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What explains the recent widening in sovereign bond yield spreads?

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In this paper we present an empirical framework for studying the evolution and determinants of sovereign credit spreads in the euro area

Our results provide new evidence supporting the notion that in the period after the eruption outbreak of the subprime crisis in the US (July 2007) a certain regime change has occurred in the EMU sovereign bond markets.

Whereas in the pre-subprime crisis period yield spreads were broadly moving in a random fashion, the period following the outbreak of the crisis saw country-specific credit risk, global risk aversion and, to a lesser extent, relative market liquidity conditions becoming important drivers of sovereign spreads.

Our empirical study also proposes a simple fundamentals-based valuation framework for sovereign spreads. Greece and Portugal are presently estimated to be the cheapest credits in the EUR sovereign bond market space.

Specifically, we estimate the current ''fair'' values for the Greek and Portuguese benchmark 10-year government bond yield spreads to Germany at ca 230bps and 65bps, respectively.

These results are theoretical ''fair values'' and represent medium-term equilibrium convergence levels for spreads, once conditions in the EUR-periphery markets stabilize.

Many thanks to Professor Gikas Hardouvelis for his insightful comments.

1. Introduction and Summary of Empirical Results

In this paper we present an empirical framework for studying the evolution and determinants of sovereign credit spreads in the euro area. Generally speaking, the disaggregation of sovereign credit spreads into constituent parts is a rather challenging exercise. Yet, recent empirical studies have documented at least there distinct determinants; namely, *credit risk, liquidity risk and international risk aversion.*

Prior to the eruption of the US subprime crisis (July 2007), EMU government bond yields were moving closely in tandem with their German counterparts, while the corresponding spreads were evolving in a broadly random fashion. [1,2] However, following the outbreak of the crisis, especially in the aftermath of the Lehman Brothers collapse, the evolution of government bond yield spreads in the euro area appears to have been broadly reflecting: **i.** global factors *e.g. risk aversion and flight-to-safety flows* and **ii.** other more intrinsic influences such as deteriorated fiscal positions as a result of worsened growth dynamics and sizeable bank rescue packages provided by euro area governments. These packages were directed to banks experiencing liquidity and/or solvency problems and appear to have resulted to a transfer of credit risk from the private financial to the public sector.

In this study, we present a *Dynamic Panel Model* for explaining and forecasting sovereign bond yield spreads in the euro area. Our data set consists of monthly data *(average-month-observations)* spanning the period July 2007-January 2010.

Our results provide new evidence supporting the following two propositions:

a) In the period following the outbreak of the subprime crisis in US (July 2007), country-specific credit risk, global risk aversion and, to a lesser extent, relative market liquidity conditions become important drivers of sovereign bond spreads in the euro area.

[1] This result has been documented by a number of recent empirical studies on euro area sovereign bond spreads. See also, Eurobank EFG, Greece Macro Monitor, November 2009.
[2] We estimate that the average 14-day rolling correlation between the benchmark 10-year Bund and GGB yields in the period 1.1.2001-15.7.2007 was around 0.97.

b) Sizable bank rescue packages announced by a number of governments in the euro area in the months following the Lehman debacle resulted in a certain transfer of risk from the private to the public sector. This had a significant incremental widening impact on EUR sovereign bond yield spreads.

We conclude our empirical study by presenting a *fundamentals-based* valuation framework for spreads. Greece and Portugal are presently estimated to be the cheapest credits in the EUR sovereign bond market space. Specifically, we estimate their benchmark 10-year government bond yield spreads to Germany to have ''fair'' values of ca 230bps and 65bps, respectively. However, these results should be interpreted with caution, as they do not necessarily represent our genuine forecasts of where the sovereign spreads are heading to in the near future. They are merely theoretical ''fair values'' for the respective spreads and thus, they could be seen as medium-term equilibrium convergence levels for spreads, once conditions in the EUR-periphery markets stabilize.

2. Literature Review

The disaggregation of sovereign credit spreads into constituent parts is generally a challenging proposition. Yet, recent empirical studies on sovereign spreads have documented at least three distinct determinants; namely, *credit risk, liquidity risk and risk aversion (the latter taking the form of a common international risk factor).* [3] Specifically,

a) Credit risk

Credit risk reflects a country's creditworthiness *i.e.,* its ability *(and willingness)* to make full and timely principal and interest payments on its obligations to international creditors. Recent empirical studies find a close link between county-specific fundamentals and variations in respective credit risk premia. Baldacci, Gupta and Mati (2008) document that both fiscal and political factors affect credit risk in emerging market economies. In particular, lower levels of political risk are often associated with tighter spreads, while credible fiscal policies tend to narrow sovereign spreads, especially in countries that experienced prior defaults. Min (1998) finds that a larger set of macroeconomic variables influence the evolution of sovereign spreads. These include domestic inflation, net foreign assets, real exchange rate and the

[3] See for instance Attinasi, M., C. Checherita, C. Nickel (2009), What explains the surge in euro area sovereign spreads during the financial crisis of 2007-09? ECB Working paper, No. 1131

terms of trade index. Rowland and Torres (2004) indicate that creditworthiness is also an important determinant of sovereign debt costs, while sovereign credit ratings themselves are found to be influenced by macroeconomic fundamentals. For European, and, in particular, euro area countries, a number of recent papers have documented a significance impact of fiscal variables such as government debt and deficit on sovereign bond spreads[4]. Fiscal transparency and the quality of data reporting have also been found to be a positive influence[5]. Finally, event study analyses have shown that announcements of macroeconomic data may have a significant impact on government bond yield differentials, especially in shorter horizons. On the latter point, recent studies find that US macroeconomic announcements not only affect US markets but also exert a significant effect on European bond markets[6].

