficits are proxied by successive *Economic Outlook* forecasts and a fiscal-track-record indicator. Barrios et al. (2009), Attinasi et al. (2009) also point to a similar influence of expected macroeconomic fundamentals during the 2008 financial crisis. Sgherri and Zoli (2009) show that, since October 2008, the euro area bond markets have been more concerned about the implication of financial fragility on future debt dynamics.

We consider three macroeconomic indicators taken from the *Consensus Economic Forecasts*, namely experts' estimate each month of the current account balance, fiscal balance (both measured as ratios of GDP) for the current year, as well as the anticipated inflation rate.

We limit our attention to these variables, since they are key indicators of structural imbalances influencing investors' decisions on debt markets[3]. The variables are the following.

CA0: expected current account balance. The current account balance (CA) reflects the borrowing ability of the national economy. If CA> 0, the country earns more than it spends and is lender vis-à-vis the rest of the world. As a consequence, a positive expected CA should lead lower spreads. We therefore expect that CA0 and spreads moves in opposite directions.

DEF0: expected fiscal balance. Anticipation of higher deficits inducing increasing financing needs should lead to a negative relationship between deficit and spreads. We therefore expect DEF0 and spreads to move in opposite directions.

P0: expected inflation. Unlike other variables, the expected relationship between inflation and spread is uncertain. In the one hand, inflation reduces the burden of existing debt. But in the other hand, inflation raises the cost of future debt. Thus the net impact of inflation expectations is undetermined.

Forecasts regarding current accounts in the euro area, for the year t[4], have differed across two groups of countries. On the one hand, large current account surpluses have been anticipated for Germany and the Netherlands (Figure 2a). On the other hand, a deterioration of the external positions of the other countries has been expected (Figure 2b). Finland is a peculiar case with changing expectations.

INSERT FIGURES 2a and 2b ABOUT HERE

As regards fiscal balance, for a majority of countries, markets' perceptions are represented as a reversed L, since from 2009 onwards experts anticipated a huge deterioration of budgetary situations (Figure 2d). This can be explained by the announcements of bank rescues, recovery plans and the expectations of a transfer of risk from the private sector (banking and corporate) to governments. However, before 2008, the shape of the forecasted fiscal positions varies across countries. In Austria, Greece, Italy and Portugal the projected fiscal account balances are described by a V curve (expectations of a degradation followed by expectations of lower deficits (see Figure 2c for an illustration). In the other countries the expectations of fiscal positions has been oriented upward.

[3] The use of consensus forecasts indicators have been subject to theoretical controversy, see for instance amongst the most recent, Crowe C. (2010), nevertheless they are widely looked at and used by market players and especially rating agencies.
[4] Using the forecasts for the year t+1 yields similar conclusions.

INSERT FIGURES 2c and 2d ABOUT HERE

As regards inflation, the expectations exhibited particularly pronounced anticipations of a deflation phenomenon following the 2008 crisis, as shown in Figure 3.

INSERT FIGURE 3 ABOUT HERE

Plotting the level of the forecasted macroeconomic variables against the spreads, we observe that the relationship between them is not necessarily stable and has been shifting across time. For illustration purpose, Figures 4a and 4b show the XY relation between the sovereign spreads and the expected fiscal and current account positions, respectively for Germany and Spain. They illustrate the fact, when analyzing the impact of expected macroeconomic fundamentals on spreads, it could be worthwhile considering level and/or slope changes in our regressions. In the case of Germany, expectations of lower public deficits imply a drop in the spreads. However, the graph shows that there were in fact two curves, thereby implying a shift across time. In the case of Spain, Figure 4b provides an illustration of a slope effect in the current account/deficit relationship. A first portion of the graph shows no sensitivity of the spreads to the expected current account (vertical “line”), a second portion depicts a positive correlation and the graph ends with a negative slope of the current account/spread curve.

Accordingly, sovereigns’ risk sensitivity with respect to expected economic fundamentals has changed over time and the impact of the latter on the sovereign yield spreads may be characterized by structural changes. Similar figures could be shown for all the euro area countries and by considering expectations for the next year. A more-in-depth analysis suggests that the year 2005 is a candidate for a “break” date separating two regimes. Again, for purpose of illustration, we plot the scatter representing the sovereign bond yields of some countries against the projected deficits for year t, distinguishing between the period before and after 2005 (Figure 5). As is seen the fiscally-related variables were more strongly correlated with the spreads after 2005.

INSERT FIGURE 4 ABOUT HERE

INSERT FIGURE 5 ABOUT HERE

One explanation to the presence of several regimes in the correlation between sovereign spreads and the expected macroeconomic fundamentals (with 2005 as a break date) is the consequence of the implementation of Basel II in the European countries. The Basel II framework contains new elements – in comparison with Basel I – that may have influenced the way in which debt markets have evaluated sovereign default risk since 2006.

Firstly, the new rules put an emphasis on the role of external ratings –which include rating agencies – in the evaluation of countries' credit risk and defaults, along with the internal risk rating by banks. This was prescribed for more transparency and time availability of public evaluation. In regards to this, we must keep in mind the following elements. As a consequence of Basel II, markets' perception of sovereign risks has been based on the rating of agencies such as Moody's, S&P or Fitch. Besides, the explanatory power of the macroeconomic variables has represented more than 90% of cross-country variations in agencies' ratings. Indeed, higher ratings are very often associated to high GDP growth and capita income, low debt to export ratios, fiscal positions, etc. Accordingly, the highest correlation between the spreads and the expected macroeconomic variables could be explained by the higher weight of the agencies' rating in the debt markets' evaluation of sovereign default. The question why the agencies give such an important role to macroeconomic variables may be that Basel II also introduces rules that led to a reduction of financial risk – and of contagion effects to the sovereign debt markets- through more prudent capital and liquidity management by banks.

A second important point is the following. Basel II prescribes statistical models as tools for evaluating credit risks and the committee insists on the fact that the key variables considered in the models should be focused on risk assessment conducted by expert personnel[5]. The Economic consensus forecast is an example of the experts' perception of countries' risk based on macroeconomic fundamentals. If the agencies' ratings are correlated to the experts' forecasts, then the variations observed in these fundamentals can lead the investors to anticipate rating changes and to adjust accordingly their risk premium on sovereign debts. This may be the case if rating agencies and investors have the same information set.

2.3.2- Financial variables

We consider the following variables as transition variables used in the vector z_t (source: Datastream and ECB Statistical Data Warehouse, 2003:01-2009:6):

AVER: degree of risk aversion. Following previous works by Blanco (2001), Codogno et al. (2003) and Favero et al. (2008) we consider a global measure of risk aversion taken

[5] See Basel Committee (2001), Consultative document, p.51, n°266 and BCBS (2004).

from the US market. Our measure of risk aversion is the difference between the yield of the US corporate 10 year bonds and the yield of the US Treasury constant maturities 10 year bonds.

