

Aizenman, Joshua; Hutchison, Michael; Jinjara, Yothin

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What is the risk of European Sovereign Debt Defaults?

Fiscal Space, CDS Spreads and Market Mispricing of Risk

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Joshua Aizenman  
Department of Economics  
University of California  
Santa Cruz, CA 95064  
[jaizen@ucsc.edu](mailto:jaizen@ucsc.edu)

Michael Hutchison  
Department of Economics  
University of California  
Santa Cruz, CA 95064  
[hutch@ucsc.edu](mailto:hutch@ucsc.edu)

Yothin Jinjarak  
Financial and Management Studies  
University of London  
WC1H 0XG  
[yj5@soas.ac.uk](mailto:yj5@soas.ac.uk)

Abstract

We estimate the pricing of sovereign risk for a large number of countries within and outside of Europe, before and after the global financial crisis, based on fiscal space and other economic fundamentals. We measure how accurately the model predicts CDS spreads based on fundamentals, and determine whether the model explains spreads equally well in the Euro zone countries, and the PIIGS in particular, as elsewhere in the world. We validate that fiscal space has been an important determinant of market-based sovereign risk, and find evidence of mispricing in PIIGS given current fiscal space and other current fundamentals: unpredicted low CDS in tranquil period and unpredicted high during global crisis period, especially 2010 when sovereign debt crisis swept over Euro area. To gain further insight, we “match” the PIIGS with 5 middle income countries outside Europe that, before the crisis (2007), were closest in terms of fiscal space (debt/tax). We find that PIIGS default risk is priced much higher than the “matched” countries in 2010, even allowing for differentials in fundamentals. A possible interpretation of this finding is that the market is pricing not on current fundamentals but future fundamentals, expecting the PIIGS fiscal space to deteriorate markedly. The adjustment challenges of the PIIGS may be viewed as economically and politically more difficult due to exchange rate inflexibility that is not a constraint in the matched group of the middle income countries.

Keywords: CDS spreads, sovereign risk, fiscal space, PIIGS and the Euro area, fiscal space  
JEL: E43, F30, G01, H63

## 1. Introduction

During the first part of the 2000s, 2000-2006, the OECD and most EMs experienced a remarkable decline in macro volatility, and the price of risk. This period turned out to be the tail-end of the *Great Moderation*, a precursor of the turbulences leading to the global crisis of 2008-9, the consequent increase in risk premia, and the focus on fiscal challenges and the importance of fiscal space in navigating future economic challenges. The crisis focused attention on the heterogeneity of the Euro block, and the unique challenges facing the PIIGS, adjusting to fiscal fragility in the context of a ten-year old currency union.

This paper investigates the pricing of risk associated with the sovereign debt crisis that has emerged in 2010 in several European countries. Our objective is to determine whether the perception of relatively high sovereign debt default risk in the fiscally distressed Euro-area countries may be explained by existing past or current fundamentals of debt (deficit) relative to tax revenues— which we term fiscal space—and other economic determinants. An alternative explanation is that high sovereign risk perception for several European countries, as seen in market credit default swap (CDS) spreads on sovereign bonds, is related to non-economic factors or expectations of deteriorating future fundamentals rather than current conditions.

To this end, we develop a model of pricing of sovereign risk for a large number of countries within and outside of Europe, before and after the global financial crisis, based on fiscal space and other economic fundamentals. We use this model to explain CDS spreads and determine whether the market pricing of risk is comparable in the affected European countries and elsewhere in the world. By this methodology and using out-of-sample predictions, we can determine whether there are systematically large prediction errors for the CDS spreads during the global financial crisis period 2008-10 and especially 2010 when the

sovereign debt crisis in Europe surfaced. Systematically large prediction errors may be due to mispricing of risk or may be attributable to expectations of a future decline in fundamentals.

Our analysis may help address a number of questions. Was risk in many markets (e.g. PIIGS) “underpriced” during the bubble, and perhaps “overpriced” now, judging by current values of the fiscal space indicator (amongst other macro variables)? Does fiscal space help systematically explain the evolution of the market pricing of risk? It would be interesting to compare the standard macro set of determinants with and without fiscal space to understand whether adding fiscal space give new insights. Specifically, we investigate how sovereign spreads on government debt, particularly in the PIIGS group, evolve as a function of fiscal space in addition to various macroeconomic controls, including foreign interest rate, trade openness, GDP/Capita and economic growth. Focusing on countries outside the Euro zone, we will obtain results that would allow us to ask the degree to which public debt was underpriced in the Euro zone prior to the crisis, and possibly over-priced after the onset of the crisis, relative to the international norm of risk pricing.

Our study uses the 2000s as a case study of the pricing of sovereign risk, aiming at identifying the role of fiscal space and other macro factors in accounting for the risk premia, and the degree to which risk pricing of the PIIGS deviates from the pricing of comparable countries. Our investigation reveals a complex and time varying environment. Specifically, we validate empirically the role key of *de-facto* fiscal space in pricing sovereign risk, controlling for other relevant macro variables.<sup>1</sup> Applying the empirical model to the OECD and emerging market countries, we find that before the crisis, the risk-pricing of the PIIGS resembles the pricing of non European countries matched by similarity of their *de-facto* fiscal

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<sup>1</sup>Our measure of fiscal space is from Aizenman and Jinjark (2010). They propose a stock and flow measure of *de-facto* fiscal space. The stock variable is defined as the inverse of the tax-years it would take to repay the public debt. In this paper, fiscal space is measured as outstanding public debt relative to the *de facto* tax base, where the latter measures the realized tax collection, averaged across several years to smooth for business cycle fluctuations.

characteristics. During the evolving crisis, we find the emergence of the PIIGS risk premia relative to the matched group.

The next section discusses the data and methodology. The third section provides a preliminary data analysis. The fourth section presents the results. We close the paper with a discussion of possible interpretation of the emerging PIIGS risk premia, including the handicapping effect of being a member of a currency union, reducing country's scope of adjustment via exchange rate and inflation adjustment.

## 2. Data

The fiscal space measures are government debt/tax revenue and fiscal deficit/tax revenue (see Aizenman and Jinjarak, 2010). We measure the risk of government debt default by the spreads on credit default swaps (CDS) for sovereign debt. The spread represents the quarterly payment (basis points) that must be paid by the purchaser to the seller for the contingent claim in the case of a credit event, in this case non-payment of sovereign debt, and is therefore an excellent proxy for market-based default risk pricing<sup>2</sup>. CDS are over-the-counter derivatives. The development of CDS contracts outstanding (left scale) compared with estimates of government debt outstanding (right scale) over 1998-2000 is shown in Figure 1. The figure shows that the CDS market has grown from the virtually nothing in the early 2000s (without any tractable statistics) to 10 trillion USD in 2004 and gigantic 60 trillion USD at the onset of the crisis in 2008.

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<sup>2</sup> While an alternative is to study the interest rate spreads of sovereign debts, the changes in risk spreads in CDS can be more informative to the degree of risk aversion than the level of sovereign interest rates in times of crisis, credit rationing and prospective different inflation rates (the difference between notional amount outstanding and market value can also be large). From the empirical standpoint, there are also extra advantages of using the CDS spreads. First, the CDS statistics are timelier and have larger country coverage. Second, using CDS spreads avoids the difficulty in dealing with time to maturity as in the case when the interest rate spreads are used. Indicative estimates of the BIS suggest that average original and remaining maturities of government debt instruments can vary remarkably across countries.

We consider sovereign credit spreads at several maturities—three, five and ten-year maturities. CDS can be used both for hedging and speculating, and is a real-time indicator of sovereign credit quality. By and large, empirical studies of CDS (corporate and sovereign) are relatively new and confined to a strand of market microstructure in finance literature. Two recent findings are relevant to our present analysis. First, at a very high frequency (intraday), differences in credit quality (CDS) are found to explain sovereign yield spreads of the Euro-area governments (Beber, Brandt, and Kavajecz, 2008).<sup>3</sup> Second, daily sovereign bond spreads are more likely to lead CDS spreads for emerging markets (Ammer and Cai, 2007).<sup>4</sup> Both studies suggest that sovereign interest rates and CDS spreads have common underlying causes. To the best of our knowledge, ours is the first to provide an empirical association between sovereign CDS spreads and economic fundamentals in times of stress and tranquility across emerging markets and developed countries.

The CDS pricing is taken from CMA Datavision, a platform that is based on data collected from a consortium of over thirty swap market participants. The sovereign CDS spreads are reported in basis points, with a basis point equals to \$1,000 to insure \$10 million of debt. These CDS spreads are the midpoint on the 5-year tenor and are based on London closing values. While CMA is not the sole provider of CDS prices, comparing across six major providers, Mayordomo et al. (2010) find that quotes of the CMA database are the most associated with price discovery process. The majority of sovereign CDS in the market are denominated in the US dollar. In the sample, about one-third of the CDS is Euro-denominated. CMA data provides a broad coverage of CDS pricing over countries and years, which fit with our empirical question.

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<sup>3</sup> Beber et al. study microstructure data of bond quotes and transactions from the interdealer markets, covering Austria, Belgium, Finland, France Germany Greece, Italy, Netherlands, Portugal and Spain. Their sample period is April 2003 to December 2004.

<sup>4</sup> Ammer and Cai examine daily data from February 2001 to March 2005, covering Brazil, China, Colombia, Mexico, Philippines, Turkey, and Uruguay. See also the discussion of findings from the European Commission (Tait and Oakley, 2010).

Appendix A provides data sources and Appendix B a list of countries in the whole data set, those included in the estimation, as well as average CDS spreads in the sample.

### 3. Statistical Contours

The mid-point 10-year CDS spreads are plotted for the selected countries in Figure 2. As shown, early 2008 marked the beginning of financial stress for Greece, Ireland, Italy, Portugal, and Spain. For Greece, this meant a manifold increase in sovereign spreads. As of 2010, the spreads of PIIGS group are well above those of emerging market countries (i.e. South Korea and Brazil). On the other hand, sovereign spreads of Germany and the US remain very low throughout the period.

Table 1 reports the mean values (standard deviation in parentheses) of CDS, fiscal space and macroeconomic variables for the PIIGS and other country groupings for the years 2005-10 and averages before crisis (2005-07) and during crisis 2008-10. The fall of 2008 was the height of the global financial crisis, the latter part of 2009 was a recovery period from the global financial panic and liquidity crisis, and the PIIGS sovereign debt crisis broke out in 2010. Prior to the crisis, PIIGS CDS values were quite low, ranging from 8-20 basis points, which are higher than the average for other Euro countries (11 basis points) and about the same as the 18 basis point average for the high income OECD group. During the early months into the global financial crisis, 2008-09, CDS spreads rose virtually in every country. The spreads dropped in most of the regions by 2010, except for PIIGS where their own sovereign debt crisis has become imminent. PIIGS CDS values in 2010 ranged from 153 basis points in Italy to 562 basis points in Greece. By contrast, in 2010 the high-income OECD countries have an average CDS spread of 127 basis points and the non-PIIGS Euro members have an average of 71 basis point.

