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Abstract

In this paper we take an innovative econometric look at the Euro Zone Sovereign Debt Crisis. We are particularly interested in understanding which determinants have led investors to ask for higher yields on sovereign debt from the Euro shatter belt. We dismiss the definition of speculation previously used in the literature, on the basis of the irrelevance of Granger Causality as an operational tool for this purpose. Instead, we suggest that speculative behavior would only exist if market assessment would be unrelated to economic fundamentals of such countries. Using a cross section of countries, we improve on the scarce literature on the Econometrics of Credit Default Swap Markets on sovereign debt. Firstly, we use an ordered probit model to determine whether economic fundamentals are driving the implied rating assessments. Secondly, we provide a pioneering application of quantile regression to this domain, to determine which variables matter at different conditional quantiles of the implied default probability distribution. Finally, Fisher's Z statistic is used to relate bond markets to domestic saving rates. Overall, the different methodologies support the conclusion that the domestic savings rate is lenders' main concern. Economies with worse saving habits are penalized both in the CDS market, and in the sovereign bonds markets. Notwithstanding, for countries on the top quantiles of the implied default probabilities, public debt and external debt also play a significant role, increasing the likelihood of higher insurance premium in the derivatives market. When looking at the Portuguese Case it seems clear that public policies that fail to take savings into proper account shall always be deemed to fail, as the country had the lowest net savings rate in the EU27 in 2008, followed closely by Greece.

Keywords: sovereign debt; Euro Area; Credit Default Swaps; Quantile Regression; Ordered Probit; savings rate

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1. Introduction

The sovereign debt crisis in the Euro Area has been receiving two standard answers in the political arena, albeit reduced attention from the scientific community. Comments from politicians in the EU, in particular in the highly indebted Euro zone periphery countries, have been resting upon blaming so called "*speculative attacks*", in debt markets, that would have rose the perception of risk far beyond its real levels. The argument would be that the high interest rates that governments in countries like Greece, Ireland, Spain, Portugal or Italy have been paying for new debt placements would have little to do with the fundamentals of these economies, but rather with the rent seeking behavior of financial investors, who would be lowering the price of bonds in secondary markets, making it increasingly more difficult for primary debt to be placed at acceptable yields. Countries, in this view, would be facing an increasingly higher debt service due to the "*hunger*" for increased returns in the secondary market, from the so-called "*speculators*".

The Credit Default Swaps' market for sovereign debt has been receiving particularly strong criticisms, as the substantial earnings made possible by high leveraged credit insurance derivatives would act as a vehicle to induce an even higher perception of risk on sovereign debt, as the insurance premium would translate into even higher bond yields, thus increasing the pressure on public debt service, and therefore the likelihood of sovereign default.

In Portugal, these arguments have been put front quite often by the 2009-2011 government, and for a long time have received support from the main opposition party, which has agreed on a number of policy actions that were said to "restore confidence" in financial markets. Both parties seemed to believe "investors' greed" was the only difficulty that has to be surpassed to achieve the goal of lowering the yields on Portuguese bonds.

In this paper, we explore another line of reasoning and political action. It is our view that a sovereign debt crisis is hardly surprising when it comes to countries such as Portugal. Indeed, in spite of the fact that nothing substantive has changed in the recent past with respect to lack of fiscal discipline (the 9.4% budget deficit of 2009 was surely high, but the successive governments have always been unable to generate a surplus for the past 36 years), going back to 2008 one cannot avoid noticing that the net internal

savings rate was -5.8% of GDP, a number to be seriously taken into account when compared to the European Union (EU27) average net internal savings rate of +6% (Gros, 2010). The Portuguese rate was the lowest in the EU27, and, not surprisingly, Greece's was the second lowest. Clearly, these countries already had a problem in raising resources internally in order to face financing needs, and such problems had nothing to do with the post Lehman Brothers collapse worldwide recession.