b) Liquidity risk

Liquidity risk relates to the notions of **i.** *market depth,* which indicates the existence of a sufficiently large number of buy and sell orders for a particular asset and **ii.** *market breadth, which basically reflects the degree to which market orders to buy or sell a particular asset c*an move prices. Though many factors can affect market liquidity *(which may itself may be time-varying)*, more liquidity markets generally deserve a lower risk premium *(and vice-versa).* That is because in a relatively illiquid market, big players run the risk of influencing the asset price against them when *e.g.* execute consecutive market buy or sell orders. A less liquid market may also be more ease to manipulate by *informed* traders at times of increased uncertainty and large information asymmetries[7]. Many studies on the determinants of sovereign credit spreads in major economies and emerging markets have empirically documented the influence of liquidity conditions on spreads.[8] Of course, liquidity risk and credit risk may be interconnected in the sense that fiscal deterioration in the form of *e.g.* increased budget deficits may necessitate higher issuance of government debt than otherwise. Here, the first effect would *ceteris paribus* tend to widen the sovereign spreads, while the latter would enhance liquidity, thus reducing the market's liquidity risk premium.

[4] E.g., Faini, R. (2006); Bernoth, K., von Hagen, J. and L.Schuknecht (2004)
[5] See for example Bernoth, K. and G. Wolff (2008).
[6] Andersson et al. (2006).
[7] Here the term informed traders is borrowed from the Market Microstructure literature and indicated a trader who holds some kind of privileged information over the rest of the market with respect to e.g. the underlying or fundamental value of a particular asset.
[8] See for instance, Barrios et al. (2009) and Attinasi, M., C. Checherita, C. Nickel (2009),

c) Risk aversion

More recently, there has been increased emphasis on global factors such as contagion from systemically-important events, investor risk appetite, interest rate expectations and world market volatility. In those lines, Weigel and Gemmill (2006) find that a small set of variables is able to explain up to 80% of the variance of the estimated *distance-to-default* for each one of the four Latin American emerging market economies under examination. Specifically, country-specific variables account for only about 8% of the explained variance, while the largest part of the latter (45%) is explained by regional factors, including joint stock-market returns, volatility and market sentiment. Global conditions, related mainly to US stock-market returns, explain another 25% of the variance. Of the 20% variance which remains unexplained, more than half is due to another common (but unidentified) factor.

For euro are bond markets, recent studies generally document that the international risk factor has a larger impact in countries with high debt ratios (Codogno et al. 2003) and fiscal deficits (Haugh et al. 2009). Using a dynamic panel approach to explain the determinants of widening sovereign bond yield spreads in a sample of selected euro area countries during the period July 2007-March 2009, Attinasi, Checherita and Nickel (2009) find that international risk aversion explains as much as 55.6% of the daily change in sovereign spreads over Germany. The latter study also shows that the remainder of the corresponding cumulative change in spreads over the said period can be attributed to **i.** the expected fiscal balance and government debt over Germany (7.7% and 13.6%, respectively) **ii.** bond market liquidity conditions relative to Germany (13.9%) and **iii.** the bank support packages announced by many Eurozone government in the months following the Lehman collapse (9.2%).

3. Government bond yields in the euro area in historical perspective

At the onset of the subprime crisis in the third week of July 2007, the yield differential of the 10-year benchmark GGB over its German counterpart (Bund) was around 27.5 basis points (bps), not far from the corresponding Italian (25.5bps) and Irish (9bps) spreads[9]. Table A1 below shows some basic statistics for the 10-year government bond yields spreads of selected EMU countries over the period March 2003-July 2007.

Table A1: Sample statistics - 10yr government bond yield spreads vs. Germany (in bps)
Sample: 3/14/2003-7/19/2007; end-of-week observations

	AUSTRIA	BELGIUM	FINLAND	FRANCE	GREECE	IRELAND	ITALY	NETHERLANDS	PORTUGAL	SPAIN
Mean	3.7	4.8	1.7	3.0	21.4	-2.4	19.6	2.8	10.4	2.1
Median	3.5	5.1	1.3	2.9	21.5	-1.1	19.5	2.6	12.5	1.8
Maximum	21.7	14.8	16.8	14.0	43.3	10.2	42.4	17.7	21.8	12.2
Minimum	-8.0	-2.8	-11.2	-9.1	7.0	-14.6	10.7	-6.8	-3.1	-8.5
Std. Dev.	4.3	2.9	5.3	2.7	6.4	4.6	5.8	3.6	6.8	3.2
Skewness	0.37	0.23	0.29	-0.39	0.05	-0.32	0.64	0.26	-0.78	0.38
Kurtosis	4.04	3.54	2.79	6.54	2.77	3.07	3.28	3.84	2.25	3.58
Observations	227	139	227	227	227	84	227	227	138	227

Source: Eurobank EFG Research Bloomberg, Reuters

The subsequent period leading to the rescue of Bear Sterns on March 16, 2008 saw Euro zone periphery sovereign spreads rising to levels not seen since early 2001, even though German bond yields remained at low levels with a tendency even to fall, supported by flight-to-safety flows and expectations of lower rates of future economic activity and inflation. At the close of the trading session on March 14, 2008, one day before Bear Sterns hammered out an emergency funding deal with the U.S. Federal Reserve and JPMorgan, the 10-year Bund yield stood 3.73% compared to ca 4.44% at the end of the third week of July 2007. At the market

[9] Besides the 10-year GGB-Bund yield spread we concentrate here on the evolution of the corresponding spreads of Italy and Ireland. Among other reasons, this is because: i. in the period leading to the fall of Lehman Brothers in Sept. 2008 (and following Greece's entry into the euro area), the Greek and Italian benchmark government bonds have exhibited similar yield levels and spreads co-movement, thanks to the fundamental commonalities of the two markets e.g,. comparable sovereign risk ratings and public debt ratios ii. In the period right before the subprime crisis erupted, the Irish 10-year bond yield was trading broadly at par with the German benchmark. The corresponding yield differential consequently followed the general widening trend experienced in other euro area periphery markets and hit levels comparable with the Greek yield spread following the nationalization of Anglo Irish on January 15, 2009.

close of that same day, the corresponding 10-year government bond spreads of Greece, Italy and Ireland were 68bps, 63bps and 41bps, respectively.

