

Empirical tests of self-fulfilling debt crises

Has there been a self-fulfilling debt crisis in the EZ? What are the signals of such a crisis?

- In a monetary union movements of distrust vis-à-vis one country lead to an increase in the government bond rate of that country → increase in the spread.
- Spreads are then likely to increase significantly without much movement of the underlying fundamentals that influence the solvency of the country.
- When market sentiments turn against a country the spreads are likely to exhibit:
 - Large movements over short periods
 - Clusters in time
 - Changes in the fundamental variables cannot account for the total change in the spreads.



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Self-fulfilling crises in the Eurozone: An empirical test



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Abstract

We test the hypothesis that the government bond markets in the Eurozone are more fragile and more susceptible to self-fulfilling liquidity crises than in stand-alone countries.

We find evidence that a significant part of the surge in the spreads of the peripheral Eurozone countries during 2010–11 was disconnected from underlying increases in the debt to GDP ratios and fiscal space variables, and was associated with negative self-fulfilling market sentiments that became very strong since the end of 2010.

We argue that this can drive member countries of the Eurozone into bad equilibria.

We also find evidence that after years of neglecting high government debt, investors became increasingly worried about this in the Eurozone, and reacted by raising the spreads.

No such worries developed in standalone countries despite the fact that debt to GDP ratios and fiscal space variables were equally high and increasing in these countries.

The estimation strategy

1. Estimate a model that explains the spreads by a number of fundamental variables.
2. Estimate the model with time dummies. This allows us to identify periods of “**regime switching**” during which market sentiments drive the spreads away from their underlying fundamentals.
3. Analyze how much of the total variation of the spreads can be accounted for by these time dummies.
4. To be convincing, use a **control group** of countries that do not belong to a monetary union.

- There are 14 “stand-alone” developed countries (Australia, Canada, Czech Republic, Denmark, Hungary, Japan, South Korea, Norway, Poland, Singapore, Sweden, Switzerland, the UK and the US) in the control group

Facts

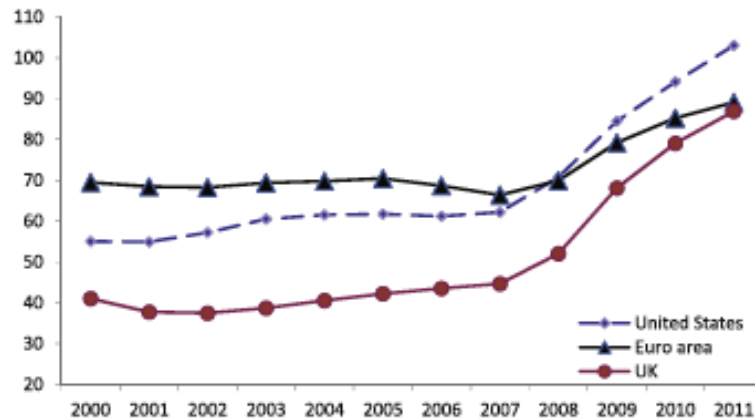


Fig. 1. Gross government debt in Eurozone, US and UK (% of GDP). Source: European Commission, Ameco