BANK: banking sector valuation. We consider an index of national banking sector quotation provided by DataStream. The evolution of this index reflects the health of the domestic banking sector. In Europe, banks are holders of sovereign bonds market. The evolution of the banking sector thus has an important influence on spreads.

NEG: share of negotiable debt. This is a proxy of the liquidity of the sovereign debt markets. They are lots of debates concerning the best way to take into account liquidity and especially to disentangle liquidity from credit risk influence (see for instance Favero et al. (2008)). We have chosen to consider a direct approach by computing national monthly share of European negotiable debt provided by the ECB Statistical Data Warehouse on a quarterly basis. To obtain monthly share we first compute a monthly GDP based on the Chow Lin interpolation methodology[6] using national IPI (Industrial Production Index) provided by Eurostat. We then use this monthly GDP for computing national monthly negotiable debt by using the Chow Lin methodology once more. We finally express the computed national monthly negotiable debt in share of European GDP.

4.- The empirical framework

4.1.- The model

With regard to the existing literature on euro area sovereign spreads, the use of Markov-switching models (MS hereafter) improves over classical regressions. The model enables to see whether events such as a higher perceived risk, a narrowing liquidity premium, or a higher financial stress in the banking sector increases or decreases the probability of a stronger or weaker influence on the fundamentals on the sovereign spreads. The fact that some financial variables are correlated, not only to government bond spreads, but also to the macroeconomic fundamentals, can explain that they drive the correlation between the sovereign spreads and the perceived macroeconomic variables.

We use an error-correction specification to capture both the short-run and long-run (cumulative) effects of the forecasted macroeconomic variables on the sovereign spreads.

[6] See Chow and Lin (1971).

Analyzing cumulative effects, in addition to instantaneous effects, allows considering duration effects. For instance, sovereign spreads may not increase this year though the experts anticipate worsening fiscal or external conditions to occur, but may vary because they have formed such an expectation over the last three or five years. Cumulative effects are likely not to matter if the experts change the "direction" of their expectations (by forecasting either positive or negative variations of the fundamentals) frequently. In this case, the cumulative changes in expectations sum to zero, which, in the view of the investors could signal a feeling of an uncertain macroeconomic environment. By contrast, if the expectations are oriented persistently in one direction, they may affect the spreads.

We consider the sovereign spreads SP_t as the endogenous variable. SP_t "visits" two regimes which are identified endogenously by the model. The occurrence of a regime is referred by a variable s_t that takes two values: 1 if the observed regime is 1 and 2 if it is regime 2[7]. We assume that *t=1,..,T*.

The observation of either regime 1 or 2 at time t depends upon the regimes visited by the endogenous variable during the previous periods, that is s_t is conditioned by $s_{t-1}, s_{t-2}, \cdots, s_{t-k}$. At any time $\tau < t$, the regime that will be observed at time t is not known with certainty. We thus introduce a probability P of occurrence of s_t given the past regime. Assuming, for purpose of simplicity, that s_t is a first-order Markov-switching process, we define

$$P\{s_t/s_{t-1}, s_{t-2}, \cdots, s_{t-k}\} = P\{s_t / s_{t-1}\}. \quad (25)$$

We further assume that the transition from one regime to the other depends upon a set of "transition" variables described by a vector z_t so that

$$P\{s_t / s_{t-1}\} = P\{s_t/s_{t-1}, z_t\}. \quad (26)$$

Assuming a Logit specification[8] for the occurrence of z_t on s_t, we have:

[7] We do not discuss here the question as whether the number of states is equal to or different from 2. This is an assumption in our case. According to the data, it seems that the dynamics of the sovereign spreads is characterized by three regimes. However, we do not have enough observations to identify the third regime (increasing spreads).

[8] Any functional form of the transition probabilities that maps the transition variables into the unit interval would be a valid choice for a well-defined log-likelihood function: logistic or Probit family of functional forms, Cauchy integral, piecewise continuously differentiable variables. We consider here the Logistic specification because this choice is common wisdom in the applied literature.

$$s_t = \begin{cases} 1, \ if\ \eta_t < a(s_{t-1}) + z_t^{'} b(s_{t-1}) \\ 2, \ if\ \eta_t \geq a(s_{t-1}) + z_t^{'} b(s_{t-1}) \end{cases}, \quad (27)$$

where η_t is a random variable that is distributed as a Logistic function. We accordingly define the transition probabilities as follows:

$$\begin{cases} P\{s_t = 1/s_{t-1} = j\,, z_t\} = p_1(z_t) = \Phi\left(\mathrm{a_j} + \mathrm{z_t^{'} b_j}\right) \\ P\{s_t = 2/s_{t-1} = j\,, z_t\} = p_2(z_t) = 1 - \Phi\left(\mathrm{a_j} + \mathrm{z_t^{'} b_j}\right) \end{cases} \quad (28)$$

where Φ is the cumulative distribution function of the logistic law.

Consider a vector x_t of exogenous variables influencing the endogenous variable SP_t. x_t contains the anticipated macroeconomic variables. We define

$$y_t = \begin{cases} x_t^{'} \beta_1 + \sigma \quad \varepsilon_t, \ \ with\ a\ probability\ p_1(z_t) \\ x_t^{'} \beta_2 + \sigma \quad \varepsilon_t, \ \ with\ a\ probability\ p_2(z_t) \end{cases} \quad (29)$$

where $\varepsilon_t \backsim N(0,1)$. $p_1(z_t)\ and\ p_2(z_t)$ are the posterior probabilities of observing regimes 1 and 2. The usual probabilistic properties for the ergodicity and the invertibility of (29) apply if we assume that $y_t, x_t\ and\ z_t$ are covariance-stationary[9].

The above model could be generalized to a higher number of states (see Kim et al. (2008)) and encompasses several classes of Markov-switching models previously proposed in the literature. It is very similar to the time-varying probability models introduced by Goldfeld and Quandt (1973), Diebold et al. (1994), Filardo (1994). When $b_j = 0$, the model reduces to the constant probability model proposed by Goldfeld and Quandt (1973) and Hamilton (1989).

The model is estimated by maximum likelihood (henceforth ML) with relative minor modifications to the nonlinear iterative filter by Hamilton (1989). We define the following vectors: $\Omega_t = (X_t, Z_t)$ the vector of observations of x and z up to period t; $\xi_t = (y_t, y_{t-1}, \dots, y_1)$; $\theta = (\beta_1, \sigma_1, a_1, b_1, \beta_2, \sigma_2, a_2, b_2)$.