Two fiscal space (fiscal capacity) measures are reported in the table, debt/taxes and deficits/taxes. While the high-income OECD countries and the non-PIIGS Euro countries saw their debt/tax ratios increasing by 0.3 percent in 2005-07 and by 0.2 percent in 2010. For Ireland and Greece, the adjustment is more drastic. The debt/taxes of Ireland jumped from 0.9 to 3.1 and that of Greece from 3.0 to 4.1. The large increase of debt/tax ratios in both countries captures a high degree of distress in their economic fundamentals.

Our two measures of de facto fiscal space during the tranquil period, 2000-07, are summarized in Figure 3 by country group. Lower pre-crisis government debt and lower average fiscal deficits relative to the tax base imply greater fiscal capacity. The figure shows that fiscal space was weakest (highest levels of debt and deficits relative to the tax base) in the low and middle-income countries. Although fiscal space measures are stronger in the PIIGS than low and middle-income countries, the debt/GDP ratio is higher. Generally, the PIIGS had more limited fiscal space during the tranquil period than other high income country groupings. The PIIGS had higher average debt and deficits to tax base ratios (despite a significant budget surplus in Ireland), and a higher level of debt to GDP, than other high-income country groupings (OECD-Euro area, other high income and other Euro members).

#### 4. Empirical Results

##### 4.1 Dynamics of CDS Spreads and Euro/PIIGS Pricing Differentials

Table 2 considers the dynamics and structure of CDS pricing over the whole 2003-10 sample period. The dependent variables are CDS spreads on sovereign bonds at maturities of 3, 5 and 10 years.<sup>5</sup> Our objectives are three-fold. First, we determine whether CDS spreads

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<sup>5</sup> Our CDS data set contains 1-10 year maturities. We focus on 3-, 5-, and 10-year here, and in subsequent baseline estimates mostly on the 10-year. While there is no precise international account of government debt maturity, some indicative statistics suggest that the average original maturity of central government debts is around 10 years for both emerging markets and developed countries (BIS, 2010)



(in a panel regression setting) are related to fiscal space measures (and U.S interest rates as a control). Second, we address whether there is an identifiable dynamic pattern to CDS spreads during the crisis period. Third, we investigate pricing differentials of CDS spreads in the Euro area, and the PIIGS in particular, compared to other countries. We seek to answer the question of whether the Euro area and PIIGS CDS spreads follow the same pattern as the rest of the world or may they considered to be “mispriced” in some sense, especially during the 2010 European debt crisis.

In order to investigate CDS pricing dynamics during the global and European financial turmoil, we include dummy variables ( $t_{2008-10}$ ) for three crisis years: 2008 is identified as the central part of the global financial crisis, 2009 is identified as a partial recovery period, and 2010 is identified with the PIIGS debt crisis and post-global financial crisis. Differential pricing in the markets of the Euro countries is investigated in the upper panel of Table 2 and of the PIIGS countries in the lower panel. The upper panel includes interactions of a dummy variable for the Euro countries with the year dummies, while the lower panel includes interactions of a dummy for PIIGS countries with the year dummies. Note that a dummy variable for the Euro and a dummy variable for PIIGS do not enter the estimation individually since these are dynamic panel estimation. The estimation covers a panel of 51 countries from 2003-10 and the methodology follows the standard Arellano-Bond dynamic panel estimator, which accounts for the correlation of lagged dependent variable and the unobserved error terms. The sovereign spreads are estimated in log form and multiplied by a hundred, allowing the coefficients to be interpreted in terms of a percentage change of sovereign credit risks (this terminology also aligns with standard practice in the financial sector that discusses the percentage change of CDS spreads).

In all of the CDS spread regressions, the fiscal space measure (inverse; higher value is equivalent to lower fiscal capacity) is positive and statistically significant at the 1 percent

level-- higher levels of debt relative to the tax base significantly increase market pricing of sovereign bond default risk. A 100 basis point rise in the debt/tax ratio increases the 10-year (3-year, 5-year) CDS spread by 9.7 percent (7.8 percent, 10.2 percent). A rise in U.S. interest rates also increases CDS spreads across the maturity spectrum. The test statistics (chi-squared reported) indicate that the dynamic panel regressions perform reasonably well in all equations.<sup>6</sup>

In addition, all of the coefficients on the 2008-10 year dummy variables are economically large and statistically significant. Controlling for other factors, sovereign spreads in 2008 jumped by 70-84 percent over the maturity spectrum relative to average rates over the 2003-10 period. Spreads were abnormally high in 2009 as well, but off their 2008 levels. Spreads fell sharply in 2010, again across the maturity spectrum, reaching average levels below the conditional period average once controlling for the deteriorating debt situation and a much lower level of U.S. interest rates. (US 10-year government bond yields dropped from 4.0% in 2007 to 1.7% at the end of 2010).

For Euro countries, and particularly the PIIGS group, sovereign spreads rose by substantially more in 2008 than the country-wide average. PIIGS CDS spreads climbed 57-86 percent above the sample-wide average spreads prevailing in 2008, declined modestly in 2009, and jumped to very high levels above the sample average in 2010. PIIGS CDS spreads were 190 percent higher than the sample average in 2010 at the 3-year maturity, 152 percent higher at the 5-year maturity and 158 percent higher at the 10-year maturity. A similar but less extreme pattern was experienced by the Euro area as a whole, driven in large part by the CDS spreads in the PIIGS group. It is evident that sovereign risk in the Euro area, and the

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<sup>6</sup> The Sargan test of over-identifying restrictions has a null hypothesis of exogenous instruments; in all cases, corresponding p-values of the Sargan test are larger than 0.20. The AR(1) test has a null of no autocorrelation in first differences (usually rejected) and the AR(2) test has a null of no autocorrelation in levels; in all cases, corresponding p-values of the AR(2) test are below 0.05.

PIIGS group in particular, were differentially priced much higher than the average of other countries, and moved in the opposite direction of the world trend in 2010. Risk assessments were falling around most of the world in 2010 but rising sharply in the Euro area and in the PIIGS.

#### 4.2 CDS Spreads, Fundamentals and Structural Change

It is evident that the Euro area, and the PIIGS in particular, have experienced much higher CDS spreads than most of the world during 2008-10, even controlling for their deteriorating fiscal situation and U.S. interest rates. However, what looks like differential pricing may in fact be associated with developments in other fundamentals not captured in Table 2. To address this issue, albeit with a more limited data set (constrained by data availability), we consider the broader role played by fundamentals in the evolution of CDS spreads and also investigate structural change in the regressions.

Specifically, Table 3 reports estimates of the determinants of sovereign spreads based on fiscal space and a larger set of control variables in a dynamic regression:

$\Delta y_{it} = \alpha \Delta y_{it-1} + \Delta x_{it}' \beta + \Delta \varepsilon_{it}$ , where  $i$  stands for country and  $t$  for year;  $x$  is a set of controls, including fiscal space (debt/tax and fiscal deficit/tax), US interest rates, trade openness (trade/GDP), GDP (PPP) growth, and per capita GDP. The above specification is by no means a straitjacket debt pricing model, but naturally an empirical exercise serving our before and after 2008 crisis investigation.<sup>7</sup>

The upper panel of Table 3 estimates over the whole 2003-07 sample, making use of all the available observations before the 2008 crisis. This is the “benchmark” case of the

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<sup>7</sup> Based on the IMF and OECD statistics, we update actual government debt data for PIIGS that account for the potential costs of financial restructuring (see Fiscal Monitor Update, January 2011). The model prediction therefore reflects the latest fiscal capacity (debt/tax) and fundamentals. For other countries, when there are missing observations in the later years (2009-10 for a number of non-OECD), we estimate the fundamentals by an average of current and two lagged values.

pricing of CDS spreads under normal financial and economic conditions. As shown, the fiscal space indicators and other controlling fundamentals are statistically significant (with the exception of CPI inflation) and most coefficient values have the expected signs. For sensitivity checks we report estimates for all the 10-, 5-, and 3-year spreads, but focus on the 10-year CDS for the abovementioned rationale about an average original maturity of central government debts. Higher trade openness is correlated with higher sovereign credit spreads, as is nominal depreciation of the exchange rate and higher per capita GDP. Faster GDP growth and higher U.S. interest rates lower CDS spreads. Most importantly for our investigation, both government debt/tax revenue and fiscal deficit/tax revenue are positively correlated with the sovereign spreads. Limited fiscal space (higher values of these two indicators) is economically as well as statistically important. For example, based on regression (I) of Table 3 (10-year CDS spreads), raising government debt/tax revenue from the level of non-PIIGS Euro area (1.3) to the level of the PIIGS group (1.8) would increase CDS spreads by 8.5 percent ( $17.0 \times (1.8 - 1.3)$ ) under normal financial and economic conditions.

In order to investigate structural change, the lower left panel of Table 3 reports regressions estimated over the entire 2005-10 sample period and the lower right panel reports regressions estimated for the crisis period 2008-10. The first sample covers both the tranquil years (2005-07) and the crisis period (2008-10). This gives a balanced panel with data roughly equal in tranquil and crisis periods, so the coefficients would reflect an “average” of the up and down periods, in essence a ‘balanced’ regression. The lower right-hand-side panel considers only the crisis period and is symmetric with the pre-crisis period regressions in the upper panel, providing a pre-crisis and crisis comparison.