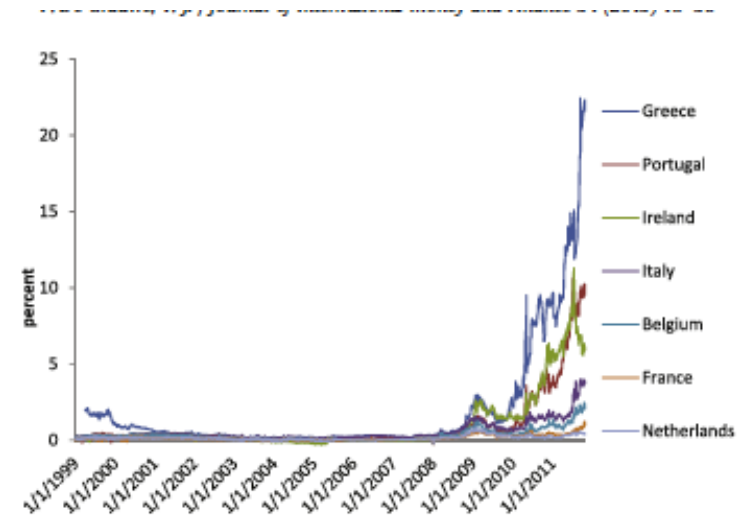


Fig. 2. Spreads 10-year government bond rates. Source: Datastream

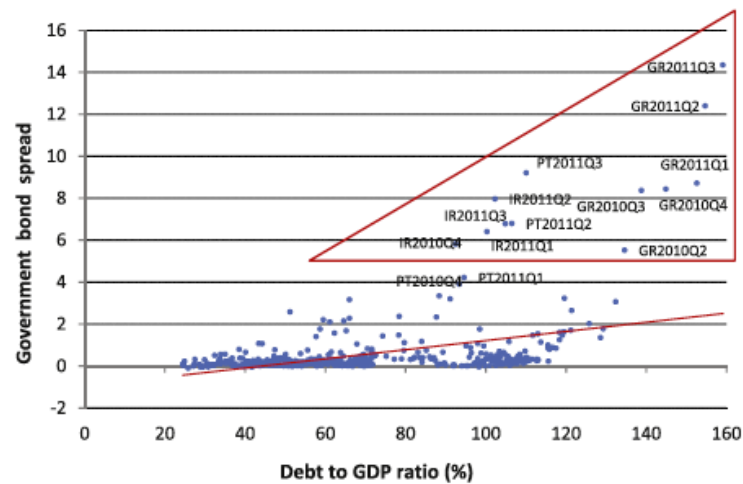


Fig. 4. Spreads and debt to GDP ratio in Eurozone (2000Q1–2011Q3). Source: Eurostat and datastream.

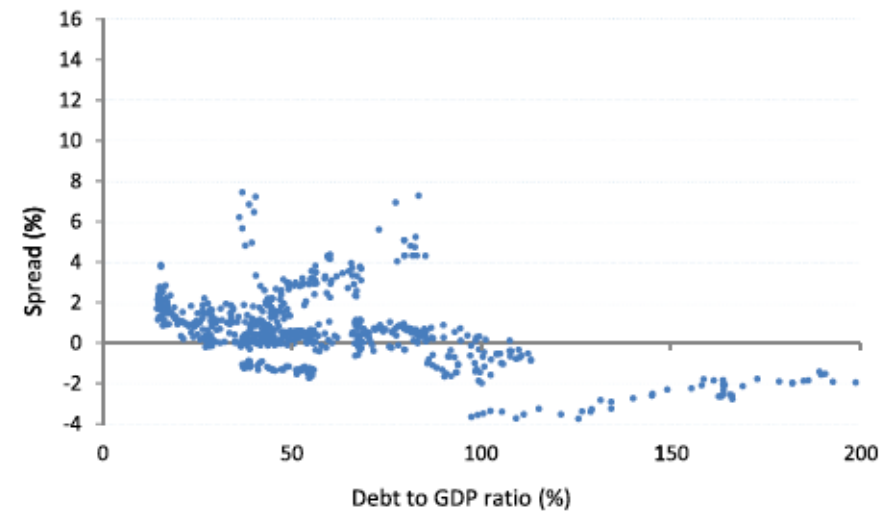


Fig. 5. Spreads of "stand-alone" countries (2000Q1–2011Q3). Source: OECD and datastream.

- Empirical evidence: strong increases in the government bond spreads in the Eurozone since 2010.
 - Role of deteriorating **fundamentals** (the most common fundamental variables found in this literature are variables measuring the sustainability of government debt.
 - Two alternative concepts are used in the paper: the debt to GDP ratio and the “fiscal space”

VERSUS

- Role of **market sentiments** (driven by panic and fear).
- The ensuing spreads forced countries into severe austerity measures that in turn led to increasing government debt to GDP ratios.

Linear model

$$I_{it} = \alpha + \lambda \times CA_{it} + \gamma \times Debt_{it} + \mu \times REE_{it} + \delta \times Growth_{it} + \alpha_i + u_{it}$$

$$I_{it} = \alpha + \lambda \times CA_{it} + \gamma_1 \times Debt_{it} + \mu \times REE_{it} + \delta \times Growth_{it} + \gamma_2 \times (Debt_{it})^2 + \alpha_i + u_{it}$$

I is the 10-year government bond spread

CA is the accumulated current account deficit to GDP ratio

$Debt$ is either the government debt to GDP ratio or the fiscal space

REE is the real effective exchange rate

$Growth$ is GDP growth rate

α_i is country i 's fixed effect (idiosyncrasies of a country that affect its spread and that are not time dependent. For example, the efficiency of the tax system, the quality of the governance, and many other variables that are country-specific are captured by the fixed effect)

Fiscal space

- “Fiscal space” is defined as the **ratio of the government debt to total tax revenues**. Aizenman and Hutchinson (2012) argue that this is a better measure of debt sustainability than the debt to GDP ratio.
- A country may have a low debt to GDP ratio, yet find it difficult to service its debt because of a low capacity of raising taxes. In this case the ratio of government debt to tax revenues will be high, i.e. it takes a lot of years to generate the tax revenues necessary to service the debt.

Table 1

Spread in Eurozone (2000Q1–2011Q3).

	(1)	(2)	(3)	(4)
Accumulated current account/GDP ratio	−0.0115 [0.0070]	−0.0001 [0.0058]	−0.0116 [0.0067]	0.0011 [0.0056]
Real effective exchange rate	0.0119 [0.0211]	0.0121 [0.0226]	0.0060 [0.0191]	0.0005 [0.0135]
Growth rate	−0.0668 [0.0476]	−0.0501*** [0.0102]	−0.0571 [0.0397]	−0.0405*** [0.0058]
Debt/GDP ratio	0.0744*** [0.0133]	−0.0523 [0.0292]		
Debt/GDP ratio squared		0.0009*** [0.0002]		
Fiscal space			2.5008*** [0.4327]	−1.7636*** [0.3053]
Fiscal space squared				0.9265*** [0.0841]
Country fixed effect	Controlled	Controlled	Controlled	Controlled
Observations	470	470	470	470
R ²	0.6696	0.7952	0.7067	0.8522

Cluster at country level and robust standard error is shown in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 2

Spread in “stand-alone” countries (2000Q1–2011Q3).