The conditional likelihood function of the observed data ξ_t is defined as

$$L(\theta) = \prod_{t=1}^{T} f(y_t/\Omega_t\,, \xi_{t-1}; \theta) \quad (30)$$

where

$$f(y_t/\Omega_t\,, \xi_{t-1}; \theta) = \sum_i \sum_j f(y_t/s_t = i, s_{t-1} = j, \Omega_t, \xi_{t-1}; \theta) \times P(s_t = i, s_{t-1} = j/\Omega_t\,, \xi_{t-1}; \theta) \quad (31)$$

The weighting probability in (7) is computed recursively by applying Bayes' rule:

[9] See Hamilton (1989).

$$
\begin{aligned}
&P(s_t = i, s_t = j/\Omega_t, \xi_{t-1}; \theta) \\
&= P(s_t = i/s_{t-1} = j, z_t) P(s_{t-1} = j/\Omega_t, \xi_{t-1}; \theta) \\
&= P_{ij}(z_t) P(s_{t-1} = j/\Omega_t, \xi_{t-1}; \theta)
\end{aligned} \tag{32}
$$

We also have

$$
\begin{aligned}
&P(s_t = i \quad /\Omega_{t+1}, \xi_t; \theta) = P(s_t = i \quad /\Omega_t, \xi_t; \theta) \\
&\frac{1}{f(y_t/\Omega_t, \xi_{t-1}; \theta)} \sum_j f(y_t/s_t = i, s_{t-1} = j, \Omega_t, \xi_{t-1}; \theta) \\
&\times P(s_t = i, s_{t-1} = j/\Omega_t, \xi_{t-1}; \theta)
\end{aligned} \tag{33}
$$

To complete the recursion defined by the equations (27) and (29), we need the regime-dependent conditional density functions

$$
f\left(y_t/\mathrm{s_t} = 1, \mathrm{s_{t-1}} = \mathrm{j}, \Omega_\mathrm{t}, \xi_{\mathrm{t-1}}; \theta\right) = \frac{\phi\left(\frac{y_t - x_t'\beta_1}{\sigma_1}\right)\Phi\left(\frac{a_j + z_t' b_j - \rho\left(\left(y_t - x_t'\beta_1\right)/\sigma_1\right)}{\sqrt{1-\rho^2}}\right)}{\sigma_1 P_{1j}(z_t)} \tag{34a}
$$

$$
f\left(y_t/\mathrm{s_t} = 2, \mathrm{s_{t-1}} = \mathrm{j}, \Omega_\mathrm{t}, \xi_{\mathrm{t-1}}; \theta\right) = \frac{\phi\left(\frac{y_t - x_t'\beta_2}{\sigma_2}\right)\Phi\left(\frac{a_j + z_t' b_j - \rho\left(\left(y_t - x_t'\beta_2\right)/\sigma_2\right)}{\sqrt{1-\rho^2}}\right)}{\sigma_2 P_{2j}(z_t)} \tag{34b}
$$

The parameters of Equations (28) and (29) are thus jointly estimated with ML methods for mixtures of Gaussian distributions. As compared with other estimators (for instance, the EM algorithm or the Gibbs sampler[10]), the ML estimator has the advantage of computational ease. As shown by Kiefer (1978), if the errors are normally distributed, then the ML yields consistent and asymptotically efficient estimates. Further, the inverse of the matrix of second partial derivatives of the likelihood function at the true parameter values is a consistent estimate of the asymptotic variance-covariance matrix of the parameter values.

The influence of z_t on P_{1j} and P_{2j} gives information about the way the transition variables influence the probability of being in either regime or another.

4.2.- Estimation results

The estimation results are reported in Tables 1 through 3. The endogenous variable is the first-difference of the sovereign spread. The explanatory variables are: a constant, an autoregressive term (first lag of the endogenous variable) whose influence is captured by the coefficient φ_1, the forecasted macroeconomic variables in level (first lag) and first-difference. We also consider the first lag of spread, so that our model is a time-varying error correction

[10] See Diebold et al. (1994) and Filardo and Gordon (1993).

model. This is important because the experts' forecasts can influence the dynamics of the spreads only in the very short-run, but their influence can also last longer time periods. We consider different transition variables (financial) that may condition the influence of the forecasted macroeconomic variables on the spreads. The coefficients A11 and A21 indicate whether a given transition variable increase (positive sign) or decrease (negative sign) the probability that the spreads evolves in respectively regime 1 and regime 2. When none of these coefficients are statistically significant, then the model behaves like a constant probability model (if the constant terms A1 and A2 are significant). In the tables, we finally report the p-value of a likelihood ratio test of the hypothesis of a constant probability MS model (with no transition variables influencing the switches between the two regimes) and a time-varying MS model (TVPMS hereafter).

An asterisk indicates that a coefficient is statistically significant at 5%, two asterisks mean that it is significant at 10%.

From the estimations, we see that the MS model dichotomizes between two regimes. One corresponds to a regime where the spread remains on average near zero and the second represents a regime where the spread is negative. If we look at the intercept coefficient, we indeed observe that for a majority of countries it is insignificant in one regime (1 or 2) and significantly negative in the other one. In fact, the MS model distinguishes between two regimes corresponding to situations that we previously identify as that of small spreads from 2003 to 2005 and to the years of decreasing spreads from 2006 to 2008.

4.2.1.- Regressions with the degree of risk aversion as the transition variable

Our variable of risk aversion can be considered as a proxy of markets' perception of the price of risk in situations of financial distress in the sovereign bond markets. If investors believe that there is an increased likelihood of sovereign bond default, because they anticipate forthcoming deteriorating macroeconomic fundamentals, then the result is a higher perceived credit risk reflected by increases in sovereign spreads. In this case, in the TVPMS model, we would expect a lower probability of observing regimes of either narrowing or unchanged spreads (conversely, a higher sovereign risk usually entails sharp upward movements in their dynamics). This means that A11 and/or A21 are expected to be negative. As is seen in the regressions in which the transition variable *AVER* has significant coefficients, this is indeed the case (France, Germany, Italy, Greece, Ireland, Belgium, Finland, and Austria).

INSERT TABLE 1 ABOUT HERE

Analyzing the short-run dependence between the forecasted macroeconomic variables and sovereign spreads across the two regimes -when the transition variable is AVER- we find that the regime with narrowing spreads (which corresponds to statistically negative intercepts) generally shows a stronger correlation between the spreads and the forecasted macroeconomic variables for all the countries except Germany. Indeed, in most regressions the short-term coefficients (those of the explanatory variables expressed in first-difference) corresponding to the regime with negative spreads are higher in absolute values compared with their value in the other regime. By contrast, in Germany, after 2005 (which corresponds to the years in regime 1), the relationship between the sovereign spread and the expectations of fundamentals seems to have weakened.

An explanation of this result may be the following. After 2005, the adoption of Basel II framework modified the perception of the sovereign debt market drivers. Any increased risk of default was then perceived as the results of factors other than financial factors. In particular, according to the investors' perception, a default on sovereign debts was more likely to stem from a mismanagement of macroeconomic policies than from a systemic crisis originating in the financial sector.

To study the effects of the cumulative changes in the expected macroeconomic variables, we consider the coefficients of the explanatory variables in level. For a long-run relationship to hold, a necessary condition is that the coefficient of the lagged spread variable in level be significant and negative.