Focusing on the fiscal space variable represented by government debt/tax and the 10-year CDS spreads, the coefficient in the pre-crisis period is 17.0 (upper panel, column I) and

11.6 in the crisis period (column X in the lower right panel). The coefficient for the balanced sample period is 15.9, reflecting an average of the two subsamples. Interestingly, the sensitivity of 10-year spreads to fiscal space declines during the crisis period, as does the explanatory power of the regression (i.e. the pseudo R-squared falls), perhaps reflecting factors other than current fundamentals that are moving spreads. This could be prediction error in some sense—spreads not related to fundamental determinants-- or more emphasis on expectations of future deterioration in fiscal space not fully reflected in current economic conditions.<sup>8</sup>

#### 4.3 PIIGS and the Euro-Area CDS Pricing Before and During the Crisis

In order to determine how the full-sample model (2005-10) and latter sample (2007-10) models of Table 3 predict for various regional groupings and individual PIIGS, we report the in-sample prediction errors over various years in Table 4. Our objective is to determine whether prediction errors demonstrate a discernable pattern. We focus on sovereign risks captured by 10-year CDS spreads, using government debt/tax revenue as a measure of de facto fiscal space, and therefore base our calculation of the prediction error on the regression VII for 50 countries.<sup>9</sup>

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<sup>8</sup> We also investigated whether the pricing of CDS spreads amongst the PIIGS and the non-PIIGS Euro countries (Euro-PIIGS) respond differently to fundamentals than the rest of world when the full set of fundamental explanatory variables is included. We estimated the model over 2005-10, reflecting the full sample and consisting of both the tranquil and turbulent periods. We focused on 10-year CDS spreads and considered interaction terms of PIIGS and Euro-PIIGS with all of the fundamental variables. The point estimates of interaction terms on government debt/tax suggest that the non-PIIGS Euro area countries have much narrower spreads (-71.7) than the sample average and the PIIGS area have much larger spreads (263.1). However, these differences are not statistically significant. The same result holds for the other fundamental factors. One exception is the trade openness variable: on average, trade openness is positively associated with CDS spreads, but less than average for non-PIIGS Euro area and more than average for PIIGS. We omit these results for brevity. They are available upon request.

<sup>9</sup> Similar calculation can be done for the 3-year and 5-year sovereign spreads, but not reported and is available upon request.

We calculate the prediction errors as a ratio of the actual relative to the predicted CDS values from column VII of Table 3:

$$\text{Prediction error} = \frac{\text{Actual 10-yr. CDS}}{\text{Predicted 10-yr. CDS}}$$

Table 4 reports the prediction errors by country groups for the 2008-10 period, a breakdown for years 2008, 2009 and 2010, as well as for the tranquil 2005-07 period. We report the prediction errors using the 2005-10 balanced sample (Table 3 Column VII) in the left panel. As a robustness check, the prediction errors from the model estimated over the 2003-2007 tranquil period (Table 3 Column I) are reported in the right panel. A breakdown of how the independent variables (fundamentals) changed from 2005-2007 to 2008-10, providing a sense of how predicted values are likely to evolve, is shown in Table 1.

Table 4 indicates that, overall, actual CDS spreads were generally quite close to predicted values (ratios close to unity) across the spectrum of the regions and countries before the 2008 crisis. CDS spreads within the Euro zone area less PIIGS, as well as the PIIGS (except for Ireland), were somewhat underpriced (ratios less than unity) during the tranquil period, 2005-07. The fundamentals would have suggested somewhat higher CDS spreads than were actually realized. The middle income countries were also marginally underpriced in this period and the high income OECD countries marginally overpriced (ratios greater than unity).

By contrast, actual sovereign credit spreads were about twice predicted values (1.9) on average for the 50 countries in the sample during 2008-10. The under-prediction of the non-PIIGS Euro zone countries (2.1) was roughly in line with the full sample average (1.9) for the model estimated over 2005-10, or with an out-of-sample prediction when the model is estimated over the 2003-07 period (shown in the right panel). Realized CDS spreads were roughly twice what the model predicted. The PIIGS, except for Italy, had even higher prediction error than the full sample average, ranging from 2.6 (Portugal and Spain) to 3.1

(Greece). Interestingly, the prediction errors for the full sample peaked at 3.2 in 2008, the first crisis year, and declined to 1.8 in 2009 and 0.8 in 2010. PIIGS prediction errors were generally higher than the sample average in 2008, but the difference climbed markedly in 2010 when the European debt crisis broke out. In particular, while the full sample was somewhat underpriced (over-prediction) in 2010 at 0.8, and Euro-zone less PIIGS was 1.0, and the PIIGS CDS were overpriced (under-prediction) by magnitudes ranging from 1.4 (Italy) to 3.3 (Greece). These results are also reflected in the out-of-sample prediction errors reported in the right-hand-side of the table. In these estimates, the overall sample is underpriced (0.8) in 2010, but all of the PIIGS are overpriced with Greece again the largest prediction error at 3.3. That is, CDS spreads are more than three times larger than would have been predicted with model coefficients estimated over the tranquil period but using actual fiscal space and other fundamentals (explanatory variables) from 2010.

Figure 3 suggests that that fiscal positions in the Euro area were relatively strong, and the PIIGS area in line with other OECD countries, in the run up to the global financial crisis. The figure shows the fiscal and debt positions of country groupings (low income, middle income, OECD-Euro, other high income, PIIGS and Euro-PIIGS) before the global financial crisis: the 2007 debt/gdp ratio and 2000-07 averages for debt/tax and deficit/tax ratios. Preconditions in the Euro countries less the PIIGS were quite favorable by international comparison prior to the global financial crisis. The average debt/tax ratio (1.29) was the lowest amongst the groups shown and the debt/GDP (0.48) was below that of other OECD countries (0.52). The PIIGS group had a somewhat worse fiscal position, but not markedly so, with an average debt/tax ratio of 1.83 over the period, somewhat above the non-Euro OECD group average, comparable to “other” high income countries and much less than the middle income group.

Are fiscal conditions prior to the crisis linked to market “overreaction” or mispricing during and after the global financial crisis? Figure 4 shows a scatter plot of government fiscal space in 2005-07 prior to the financial crisis against 2008-10 prediction errors in Euro and non-Euro zone countries. The left panel shows the debt/tax revenue measure and the right panel shows the deficit/tax revenue fiscal space measure. The correlation in the Euro zone between government debt/tax revenues and prediction error is 0.36 and -0.51 for other (non Euro) countries in the sample. A similar pattern is seen when the deficit/tax measure of fiscal space is employed. Markets apparently systematically overreacted to fiscal pre-conditions in pricing Euro area default risk during the financial crisis (actual CDS spreads above predicted), while having the opposite reaction outside the Euro area.

#### 4.4 PIIGS Compared to “Matched” Middle Income “Countries

To gain further insight, we “match” the PIIGS with 5 middle income countries (MI) that, before the crisis (2007), were closest in terms of fiscal space (debt/tax). The objective is to see if the pricing of risk in the PIIGS was different than corresponding MI countries. The matches (PIIGS to MI) are Ireland-South Korea, Spain-Russia, Portugal-South Africa, Italy-Mexico and Greece-Philippines. Figure 5 shows a cluster diagram of the estimated prediction errors during these two periods, depicting the size of debt/tax by circles. This figure suggests that market pricing of risk above fundamental values (unpredicted high CDS spreads) was much higher for PIIGS than MI countries during the global crisis and especially in 2010, and about the same during the tranquil period. Some under-pricing (over prediction) of risk appeared for both groups during the tranquil period, given prediction errors less than unity (except for Ireland), followed by overpricing for both groups in the crisis period. But the over-pricing (under-prediction) of the PIIGS was much greater across the board relative to the matched MI countries during the crisis period.



Table 5 summarizes in more detail the characteristics of the PIIGS with the matched countries, before and during the crisis, and considers the evolution of fiscal space, CDS spreads, government bond yields, currency depreciation, inflation and international debt positions. This table allows a detailed comparison of the matched countries. In terms of initial conditions, for example, Italy and Mexico had very similar debt/tax ratios in 2007 (2.3-2.5), but Mexico had twice the cost of borrowing of Italy (8% versus 4%) in nominal terms at that time. Differential borrowing costs, however, are consistent with a much weaker currency and higher inflation rates in Mexico. The difference in CDS spreads between the two countries, with Italy at 19 and Mexico at 95.1, appears is in line with relative fiscal space and economic performance. By 2010, however, the roles were reversed: Italy had a CDS spread of 153 and Mexico 145, despite still having very similar debt/tax ratio and Mexico maintaining higher rates of inflation and currency depreciation. Pessimism about Europe in 2010 appears to have led to higher risk perceptions in Italy compared to Mexico than would be justified by fundamentals. This observation is seen as well in Figure 5, where the prediction error for 2008-10 is about 1.5 in Mexico and 2.0 in Italy.

Another illustrative case is Portugal and South Africa. The 2007 debt/tax ratios were similar, but South Africa was subject to a higher government borrowing costs and had a substantially higher CDS spread. Partly this reflected the respective political situations but also that South Africa had higher inflation and a higher rate of currency depreciation. Again, the market pricing of risk was reversed in the two countries by 2010 with the CDS spread in Portugal reaching 235 compared to 160 in South Africa. This difference may be partly due to fundamentals—real GDP growth was higher and the debt/tax ratio lower in South Africa. On the other hand, the inflation rates in South Africa were above 9% in 2010, compared to less than 1% in Portugal. The suspicion that default risk in Portugal is mispriced compared to South Africa is also suggested by the prediction error given in Figure 5—the average

prediction error for Portugal during 2008-10 is over 2.5 and about 1.7 in South Africa (both countries were similarly underpriced at around 0.8 during 2005-07).

In summary, there is strong evidence that high market default risk assessments in the PIIGS are partly attributable to deteriorating fundamentals but that a large component is unpredicted. Actual CDS spreads in the PIIGS are more than twice what the model predicts, given current fundamentals. In terms of the model, these spreads may be “mispriced” due to excessive pessimism on the part of market participants about the PIIGS or expectations of the further deterioration of fundamentals. This point is well illustrated by a comparison of PIIGS with MI countries starting out with similar fiscal conditions. In every case, risk pricing of the PIIGS is comparatively high given current economic conditions.

## 5. Conclusion

We develop a model of pricing of sovereign risk for a large number of countries within and outside of Europe, before and after the global financial crisis, based on fiscal space and other economic fundamentals. We use this model to explain CDS spreads and determine whether the market pricing of risk is comparable in the affected European countries and elsewhere in the world. By this methodology and using out-of-sample predictions, we determine whether there are systematically large prediction errors for the CDS spreads during the global financial crisis period 2008-10 and especially 2010 when the sovereign debt crisis in Europe surfaced.

We find that market-priced risk of sovereign debt as measured by CDS spreads is partly explained by fiscal space and other economic determinants. Fiscal space is an economically important and robust predictor of CDS spreads using a data set of fifty-four countries over 2000-10, measured either by government debt/tax base or government deficits/tax base. In addition to validating that fiscal space is an important determinant of

market-based sovereign risk, we find evidence of mispricing in PIIGS given current fiscal space and other current fundamentals: unpredicted low CDS in tranquil period and unpredicted high during global crisis period, especially 2010 when sovereign debt crisis swept over Euro area. We also matched the PIIGS with 5 middle-income countries outside Europe that, before the crisis (2007), were closest in terms of fiscal space (debt/tax). We find that PIIGS default risk is priced much higher than the “matched” countries in 2010, even allowing for differentials in fiscal space and other fundamentals.