Looking at the fundamentals of the Portuguese economy one could easily notice the persistent trade deficits over the past three decades, and very low growth in productivity over the first decade of the new millennium. Indeed, according to the IMF, Portugal ranked 3rd from the bottom, in the 2001-2010 period, as far as GDP growth was concerned, in a sample of 180 countries (accumulated GDP growth over the entire decade was only of about 6.47% in the Portuguese case, with a clear L pattern that strongly resembles that of Japan (González, 2010)). Thus, we think one should pay a deeper attention to the country's ability to raise internal financing resources in order to properly understand the lack of productive investment that might entail a better export performance and raise productivity to levels capable of sustaining acceptable standards of external debt.

Although it is not the purpose of this paper to look at behavior of Portuguese internal savings over the long run, something should be said in this respect. It can hardly be argued that Portugal has been increasingly unable to save. In the mid 1990s gross internal savings were of about 20% of GDP, and 13 years later, they had dropped to 10.3% (OECD, 2010). In 1995, Portugal was at the median of the gross savings rate within OECD economies, whilst in 2008 it had dropped to the third lowest saving country in that group, beaten only by Greece and Iceland. When compared to the countries such as Germany (25,2%), Italy (18%), Spain (19,4%) or even the UK (15%) or the US (11.4%), it should be obvious that some drivers in Portugal had been consistently lowering the savings rate to previously unimaginable levels. If one is to bear in the mind that government deficits remained relatively stable, on average, over such a period, it is clear that household and corporate savings becomes primary suspect to be investigated in such a sample period. The issue is private corporate savings, in Portuguese national accounts, also include the highly indebted State Owned Public Firms. So the government has played a key role over this period. We pursue that line in a different paper (see Santos 2011b).

This paper is organized as follows. In the following section, we make an assessment of the only existing paper, to the best of our knowledge, taking an econometric look into the CDS markets for sovereign debt. We strongly disagree with the definition of speculative behavior the authors use, and suggest an alternative measurement that is related to each country's economics fundamentals. On section 3, we take a serious look at the claim that movements in Euro zone bond ratings are merely speculative. We study bond risk according to three different metrics. Firstly, an ordered probit model is estimated to check if economic fundamentals play a role in CDS implied ratings for a sample of OECD countries. Secondly, we provide a pioneering use of quantile regression to determine whether the role of fundamentals is the same at different implied CDS levels of default probabilities. Thirdly, we run a standard non-parametric correlation test to see if certain variables pertaining to financial sustainability in OECD economies are related to bond yields. Our overall conclusions are the same across the different methodologies used and favor the view that CDS market investors are playing a close attention to economic fundamentals instead of just using high leveraged derivatives to induce bond movements that would be unrelated to real economic conditions in targeted countries. In particular, domestic savings play a key role in market assessment of sovereign default risk. Section 4 concludes.

2. The caveats of Granger Causality as a basis to assess speculative behavior in the CDS and Bonds Markets.

This section is motivated by the recent paper by Dammette and Frouté (2010) on the issue of the existence of speculative behavior is the Credit Default Swaps market for sovereign debt. The authors claim that the highly leveraged CDS market has been used to allow for the manipulation of risk perception in the sovereign bonds markets, inducing higher yields than those that fundamentals from the relevant economies would support. It should be noticed we are not judging whether or not Dammette and Frouté (2010) are correct in claiming that could happen. Rather, we strongly disagree with the methodology they use to produce such a claim, which essentially rests on Granger Causality (1969).

Whilst their analysis has the fundamental merit of bringing Credit Default Markets on sovereign debt to the arena of academic debate, their concern is misplaced. It is the

authors' claim, after a rigorous econometric analysis of daily quotes from the CDS and the bonds markets, that whilst movements in the CDS markets Granger cause movements in the Bonds markets, nothing happens in the opposite direction. That is bonds markets movements do not Granger cause changes in CDS quotes. As such, they conclude that after the turbulence of 2008, investors are taking so-called speculative actions, reducing their exposure to risk, since they expect to earn from induced movements in the bonds markets, whilst they are guaranteed to have minimum losses with default swaps. Absence of feedback from bonds to CDS quotes is essential in their reasoning concerning the existence of speculation.