Evidently, public support to rescue Bear Sterns created a link between the global financial sector and public finances[10]. This along with a temporary spike in inflation expectations -- among other reasons, due to the strong rallies in world commodity prices in Q2 2008 -- prompted a subsequent bear-market sell-off in Eurozone government bonds, with the 10-year Bund yield hitting in June 2008 highs above 4.60%. The said yield mostly remained at 4.20%-plus levels for the greater part of the third quarter of that year, but declined precipitously following the Lehman Brothers collapse in mid-September 2008. The 10-year German bond yield fell to multi-decade lows near 3.00% in December 2008 and temporarily eased below 2.90% a month latter amid rising investor fears over the viability of the Economic and Monetary Union (EMU) following the nationalization of Anglo Irish on January 15, 2009.

In contrast to the sharp post-Lehman declines evidenced in short-, medium- and long-dated yields in U.S., Germany and other major government bond markets, sovereign spreads in euro area periphery markets widened sharply, recording levels not seen since the inception of EMU in January 1999 (Table A2). Indicatively, the 10-year bond yield spread of Greece hit levels near 300.5bps on March 12, 2009, while the corresponding Italian and Irish spreads recorded highs of 158.6bps and 283.5bps on January 27, 2009 and March 19, 2009, respectively. These dramatic developments interrupted a long period of remarkable convergence and stability in euro area sovereign bond markets that used to epitomize the market's confidence in the stability and longevity of EMU.

Table A2: Sample statistics - 10yr government bond yield spreads vs. Germany (in bps)
Sample: 7/19/2007- 2/28/2010; end-of-week observations

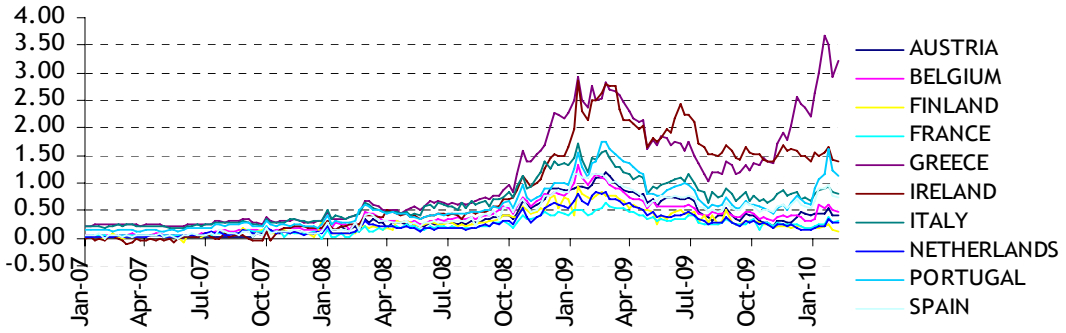
	AUSTRIA	BELGIUM	FINLAND	FRANCE	GREECE	IRELAND	NETHERLANDS	PORTUGAL	SPAIN
Mean	41.7	45.3	31.7	25.5	124.7	104.2	29.4	65.6	49.2
Median	33.5	39.9	26.0	23.6	115.1	97.6	23.5	55.4	49.6
Maximum	120.0	133.7	92.6	62.7	367.8	286.5	83.4	175.3	117.3
Minimum	3.4	9.1	1.7	-2.1	26.4	-5.4	6.5	19.9	2.5
Std. Dev.	28.9	25.9	20.6	14.0	87.6	81.5	19.3	38.0	30.6
Skewness	0.75	0.99	0.98	0.46	0.67	0.37	1.09	0.99	0.41
Kurtosis	2.67	3.71	3.17	2.64	2.36	1.91	3.39	3.30	2.30
Observations	227	139	227	227	227	84	227	138	227

[10] See Mody, Ashoka, 2009, ''From Bear Sterns to Anglo Irish: How Eurozone Sovereign Spreads Related to Financial Sector Vulnerability'', *IMF Working Papers WP/09/108.*

Source: Bloomberg, Reuters, Eurobank EFG Research

The strong recovery in investor sentiment since mid-March 2009 as a result of a coordinated effort by international organizations, monetary authorities and government around the world to support financial institutions and assist aggregate demand allowed a rapid de-escalation of euro area sovereign bond spreads. Indicatively, the 10-year Greek bond (GGB) yield spread vs. the 10-year German benchmark (Bund) hit in August 2009 multi-monthly lows around 108bps. Other euro area sovereign bond spreads also tightened significantly, with the 10-year bond yields differentials of Ireland, Spain, Portugal and Italy recording lows of ca 136bps, 45bps, 43bps and 6bps, respectively in August 2009.

Graph 1i. 10YR sovereign bond spreads vs.Germany (in ppts)



Source: Bloomberg

However, conditions in the EMU sovereign credit markets worsened anew since last November as a result of mounting market fears over the ability of Greece and other euro area countries including Portugal, Spain and Italy to put their fiscal accounts in order and meet rising external financing needs in an environment of weak economic growth and persisting dis-functionalities in world credit markets *(Graph 1i).*

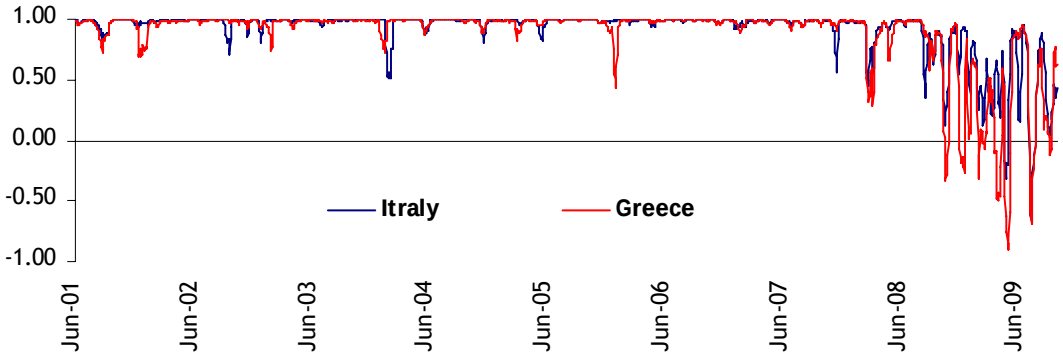
But what caused the dramatic rise in Euro zone periphery spreads after the Lehman incidence, their subsequent de-escalation and the recent re-widening to new multi-year highs?