One interpretation of these findings is that market-priced risk of sovereign default follows waves of contagion, overreacting and mispricing risk of sovereign default over a period of several years. The extraordinarily high CDS spreads in PIIGS in 2010, largely unpredicted by the model, may be attributable to excessive pessimism and an overreaction to the fiscal deterioration. Another interpretation, of course, is that the CDS market is pricing default risk not primarily on current fundamentals but future fundamentals, expecting the PIIGS fiscal space to deteriorate markedly. The adjustment challenges of the PIIGS may be viewed as economically and politically more difficult due to exchange rate inflexibility associated with participation in the Euro area that is not a constraint in the matched group of the middle income countries.

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## **Appendix A: Data sources.**

Spreads on credit default swaps (CDS) for 10, 5, and 3 years: The CDS pricing is based on data collected from a consortium of over thirty swap market participants. Most of CDS are denominated in US dollar, except the following which are in Euro: Croatia, Czech Republic, Denmark, Estonia, Hungary, Iceland, Latvia, Lithuania, Morocco, Poland, Romania, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, and Ukraine. The CDS spreads are the midpoint on the 5-year tenor, based on London closing values.  
Source: CMA Datavision.

De facto fiscal space: Government debt/tax revenue and fiscal deficit/tax revenue. The values are inflation adjusted.  
Source: IMF Fiscal Affairs Department, OECD, Eurostat, World Bank.

US interest rates: Yield of the 10-Year US Treasury bonds.  
Source: Economist Intelligence Unit and Datastream.

Trade openness:  $(\text{exports} + \text{imports})/\text{GDP}$ . The values are averaged over the contemporaneous value and two lags.  
Per capita GDP: The values are in 2005 US dollars, divided by 100, and averaged over the contemporaneous value and two lags.  
Source: World Bank.

GDP (PPP) Growth: The values are calculated as  $100 * [\ln(\text{GDP}(t)) - \ln(\text{GDP}(t-1))]$ .  
Source: Economist Intelligence Unit and Datastream.

Yields on 10-Year Government Bond, Currency per US Dollar, Consumer Price Inflation, Foreign Exchange Reserves  
Source: World Bank, Economist Intelligence Unit and Datastream.

International Debt Securities (Total and Government Issued) and Outstanding OTC Credit Default Swaps (billion USD)  
Source: Bank for International Settlements

**Appendix B: Country list.** There are 121 countries with debt/tax information (\* are countries with available data for estimation and constitute a core set of sample).

Group	Country	Code	CDS Spreads			Group	Country	Code	CDS Spreads		
			05-07	08-10	%chg.				05-07	08-10	%chg.
Low Income	Afghanistan	AFG				Middle Income	Albania	ALB			
	Bangladesh	BGD					Algeria	DZA			
	Benin	BEN					Argentina	ARG *	414	1436	247
	Burkina Faso	BFA					Armenia	ARM			
	Cambodia	KHM					Belarus	BLR			
	Central African Republic	CAF					Bhutan	BTN			
	Congo, Dem. Rep.	ZAR					Bolivia	BOL			
	Ethiopia	ETH					Bosnia and Herzegovina	BIH			
	Ghana	GHA					Brazil	BRA *	252	199	-21
	Kenya	KEN					Bulgaria	BGR *	50	278	455
	Kyrgyz Republic	KGZ					Cape Verde	CPV			
	Madagascar	MDG					China	CHN *	32	103	223
	Mali	MLI					Colombia	COL *	249	227	-9
	Myanmar	MMR					Congo, Rep.	COG			
	Nepal	NPL					Côte d'Ivoire	CIV			
	Niger	NER					Dominican Republic	DOM			
	Tajikistan	TJK					Egypt, Arab Rep.	EGY *	120	314	162
	Togo	TGO					El Salvador	SLV			
	Uganda	UGA					Fiji	FJI			
Zambia	ZMB				Georgia	GEO					
OECD - EURO	Australia	AUS *	19	61	214	Guatemala	GTM				
	Canada	CAN				Honduras	HND				
	Czech Republic	CZE *	11	106	838	India	IND				
	Denmark	DNK *	15	45	192	Indonesia	IDN *	257	322	25	
	Hungary	HUN *	41	261	540	Iran, Islamic Rep.	IRN				
	Iceland	ISL				Jamaica	JAM				
	Israel	ISR *	45	134	198	Kazakhstan	KAZ *	92	367	297	
	Japan	JPN *	9	64	618	Lesotho	LSO				
	Korea, Rep.	KOR *	38	163	332	Lithuania	LTU *	23	304	1243	
	New Zealand	NZL *	12	64	427	Macedonia, FYR	MKD				
	Norway	NOR *	7	24	223	Malaysia	MYS *	39	143	271	
	Poland	POL *	25	141	455	Maldives	MDV				
	Sweden	SWE *	24	50	113	Mauritius	MUS				
	Switzerland	CHE				Mexico	MEX *	95	194	104	
	United Kingdom	GBR *	8	67	697	Moldova	MDA				
	United States	USA				Mongolia	MNG				
	Other High Income	Bahamas, The	BHS				Morocco	MAR *	108	174	60
		Bahrain	BHR				Namibia	NAM			
		Croatia	HRV *	52	240	365	Pakistan	PAK *	306	1221	299
Estonia		EST *	18	229	1157	Panama	PAN *	188			
Kuwait		KWT				Papua New Guinea	PNG				
Latvia		LVA *	23	453	1852	Paraguay	PRY				
Oman		OMN				Peru	PER *	205	202	-1	
Qatar		QAT *	37	136	268	Philippines	PHL *	319	261	-18	
San Marino		SMR				Romania	ROM				
Singapore		SGP				Russian Federation	RUS *	98	270	174	
Trinidad and Tobago		TTO				Senegal	SEN				
PIIGS		Greece	GRC *	21	270	1159	Seychelles	SYC			
		Ireland	IRL *	8	171	1948	South Africa	ZAF *	79	217	175
		Italy	ITA *	20	109	450	Sri Lanka	LKA			
		Portugal	PRT *	13	124	875	St. Kitts and Nevis	KNA			
		Spain	ESP *	14	108	675	Swaziland	SWZ			
EURO members - PIIGS		Austria	AUT *	4	75	1946	Thailand	THA *	57	148	160
		Belgium	BEL *	5	65	1255	Tunisia	TUN *	70	167	137
		Cyprus	CYP				Turkey	TUR *	276	277	1
	Finland	FIN				Ukraine	UKR *	248	1127	355	
	France	FRA *	4	44	1057	Uruguay	URY				
	Germany	DEU *	4	33	810	Venezuela, RB	VEN *	318	1160	265	
	Luxembourg	LUX									
	Malta	MLT									
	Netherlands	NLD *	9	43	369						
	Slovak Republic	SVK *	13	90	611						
	Slovenia	SVN *	16	80	409						

**Table 1: Sovereign Credit Spreads and Fundamentals.** This table provides means and standard deviations (in parentheses) of sovereign CDS spreads and fundamentals. See Appendix B for country groups.