	(1)	(2)
Accumulated current account GDP ratio	–0.0012 [0.0028]	–0.0023 [0.0028]
Real effective exchange rate	0.0019 [0.0081]	0.0014 [0.0080]
Change in exchange rate	–0.0274** [0.0095]	–0.0278*** [0.0092]
Growth rate	–0.0216 [0.0295]	–0.0231 [0.0296]
Debt/GDP ratio	0.0105 [0.0080]	
Fiscal space		0.2653 [0.2127]
Country fixed effect	Controlled	Controlled
Observations	658	658
R^2	0.8418	0.8413

Cluster at country level and robust standard error is shown in brackets.

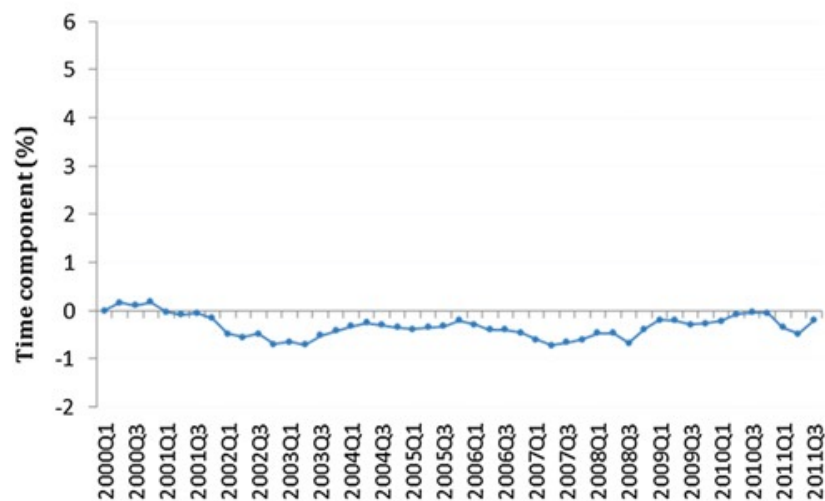
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

- An important aspect of the fragility hypothesis and of its capacity to generate self-fulfilling crisis is that it can lead to movements in the spreads that appear to be unrelated to the fundamental variables of the model.
- Add time component captured by time dummies, to the regression; by definition exogenous and unrelated to fundamentals

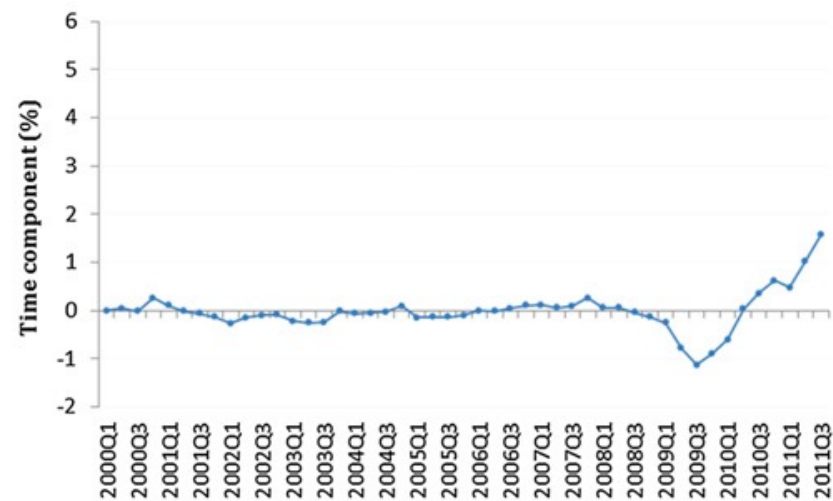
$$I_{it} = \alpha + \gamma \times CA_{it} + \gamma_1 \times Debt_{it} + \mu \times REE_{it} + \delta \times Growth_{it} + \gamma_2 \times (Debt_{it})^2 + \alpha_i + \beta_t + \varepsilon_{it}$$