Anecdotally, some of the main drivers of these moves are the following:

a) Flight-to-safety flows & re-evaluation of risk on the part of investors

In periods of increased political and economic uncertainty, it is customary for investors to flee riskier assets and channel their capital to traditional safe-havens such as gold, money market funds, US & German government bonds and other higher-quality assets. This phenomenon was observed in many instances in the past and, again, in the aftermath of the Lehman Brothers debacle, albeit with a much higher intensity and duration. Indicatively, the yield of the benchmark 10-year U.S. Treasury note hit 50-year lows near 2.05% on December 30, 2008 while the yield of the German counterpart recorded multi-year lows around 2.89% on January 15, 2009. In the euro area, the earlier strong positive correlation between the government bond yields of the so-called *core* (eg., Germany and France) and *periphery* markets (eg., Ireland, Greece, Italy, Spain and Portugal) broke down after September 2008, suggesting that investors now tend to view the two markets as distinct asset classes with intrinsic characteristics (graph 1.ii). Indeed, even in more recent months, and in spite of the recent significant improvement in global financial market conditions, pockets of increased macro economic uncertainty and sporadic sell-offs in riskier markets have tended to benefit core Eurozone bond markets and, concurrently, exercise downward pressure on periphery markets (and vise-versa).

Graph 1ii 10yr Greek/German & Italian/German government bond yield spreads: 21-day rolling correlations



Source: Eurobank EFG Research & Bloomberg

b) Financial crisis leads to major re-evaluation of risk on the part of investors

Risk aversion skyrocketed and money market spreads exploded to unprecedented levels after the Lehman incidence, leading to a major change on how market participants viewed lower-rated credits. In this environment, sovereign names exhibiting inconsistent domestic policy frameworks, large current account deficits and other macro imbalances suffered the most on fears over their ability to maintain high rates of growth and meet large external borrowing

needs. In view of these weaknesses, the FX, equity and rate markets in Central and Eastern Europe (CEE) came under immense selling pressure in the aftermath of the Lehman debacle, amid fears over a major financial and economic collapse in the region.

c) Downward revisions to world economic growth forecasts & perceptions of increased deflation risks

It is an empirically documented result that short-dated bond yields (maturities of up 2-3years) are mainly driven by monetary policy expectations, while intermediate and longer-maturity yields are driven by a) expectations regarding the future evolution of short-rates b) expectations about future inflation and c) term-related and various other risk premia[11]. The Lehman Brothers collapse and the consequent distortions in global financial markets prompted rapid and significant revisions to the outlook of world economic growth and raised fears of deflation. As a result, short-maturity yields in U.S. and Germany fell precipitously since Q4 2008, tracking aggressive rate cuts by the Fed and the ECB and have remained at very low levels so far this year, supported by expectations of excessively low policy rates for longer[12]. In a similar vein, longer-dated yields *(maturities of 5-year of longer)* in the U.S. and Germany fell to multi-year lows following the Lehman incidence, driven lower by declining real rates and, primarily, collapsing inflation premia. Notably, breakeven rates in the U.S. and the Eurozone temporarily touched negative levels in November 2008, implying medium-term expectations of persisting deflation. Breakeven rates have bounced strongly in recent months, returning to levels more consistent with historical averages.

d) Credit crunch takes a heavy toll on countries featuring acute macro imbalances and large borrowing requirements

The previous two points provide some fundamental rationale for the sharp yield declines in major government bond markets in the period following the collapse of Lehman Brothers. They also help to explain the incipient widening in the Eurozone periphery spreads, albeit from the side of reference (i.e., Bund) yields. But, as we have noted already, over the corresponding period a break occurred in the previous positive correlation between the euro area core and periphery spreads. Apart from any technical-, and flow-related reasons, eg.,

[11] See for instance Diebold, F.X., Li, C., 2005. Forecasting the term structure of government bond yields. Journal of Econometrics 130 (2006) 337-364.

[12] Following the Lehman collapse, the ECB delivered 325bps of cumulative rate cuts, bringing its key 2-week refi rate down to 1.00% on May 7, 2009. In a similar vein, the Fed reduced its funds target rate by a further 187.5bps, bringing it to .0.00%-0.25% on December 16, 2008.

higher cost of funding for carrying leveraged positions, fire-sales by hedge funds and other leveraged players, other, more fundamental drivers, may help explain the latter developments.

e) Worsened fiscal positions led to a differentiation of sovereign debt markets with respect to respective-country debt-to-GDP levels. While Lehman was allowed to go bankrupt, authorities in the U.S., the Euro zone, Japan and other G20 economies made it immediately clear that certain entities were *too big to fail* and proceeded with aggressive measures to shore up their financial sectors. This, in turn, shifted the focus on the potential fiscal impact of such rescue packages and led to differentiation of countries with respect to their prevailing debt-to-GDP levels. This had significant repercussions for Euro zone periphery bond spreads, especially for member States exhibiting structurally weak fiscal positions eg., Ireland and Greece.