Countries/Fundamentals	CDS Spreads					Government Debt/Tax Revenue					Fiscal Deficit/Tax Revenue					Nominal Depreciation				
	2005-07	2008	2009	2010	2008-10	2005-07	2008	2009	2010	2008-10	2005-07	2008	2009	2010	2008-10	2005-07	2008	2009	2010	2008-10
All	101.1 (131.3)	203.1 (258.9)	343.6 (487.9)	208.2 (210.7)	251.9 (345.9)	2.5 (2.5)	2.0 (1.6)	2.0 (1.5)	2.1 (1.5)	2.0 (1.5)	5.4 (18.5)	3.8 (16.8)	3.1 (16.5)	2.5 (16.7)	3.1 (16.6)	-3.5 (5.5)	-3.5 (3.9)	-2 (4.9)	2.5 (5.4)	-4 (5.3)
Middle income	195.0 (143.9)	363.0 (319.1)	587.0 (650.7)	299.1 (268.8)	418.2 (458.7)	3.6 (3.1)	2.6 (1.8)	2.5 (1.6)	2.5 (1.6)	2.5 (1.6)	9.5 (19.6)	7.0 (18.9)	5.5 (18.6)	3.7 (19.0)	5.4 (18.6)	-1.1 (6.3)	-2.1 (4.4)	1.5 (5.3)	3.6 (6.6)	.9 (5.9)
High income: Non OECD	43.7 (26.2)	205.1 (97.8)	372.5 (187.3)	215.9 (130.7)	264.5 (152.4)	1.1 (.7)	.8 (.6)	1.0 (.6)	1.2 (.6)	1.0 (.6)	-15.7 (32.7)	-12.4 (27.2)	-11.1 (27.1)	-9.9 (27.3)	-11.1 (24.6)	-2.5 (4.0)	-2.1 (4.7)	.8 (6.4)	4.4 (7.6)	1.0 (6.4)
High income: OECD	17.8 (15.2)	56.2 (40.6)	115.6 (69.9)	127.2 (114.7)	99.7 (85.8)	1.6 (1.3)	1.6 (1.3)	1.8 (1.4)	1.9 (1.5)	1.8 (1.4)	4.2 (11.8)	3.5 (11.2)	3.3 (11.5)	3.5 (11.8)	3.4 (11.3)	-5.9 (3.5)	-4.9 (2.8)	-2.0 (3.6)	1.3 (3.5)	-1.9 (4.1)
ESP	14.0 (3.3)	52.5	95.2	177.8	108.5 (63.7)	1.1 (.1)	1.1	1.5	1.8	1.5 (.4)	1.6 (.7)	.7	2.3	4.9	2.6 (2.1)	-6.7 (3.4)	-5.5	-3.4	1.8	-2.4 (3.8)
GRC	19.8 (4.0)	77.8	170.3	561.6	269.9 (256.8)	3.0 (.0)	3.1	3.6	4.1	3.6 (.5)	22.1 (1.0)	22.3	23.2	24.7	23.4 (1.2)	-6.7 (3.4)	-5.5	-3.4	1.8	-2.4 (3.8)
IRL	8.5 (4.0)	55.5	199.4	258.1	171.0 (104.2)	.9 (.1)	1.5	2.2	3.1	2.3 (.8)	-4.2 (1.6)	-1.4	3.1	8.7	3.5 (5.1)	-6.7 (3.4)	-5.5	-3.4	1.8	-2.4 (3.8)
ITA	18.3 (4.2)	62.2	112.5	153.0	109.2 (45.5)	2.5 (.1)	2.5	2.7	2.7	2.7 (.1)	7.0 (.6)	7.2	7.2	7.2	7.2 (.0)	-6.7 (3.4)	-5.5	-3.4	1.8	-2.4 (3.8)
PRT	12.7 (1.3)	52.9	82.5	235.5	123.6 (98.0)	1.9 (.1)	1.9	2.2	2.4	2.2 (.2)	2.6 (.7)	3.2	4.2	4.9	4.1 (.9)	-6.7 (3.4)	-5.5	-3.4	1.8	-2.4 (3.8)
Euro area - PIIGS	10.6 (10.9)	35.3 (18.9)	77.9 (31.4)	71.1 (20.6)	61.4 (29.9)	1.3 (.4)	1.4 (.5)	1.5 (.5)	1.5 (.5)	1.4 (.5)	7.2 (6.0)	4.9 (3.0)	4.6 (2.7)	4.8 (3.1)	4.8 (2.8)	-5.9 (3.2)	-5.5 (.0)	-3.4 (.0)	1.3 (.5)	-2.6 (2.9)
Non Euro	127.2 (138.9)	252.8 (279.5)	420.4 (537.9)	224.7 (226.9)	300.0 (381.4)	2.8 (2.8)	2.1 (1.8)	2.1 (1.7)	2.1 (1.6)	2.1 (1.7)	5.1 (20.6)	3.2 (19.0)	2.2 (18.7)	1.0 (18.7)	2.1 (18.7)	-2.7 (5.8)	-2.8 (4.3)	.8 (5.2)	2.9 (6.2)	.3 (5.7)
Countries/Fundamentals	CPI Inflation					Trade Openness					Per Capita GDP					GDP Growth				
	2005-07	2008	2009	2010	2008-10	2005-07	2008	2009	2010	2008-10	2005-07	2008	2009	2010	2008-10	2005-07	2008	2009	2010	2008-10
All	5.7 (4.2)	5.3 (4.8)	5.6 (5.6)	5.6 (4.9)	4.4 (4.1)	89.9 (42.4)	86.9 (41.9)	83.8 (40.2)	86.9 (41.3)	86.5 (40.8)	205.0 (141.0)	206.1 (144.0)	207.3 (146.5)	206.1 (142.9)	188.3 (134.0)	5.0 (3.6)	2.1 (3.9)	.1 (4.5)	2.4 (4.5)	5.1 (2.8)
Middle income	8.2 (4.6)	8.2 (5.8)	9.3 (6.8)	8.5 (5.7)	6.3 (5.1)	79.1 (42.4)	75.4 (40.2)	69.1 (33.2)	74.6 (38.5)	80.3 (43.0)	86.7 (39.6)	88.3 (39.4)	86.8 (38.9)	87.3 (38.7)	76.3 (33.4)	6.2 (1.9)	3.4 (2.8)	1.6 (3.9)	3.8 (3.5)	6.4 (2.2)
High income: Non OECD	8.9 (4.1)	6.8 (2.6)	6.0 (2.4)	7.2 (3.1)	5.3 (3.0)	112.3 (33.3)	103.8 (30.8)	100.1 (30.7)	105.4 (29.1)	107.7 (26.5)	317.2 (293.6)	326.7 (321.2)	329.8 (337.2)	324.6 (287.5)	320.4 (247.7)	9.5 (9.4)	3.2 (11.6)	-1.4 (13.0)	3.8 (11.4)	9.5 (4.3)
High income: OECD	3.0 (1.1)	2.5 (1.1)	2.4 (1.3)	2.6 (1.2)	2.5 (1.4)	96.0 (42.6)	94.6 (43.6)	93.9 (44.0)	94.8 (42.8)	89.7 (39.2)	294.8 (75.6)	294.0 (73.5)	292.4 (72.2)	293.7 (72.7)	279.1 (79.4)	3.1 (1.9)	.6 (1.7)	-1.1 (2.0)	.9 (2.5)	3.3 (1.6)
ESP	3.5	2.2	1.8	2.5 (.9)	3.2 (.1)	59.4	56.1	53.9	56.5 (2.8)	57.3 (1.5)	282.9	279.7	277.0	279.9 (2.9)	274.3 (5.4)	2.8	.3	-1.4	.6 (2.1)	3.6 (.2)
GRC	3.4	2.8	2.7	3.0 (.4)	3.3 (.1)	57.5	54.8	53.5	55.3 (2.0)	54.5 (.9)	264.9	267.7	268.0	266.9 (1.7)	244.1 (10.9)	3.7	1.5	.0	1.7 (1.8)	4.1 (.4)
IRL	4.3	1.5	-.2	1.9 (2.3)	3.4 (.7)	152.5	156.7	159.2	156.1 (3.4)	156.4 (7.7)	400.3	388.9	377.7	389.0 (11.3)	373.4 (18.8)	2.8	-1.4	-5.1	-1.2 (3.9)	5.4 (.3)
ITA	2.4	2.0	2.1	2.2 (.2)	2.2 (.2)	57.6	55.0	53.3	55.3 (2.2)	52.0 (2.7)	285.0	278.4	273.7	279.0 (5.6)	282.6 (1.7)	.7	-1.6	-3.2	-1.4 (2.0)	1.0 (.4)
PRT	2.7	1.5	.9	1.7 (.9)	2.6 (.1)	72.8	70.4	69.4	70.9 (1.8)	66.7 (2.8)	218.3	217.7	216.6	217.5 (.8)	213.8 (2.1)	1.3	-.1	-1.3	.0 (1.3)	1.1 (.6)
Euro area - PIIGS	2.7 (.9)	2.2 (.7)	2.2 (.7)	2.4 (.8)	2.9 (1.8)	124.1 (42.3)	122.3 (44.3)	121.0 (45.4)	122.5 (41.8)	114.1 (35.7)	306.9 (62.3)	307.3 (60.7)	306.5 (59.9)	306.9 (57.8)	277.6 (69.3)	3.7 (2.4)	.8 (1.3)	-1.1 (.7)	1.1 (2.6)	3.3 (1.9)
Non Euro	6.6 (4.5)	6.3 (5.1)	6.9 (6.0)	6.6 (5.2)	4.9 (4.5)	84.9 (40.6)	81.4 (38.9)	77.5 (35.5)	81.3 (38.2)	82.4 (39.4)	175.0 (146.1)	176.9 (150.8)	178.4 (155.1)	176.7 (149.4)	160.9 (136.9)	5.5 (3.8)	2.6 (4.3)	.6 (5.1)	2.9 (4.8)	5.7 (2.8)

**Table 2: Dynamics of CDS Spreads and Euro/PIIGS Pricing Differentials over the 2003-10 Period.** This table reports panel data analysis, covering years 2003-10 (see appendix B for the country list). The dependent variable is  $100 \times \ln(\text{sovereign credit spreads})$ , based on CDS values. The explanatory variables include the lagged CDS spreads, year dummies (t2008-10), Euro dummy (equals to one if country is currently a member of the Euro area), US interest rates and government debt/tax revenue (deflated using CPI). Standard errors are in parentheses, with \*\*\* (\*\*, \*) denoting statistical significance at 1 (5, 10) percent level. The estimation follows Arellano-Bond dynamic panel estimator.

y =	ln(3-yr. CDS)	ln(3-yr. CDS)	ln(5-yr. CDS)	ln(5-yr. CDS)	ln(10-yr. CDS)	ln(10-yr. CDS)
x=	coeff. (s.e.)	coeff. (s.e.)	coeff. (s.e.)	coeff. (s.e.)	coeff. (s.e.)	coeff. (s.e.)
y(t-1)	0.6 (0.1) ***	0.5 (0.0) ***	0.6 (0.1) ***	0.5 (0.0) ***	0.6 (0.1) ***	0.5 (0.0) ***
t2008	139.6 (6.5) ***	84.0 (6.1) ***	127.6 (6.8) ***	82.6 (5.6) ***	103.5 (6.6) ***	69.9 (4.4) ***
t2009	123.3 (16.9) ***	66.9 (11.8) ***	106.6 (13.9) ***	64.2 (9.0) ***	77.7 (10.8) ***	46.9 (7.3) ***
t2010	8.9 (24.0)	-34.7 (14.0) **	7.6 (20.3)	-21.2 (10.0) **	-2.5 (14.8)	-29.2 (8.3) ***
t2008 x Euro dummy	66.0 (11.3) ***	72.5 (4.7) ***	67.0 (12.5) ***	70.8 (3.0) ***	36.0 (10.2) ***	47.7 (2.5) ***
t2009 x Euro dummy	59.9 (10.3) ***	69.0 (5.2) ***	54.4 (12.2) ***	69.8 (4.2) ***	43.5 (8.2) ***	55.6 (4.4) ***
t2010 x Euro dummy	120.7 (23.6) ***	138.3 (10.6) ***	126.3 (19.8) ***	132.6 (3.5) ***	98.9 (15.8) ***	113.5 (6.7) ***
US Interest Rates		-47.1 (5.3) ***		-35.5 (4.0) ***		-25.8 (3.9) ***
Government Debt/Tax		7.8 (0.7) ***		10.2 (1.0) ***		9.7 (0.8) ***
constant term	3.1 (3.1)	9.2 (1.5) ***	1.5 (2.8)	7.6 (0.9) ***	2.6 (1.9)	7.8 (1.0) ***
Observations	236	236	236	236	236	236
Countries	51	51	51	51	51	51
Chi-sq: Sargan tests	23.2	46.3	24.1	45.9	21.0	44.3
AR(1) tests	-3.3	-3.4	-3.6	-3.7	-3.1	-3.2
AR(2) tests	2.3	2.4	2.3	2.3	2.1	2.2

y =	ln(3-yr. CDS)	ln(3-yr. CDS)	ln(5-yr. CDS)	ln(5-yr. CDS)	ln(10-yr. CDS)	ln(10-yr. CDS)
x=	coeff. (s.e.)	coeff. (s.e.)	coeff. (s.e.)	coeff. (s.e.)	coeff. (s.e.)	coeff. (s.e.)
y(t-1)	0.8 (0.1) ***	0.6 (0.0) ***	0.8 (0.1) ***	0.6 (0.0) ***	0.8 (0.1) ***	0.6 (0.0) ***
t2008	134.7 (6.1) ***	98.5 (8.3) ***	128.9 (6.3) ***	89.9 (3.7) ***	100.8 (5.9) ***	82.1 (4.1) ***
t2009	77.5 (12.4) ***	65.0 (13.6) ***	70.7 (10.5) ***	49.6 (6.2) ***	51.9 (10.6) ***	51.3 (6.5) ***
t2010	-56.1 (18.1) ***	-45.2 (14.7) ***	-38.1 (14.9) **	-42.0 (6.1) ***	-36.9 (13.3) ***	-27.1 (6.6) ***
t2008 x PIIGS dummy	100.6 (18.6) ***	85.6 (9.3) ***	42.1 (26.6)	66.7 (11.4) ***	57.8 (13.2) ***	56.8 (18.3) ***
t2009 x PIIGS dummy	55.7 (12.1) ***	68.6 (12.7) ***	10.8 (20.9)	54.5 (13.9) ***	41.8 (9.9) ***	55.1 (17.6) ***
t2010 x PIIGS dummy	197.8 (29.0) ***	189.8 (19.3) ***	118.9 (34.1) ***	151.6 (16.1) ***	141.9 (22.9) ***	158.3 (16.8) ***
US Interest Rates		-37.5 (6.9) ***		-35.6 (3.4) ***		-18.7 (4.2) ***
Government Debt/Tax		6.4 (0.5) ***		10.0 (0.6) ***		8.3 (0.6) ***
constant term	11.6 (2.9) ***	10.3 (1.7) ***	8.5 (2.6) ***	9.4 (1.0) ***	6.0 (2.3) **	7.9 (0.8) ***
Observations	236	236	236	236	236	236
Countries	51	51	51	51	51	51
Chi-sq: Sargan tests	20.5	43.7	23.0	45.4	25.9	44.3
AR(1) tests	-3.2	-3.3	-3.5	-3.5	-3.0	-3.0
AR(2) tests	2.4	2.6	2.5	2.7	2.0	2.2