Time component: estimated parameters of the time dummies

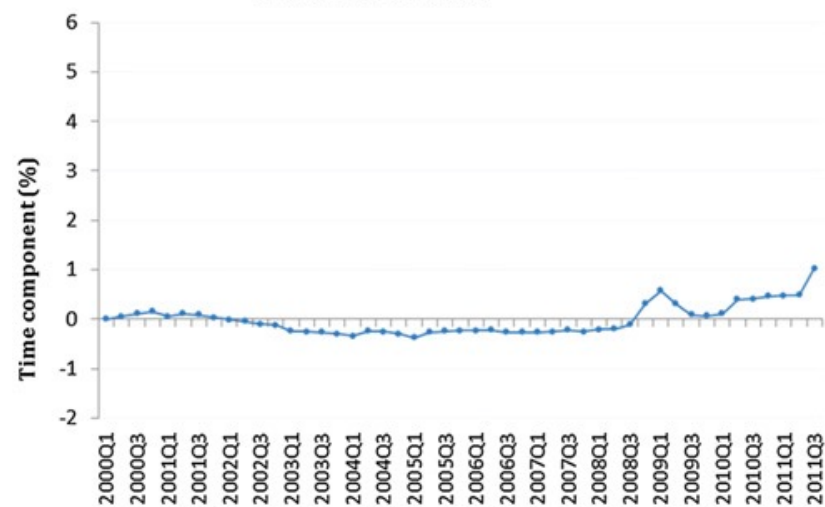
Stand-alone



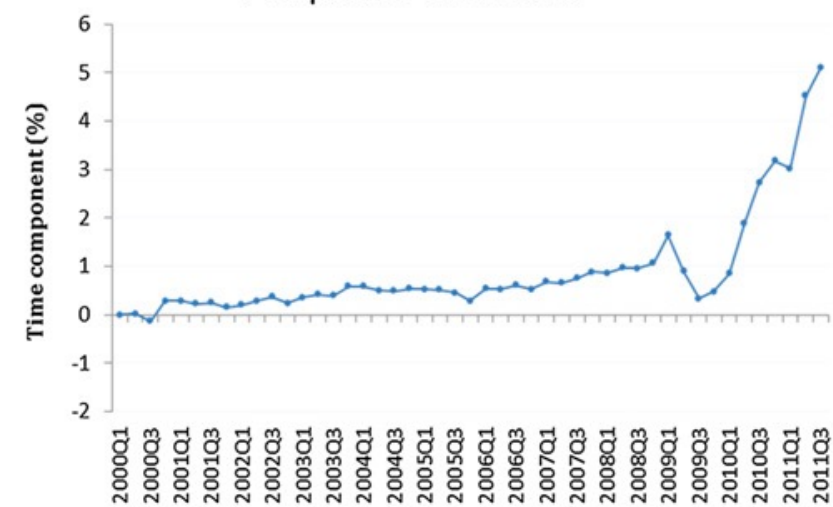
Eurozone



Core Eurozone



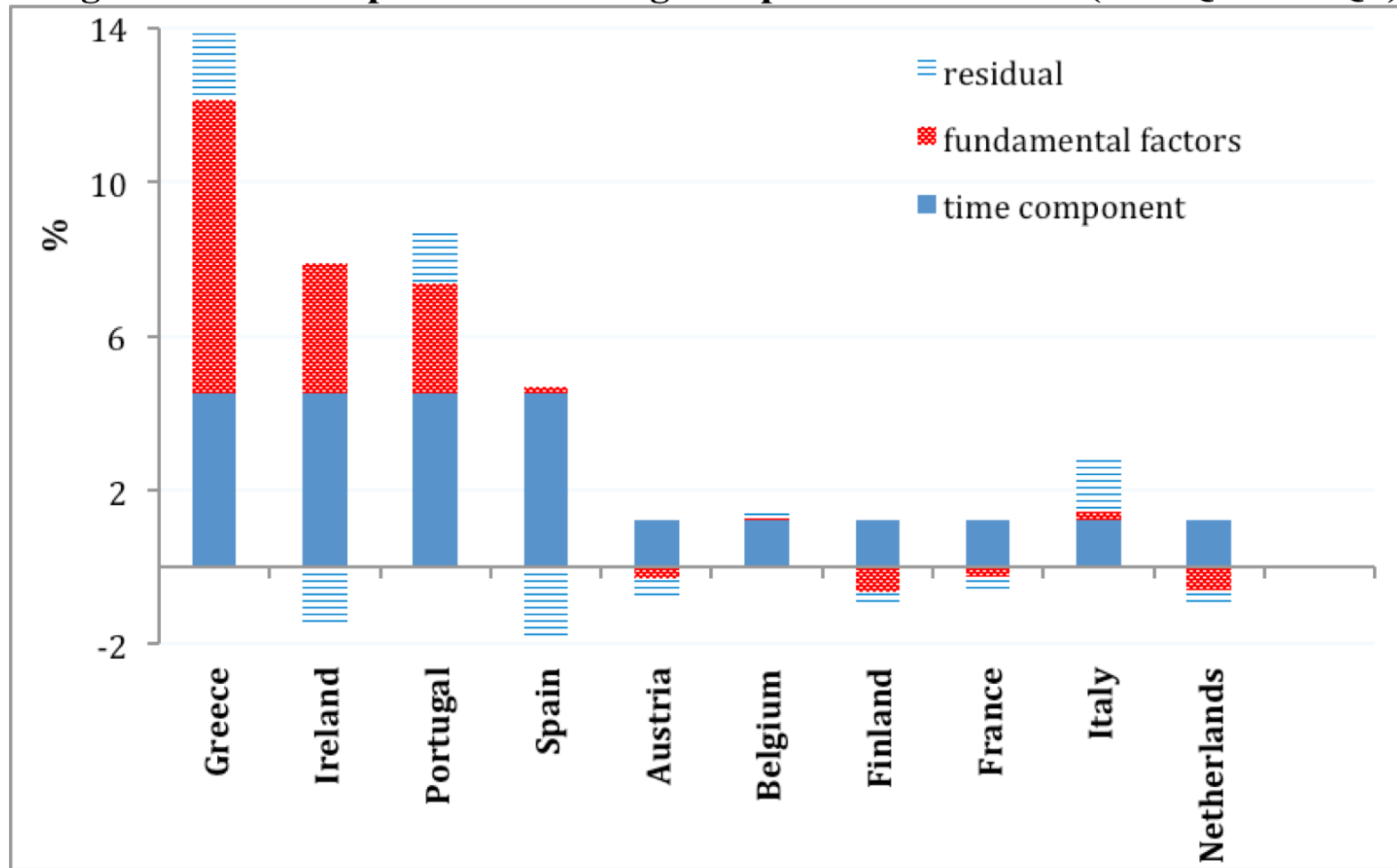
Peripheral Eurozone



- Especially in the periphery “departures” occurred in the spreads, i.e. an increase in the spreads that cannot be accounted for by fundamental developments, in particular by the changes in the debt to GDP ratios and fiscal space during the crisis.
- This result can also be interpreted as follows.
- Before the crisis the markets did not see any risk in the peripheral countries’ sovereign debt. As a result, they priced the risks in the same way as the risk of core countries’ sovereign debt.
- After the crisis, spreads of the peripheral countries increased dramatically and **independent from observed fundamentals**.
- This suggests that the markets were gripped by negative sentiments and tended to exaggerate the default risks.
- Thus, **mispricing of risks (in both directions)** seems to have been an **endemic feature** in the Eurozone

Decomposing the change in the spread: EZ

Figure 5.7. Decomposition of change in spreads: Eurozone (2008Q1-2011Q3)



Source: De Grauwe and Ji(2013a)