4. A Dynamic Panel framework for explaining euro area sovereign bond spreads during the recent financial crisis

4.1 Data and model specification

In this chapter we present a dynamic panel model to explain 10-year euro area government bond yield spreads vs. Germany. The countries examined in our study include Greece, Portugal, Spain, Belgium, Netherlands, Austria, Italy, Ireland, France, Finland and Germany. We exclude from our study the rest of EU-16 countries as they do not currently have liquid 10-year government bond markets. Our data consist of *(average)* monthly observations spanning the period from July 2007 *(eruption of sub-prime crisis in the US)* to January 2010. The main results of our model remain broadly robust to alternative model specification, different data frequencies (eg., weekly) and alternative time spans (eg., September 2008-January 2010). Moreover our coefficient estimates are broadly highly significant and the fit of the model impressively high (over 0.70) under alternative model specifications.

The equation below shows the general form of our baseline specification[13]:

[13] Our model specification is broadly in line with Maria-Grazia Attinasi, Cristina Checherita and Christiane Nickel "What explains the surge in euro area sovereign spreads during the financial crisis of 2007-09?" ECB Working Paper Series NO 1131/December 2009

$$(Sovereign\ Spread)_t = c + b_1 * (Sovereign\ \ Spread)_{t-1} + b_2 * (Budget\ \ Balance)_t + b_3 * (Debt\ Ratio)_t + b_4 * (Dummy)_{Bank\ Re scue} + b_5 * (Risk\ Aversion)_t + b_6 * (Liquidity)_t + e_t$$

Where,

SovereignSpread $_t$: 10-year government bond yield spread vs. Germany (in levels)

List of independent variables

i. SovereignSpread $_{t-1}$: 1st lag of 10-year government bond yield spread vs. Germany. This is to capture any persistency in the dependent variable.

ii. Fiscal variables - proxies for credit risk

- ***BudgetBalance*** $_t$: expected general government budget balance *(%-of-GDP)* relative to Germany. Here we use the arithmetic average for a 2-year period of a country's expected budget balances as they appear in the in the European Commission Forecasts *(released bi-annually*). In our study, we use country deficit differences to Germany.

- ***DebtRatio*** $_t$: expected public debt ratio *(%-of-GDP)* relative to Germany. Again, we use here the arithmetic average for a 2-year period of a country's expected public debt ratios as they appear in the in the European Commission Forecasts. In our study we use country debt-ratio differences vs. Germany.

iii. Dummy $_{BankRescue}$: country-specific dummy aiming to capture the effect of the banking-sector support packages introduced in late 2008 in all of the countries included in the analysis (see Table A3). This dummy takes the value of 1 in the month of announcement of the country's banking-sector rescue package onwards (and the value of 0 otherwise). The idea here is to examine whether these packages had a widening effect on sovereign spreads as they signified a transfer of risk from the private sector (banks) to public sector.

Table A3: Bank rescue packages (as % of country GDP)			
Country	Date of (first) announcement	Cumulative recapitalisation	Cumulative guarantees*
AUSTRIA	13/10/08	5.0	26.0
BELGIUM	26/09/08	5.1	74.0
GERMANY	06/10/08	3.5	19.0
SPAIN	07/10/08	2.8	9.1
FINLAND	20/10/08	2.1	26.4
FRANCE	30/09/08	2.0	16.4
GREECE	15/10/08	5.2	6.0
IRELAND	29/09/08	5.0	259.0
ITALY	08/10/08	3.0	-
NETHERLANDS	26/09/08	18.0	33.7
PORTUGAL	13/10/08	2.3	11.9

Note: The table reflects the cumulative amounts of bank rescue packages as released in some countries in subsequent announcements

* Includes retail deposit guarantees.

Source: Attinasi, M., C, Checherita, C, Nickel (2009)

iv. RiskAversion$_t$: our *Risk Aversion Indicator* is proxied in our baseline specification by the Itraxx Main index. As a robustness check, we also use a custom-made risk aversion indicator which is deduced as the *first principal component* of a set of observed variables including:

a) the 1month LIBOR-OIS spread, which constitutes a widely-monitored indicator of implied counterparty risk in money markets

b) the 1 month implied volatility in the EUR-JPY exchange rate

c) an equity-market volatility index (here the Vstoxx index) and

d) a proxy for private-sector credit risk, represented here by the yield spread between US BBB-rated corporate paper and similar-time-to-maturity US Treasury securities[14].

In general, the principal components of set of variables are obtained by computing the eigenvalue decomposition of the observed variance matrix. The first principal component is the unit-length linear combination of the original variables with maximum variance. Subsequent principal components maximize variance among unit-length linear combinations that are orthogonal to the previous components. [15]

[14] For a more detailed description of the relevance and historic evolution of some of these risk indicators see Eurobank EFG *Economy and Markets* (April 2009).

[15] For additional details see Johnson and Wichtern (1992).

Table B1 below shows the results of our principal components analysis. As the table illustrates that the 1st principal component explains a significant portion (ca 84%) of the variance in the full data set. Moreover, the factor loadings indicate that all four risk indicators under examination contribute to the common factor to a very similar extent.