**Table 3: CDS Spreads, Fundamentals and Structural Change.** This table reports panel data analysis, covering years 2003-10 (see appendix B for the country list). The dependent variable is  $100 \times \ln(\text{sovereign credit spreads})$ , based on CDS values. The explanatory variables include the lagged CDS spreads, trade openness, GDP (PPP) growth, GDP per capita, Nominal depreciation (against the US dollar), CPI inflation, US interest rates, government debt/tax revenue and fiscal deficit/tax (deflated using CPI). A constant term is included. t-statistics are in parentheses, with \*\*\* (\*\*, \*) denoting statistical significance at 1 (5, 10) percent level. The estimation follows Arellano-Bond dynamic panel estimator.

y =	(I) ln(10-yr. CDS)	(II) ln(5-yr. CDS)	(III) ln(3-yr. CDS)	(IV) ln(10-yr. CDS)	(V) ln(5-yr. CDS)	(VI) ln(3-yr. CDS)
Sample: 2003-07						
x=	coeff. (t-stat)		coeff. (t-stat)		coeff. (t-stat)	
y(t-1)	0.18 (6.39) ***	0.08 (1.60)	-0.02 (-0.44)	0.11 (6.70) ***	0.00 (0.14)	-0.07 (-2.07) **
Trade Openness	1.91 (4.05) ***	1.40 (2.29) **	2.09 (2.88) ***	2.68 (9.64) ***	2.81 (5.47) ***	3.43 (4.26) ***
GDP (PPP) Growth	-11.31 (-10.42) ***	-12.78 (-10.64) ***	-14.53 (-11.77) ***	-11.43 (-9.62) ***	-11.92 (-9.82) ***	-12.85 (-9.06) ***
Per Capita GDP	1.49 (4.88) ***	1.34 (5.13) ***	1.56 (5.70) ***	1.55 (5.57) ***	1.36 (3.93) ***	0.87 (3.19) ***
Nominal Depreciation	1.44 (4.36) ***	-0.12 (-0.37)	-0.58 (-1.61)	1.00 (3.25) ***	-0.08 (-0.20)	-0.95 (-2.70) ***
CPI Inflation	-0.50 (-0.40)	-1.09 (-0.76)	-0.12 (-0.08)	-1.18 (-1.14)	-1.21 (-0.78)	-0.76 (-0.41)
US Interest Rates	-24.82 (-3.43) ***	-20.98 (-3.15) ***	-41.64 (-7.95) ***	-25.58 (-4.48) ***	-30.31 (-5.34) ***	-35.72 (-4.51) ***
Government Debt/Tax	17.00 (3.19) ***	17.13 (3.33) ***	16.64 (2.93) ***	2.48 (10.95) ***	2.10 (6.25) ***	2.44 (3.69) ***
Fiscal Deficit/Tax						
Observations	88	88	88	86	86	86
Countries	45	45	45	44	44	44
Chi-sq: Sargan tests	37.39	35.33	39.10	30.75	32.92	36.08
AR(1) tests	-2.26	-2.47	-2.66	-1.94	-2.12	-2.38
AR(2) tests	-0.46	-0.67	-1.01	-0.51	-0.70	-0.84
Pseudo R-squared	.117	.080	.037	.082	.051	.022

y =	(VII) ln(10-yr. CDS)	(VIII) ln(10-yr. CDS)	(IX) ln(10-yr. CDS)	(X) ln(10-yr. CDS)	(XI) ln(10-yr. CDS)	(XII) ln(3-yr. CDS)
Sample: 2005-10			Sample: 2008-10			
x=	coeff. (t-stat)		coeff. (t-stat)		coeff. (t-stat)	
y(t-1)	0.37 (15.66) ***	0.36 (25.76) ***	0.47 (70.73) ***	0.30 (17.88) ***	0.30 (10.40) ***	0.29 (10.83) ***
Trade Openness	1.83 (9.11) ***	1.68 (6.82) ***	1.17 (10.97) ***	1.86 (7.82) ***	2.04 (4.30) ***	1.32 (2.45) **
GDP (PPP) Growth	-3.81 (-3.64) ***	-5.24 (-4.61) ***		-4.51 (-6.65) ***	-5.61 (-10.20) ***	-3.78 (-4.54) ***
Per Capita GDP	0.85 (7.49) ***	1.04 (7.07) ***		0.65 (6.24) ***	0.95 (5.33) ***	0.35 (2.18) **
Nominal Depreciation	-0.31 (-1.66) *	-0.27 (-1.33)		-0.10 (-0.48)	-0.67 (-2.22) **	0.07 (0.35)
CPI Inflation	2.97 (6.31) ***	4.65 (7.33) ***		-0.40 (-0.83)	1.64 (1.88) *	-0.20 (-0.38)
US Interest Rates	-72.98 (-33.36) ***	-67.52 (-20.85) ***		-174.57 (-17.60) ***	-140.39 (-8.41) ***	-234.18 (-29.79) ***
Government Debt/Tax	15.96 (4.64) ***		2.94 (1.88) *	11.62 (2.71) ***		19.53 (12.16) ***
Fiscal Deficit/Tax		2.93 (9.33) ***			2.51 (4.77) ***	
Observations	181	181	207	95	95	95
Countries	50	50	50	49	49	49
Chi-sq: Sargan tests	47.05	47.16	49.67	42.79	43.45	40.92
AR(1) tests	-3.78	-3.61	-4.49	-1.68	-1.57	-1.83
AR(2) tests	2.50	2.07	-1.98	.	.	.
Pseudo R-squared	.083	.086	.041	.058	.045	.088

**Table 4: Prediction Error of Sovereign CDS Spreads.** This table provides estimates of prediction error on the 10-year CDS spreads. Based on the evidence in Table 2 that CDS spreads in tranquil period (before 2008) were relatively under-priced, the below prediction errors are reported relative to the actual CDS spreads. Using the balanced sample: 2005-07 for tranquil years and 2008-10 for crisis years, the predicted 10-yr. CDS spreads are derived from coefficients of regression (VII) Table 3:

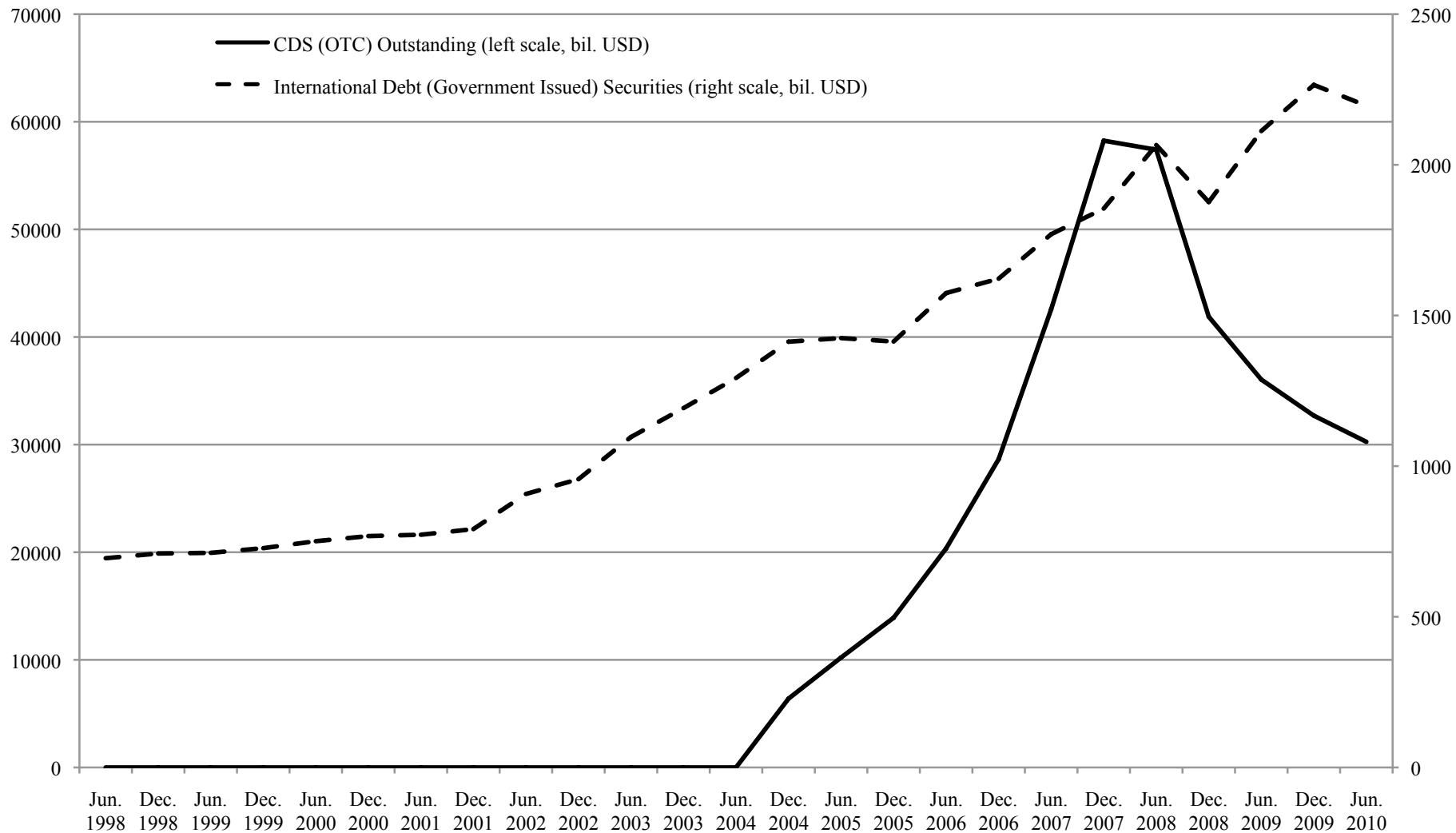
Prediction error =  $\frac{\text{Actual 10-yr. CDS}}{\text{Predicted 10-yr. CDS}}$ . Hence, if the prediction error is greater than 1, we have a case of under-prediction and it provides supportive evidence that the CDS is over-priced. See Figure 3 for country estimates.