In some regressions, the cumulative changes in the forecasted macroeconomic fundamentals are not a reliable source of information to predict the observed variations in the sovereign spreads. For instance, this is the case for Germany (over the period before 2006), for France and Italy (over the period after 2005). Indeed, for these countries, we either obtain an insignificant coefficient in either regime 1 or regime 2, or a significant error-correction term with insignificant effect of the explanatory variables. In the case of France and Italy, one explanation is the following. In 2005, the second version of the European Stability Pact was voted and was characterized by a more flexible interpretation of the conditions triggering sanctions to a country not meeting the criteria. The macroeconomic forecasters – and investors in the debt markets - interpreted this change as a period of greater uncertainty about the choices of the policymakers (with the exception for Germany). This resulted in frequent changes in the "direction" of expected fiscal and external account balances (expectations of improving macroeconomic balances followed by anticipations of deteriorating situations). Since the summation of alternatively positive and negative changes in the expected variables results in cumulative expectations changes that are near zero, the consequence is either a non-significant coefficient of the error-correction term or insignificant coefficients of the level explanatory variables in level.

In the regressions in which the error-correction term coefficient is statistically significant in both regimes, the coefficients of the explanatory variables that are significant are often higher in magnitude in the regime corresponding to negative spreads (years following 2005 as in the case of Ireland, Finland and Austria).

4.2.2.- Regressions with the banking sector valuation and the share of negotiable debt as the transition variables

These two variables are driving factors of the regime-switching dynamics of the sovereign spreads in only but a few regressions. The regressions for which the following both conditions are met concerns, Germany, Greece, Ireland, and Belgium: A11 or A21 significant and a p-value of the likelihood ratio test below 5%. An increase in the value of banks in the stock markets can signal two different phenomena. On the one hand, one can argue that this reduces the risk of default on sovereign debts, because banks are important holders of public debts, and upward oriented prices of the banking sector stock prices indicate that their financial and economic indicators are improving. As a consequence markets may ask lower or unchanged risk premium to continue holding debts. In this case, the expected signs of A11 and A21 are positive. On the other hand, banks, like other financial institutions, can find an incitation in committing themselves in riskier activities that are undervalued in their balance-sheets, as observed for instance during the recent 2008 crisis. If investors share this view and believe that banks take risky decisions as much as they can, then the elevated stock market prices of the banking sector may signal a bubble and finally increased costs of borrowing for government if the bubble bursts. As banks' strategy can raise concerns about the credibility of the indicators shown by bank's managers, investors may accept to bear the risk of holding sovereign debts at the expense of non-decreasing spreads. In this case, we would expect a negative sign of the coefficients A11 and A21. In all four regressions, it is seen that the estimated coefficients carry a negative sign with a value for Greece tenth as high as in the other three countries.

For Greece, the impact of changes in the fundamentals on the sovereign spreads is stronger for the regime of negative spreads (after 2005), whether one considers instantaneous (significant short-run coefficients) or cumulative (significant long-run coefficients) changes in the anticipated fundamentals.

Finally, sovereign debt market liquidity (captured by the share of negotiable debt) influence the nonlinear relationship between the macroeconomic fundamentals and spreads, in France, Germany and Ireland. We do not succeed to obtain other regressions in which A11 or A21 are significant and for which the p-value of the likelihood ratio test remains under 5%. Putting aside the case of Ireland, market liquidity risk, which is related to the size of the sovereign bonds markets, explains the regime-switching nature of the fundamental/spread link in the two countries (France and Germany) where governments are the most important issuers of bonds in terms of volume within the euro area. Just as in the regressions with the other transition variables, we find the following difference between the countries: the anticipated fundamentals have a stronger effect on the sovereign spreads from 2006 onwards in France but up until 2005 in Germany.

5.- Conclusion

Do changes in the anticipated fundamentals convey information on the sovereign spreads in the euro area? Regarding the preceding developments the answer seems to be positive. The expected macroeconomic variables are sources of structural changes in the spreads because their influence is contingent upon the financial environment and the attitude towards risk. For instance, in a situation of lower risk aversion or higher market liquidity (a situation usually prevailing after a financial reform), it is likely that the macroeconomic fundamentals will mobilize the investors' attention when they evaluate the default risk of public debts more than in a situation of financial crisis characterized by a strong risk aversion and illiquid markets. We have proposed here a sunspot model to illustrate, in this context, the possibility of multiple equilibria with a transition dynamics described by time-varying probabilities.

There are several possible extensions of this paper. Firstly, the model could be of particular interest in order to study the dynamics of sovereign debt spreads in emerging markets because the latter are subject to significant instabilities reflected by changing volatilities, structural breaks, bull and bear secondary markets. Dailami et al. (2008) show that these instabilities induce nonlinearities, but they use a deterministic model. Secondly, it could be interesting to investigate how governments' preferences affect the determination of the equilibrium. Indeed, Markov-switching models generate multiple equilibria (both theoretically and econometrically) and the question of how to coordinate on specific equilibria is an issue.

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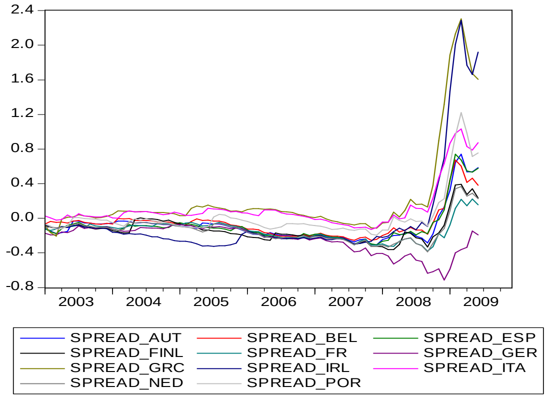
Figure 1.- Spreads of 10-year government bond yield to 10-year euro swap



Data source: datastream and authors' calculation

Figure 2a. Expected current account surpluses for year t (Germany and the Netherlands)

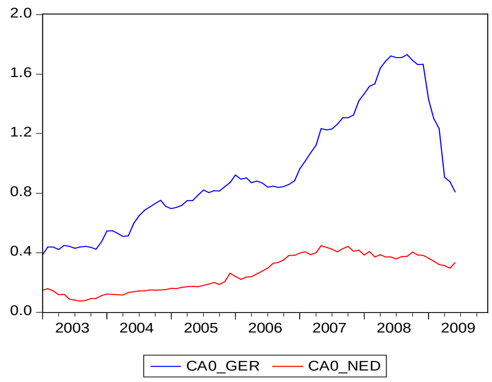
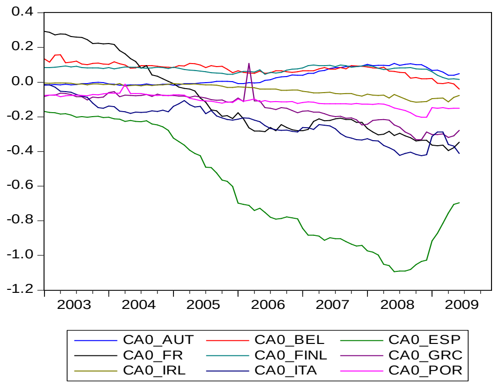