Table B1 Principal Components Analysis

Sample: 3/14/2003 2/19/2010; Computed using ordinary correlations

Eigenvalues: (Sum = 4, Average = 1)

	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	3.331099	3.002319	0.8328	3.331099	0.8328
2	0.32878	0.122216	0.0822	3.659879	0.915
3	0.206564	0.073007	0.0516	3.866443	0.9666
4	0.133557	---	0.0334	4	1

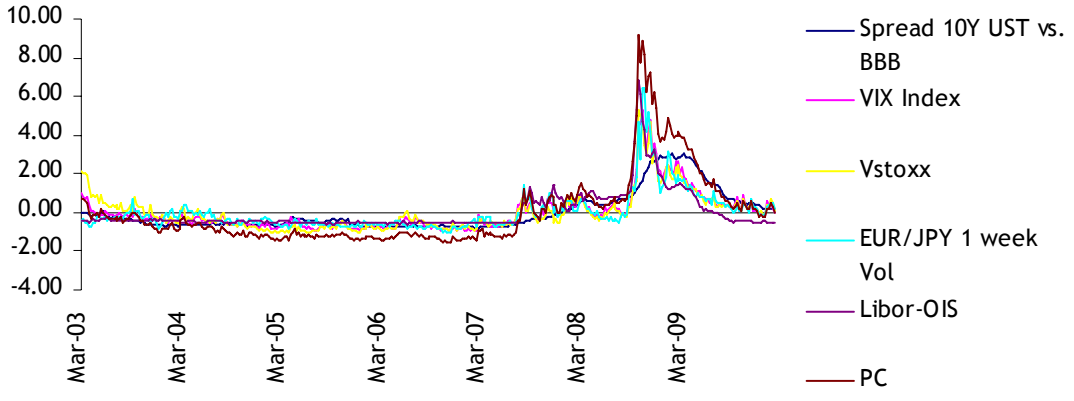
Eigenvectors (loadings):

Variable	PC 1	PC 2	PC 3	PC 4
RISKBBBSPREAD	0.479954	0.776479	0.408245	-0.007825
RISKEURJPYVOL	0.516883	-0.171373	-0.29676	-0.784472
RISKLIBOROIS	0.490802	-0.605839	0.57982	0.236394
RISKVSTOXX	0.511459	0.025912	-0.639592	0.573289

Source: Eurobank EFG Research

Graph 2i below shows a graphical depiction of the four risk indicators utilized in our study and their 1st principal component.

Graph 2i: Risk indicators & 1st Principal Component (PC)



Source: Eurobank EFG Research, Bloomberg

To further defend the efficacy of including a general risk aversion indicator as an explanatory variable in our baseline model specification we perform a principalcomponents analysis to the full-sample of 10-year EMU sovereign bond yield differentials (levels) utilized in our study. The results of this exercise are shown on Table Bii (page 12).

The latter indicates that a common factor *(i.e., the 1st principal component)* explains an overwhelming portion of the total variation in covariance matrix of sovereign bond yield spreads over the full sample under examination. Note also that the factor loadings of sovereign spreads are of broadly of an equal magnitude. Yet, the second principal component places significant positive weighs on Greece, Ireland and to a somewhat lesser extent, Portugal and Spain. This could be interpreted as an additional spread on those countries as a result of their intrinsic vulnerabilities (week fiscal positions, high debt levels etc) during the recent crisis.

v. Liquidity$_t$: depicts our liquidity indicator, which is expressed here as a country's total amount of gross government debt issuance *(taken as the ratio of domestic issuance to the total euro area bond market)* minus the corresponding German ratio. The corresponding data are available on a monthly basis from the ECB Securities Issues Statistics. Alternatively, time series of bid-ask spreads relative to Germany could be used as a proxy for market liquidity (Barrios et al. (2009)).

vi. c and e_t : our constant and error terms, respectively.

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2	0.32878	0.122216	0.0822	3.659879	0.915
3	0.206564	0.073007	0.0516	3.866443	0.9666
4	0.133557	---	0.0334	4	1

Eigenvectors (loadings):

Variable	PC 1	PC 2	PC 3	PC 4
RISKBBBSPREAD	0.479954	0.776479	0.408245	-0.007825
RISKEURJPYVOL	0.516883	-0.171373	-0.29676	-0.784472
RISKLIBOROIS	0.490802	-0.605839	0.57982	0.236394
RISKVSTOXX	0.511459	0.025912	-0.639592	0.573289

Table Bii: Principal Components Analysis

Sample (adjusted): 12/09/2005 2/19/2010

Computed using: Ordinary correlations

Eigenvalues: (Sum = 10, Average = 1)

Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	9.373045	9.04279	0.9373	9.373045	0.9373
2	0.330255	0.244148	0.033	9.7033	0.9703
3	0.086107	0.03006	0.0086	9.789406	0.9789
4	0.056047	0.011901	0.0056	9.845453	0.9845
5	0.044146	0.004491	0.0044	9.889599	0.989
6	0.039655	0.009483	0.004	9.929253	0.9929
7	0.030172	0.012773	0.003	9.959425	0.9959
8	0.017399	0.003603	0.0017	9.976824	0.9977
9	0.013796	0.004415	0.0014	9.990619	0.9991
10	0.009381	---	0.0009	10	1

Eigenvectors (loadings):

Variable	PC 1	PC 2	PC 3	PC 4	PC 5
AUSTRIA10YR	0.321704	-0.136924	0.037168	0.168068	0.17934
BELGIUM10YR	0.320877	-0.193392	-0.259061	0.015036	-0.246967
FINLAND10YR	0.308991	-0.480948	0.04274	0.417933	0.16668
FRANCE10YR	0.318144	-0.140149	0.110574	-0.751589	-0.340371
GREECE10YR	0.298662	0.662401	-0.307463	0.219811	-0.108319
IRELAND10YR	0.311101	0.305322	0.826579	0.040614	0.185321
ITALY10YR	0.322054	-0.056425	-0.015109	0.316691	-0.484149
NETHERLANDS10Y	0.319251	-0.296749	-0.037354	-0.112479	0.240602
PORTUGAL10YR	0.318859	0.175293	-0.370835	-0.260918	0.619363
SPAIN10YR	0.321807	0.19731	-0.023312	-0.031346	-0.20306

4.2 Empirical results & interpretation

Tables D1 & D2 below summarize the results of our study. The empirical methodology used in estimating our baseline specification is Panel Least Squares, corrected for heteroskedasticity across panels and panel-specific 1st order autocorrelations. Our baseline specification corresponds to the second column of Table D1 (*''Model 1''*). As a specification and robustness check we also use several alternative specifications to our baseline model, with empirical results provided under columns *Model 2* through *Model 11* in tables D1 and D2. Estimated coefficient significance levels are indicated by star signs *(***, **, * indicate significance at 1%, 5% and 10%, respectively)*