Decomposing the change in the spread: Stand-alone countries

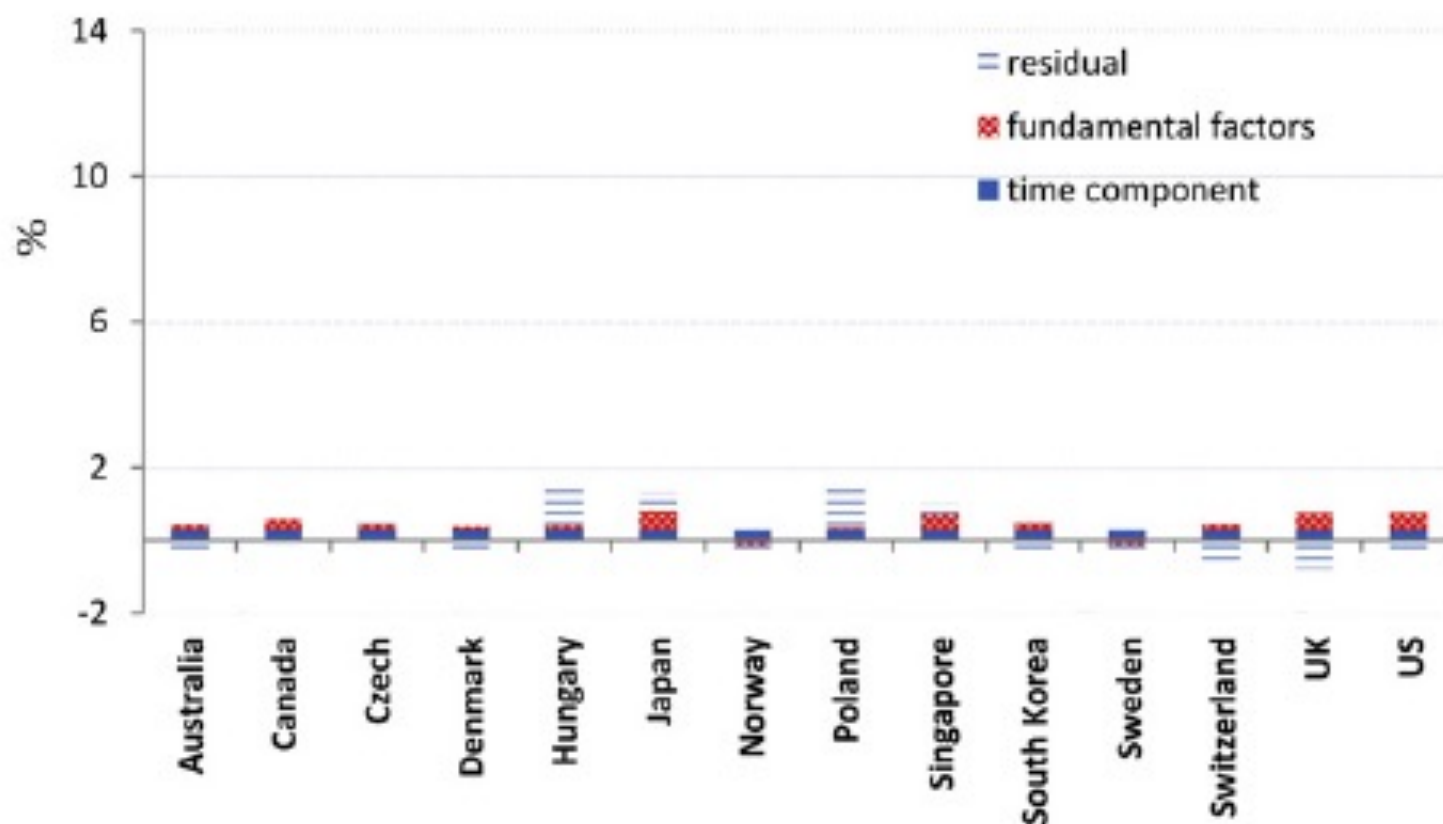


Fig. 11. Decomposition of change in spreads: Stand-alone countries (2008Q1–2011Q3).

On the whole (1)

- In **Portugal and Ireland** about half of the total variation of the spreads is due to the time dummies and the other half to the fundamentals.
- In the case of **Spain** most of the surge in the spreads is due to the time dummies.
 - Thus, in the case of Spain the fundamentals had little to do with the increasing spread and most of the explanation comes from the changes in market sentiments vis-a-vis Spain.
- In **Greece** most of the surge in the spreads is explained by deteriorating fundamentals (about 60%) while the time dummies explain less than 40%.

On the whole (2)

- In the case of Spain, it is mostly distrust that moved the spread, while in the case of Greece, it is bad fundamentals together with distrust.
→ financial markets were pricing the risk of Greek bonds with some ground but may have mispriced the risk of Spanish government bonds.
- A similar phenomenon in the cases of six core Eurozone members where the largest part in the surge of the spreads is explained by the time dummies.
- This creates the **risk that markets may be pushing countries into a bad equilibrium**, which could be avoided by policies aimed at taking out the fear factor in the market.

From liquidity crises to forced austerity in the Eurozone

- Empirical evidence: strong increases in the government bond spreads in the Eurozone since 2010
 - not only due to deteriorating **fundamentals**;
 - but driven mainly by **market sentiments**
- The ensuing spreads forced countries into severe austerity measures that in turn led to increasing government debt to GDP ratios.

Do other studies obtain similar conclusions?

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What is the risk of European sovereign debt defaults? Fiscal space, CDS spreads and market pricing of risk[☆]



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CDS definition

- Credit default swaps (CDS) are the most common type of credit derivatives.
- A CDS is a bilateral contract that provides protection on the par value of a specified reference asset, with the protection buyer paying a periodic fee (spread) or a one-off premium (set as a percentage amount of the protection bought) to a protection seller, while the protection seller makes the payment when a credit event occurs during the life of the contract (Alessandro Carboni (2011) “The sovereign credit default swap market: price discovery, volumes and links with banks’ risk premia” Banca d’Italia wp 821)