We disagree with their claim on two grounds. Firstly, it is widely known the "Granger Causality" is a weak indication of actual causality. Hendry (1995) details clearly that a failure on parameter invariance - and hence on super exogeneity (Engle, Hendry and Richard, 1983) -, should be interpreted as a causal effect of the policy decision variable on agents' behavior. Failures of invariance would largely provide support for the Lucas Critique (1976), which is clearly related with causality albeit not with Granger causality. Hendry and Santos (2010) find some evidence of failures in parameter invariance in a widely studied UK money demand equation, using their new super exogeneity test based on impulse saturation (see Hendry, Johansen and Santos, 2008) and the related impulse saturation break test developed by Santos (2008). Such failure in parameter in invariance provides, in the Hendry and Santos' (2010) example strong evidence of a way in which shocks (either policy shocks or others) might cause parameters to change without affecting the levels of certain variables.

In short, discussions around super exogeneity and invariance should suffice to point out that it is not rigorous for Dammette and Jouté (2010) to argue in favor of the absence of causality of bonds to CDS markets just because a specific type of causality - Granger Causaylity - is not found in the data.

Secondly, and more deeply, we disagree with Dammette and Jouté's (2010) approach to the issue of speculation. The finance literature provides no definition of speculation, and if one is to make a suggestion it hardly seems that causality between price movements in different markets would be a sound basis for that. In particular, Granger causality is subject to the *post hoc ergo propter hoc* fallacy widely known in economics: why should we look at yield movements in the secondary bond market as a result of rises in CDS quotes simply because one happens after the other?

We suggest a different approach to the endeavor of econometric assessment of speculation. In particular we seek to understand whether quotes in the CDS market are related (in a statistically sound way) to the fundamentals of the associated economy. Should the differences in the implied credit default probabilities for a sample of countries be unrelated to fundamental differences between these, one might conclude that CDS market players were in fact attempting to induce defaults just by rising interest rates and forcing governments to ask for external assistance. Quite differently, if CDS market activity is such that countries with higher default probabilities are also countries with weaker performance in some relevant variables, CDS market agents are more likely to actually be buying insurance against a higher likelihood of default. This suggestion seems to avoid the caveats of Granger causality and, in our view, to provide a more meaningful way of understanding why people insure against sovereign credit defaults.

3. Credit Default Probabilities in CDS Markets and underlying economic fundamentals

3.1 Implied Ratings on Sovereign Debt: An Ordered Probit Model

The credit default probabilities as of the 31st December 2010 are retrieved from the CMAVISION Report (2011) with respect to 5 years' maturity government bonds, for the 65 countries listed. We are only interested in 30 of these countries: the OECD ones CMAVISION (2011) provides a rating assessment for the sovereign debt of each of these 30 countries, ranging from CCC-, for Greece to AAA for the USA, Switzerland, Sweden, Finland and Norway. The seven ratings classification applicable to our sample of 30 countries is translated into a natural numbers scale, ranging from 1 (for the lowest rating) to 7 (the highest rating).

Debt ratings provide a natural application for ordered probit models. These have been well known in the literature since the late 1950s. They were first considered by Aithchison and Silvey (1957) and by Ashford (1959). Statistical theory was further developed by Gurland et al. (1960) and Cox (1970). Mackalvey and Zavoina (1975) provided one the first econometric applications, as they used it to assess congressional voting on the Medicare bill of 1965.