Figure 2b. Expected current account surpluses for year t (other countries)



Data source: Consensus Economic Forecasts

Figure 2c. Expected fiscal balance for year t (Greece and Italy)

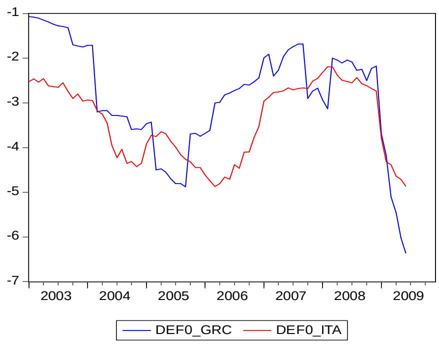
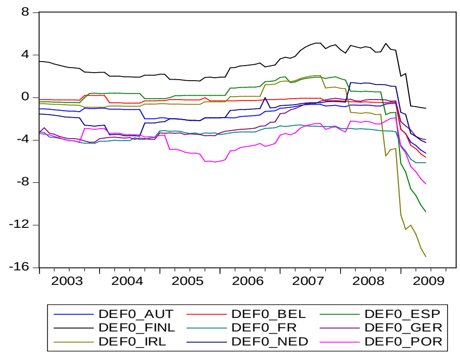
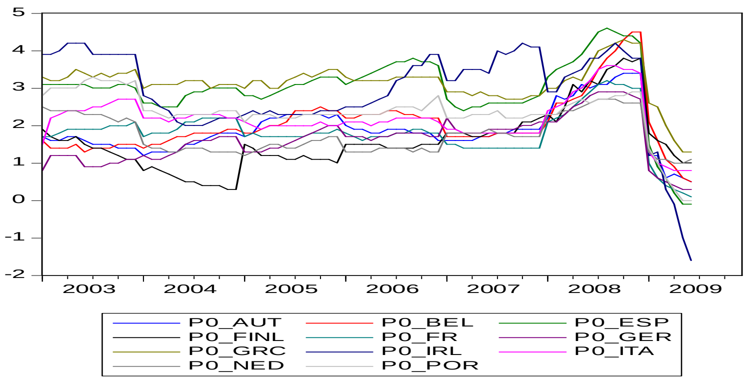


Figure 2d. Expected fiscal balance for year t of (all countries except Greece and Italy)



Data source: Consensus Economic Forecasts

Figure 3. Expected inflation rates in the euro area countries



Data source : consensus Economic Forecasts

Figure 4a. Sovereign spread against expected fiscal position for year t (Germany)

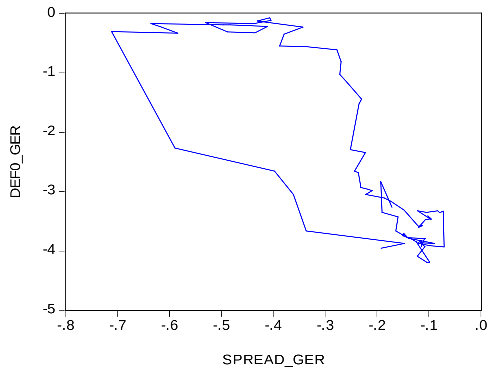


Figure 4b. Sovereign spread against expected current account for year t (Spain)

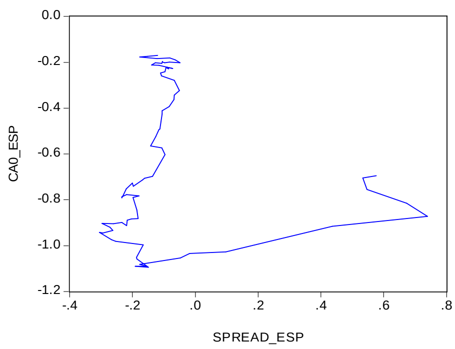
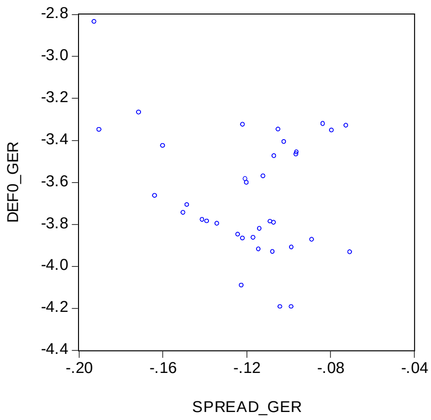
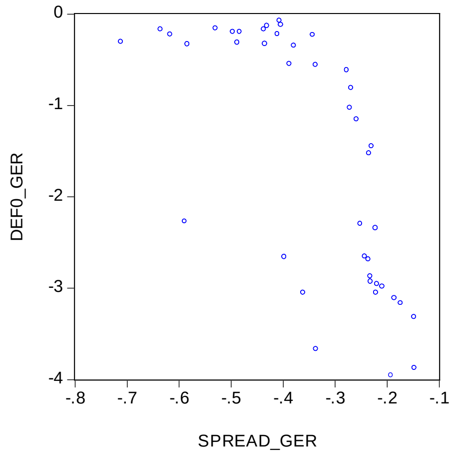


Figure 5 Scatter of sovereign bond yields against the projected fiscal position and correlation coefficient (rho). Left Panel : 2003-2005; right panel: 2006-2009