Table D1: Dynamic Panel - Empirical Results

Dependent Variable: 10yr Sovereign Spread vs. Germany
Method: Panel Least Squares
Sample (adjusted): 2007M08 2010M01; Period included: 30; Cross-sections included: 10; Data frequency; monhtly
White cross-section standard errors & covariance (d.f. corrected)

Coefficients and significance levels[1]

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	-0.164*	-0.026	-0.017	-0.003	0.046*	0.050**
10yr Sovereign Spread (t-1)	0.870***	0.895***	0.891***	0.905***	0.926***	0.93***
Dummy-BankRescue	-0.024			-0.032	-0.029	-0.045
Budget Balance (t)	-0.018***	-0.014***	-0.016***	-0.016***	-0.015***	-0.015***
Debt Ratio (t)	0.001**	0.001*				
iTraxx Main (t)	0.169***					
Market Liquidity (t)	-0.001***	-0.004***	-0.004***	-0.003***		
Dummy-GreekCrisis		0.061				
Risk Aversion (t)		0.036***	0.037***	0.038***	0.034***	0.036***
(Dummy-GreekCrisis)*(Debt Ratio(t))			0.005***	0.005***		
(Dummy-BankRescue)*(Debt Ratio(t))						
(Debt Ratio (t))^2						

Table D2: Dynamic Panel - Empirical Results

Dependent Variable: 10yr Sovereign Spread vs. Germany
Method: Panel Least Squares
Sample (adjusted): 2007M08 2010M01; Period included: 30; Cross-sections included: 10; Data frequency; monhtly
White cross-section standard errors & covariance (d.f. corrected)

Coefficients and significance levels[1]

Variable	Model 7	Model 8	Model 9	Model 10	Model 11
Constant	0.043**	-0.028	0.003	0.034**	-0.019
10yr Sovereign Spread (t-1)	0.906***	0.885***	0.891***	0.914***	0.897***
Dummy-BankRescue					
Budget Balance (t)	-0.014***	-0.016***	-0.019***	-0.014***	-0.016***
Debt Ratio (t)				0.0002	0.001***
iTraxx Main (t)					
Market Liquidity (t)		-0.004***			-0.004***
Dummy-GreekCrisis		0.056			
Risk Aversion (t)	0.032***	0.037***	0.034***	0.031***	0.033***
(Dummy-GreekCrisis)*(Debt Ratio(t))					
(Dummy-BankRescue)*(Debt Ratio(t))	0.001**	0.001**			
(Debt Ratio (t))^2			0.0001***		

(*), (**), (***) Indicate significance at 10%, 5% and 1%, respectively
Source: Eurobank EFG Research

The explanatory variables included in the alternative specifications shown on Tables D1 & D2 are defined as follows:

Dummy_GreekRisk takes the value of 1 November 2009 onwards and 0 otherwise. This dummy intends to capture contagion from the recent explosion in Greek government bond yield spreads on other EMU sovereign spreads and the incipient market worries over the sustainability and viability of EMU.

(Dummy_GreekRisk)*(DebtRatio$_t$) is our Greek risk dummy entering our model in multiplicative form (i.e., multiplied by a country's debt-to-GDP ration at time t). This is to capture any asymmetric effects (as a result of the Greek sovereign debt crisis) on EMU countries carrying unsustainably big debt burdens.

(Dummy_BankRescue)*(DebtRatio$_t$) is our bank rescue dummy (see description on page 9) entering our model in multiplicative form (i.e., multiplied by a country's debt-to-GDP ration at time t).

(Debt$_t$)^2 is our expected *(relative)* debt ratio variable squared**.** This is to capture potential non-linearities in the effect of a country's public burden on the its sovereign bond spreads.

Our empirical results summarized in Tables D1 and D2 can be summarized as follows:

The coefficient of the lagged sovereign spread variable is positive and highly significant under all alternative specifications, indicating strong persistency of our dependent variable in monthly frequencies.

Our fiscal variables -- *Budget Balance* and *Public Debt ratio* -- are generally highly significant under alternative specifications and their coefficients exhibit the correct signs *(negative and positive, respectively).* This helps to empirically document the existence of a credit risk component in the euro area sovereign bond yield spreads. Note that the negative sign of the coefficient of our Budget Balance variable is because budget deficits enter our estimations with a negative sign.

The coefficients of our *Itraxx Main*, *Risk Aversion* and *Liquidity* explanatory variables are also highly significant and correctly signed. Specifically, the first two are positive, indicating that a rise in global risk aversion tends to *ceteris paribus* widen EMU sovereign bond spreads. On the other hand, the coefficient of our *Liquidity* variable is negative, meaning that an increase in a country's relative bond market liquidity causes -- on a ceteris paribus basis -- a tightening in that country's spread levels and vice versa *(for additional inside on the latter result see also page 3).*

The coefficient Our *BankRescue* dummy variable -- which intends to capture the effects of banking-sector support packages introduced in the months following the Lehman collapse -- is wrongly signed (and insignificant) in our baseline specification and in Models 4 through 6. Yet, when entering in multiplicative form, these coefficients become positive and highly significant. Overall, we interpret our results as providing some support to the argument that banking-sector support packages introduced by euro area governments in late 2008 transferred a certain part of private-sector risk to the public sector.

The coefficient of our GreekCrisis dummy is correctly signed *i.e., positive* but insignificant (Models 2 & 8). This may be explained by the span of our data, which excludes the period February-March 2010. In the latter period (especially during February 2010) the sharp widening in Greek sovereign bond spreads drove significant increases (though to a lesser extent) in other bond spreads in EUR-periphery markets, primarily Portugal and Spain.