In financial econometrics, applications to intra-day transactions data became popular since the seminal work of Hausman, Lo and Mackinley (1992). Notwithstanding, their use with sovereign credit ratings was suggested, *inter alia*, by Cantor and Packer (1996). The specific nature of the rating problem fits adequately in a framework where the difference between and ordinal score of, say, 15 and 16 cannot be thought of as equivalent to a difference between the cardinals 8 and 9, for which multinomial probit or logit models are clearly better designed (Cameron and Trivedi, 2005). In the ratings case, all one is able to say is that a score increase is equivalent to an increase in assessed credit worthiness. Quantifying that increased worthiness is unfeasible with credit ratings alone.

The sovereign debt problem we are dealing with avoids, in our view, the sample selection issue that commonly arises in the corporate finance literature, when agencies provide unsolicited firms' ratings. It is frequently argued that such unsolicited ratings are downwards biased, as they fail to take into account the riskiness of the country in which the firm operates, whether or not the firm might not be planning to issue any debt soon, the financing conditions in the surrounding environment, etc. However, with CDS data of the type contained in the CMAVISION Report (2011), ratings are implicit functions of market pricing of credit insurance derivatives. Hence, the "unsolicited" issue of the ratings does not arise here, as they are nothing more than the result of supply and demand for such derivatives. Furthermore, we are dealing with OECD countries in this section, so sovereign credit risk should not be (albeit it is!) that different from one country to the other. All in all, it would not be reasonable to make a case against the credit notation we are using here, since none of these countries has asked CMA for such a classification, nor is CMA a rating agency. Hence, there was no self selection, of the type referred to in the unsolicited corporate ratings literature (see, e.g., Poon (2003)).

The general structure of the ordered probit problem we are looking at uses 7 rating standards. Let R_i^* be the latent or unobserved credit risk of country i, and R_i be the computed rating by CMA for its annual report, based on Credit Default Swaps market data. It is assumed that $R_i^* = \boldsymbol{x_i}\boldsymbol{\beta} + \varepsilon_i, \varepsilon_i \sim N(0;1)$, and $\boldsymbol{x_i}$ is a $(k \times 1)$ vector of individual characteristics pertaining to country $\boldsymbol{i}$. Standard ordered probit theory provides details as to why $\boldsymbol{x_i}$ cannot contain a 1, meaning there is no intercept in the model, in contrast with the binary probit (see, e.g. Cameron and Trivedi (2005)).

Clearly, R_i^* and the observed rating R_i are related by:

$$R_i = \begin{Bmatrix} 1 \Leftarrow R_i^* \leq \alpha_0 \\ 2 \Leftarrow \alpha_0 < R_i^* \leq \alpha_1 \\ 3 \Leftarrow \alpha_1 < R_i^* \leq \alpha_2 \\ 4 \Leftarrow \alpha_2 < R_i^* \leq \alpha_3 \\ 5 \Leftarrow \alpha_3 < R_i^* \leq \alpha_4 \\ 6 \Leftarrow \alpha_4 < R_i^* \leq \alpha_5 \\ 7 \Leftarrow \alpha_5 < R_i^* \leq \alpha_6 \end{Bmatrix},$$

where the α_i are unknown parameters, which, as in the standard probit, are estimated by Maximum likelihood, (although Markov Chain Monte Carlo methods may also be used here (see Tsay, 2010)). Indeed the probability that the CMA assigned credit rating to a country would be s_j , *j =1, 2,….,7* is:

$$P(R_i = s_j|\boldsymbol{x_i}) = P(\alpha_{j-1} < \boldsymbol{x_i\beta} + \varepsilon_i \leq \alpha_j)$$

$$= \begin{Bmatrix} P(\boldsymbol{x_i\beta} + \varepsilon_i \leq \alpha_1|\boldsymbol{x_i}) \Leftarrow j = 1 \\ P(\alpha_{j-1} < \boldsymbol{x_i\beta} + \varepsilon_i \leq \alpha_j|\boldsymbol{x_i}) \Leftarrow 1 < j \leq 6 \\ P(\alpha_6 < \boldsymbol{x_i\beta} + \varepsilon_i|\boldsymbol{x_i}) \Leftarrow j = 6 \end{Bmatrix}$$

$$= \begin{Bmatrix} \Phi(\alpha_1 - \boldsymbol{x_i\beta}) \Leftarrow j = 1 \\ \Phi(\alpha_j - \boldsymbol{x_i\beta}) - \Phi(\alpha_{j-1} - \boldsymbol{x_i\beta}) \Leftarrow j = 2,..,6 \\ 1 - \Phi(\alpha_6 - \boldsymbol{x_i\beta}) \Leftarrow \mathrm{j} = 7 \end{Bmatrix}$$