Germany : rho = -0.29

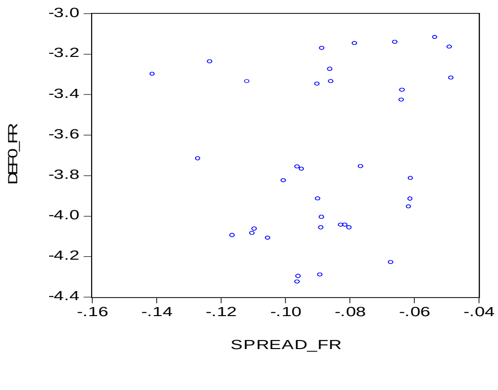
Germany : rho = -0.69

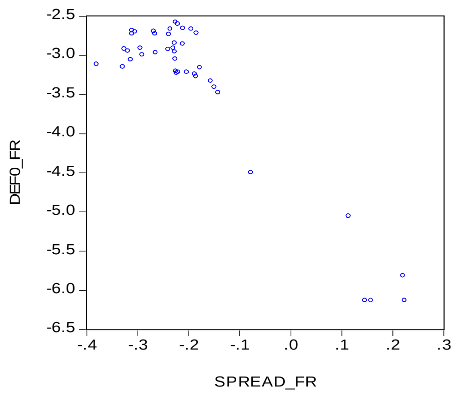




France : rho = 0.187

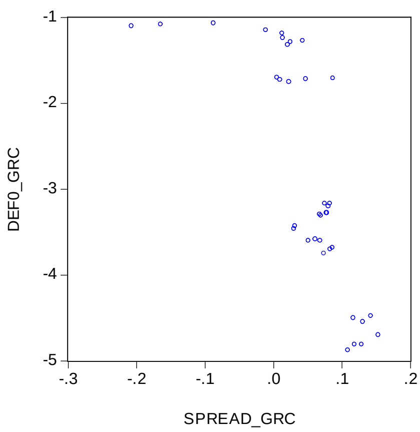
France : rho = -0.92

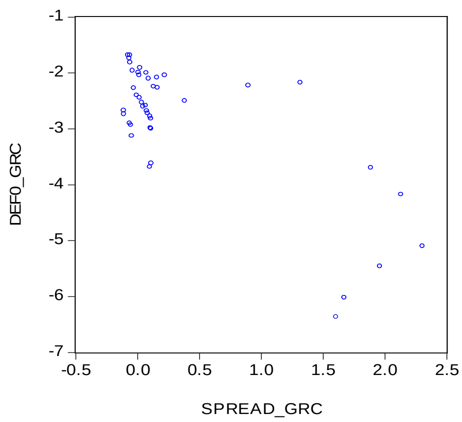




Greece : rho = -0.75

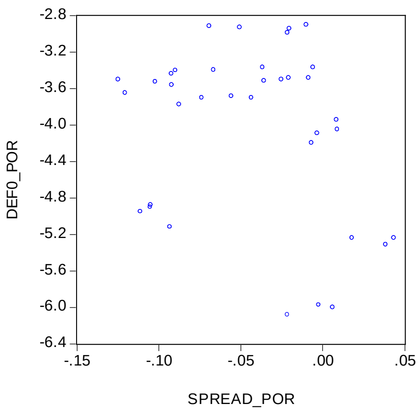
Greece : rho = -0.75

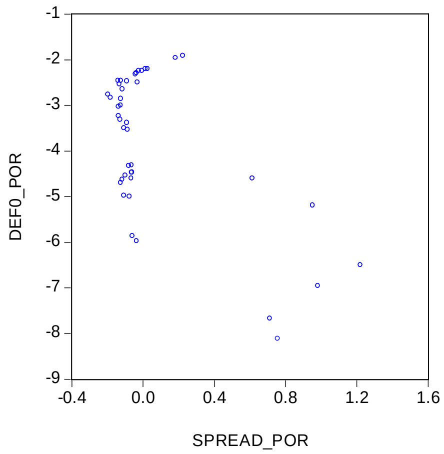




Portugal : rho = -0.25

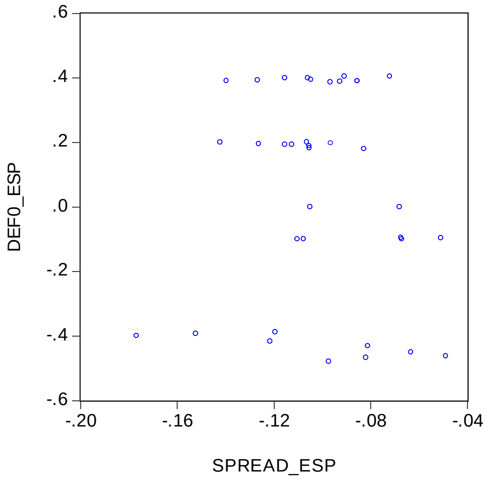
Portugal : rho = -0.61





Spain : rho = -0.07

Spain : rho = -0.97



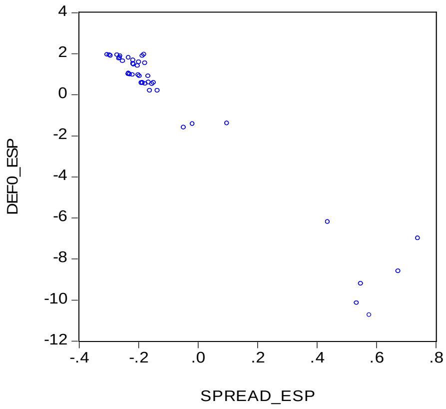
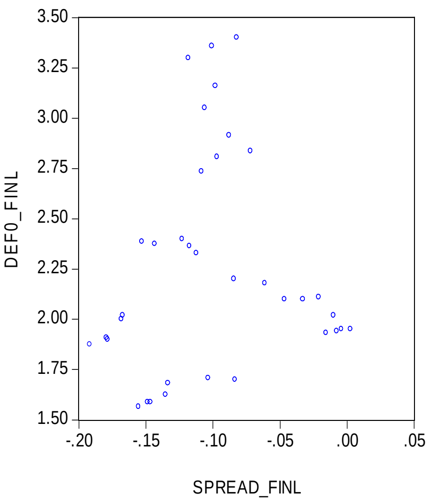


Figure 5. Continued

Finland : rho = 0.08

Finland : rho = -0.81



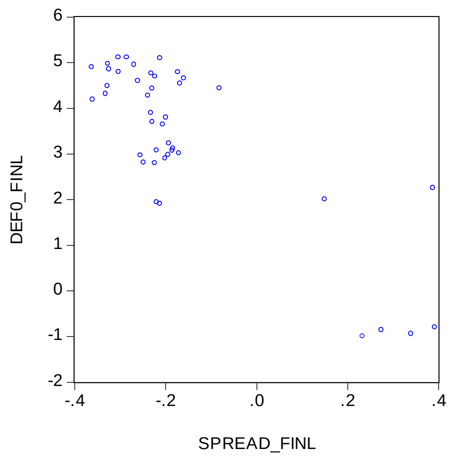


Table 1. – Results of Markov switching models: France, Netherlands, Germany, Italy