- The quoting convention for CDSs is the annual premium payment as a percentage of the notional amount of the reference obligation.
- [In the paper](#), the sovereign CDS spreads are reported in basis points, with a basis point equal to \$1000 to insure \$10 million of debt. For example, if the spread is 197 basis points, meaning 197,000 USD to insure against 10,000,000 in sovereign debt for 10 years; 1.97% of the notional amount needs to be paid each year, so $0.0197 \times 10 \text{ million} = \$197,000$ per year.
- According to the literature, sovereign interest rates and CDS spreads have common underlying causes, rather than one driving the other.
- However, before the financial crisis, CDS were traded over-the-counter (OTC), i.e. outside the standard exchange market, using brokers or dealers.
- Since the financial crisis, CDS trading has been subjected to more regulation and standard contracts

A B S T R A C T

We estimate the pricing of sovereign risk for fifty countries based on fiscal space (debt/tax; deficits/tax) and other economic fundamentals over 2005–10. We focus in particular on five countries in the South-West Eurozone Periphery, Greece, Ireland, Italy, Portugal and Spain. Dynamic panel estimates show that fiscal space and other macroeconomic factors are statistically and economically important determinants of sovereign risk. However, risk-pricing of the Eurozone Periphery countries is not predicted accurately either in-sample or out-of-sample: unpredicted high spreads are evident during global crisis period, especially in 2010 when the sovereign debt crisis swept over the periphery area. We match the periphery group with five middle income countries outside Europe that were closest in terms of fiscal space during the European fiscal crisis. Eurozone Periphery default risk is priced much higher than the matched countries in 2010, even allowing for differences in fundamentals. One interpretation is that these economies switched to a “pessimistic” self-fulfilling expectational equilibrium. An alternative interpretation is that the market prices not on current but future fundamentals, expecting adjustment challenges in the Eurozone periphery to be more difficult for than the matched group of middle-income countries because of exchange rate and monetary constraints.