Where, $\Phi(w)$ denotes, as usual, the cumulative distibution function for a standard normal evaluated at *w*.

A particular feature of the ordered probit model is that in spite of the fact that the sign of $P(\boldsymbol{x_i\beta} + \varepsilon_i \leq \alpha_1|\boldsymbol{x_i})$ clearly is equal to sign of $\boldsymbol{\beta}$, the same happening for $P(\alpha_j < \boldsymbol{x_i\beta} + \varepsilon_i|\boldsymbol{x_i})$, $j = k$, if there are *k* possible states, the signs of probabilities intermediate states might not depend entirely on $\boldsymbol{\beta}$ (see Wooldridge (2002) for an explanation). Nonetheless, from our point of view, that is irrelevant, since we are only interested in knowing whether the implied rating obtained from the credit default market depends positively and significantly on the explanatory variables, in the sense that these influence countries with the lowest ratings and countries with the highest. We consider three variables in the $\boldsymbol{x_i}$ vector: country i's savings rate (*srate*), external debt as a ratio of GDP (*extdebt*), and public debt as a ratio of GDP (*pdebt*)[2]. We are especially

[2] We use the 2008 domestic savings rate for each country in the sample. Data was collected from the OECD. External and Public Debt Ratios refer to 2009 and were obtained from the IMF.

interested in the effect of the savings rate, but the other two were also included in the final model[3]. Other variables, such as average GDP growth, the economy's openness and the weight of foreign demand were also considered, but deemed to be meaningless in this section and the following one.

Table 1 provides confirmation of our hypothesis on the role of domestic savings. z is the observed test statistic in the individual significance test and P > z is the associated p-value.

	Coefficient	Std. Error	Z	$P > z$	[95% C.I.]
Srate	0.088	0.033	2.68	0.007	[0.023;0.152]
Extdebt	-0.142	0.111	-1.27	0.204	[-0.36;0.077]
Pdebt	-0.005	0.005	-0.96	0.339	[-0.01;0.005]

Table 1Ordered Probit Results for Credit Default Swaps Implied Ratings on Sovereign Debt

It should further be noticed that the observed likelihood ratio for the estimated model was 10.64, implying a p-value of 1.38% in the global significance test, usin the $\chi^2_{(3)}$ reference distribution.

According to table 1, the estimated coefficient on domestic savings in the ordered probit model for sovereign credit ratings is indeed positive. Furthermore, it is significant at a 1% level. This is to say that as we move from very low saving countries such as Greece to the highest saving country in the sample (Norway), credit ratings improve, even if we cannot assure such that improvement is monotonic. Nonetheless, it hardly seems Credit Default Swaps investor are making their bets without paying attention to the fundamentals of the economies, namely, their ability to internally generate sufficient resources to finance themselves, without exploding public and external debts.

Neither of the other two variables is statistically significant, contrary to what shall happen in the next section, but is should nonetheless be mentioned that their estimated signs are also the ones we would expect. In fact, a reduction in external debt as a ratio of GDP as a positive impact on the probability of having the highest sovereign debt rating, rather than the lowest, and a reduction in the public debt to GDP ratio has the same

[3] Clearly, neither the external debt to GDP ratio not the Public Debt to GDP ratio are significant in this model, so it would be valid to ask whey where these two variables kept in the model whilst others were dropped. The answer requires to consider the models in section 2.2. also, since these two ratios were relevant in some of those. Hence, we chose to keep them here for coherence.

effect. Overall, one could argue that highly rated countries do indeed save more, and have smaller external and public debts as ratios of the Gross Domestic Product.