Countries\Sample	Balanced Sample: 2005-10 [Regression (VII)]					Pre-Crisis Sample: 2003-07 [Regression (I)]				
	2005-07	2008	2009	2010	2008-10	2005-07	2008	2009	2010	2008-10
All	1.0	3.2	1.8	.8	1.9	1.0	3.4	1.8	.8	2.0
Middle income	.9	2.8	1.4	.6	1.6	.9	2.9	1.4	.6	1.6
High income: Non OECD	.7	6.1	1.8	.6	2.8	.7	6.3	1.8	.6	2.9
High income: OECD	1.1	3.1	2.1	1.1	2.1	1.1	3.3	2.1	1.1	2.2
ESP	.6	4.3	1.7	1.9	2.6	.6	4.5	1.7	1.8	2.7
GRC	.9	3.8	2.1	3.3	3.1	.9	3.9	2.1	3.3	3.1
IRL	1.3	3.3	3.4	1.3	2.7	1.3	3.7	3.4	1.3	2.8
ITA	.9	3.3	1.7	1.4	2.1	.9	3.4	1.8	1.4	2.2
PRT	.8	3.6	1.5	2.8	2.6	.8	3.8	1.5	2.8	2.7
Euro area - PIIGS	.9	3.3	2.2	1.0	2.1	1.0	3.7	2.2	1.0	2.3
Non Euro	1.0	3.1	1.7	.6	1.8	1.0	3.2	1.7	.6	1.9

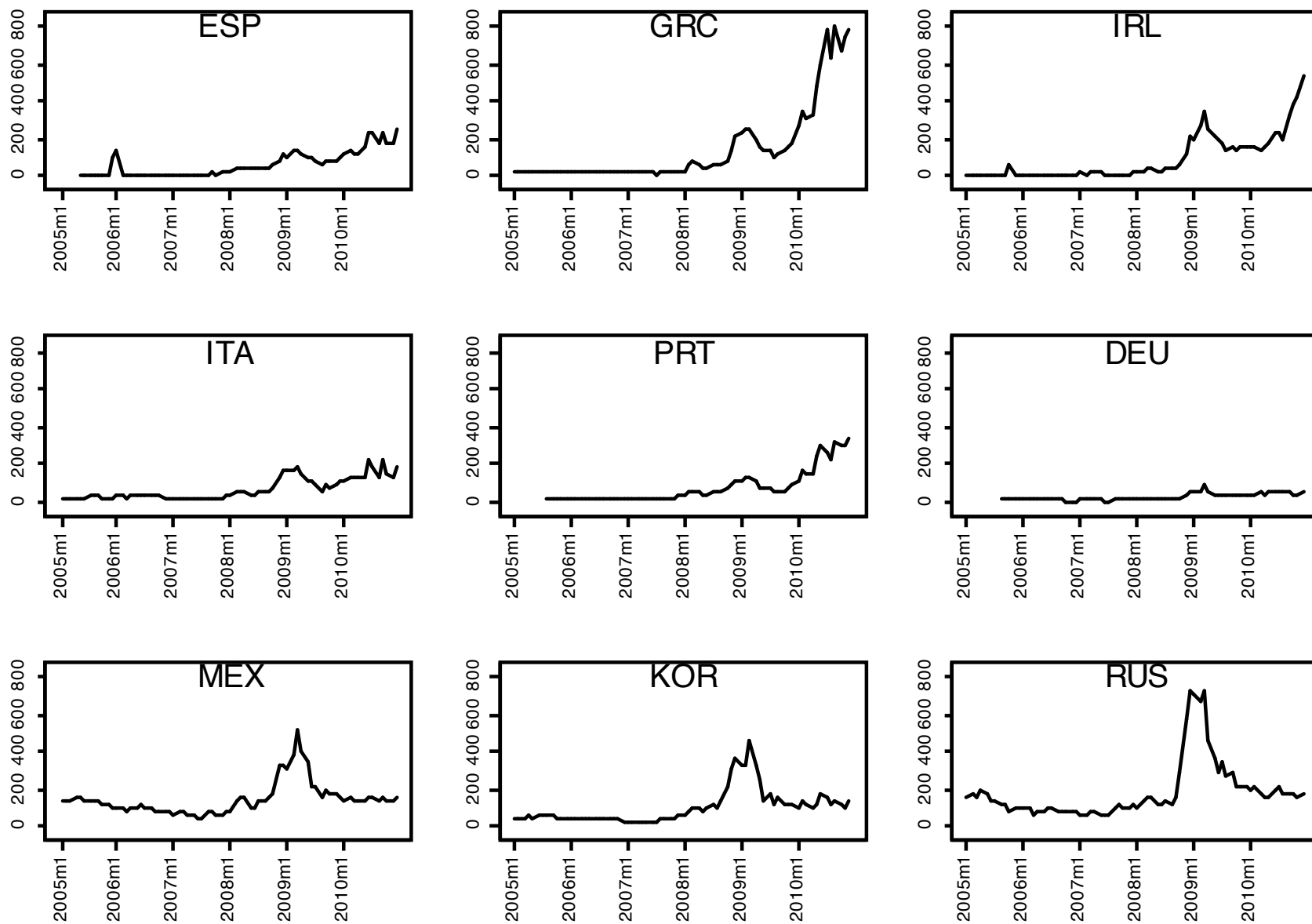
**Table 5: PIIGS Compared to “Matched” Middle-Income Countries.** This table matches middle-income countries and PIIGS countries by their closeness of debt/tax ratio before the crisis (year 2007), and reports their sovereign 10-year CDS spreads, yields on 10-year government bond (%), rates of currency depreciation (%) against the US dollar, and CPI inflation (%), foreign exchange reserves/GDP (%), and international debt securities (% GDP).

Variables	Year	IRL	KOR	ESP	RUS	PRT	ZAF	ITA	MEX	GRC	PHL
Government Debt/Tax Revenue	2007	.9	1.1	1.1	1.2	1.9	1.3	2.5	2.3	3.0	4.8
	2008	1.5	1.2	1.1	.6	1.9	1.1	2.5	2.2	3.1	3.8
	2009	2.2	1.2	1.5	.6	2.2	1.0	2.7	2.3	3.6	3.6
	2010	3.1	1.2	1.8	.6	2.4	1.0	2.7	2.4	4.1	3.6
	2008-10	2.2	1.2	1.5	.6	2.1	1.1	2.7	2.3	3.6	3.7
10-Year CDS Spread	2007	8.4	37.7	14.0	98.4	12.7	79.1	19.9	95.1	21.4	318.5
	2008	55.5	144.2	52.5	232.1	52.9	227.8	62.2	164.5	77.8	304.8
	2009	199.4	218.8	95.2	395.0	82.5	263.5	112.5	271.4	170.3	281.1
	2010	258.1	124.7	177.8	181.5	235.5	160.0	153.0	145.4	561.6	197.1
	2008-10	171.0	162.6	108.5	269.5	123.6	217.1	109.2	193.8	269.9	261.0
10-Year Government Yield	2007	3.7	5.0	3.8	7.9	2.6	8.5	4.0	8.1	4.0	8.4
	2008	4.3	5.4	4.2	7.1	4.0	8.3	4.4	7.7	4.5	6.8
	2009	4.6	5.4	4.2	8.3	3.4	8.6	4.5	7.2	4.8	7.1
	2010	5.0	5.6	4.2	8.7	3.7	8.6	4.3	7.0	5.6	7.9
	2008-10	4.6	5.4	4.2	8.0	3.7	8.5	4.4	7.3	5.0	7.3
Depreciation (against USD)	2007	-5.3	-7.0	-5.3	-3.8	-5.3	-5.8	-5.3	1.1	-5.3	-2.0
	2008	-5.5	2.4	-5.5	-4.3	-5.5	8.7	-5.5	.7	-5.5	-7.2
	2009	-3.4	9.7	-3.4	5.2	-3.4	7.3	-3.4	7.2	-3.4	-2.4
	2010	1.8	7.2	1.8	5.3	1.8	1.5	1.8	4.8	1.8	-.8
	2008-10	-2.4	6.4	-2.4	2.1	-2.4	5.9	-2.4	4.2	-2.4	-3.5
CPI Inflation	2007	3.1	2.9	3.2	11.3	2.6	3.9	2.1	4.1	3.3	6.0
	2008	4.3	3.1	3.5	10.9	2.7	7.8	2.4	4.2	3.4	6.1
	2009	1.5	3.3	2.2	11.6	1.5	8.6	2.0	4.8	2.8	5.1
	2010	-2	3.7	1.8	12.9	.9	9.3	2.1	5.2	2.7	6.3
	2008-10	1.9	3.4	2.5	11.8	1.7	8.6	2.2	4.7	2.9	5.8
Foreign Exchange Reserves	2007	.9	25.5	1.8	25.6	5.7	8.3	3.9	8.4	1.3	19.7
	2008	.4	23.9	1.4	31.0	4.9	11.2	4.4	8.4	1.1	21.8
	2009	.6	26.4	1.5	32.7	5.5	12.6	5.1	9.6	1.3	24.5
	2010	.7	27.1	1.6	30.6	5.8	13.1	5.4	10.1	1.3	25.0
	2008-10	.5	25.8	1.5	31.4	5.4	12.3	5.0	9.4	1.2	23.7
International Debt Securities: Total	2007	105.3	9.7	79.9	8.5	75.2	9.1	47.3	9.6	67.4	27.3
	2008	170.0	12.4	100.9	8.7	92.1	11.7	53.3	8.5	81.1	19.2
	2009	254.2	15.9	125.7	11.3	126.5	11.6	66.9	10.2	115.0	21.4
	2010	212.9	14.9	120.7	10.4	116.2	13.3	63.5	10.9	125.3	24.7
	2008-10	212.4	14.4	115.8	10.1	111.6	12.2	61.3	9.9	107.1	21.8
International Debt Securities: Government	2007	1.9	.7	5.2	3.0	19.7	3.1	11.4	4.7	43.7	19.0
	2008	13.7	.5	6.1	1.7	20.7	2.8	9.8	3.8	48.1	13.6
	2009	26.2	.9	9.9	2.1	28.2	2.9	11.5	4.7	70.9	14.9
	2010	27.0	.8	11.3	2.2	27.9	3.6	11.7	4.2	69.1	17.3
	2008-10	22.3	.7	9.1	2.0	25.6	3.1	11.0	4.3	62.7	15.2
International Debt Securities: Government/Total	2007	.01	.07	.07	.36	.27	.36	.24	.49	.65	.70
	2008	.08	.04	.06	.19	.22	.24	.18	.45	.59	.71
	2009	.10	.06	.08	.19	.22	.25	.17	.46	.62	.70
	2010	.13	.05	.09	.21	.24	.27	.18	.39	.55	.70
	2008-10	.10	.05	.08	.20	.23	.26	.18	.43	.59	.70