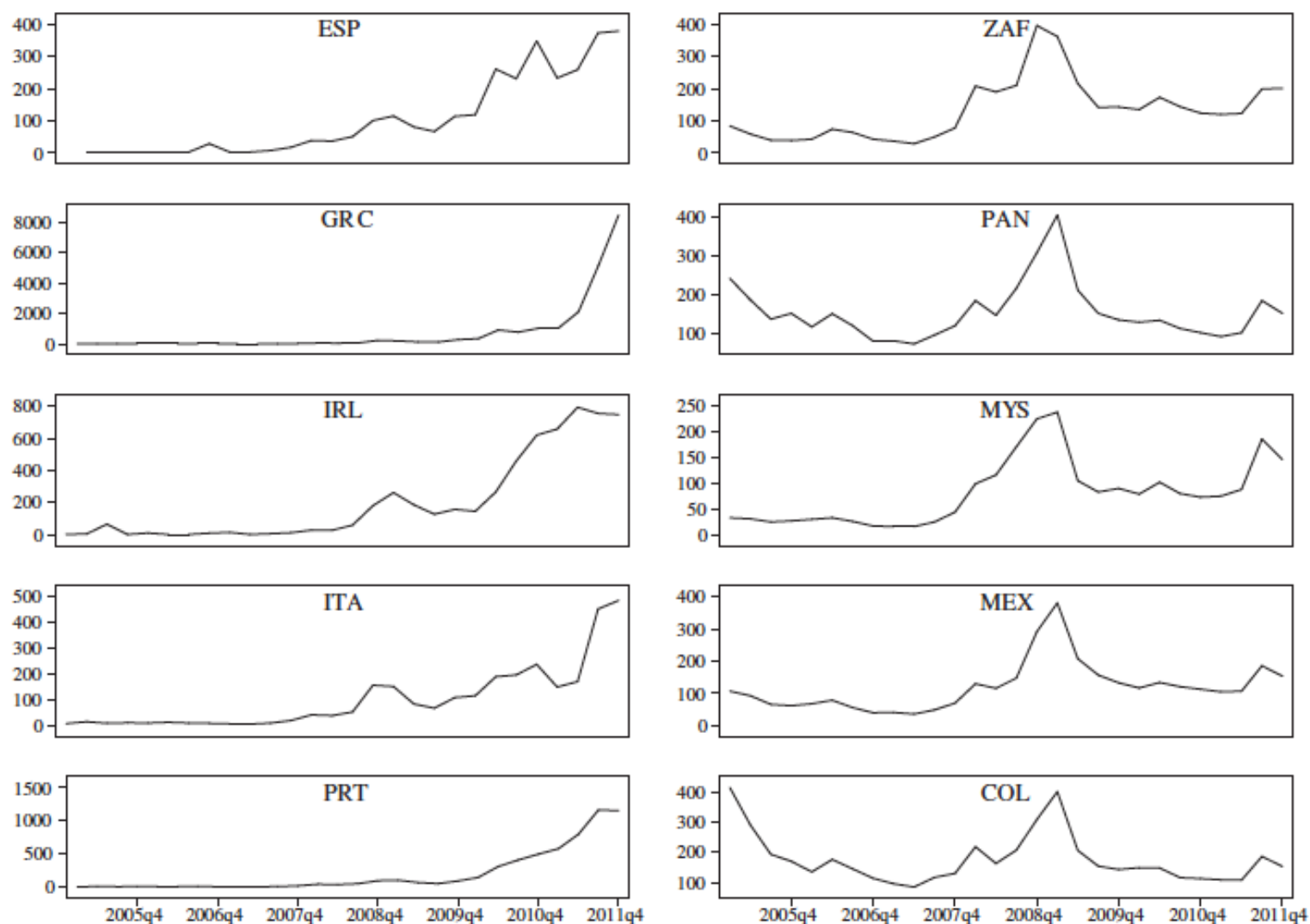
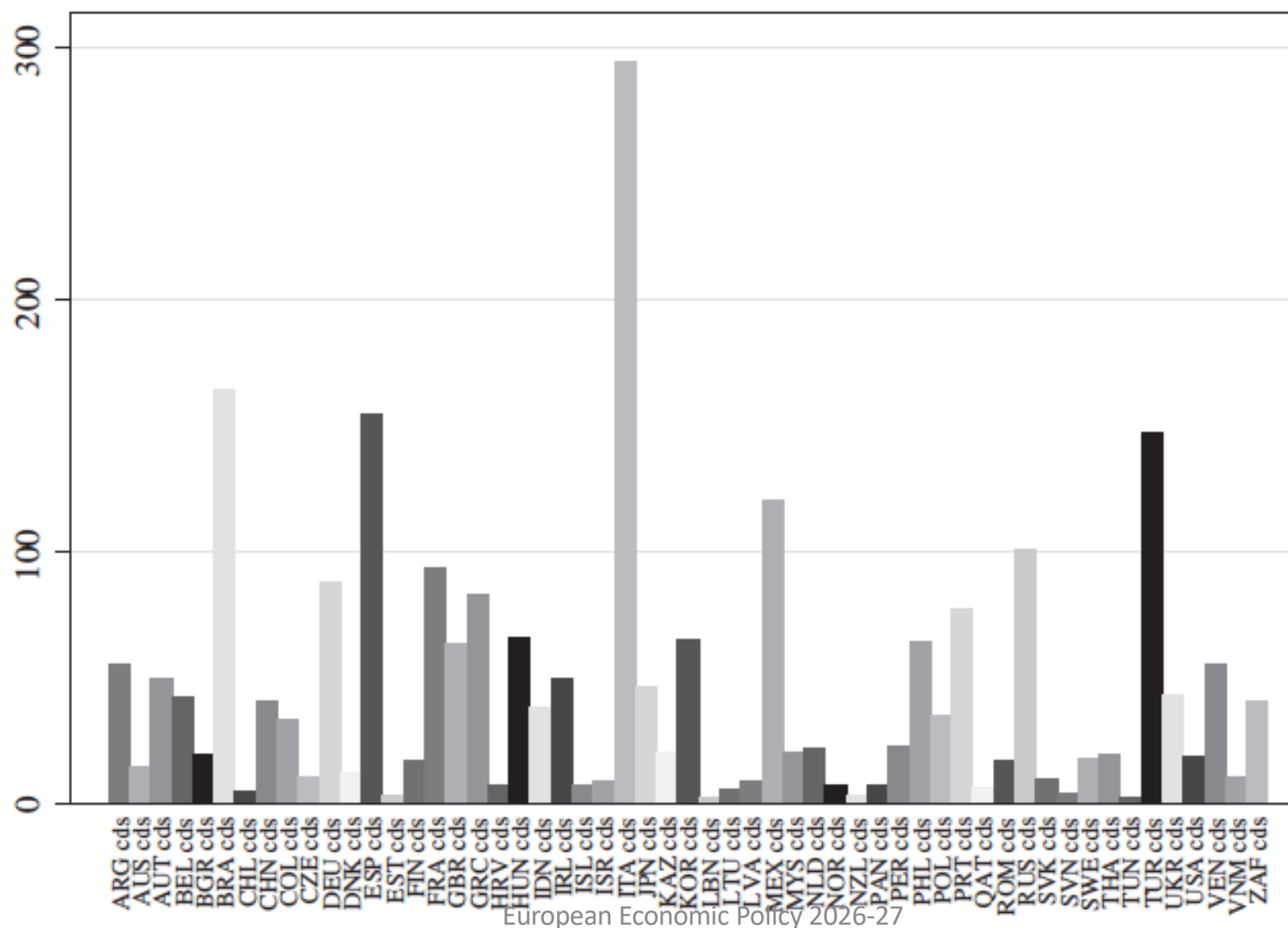