3.2 A quantile regression approach to credit default probabilities

A second way of providing evidence of influence of the macroeconomic fundamentals in the behavior of Credit Default Swaps investors is to look at the significance of the earlier suggested variables (domestic savings rate; external debt as a ratio of GDP; public debt as a ratio of GDP) for different quantiles of the credit default probabilities implied by the CDS quotes. To the best of our knowledge, no application of quantile regression models to credit insurance derivatives has been previously attempted.

Quantile regression was first suggested by Koenker and Bassett (1978) in the context of robust econometrics. Indeed, for most the most common indicator and metrics used (leverage, breaking point, influence curve curves, etc.), OLS is a very poor estimation method when a sample is contaminated with outliers. Median regression, instead of regression through the mean, as suggested by Least Absolute Deviations (LAD), albeit computationally demanding, was a far more robust estimation method. Nonetheless, quantile regression soon developed as a tool with a much broader range of applications than merely robustifying regression analysis to the presence of outliers. Extensions to discrete choice models (Manski (1985), Horowitz (1992)), limited dependent variable models (Powell (1984, 1986)), ordered probits (Lee, 1992), duration models (Koenker and Geling (2001); Koenker and Bilias (2001)), and count models (Machado e Silva, 2005) amongst others, exploded quickly, as the idea of knowing which particular set of variables is statistically influent for particular sample cohorts, and the idea of knowing the different magnitudes of estimated coefficients for a certain variable at a number of sample quantiles became quite appealing.

We trust sovereign credit risk had not before been a field of application of quantile regression, albeit it does seem quite a natural one. The highly skewed nature of default probabilities, with a large number of countries on the low risk side, and fewer countries on the very high risk of default, naturally suggests that the relevance of explanatory variables might change and that quite different magnitudes of their estimated coefficients is likely to occur as one looks at different default probability cohorts. If one adds to this the risk of financial contagion the recent global recession has highlighted, knowing which sovereign debt requires higher insurance turns out to be fundamental for

investors. Hence, using quantile regression in this context, albeit motivated by a particular concern with certain variables and with the Euro Area in the early months of 2011, should spread quite quickly improving on this paper. Obviously we are not claiming Financial Econometrics has been blind to the developments of quantile regression (see, e.g. Tsay (2010)), but merely asserting that thus far empirical applications seem to have been somewhat restricted to stock returns and portfolio Value at Risk (see Engle and Manganelli (2004) for a use of regression quantiles in the Conditional Autoregressive Value at Risk Model (CaViaR); White, Kim and Manganelli (2010) for a Multi-Quantile CaViaR model; and Gourieroux and Jasiak (2009) for Dynamic Quantile Models).

We use the same data sources as in the ordered probit model of the previous subsection. The credit default probability variable is retrieved from the CMAVISION Report (2011), and refers to the 31st December 2010. These probabilities are computed on credit insurance derivatives for 5 years maturity Government Bonds.
The model we aim to estimate, for different quantiles of the default probability is:

$$cpd_i = \theta_0 + \theta_1 srate_i + \theta_2 extdebt_i + \theta_3 pdebt_i + \varepsilon_i$$

where cpd stands for credit default probability, and the explanatory variables have the same meaning as in the previous subsection. Relevant quantiles chosen are 0.25, 0.5, 0.9 and 0.99. Results are provided in tables 2, 3, 4 and 5. Although the intercept is estimated, we do not report in this paper, as it lacks any meaning for our purposes.
Rather, we give a special attention to the reported estimates of θ_1, θ_2 and θ_3, for the 4 relevant quantiles. In tables 2 to 5, these estimates are in the column labeled "coefficient". Their estimated standard errors are under "Std. Error", *t* is the observed test statistic for the individual significance of each variable for these quantiles, $P > |t|$ is the associated p-value, and [95% C. I.] is the estimated 95% confidence interval for each parameter. Estimation is conducted without taking into account the truncation issue the nature of the *cpd* variable might induce, since the interval limits are not relevant in our data, and we do not wish to conduct a forecasting exercise. Nonetheless, matching estimated tobit quantile regression models are reported in the appendix. As the interested reader can easily check, there is no significant difference in the results.