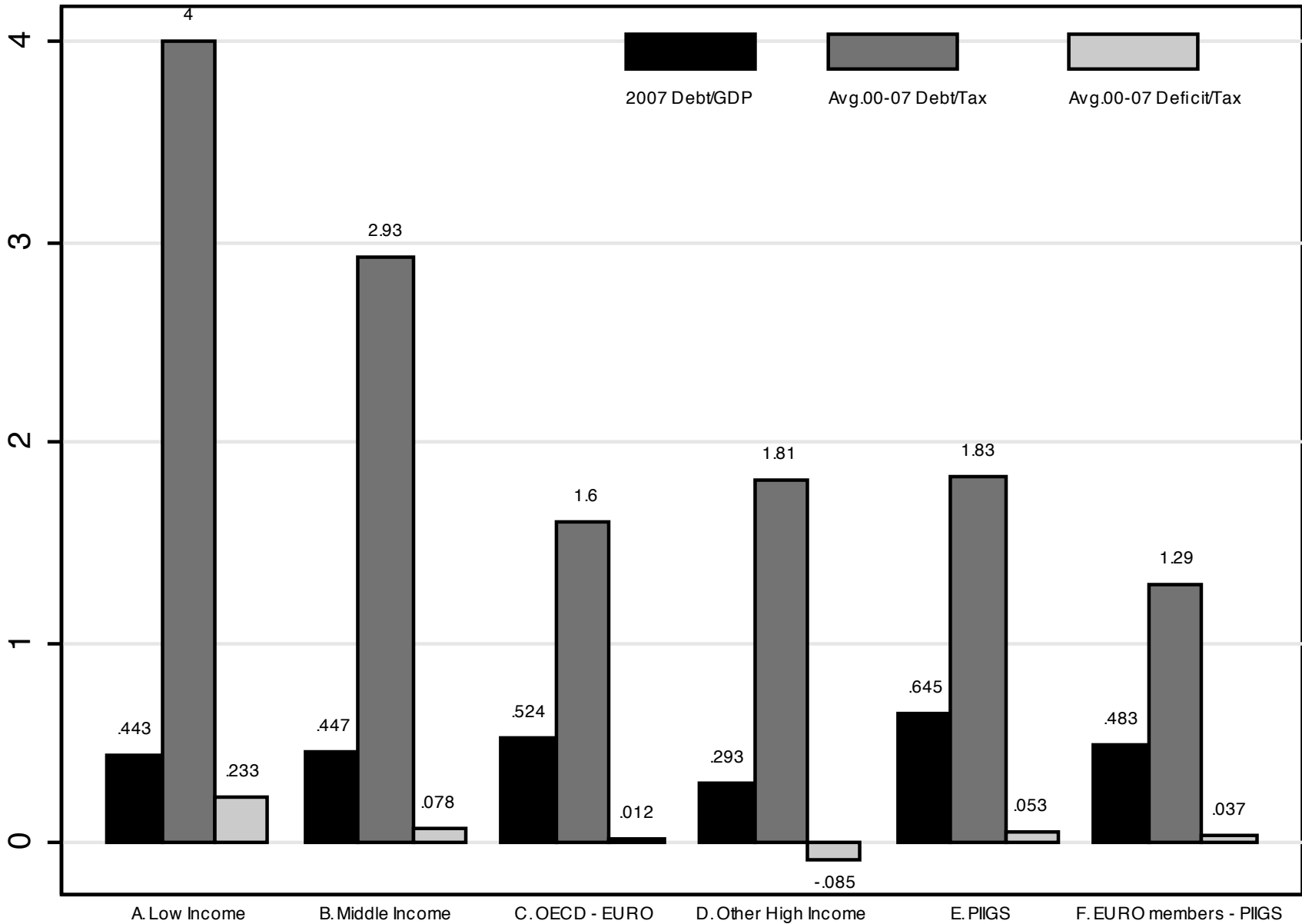
**Figure 1: Outstanding Credit Default Swaps and International Debt Securities of Governments.** This figure plots the amount outstanding of over-the-counter (OTC) Credit Default Swaps (CDS) and the international debt securities (bonds, notes, and money market instruments) issued by governments in billions of US dollars. The BIS statistics for CDS outstanding began in June 2004. Both series are notional amounts (deviation from market values can be large during the crisis; see BIS (2010)).



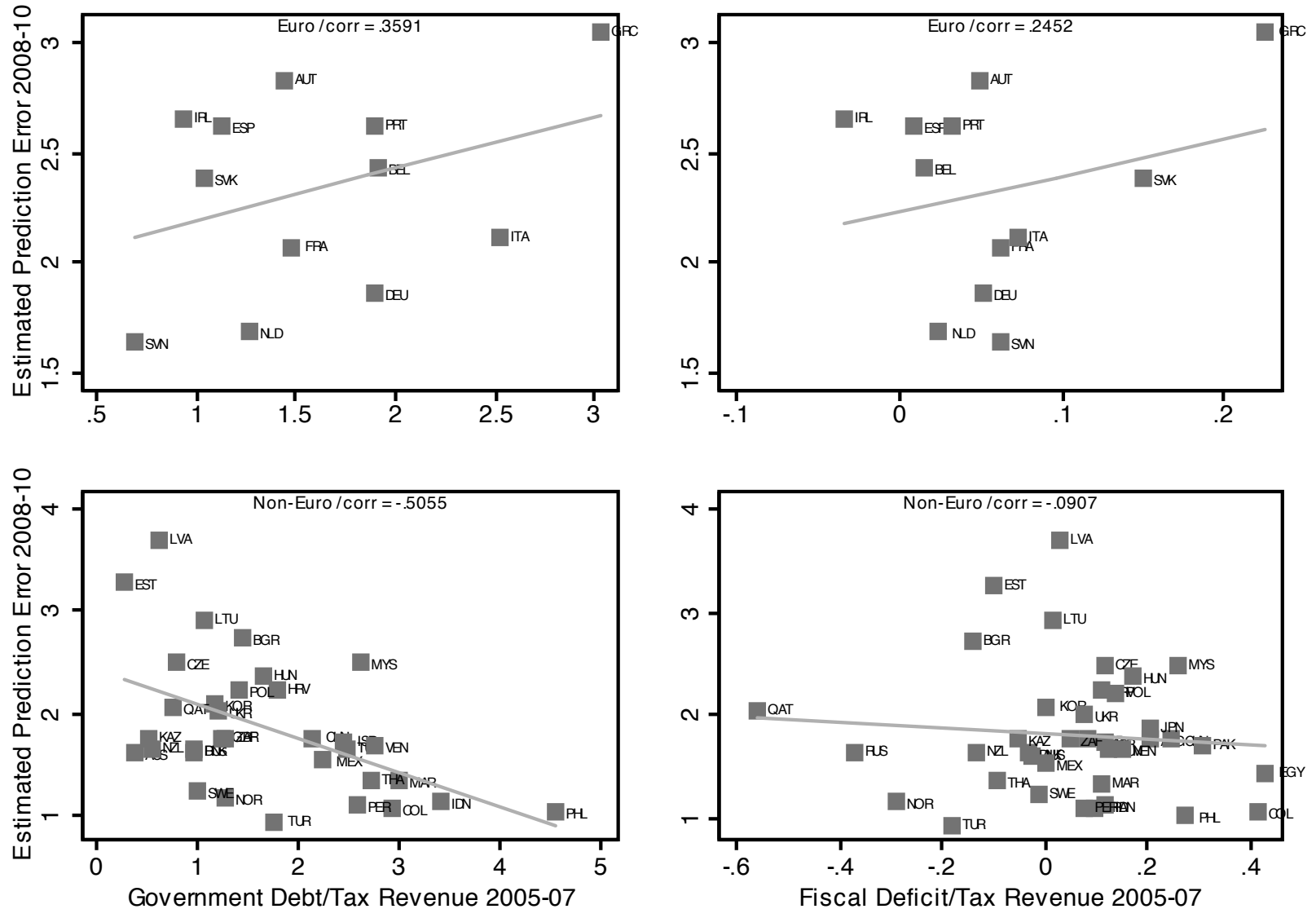
**Figure 2: Sovereign CDS Spreads.** This figure plots the 10-Year CDS spreads for Spain (ESP), Greece (GRC), Ireland (IRL), Italy (ITA), Portugal (PRT) (“PIIGS” group), together with Germany (DEU), Mexico (MEX), South Korea (KOR) and Russia (RUS). See Appendix B for all countries in the sample.



**Figure 3: De facto Fiscal Space before 2008-10.** This figure provides the size of fiscal space from 2000-07, averaged by country group. The total number of countries is 121; Low income (20), Middle income (58), OECD excluding EURO (16), Other high income (11), PIIGS (5), and EURO excluding PIIGS (11).



**Figure 4: Markets systematically overreacted to fiscal pre-conditions in price Euro-area default risk during the crisis.** This figure plots the 2008-10 prediction error estimates of the 10-year CDS spreads on the vertical axis and the 2005-07 size of the de facto fiscal space on the horizontal axis. Based on the evidence in Table 2 that CDS spreads in tranquility (before 2008) were relatively under-priced, the estimated prediction errors relative to the actual 2005-10 average CDS spreads are derived from the estimation (VII) Table 3 of the balanced sample: 2005-07 for tranquil years and 2008-10 for crisis years. Table 4 reports the prediction errors by country group.



**Figure 5: Debt/Tax Ratios and Prediction Errors on the 10-Year CDS Spreads of PIIGS and the Matched Middle-Income Countries.** For the matched countries in Table 5, this figure plots the 2008-10 prediction error estimates of the 10-year CDS spreads on the vertical axis and the 2005-07 prediction errors on the horizontal axis. Based on the evidence in Table 2 that CDS spreads in tranquility (before 2008) were relatively under-predicted, the estimated prediction errors relative to the 2005-10 actual CDS spreads are derived from the estimation (VII) Table 3 of the balanced sample: 2005-07 for tranquil years and 2008-10 for crisis years. The size of circles is proportional to 2005-07 (before crisis) government debt/tax revenue ratios. Table 4 provides prediction errors by country group.