The coefficient of our debt-ratio squared variable is highly significant and positive, indicating potential non-linearities in the effect of a country's debt burden on respective sovereign bond spreads. Finally, our Durbin-Watson (DW) statistic values indicate existence of serial correction in some of the estimated regressions. Other residual diagnostic tests (not reported in the tables above) also indicate existence of heteroskedasticity in the error terms, especially in period of high volatility in the post-Bear Sterns period.

4.3 Explanatory variable contributions to the widening in sovereign bond spreads

In the spirit of Attinasi, M., et al. (2009), we next proceed to estimate the relative contribution of each explanatory variable in our model (baseline specification) to the cumulative widening in the sovereign bond spreads. For each country, the contribution to the change in spread of each variable is calculated as the product between the average value of that variable across time and its coefficient estimates *(both in absolute terms).* The *relative* contribution of each variable is consequently calculated as the ratio between absolute contribution calculated in the previous step and the sum of the absolute value of the contributions of the entire set of explanatory variables[16]. Results of that exercise are summarized in Table D3. The latter depicts the actual and model-predicted spreads (first 2 columns) as well as the contributors

[16] For simplicity, we assume here that $y_{it} - \rho * y_{it-1}$ is roughly equal to Δy_{it}, where y_{it} our explanatory variable i.e., the 10-year spread of country i at time t.

to the monthly changes in the spreads. For instance, line 1/column 3 of Table D3 indicates that ca 6.5% of the cumulative change in the 10yr Austria/Germany yield spread between July 2007 and January 2010 can be attributed to the evolution of Austria´s fiscal position relative to Germany *(i.e., relative expected fiscal deficit and debt ratios).* For the whole group of sovereigns under study, the last line of Table D3 suggest that the average monthly change in the (country-average) sovereign spread over the period July 2007-January 2010, can be decomposed as follows: a) 21.48% of that can be attributed to the concomitant rise in credit risk and b) 78.53% of that can be attributed to international risk aversion and liquidity risk. These proportions should be interpreted as maximum contributions since other factors may also play some incremental role[17].

Table D3: Eurobank EFG Research Dynamic Panel Model for EUR Sovereign Spreads

	10YR spreads vs. Germany (in bps)		Contributors to the monthly change in sovereign spreads (%)	
	Actual	Fitted	Credit risk	Risk aversion & Liquidity risk
Austria	44	46	6.50	93.50
Belgium	47	51	13.16	86.84
Finland	31	27	34.66	65.34
France	27	30	18.20	81.80
Greece	123	116	28.93	71.07
Iteland	103	101	34.98	65.02
Italy	75	72	25.33	74.67
Portugal	65	69	21.37	78.63
Spain	50	50	20.71	79.29
Netherlands	30	32	10.91	89.09
Average	**59.5**	**59.4**	**21.48**	**78.53**

Source: Eurobank EFG Research

Specifically for Greece, our results indicate that some 57% of the average monthly change in the Greek/Bund 10-year bond yield spread over the period November 2009-Janury 2010 can be attributed to the perceived rise in the country's credit risk with the rest of it being due to global risk aversion and liquidity risk. Again the percentages should be viewed as maximum contributions.

4.4. A valuation framework for EUR sovereign bond yield spreads

In this section we propose a simple valuation framework for sovereign bond yield spreads in the euro area. Specifically, we begin by estimating the dynamic panel model presented in this

[17] For instance, the constant in our baseline specification is found to be significance

chapter with fixed cross-section and period random effects. Then, we implement out-of-sample (1-period-ahead) forecasting to get a ''fair value'' for the corresponding 10-year bond yield differentials. Results of this exercise are summarized below (Table D4):

Table D4: EUR Sovereign Spreads Valuation Framework

	10yr Spreads to Germany (as of 8.3.2010)	Model-based (out-of-sample) forecasts	Cheap (+)/Rich (-)
Greece	306	232	74
Portugal	89	64	25
Spain	70	63	7
Belgium	51	36	15
Austria	42	32	10
Netherlands	27	18	9
Italy	79	75	4
Ireland	134	153	-19
France	29	21	8
Finland	13	27	-14

Source: ECB, EC, Bloomberg, Eurobank Research

Table d4 above demonstrates that, according to our valuation framework, Greece and Portugal are currently among the cheapest sovereign credits in the EUR sovereign bond market space. However, these results should be interpreted with a considerable amount of caution as they do not necessarily represent our genuine forecasts of where the sovereign spreads are heading. They are merely theoretical fair values for the spreads and thus, they could be seen as equilibrium convergence levels for spreads to converge to, once conditions in the EUR-periphery markets stabilize.

7. Concluding Remarks

In this empirical study, we present a simple Dynamic Panel Model for explaining and forecasting Eurozone sovereign bond yield spreads in the period following the eruption of the subprime crisis in the US (July 2007). Our results provide new evidence supporting the following two propositions:

c) The period following the outbreak of the sub-prime crisis saw country-specific credit-risk, global risk aversion and, to a lesser extent, relative market liquidity conditions becoming important drivers of sovereign spreads.

d) Sizable bank rescue packages announced by a number of governments in the euro area in the months following the Lehman debacle resulted to a certain transfer of risk from the primate to the public sector. This had an incremental widening impact on EUR sovereign bond yield spreads.

We conclude our empirical study by presenting a *fundamentals-based* valuation framework for spreads. Greece and Portugal are presently estimated to be the cheapest credits in the EUR sovereign bond market space. Specifically, we estimate their benchmark 10-year government bond yield spreads to Germany to have ''fair'' values of ca 230bps and 65bps, respectively. However, these results should be interpreted with caution, as they do not necessarily represent our genuine forecasts of where the sovereign spreads are heading to in the near future. They are merely theoretical ''fair values'' for the respective spreads and thus, they could be seen as medium-term equilibrium convergence levels for spreads, once conditions in the EUR-periphery markets stabilize

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