	coefficient	Std. Error	T	$P > \|t\|$	[95% C.I.]
Srate	-0.184635	0.0799881	-2.31	0.031	[-0.35;-0.02]
Extdebt	0.3081445	0.2567845	1.20	0.043	[-0.224;0.84]
Pdebt	0.0158233	0.0075059	2.11	0.247	[0.0002;003]

Table 2: Quantile Regression results for the bottom 25% Credit Default Probability Countries.

	coefficient	Std. Error	T	$P > \|t\|$	[95% C.I.]
Srate	-0.3301	0.2514	-1.31	0.203	[-0.85;0.19]
Extdebt	3.1869	1.2808	0.49	0.021	[0.531;5.84]
Pdebt	0.13728	0.0327	0.42	0.679	[-0.054;0.08]

Table 3: Quantile Regression results for the median of Credit Default Probabilities.

	Coefficient	Std. Error	T	$P > \|t\|$	[95% C.I.]
Srate	-1.107	0.146	-7.58	0.000	[-1.41;-0.8]
Extdebt	1.524	0.399	3.82	0.001	[0.696;2.35]
Pdebt	0.134	0.029	4.6	0.000	[0.074;0.195]

Table 4: Regression results for Quantile 90% of Credit Default Probabilities.

	coefficient	Std. Error	T	$P > \|t\|$	[95% C.I.]
Srate	-1.189199	0.1403	-84.72	0.000	[-1.21;-1.16]
Extdebt	1.3006	0.398	32.61	0.000	[1.22;1.38]
Pdebt	1.1123	0.0027	40.95	0.000	[0.106;0.117]

Table 5: Regression results for Quantile 99% of Credit Default Probabilities.

Several relevant features emerge from the previous tables. In our view, the most striking of these is the monotonic increasing nature (in absolute value) of the coefficient on the domestic savings variables. Given that such estimates are always negative, this clearly implies that the impact of an increase in domestic savings in lowering the credit default probability is sharply increasing as we approach the riskiest countries in the sample. Indeed, whilst for the first quartile, an increase of 1 percentage point (pp) in domestic savings (as a ratio of GDP) has an estimated impact of -0.18 pp in the probability of default, for the riskiest countries in the sample, the same increase in their domestic savings rate is estimated to lower their credit default probabilities by more than 1.1 percentage points. For countries like Portugal, Greece or Ireland, increasing the

domestic savings rate seems to be even more relevant than reducing the public debt ratio (in spite of the relevance of the latter!). As such, pursuing a consolidation avenue of budget deficits that does not entail higher taxes but rather rests upon reducing the size of the public sector is fundamental in such countries, if one is to give a clear signal to the CDS market players that default risk on sovereign debt is being dealt with seriously.
If the domestic savings rate is of the utmost importance, the only variable that remains significant even for the median of the default likelihood distribution is the ratio of external debt to GDP. For countries with systematic trading deficits, like Portugal, this entails a major competitiveness challenge, which becomes even more relevant if one is to bear in mind that productivity has almost stalled over the first decade of new millennium. Given the domestic indebtness problem, and the low value added pattern of the domestic industry that still prevails in Portugal, attracting intermediate and high tech foreign investment seems to be fundamental. Again this entails a strong gain in fiscal competitiveness, as the tax burden is quite heavy in Portugal. In order to do this without damaging the necessary reduction in the debt to GDP ratio, the implicit policy option seems once more to entail in a meaningful reduction of the public sector size, independently of the political costs of such a reduction. The p-value on public debt for quantiles 90% and 99% enforce the perception of need of such a reduction.