		France			**Netherlands**		
		AVER(t-1)	BANK(t-1)	NEG(t-1)	AVER(t-1)	BANK(t-1)	NEG(t-1)
Reg 1	Constant	-0.241*	-0.287*	-0.26*	-0.025	-0.00072	-0.02
	φ_1	0.01	0.063*	0.074*	-0.013	-0.028	-0.025
	Δ CA0	2.305*	1.11*	0.959*	0.182	0.162	0.086
	Δ DEF0	-0.390*	-0.183*	-0.159**	-0.039*	-0.041*	-0.04*
	Δ P0	-0.09*	-0.165*	-0.187*	0.043*	0.043*	0.048*
	Spread(t-1)	-0.156	-0.347*	-0.309*	-0.126*	-0.122*	-0.122*
	CA0(t-1)	0.04**	-1.53*	-1.652*	-0.025	-0.06	-0.05
	DEF0(t-1)	-0.017	0.052	0.064	-0.013*	-0.009	-0.013*
	P0(t-1)	0.08**	-0.029	-0.033	-0.013*	-0.02	-0.010
Reg 2	Constant	-0.02	-0.0005	0.007	-0.016*	-0.014*	-0.015*
	φ_1	0.203**	0.018*	0.015	1.37*	1.404*	1.39*
	Δ CA0	-0.351*	-0.333*	-0.315*	0.518	0.48	0.439
	Δ DEF0	-0.05*	-0.048*	-0.042*	0.006	0.008	0.005
	Δ P0	-0.06*	-0.055*	-0.06*	-0.051	-0.052	-0.047
	Spread(t-1)	-0.09*	-0.083*	-0.089*	-0.072	-0.049	-0.06
	CA0(t-1)	-0.004	0.019	0.021*	-0.098	-0.102**	-0.102
	DEF0(t-1)	-0.018*	-0.013*	-0.012*	0.009*	0.011*	0.010
	P0(t-1)	-0.03*	-0.034*	-0.035*	0.03*	0.03*	0.032*
	σ	0.015*	0.015*	0.016*	0.018*	0.018*	0.018*
	A1	0.664	1.684	11.82*	2.22	0.339	6.03
	A2	5.08*	20.06*	25.03*	-265.41	3.174	-30.62
	A11	-0.602	-6.63	-83.07*	-0.73	0.319	-171.89

	A21	-2.07*	-59.77	-166.75*	81.49	-10.85	773.076
	LRT (pvalue)	**11.382 (0.0033)**	21.56 (0.00002)	**19.564 (0.00005)**	7.62 (0.02)	0.922 (0.630)	5.09 (0.078)
		Germany			**Italy**		
		AVER(t-1)	BANK(t-1)	NEG(t-1)	AVER(t-1)	BANK(t-1)	NEG(t-1)
Reg 1	Constant	-0.0098	-0.02	-0.06	-0.29*	-0.312*	-0.308*
	φ_1	-0.28**	-0.227	-0.28	-0.02	-0.025**	-0.025
	Δ CA0	1.688*	1.824*	2.26*	0.365	0.462*	0.448*
	Δ DEF0	-0.21*	-0.215*	-0.07	-0.243*	-0.236*	-0.232*
	Δ P0	-0.073	-0.167*	-0.143	0.118*	0.121*	0.119*
	Spread(t-1)	-0.095	0.04	-0.210	0.01	0.017	0.019
	CA0(t-1)	0.0182	0.077	0.104	-0.336*	-0.324*	-0.318*
	DEF0(t-1)	0.0028	-0.0009	-0.012	-0.035*	-0.038*	-0.037*
	P0(t-1)	-0.0890*	-0.09*	-0.143	0.071*	0.075*	0.074
Reg 2	Constant	-0.143*	-0.142*	-0.14*	-0.02**	-0.023*	-0.023*
	φ_1	0.216*	0.160*	0.143	-0.54*	-0.563*	-0.571*
	Δ CA0	0.293*	0.325*	0.274*	0.08	0.08	0.10
	Δ DEF0	-0.01	-0.007	-0.017	-0.006	-0.005	-0.005
	Δ P0	-0.039*	-0.048*	-0.034*	0.02	0.019	0.016
	Spread(t-1)	-0.328*	-0.322*	-0.32*	-0.155*	-0.154*	-0.153*
	CA0(t-1)	0.0691*	0.08*	0.078*	0.121*	0.127*	0.129*
	DEF0(t-1)	-0.0318	-0.033*	-0.03*	-0.006*	-0.0068*	-0.006*
	P0(t-1)	-0.0615	-0.06*	-0.059*	0.0131	0.014*	0.015*
	σ	0.018*	0.017*	0.019*	0.014*	0.0137*	0.013*
	A1	∞	-904.38	-250	-2.94	0.169	5.41
	A2	4.776*	10.574*	29.58*	3.25*	3.359*	4.41
	A11	∞	325.18	69.35	1.282	1.254	-27.17
	A21	-1.684*	-35.12*	-179.76	-1.25**	-17.04	-16.68
	LRT (pvalue)	**7.845 (0.0197)**	**7.08 (0.028)**	5.82 (0.054)	**5.013 (0.08)**	1.98 (0.37)	0.602 (0.739)

Table 2. – Results of Markov switching models: Greece, Portugal, Spain, Ireland

		Greece			**Portugal**		
		AVER(t-1)	Δ BANK(t)	NEG(t-1)	AVER(t-1)	BANK(t-1)	NEG(t-1)
Reg 1	Constant	-0.389**	-0.389*	-0.389*	0.019	0.023	0.019
	φ_1	0.647*	0.647*	0.647*	0.548*	0.553*	0.53*
	Δ CA0	-0.573	-0.575	-0.576	0.728	0.671	0.582
	Δ DEF0	0.108*	0.108*	0.108*	-0.004	-0.003	-0.0039
	Δ P0	-0.272*	-0.272*	-0.272*	-0.193*	-0.194*	-0.197*
	Spread(t-1)	-0.226*	-0.226*	-0.226*	0.003	0.005	0.011
	CA0(t-1)	-0.038	-0.04	-0.036	-0.09	-0.091	-0.125
	DEF0(t-1)	-0.068*	-0.068*	-0.068*	-0.0001	0.001	0.001
	P0(t-1)	0.07*	0.07*	0.07*	-0.007	-0.005	-0.007
Reg 2	Constant	-0.03	-0.03*	-0.03	-0.127	-0.137	-0.014
	φ_1	-0.03	-0.03	-0.03	-0.002	-0.04	-0.014
	Δ CA0	0.009	0.008	0.009	-0.664	-0.922	-0.371
	Δ DEF0	-0.0004	-0.0005	-0.005	0.022	-0.022	0.025**
	Δ P0	0.037	0.037	0.038	0.103*	0.09*	0.09*
	Spread(t-1)	-0.09*	-0.09*	-0.09*	-0.322*	-0.314*	-0.26*
	CA0(t-1)	-0.0137	-0.014	-0.013	-0.91*	-0.998*	-0.782*
	DEF0(t-1)	-0.003**	-0.003	-0.003	-0.008	-0.006	0.014**
	P0(t-1)	0.007	0.008*	0.008	0.016	0.019	0.008
	σ	0.03*	0.03	0.03*	0.023*	0.023*	0.024*
	A1	-2.74	1.16	-1.82	2.616*	4.728	-6.48**
	A2	16.51*	4.39*	10.46*	-7.17	-0.787	-12.33