Although a proper policy discussion shall only be entailed in section 4 of this paper, one should bear in mind that the type of programs in which Greece and Ireland have stepped upon, through the IMF and the European Rescue Fund, which is not dissimilar to many of the measures the Portuguese Government has been trying to pursue, comprises the fundamental flaw of ignoring the relevance investors seem to be giving to domestic savings. Furthermore, countries seem to be more concerned with budget deficits than with actual debt reduction, lowering their leverage sharply. Rolling over public finances seems to be a dominant concern but our results suggest that the level of leverage already achieved requires much more than simply repaying debt with debt: an actual effort to spend less, both by the private sector and by the government needs to be carried over. Unfortunately, this does not seem to be a front topic on the policy agenda of such countries.

3.3 Yields on ten year bonds and the domestic savings rate for a cross section of countries

A final check on the relevance of pre-Lehman Brothers domestic savings to actual market risk perception of sovereign debt is performed using a cross section sample of 17 OECD countries listed in the Financial Times secondary market yields report for 10 years government bonds. Data was a collected on the 19th January 2011, after a number of successful Portuguese government bonds and T-bills auctions, Spanish bond auctions and Italian bond auctions. Therefore, our sample is not contaminated by extreme events of the type of a failed bond auction. In fact, if anything, it could be argued that the sample is sympathetic to these countries, moreover, when the ECB is said to have intervened both in such auctions indirectly, and on the secondary market to prevent Portuguese bonds' yields to go above the 7% threshold the Finance Minister had defined as the cost of market financing that would lead Portugal to ask for financial assistance from the IMF and the European Rescue Fund (this statement is from October 2010).

Denoting by *r* the Pearson correlation coefficient between domestic savings rate in 2008 and the yields on 10 year bonds in such debt markets, we aimed at testing the hypothesis of whether or not $r < 0$. Accepting such a hypothesis would lead us to conclude, again, that market participants were asking for higher spreads on riskier bonds, these being perceived as those pertaining to countries with low domestic savings.

R. A. Fisher's (1915, 1921) Z transformation, whereby

$$Z = \frac{1}{2}\log_{10}\left(\frac{1+r}{1-r}\right) = artanh(r),\ \sigma_Z = \frac{1}{\sqrt{N-3}}$$

was used, given the asymmetry resulting from the estimated *r* in our sample: in fact, for the 17 countries considered, $r = -0{,}75216$, with $N = 17$, implying a confidence interval for the true correlation coefficient, at a 95% significance level, of [-0.9; -0.4]. Conversion from *Z* back to *r* was done in the standard way using Fisher's *Z* tables. Clearly, even if this result is to be taken with caution as there is little chance that the two series are jointly normally distributed, the result is strongly indicative, at least asymptotically, of the negative correlation between the variables under analysis (Gayen, 1951). Overall, this provides strong evidence in favor of the hypothesis under analysis in this section. In fact, participants in 10 years maturity bonds secondary markets seem to be asking spreads that are heavily dependent on the domestic ability to generate the

means of solvency to such government debt. This is to say that once again we find strong evidence in support of the role of domestic savings as a key indicator investors and lenders take into account when considering the proper yield to acquire risky government bonds.

4. Conclusion

Overall, it is fair to say that government shrinkage alone, allowing for a smaller public debt and for higher disposable income levels for households, which in turn are essential for higher domestic savings, are fundamental for highly indebted countries to reduce their default likelihood risk. Moreover, domestic savings are also being punished in some countries by large public companies deficits which shall turn into the need to borrow more from abroad. Conventional receipts based on higher taxation are therefore uncapable of sustaining a financial recovery. Highly indebted economies need to save more across sectors: both by inducing real government shrinkage, and by stimulating savings in the private sector. It seems clear the problems that the IMF/ERF plans are experiencing are directly related to the inability to induce savings, but rather to transfer debt from the government to the private sector through taxation. This should be something to be taken into account in the near future.

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