	A11	1.206	-56.35	84.22	-0.932	-10.22	654.73*
	A21	-7.15**	-264.46*	-293.76	2.323	0.387	904.86
	LRT (pvalue)	**14.58 (0.0006)**	**8.045 (0.017)**		4.027 (0.133)	1.112 (0.573)	**5.64 (0.059)**
		Spain			**Ireland**		
		AVER(t-1)	Δ BANK(t)	NEG(t-1)	AVER(t-1)	BANK(t-1)	NEG(t-1)
Reg 1	Constant	-0.07*	-0.049*	-0.05*	-0.07*	-0.07*	-0.07*
	φ_1	-0.13*	-0.137*	-0.144*	-0.47*	-0.47*	-0.468*
	Δ CA0	-0.924*	-0.695*	-0.811*	1.26*	1.26*	1.272*
	Δ DEF0	-0.06*	-0.063*	-0.066*	-0.029*	-0.029*	-0.029*
	Δ P0	-0.018	-0.007	-0.0007	-0.014	-0.014	-0.014
	Spread(t-1)	-0.575*	-0.537*	-0.505*	-0.418*	-0.418*	-0.418*
	CA0(t-1)	0.035*	0.045*	0.046*	-0.192	-0.192	-0.189
	DEF0(t-1)	-0.041*	-0.036*	-0.03	-0.028*	-0.028*	-0.028*
	P0(t-1)	0.011*	0.0077**	0.008*	0.008	0.008	0.008
Reg 2	Constant	-0.02*	-0.026*	-0.027**	-0.139*	-0.139*	-0.137*
	φ_1	0.348*	0.304*	0.280*	0.408*	0.408*	0.410*
	Δ CA0	0.417*	0.365*	0.366*	-0.197	-0.196	-0.218
	Δ DEF0	-0.008	-0.009	-0.008	-0.065*	-0.06*	-0.064*
	Δ P0	-0.046*	-0.048*	-0.52*	-0.07*	-0.07*	-0.072*
	Spread(t-1)	0.147	0.139*	0.117	-0.22*	-0.220*	-0.220*
	CA0(t-1)	-0.032*	-0.047*	-0.046*	-1.169*	-1.168*	-1.189*
	DEF0(t-1)	-0.006	-0.008*	-0.01	-0.038*	-0.038*	-0.038*
	P0(t-1)	0.009*	0.007*	0.006	-0.007	-0.007*	-0.008
	σ	0.012*	0.012*	0.012*	0.02*	0.022	0.021*
	A1	-1.784	0.559	-1.298	6.57*	6.61*	6.75*
	A2	0.893	0.867**	1.918	3.60*	4.79*	4.57*
	A11	1.439	193.70	52.568	-2.10*	-2.96**	-597.35*
	A21	-0.179	-17.40	-22.32	-0.572	-2.072	-303.408
	LRT (pvalue)	3.52 (0.172)	6.12 (0.046)	0.601 (0.740)	**5.79 (0.05)**	2.95 (0.228)	**8.21 (0.016)**

Table 3. – Results of Markov switching models: Belgium, Finland, Austria

		Belgium			**Finland**		
		AVER(t-1)	BANK(t-1)	NEG(t-1)	AVER(t-1)	BANK(t-1)	NEG(t-1)
Reg 1	Constant	-0.129*	-0.12*	-0.127*	-0.40*	-0.40*	-0.40*
	φ_1	0.335*	0.333*	0.343*	0.369*	0.369*	0.369*
	Δ CA0	0.655*	0.609*	0.637*	-5.274*	-5.27*	-5.274*
	Δ DEF0	-0.05*	-0.05*	-0.056*	0.04*	0.04**	0.04*
	Δ P0	-0.032	-0.028	-0.032*	-0.066*	-0.06*	-0.066*
	Spread(t-1)	-0.02	-0.005	-0.037**	0.087*	0.087	0.087**
	CA0(t-1)	0.096	0.07	0.096*	4.388*	4.389*	4.38*
	DEF0(t-1)	-0.02*	-0.019**	-0.024*	0.049*	0.05**	0.049*
	P0(t-1)	0.053*	0.052*	0.051*	-0.051*	-0.05*	-0.051*
Reg 2	Constant	-0.067*	-0.06*	-0.06	-0.03**	-0.03**	-0.03
	φ_1	-0.08	-0.08	-0.068	0.164*	0.164*	0.163*
	Δ CA0	0.248	0.284	0.137	-0.878*	-0.878*	-0.878*
	Δ DEF0	0.013	0.009	0.012	-0.009	-0.009	-0.009
	Δ P0	-0.009	-0.006	-0.014	0.004	0.004	0.0046
	Spread(t-1)	-0.146*	-0.144*	-0.152*	-0.159*	-0.159*	-0.159*
	CA0(t-1)	0.734*	0.701	0.693*	0.365	0.365	0.365
	DEF0(t-1)	0.00035	0.0006	0.0006	-0.0078	-0.0078	-0.007
	P0(t-1)	-0.003	-0.0026	-0.003*	-0.0089	-0.0089	-0.0089
	σ	0.015*	0.014*	0.014*	0.021*	0.021*	0.021*
	A1	4.10*	5.40*	13.73*	-14.75*	-0.858	-45.39

	A2	6.25*	8.315*	23.53	8.24*	4.99*	-8.77
	A11	-1.51**	-8.543*	-366.68*	5.11*	5.19	6234.81
	A21	-2.48*	-11.12*	-617.09*	-3.14*	-14.33	1675.53
	LRT (pvalue)	**15.82 (0.00036)**	**5.909 (0.052)**	**11.379 (0.003)**	**16.00 (0.00033)**	2.157 (0.34)	7.836 (0.019)
		Austria					
		AVER(t-1)	BANK(t-1)	NEG(t-1)			
Reg 1	Constant	-0.03**	-0.04**	-0.04*			
	φ_1	1.99*	1.99*	2.01*			
	Δ CA0	-15.82*	-16.06	-16.35*			
	Δ DEF0	-0.418*	-0.415*	-0.409*			
	Δ P0	0.539*	0.538	0.534*			
	Spread(t-1)	-0.245*	-0.241	-0.239*			
	CA0(t-1)	0.557*	0.559*	0.561*			
	DEF0(t-1)	-0.037**	-0.03	-0.038**			
	P0(t-1)	-0.014	-0.014	-0.015			
Reg 2	Constant	-0.029	-0.03	-0.03			
	φ_1	0.74*	0.749*	0.757*			
	Δ CA0	0.436	0.44	0.533			
	Δ DEF0	-0.013	-0.01	-0.014			
	Δ P0	-0.032**	-0.034**	-0.032**			
	Spread(t-1)	-0.173*	-0.176*	-0.174*			
	CA0(t-1)	-0.498*	-0.499*	-0.504*			
	DEF0(t-1)	0.016*	0.015*	0.016*			
	P0(t-1)	0.006	0.006	0.007			
	σ	0.02	0.02*	0.02*			
	A1	-1.91	-4.18	-3.95			
	A2	5.04*	5.63*	5.81			
	A11	0.402	8.41	151.47			
	A21	-1.578*	-10.32	-193.42			
	LRT (pvalue)	**7.69 (0.02)**	3.56 (0.16)	1.02 (0.60)			