fig. 2. Evolution of sovereign CDS prices. This figure plots CDS 5-year tenor (basis points) for selected middle-income countries and eurozone members.

Financial stress in global markets emerged in early 2008 but became dramatic and widespread in late 2008. The turbulence subsided by mid-2009 in most countries, with the notable exception of the SWEAP group: Greece, Ireland, Italy, Portugal, and Spain. For Greece, the unraveling of its fiscal condition in late 2009 resulted in a manifold increase in sovereign CDS spreads. CDS of South Africa, Mexico, Panama, Malaysia and Colombia are shown on the right.

Global sovereign CDS positions in early 2011. This figure provides the gross notional amount of **outstanding sovereign CDS positions** (the sum of all the principal amounts insured) (billion US\$) as of February 25, 2011

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- **Facts:** The pricing of risk associated with the sovereign debt crisis escalated during 2010 in several European countries and culminating in the **selective default** on Greek sovereign debt in early 2012.
- **Objective:** determine whether the perception of relatively high sovereign default risk of the fiscally distressed Euro area countries, as seen in market pricing of credit default swap (CDS) spreads, may be explained by existing past or current fundamentals of debt and deficits relative to tax revenues – which we term de facto fiscal space – and other economic determinants.
- **Research questions**
 1. Does **fiscal space** help systematically explain the evolution of the market pricing of risk beyond that embedded in other macroeconomic indicators?
 2. Was risk in some markets (e.g. SWEAP) “overpriced” in 2010 judging by model predictions using the prevailing values of fiscal space and other macro variables?
- Empirical studies of CDS (corporate and sovereign) are relatively new

Table 1

Summary statistics of sovereign CDS values and fundamentals.

Country	Sovereign CDS 5-yr tenor (basis points)				
	05-07	08	09	10	08-10
Spain	16.7	100.7	113.5	347.7	187.3
Greece	15.0	232.1	283.4	1026.5	514.0
Ireland	8.6	181.0	158.0	619.2	319.4
Italy	13.4	156.9	109.2	238.0	168.0
Portugal	10.4	96.3	91.7	497.3	228.4
Middle-income group	124.2 (102.8)	829.9 (1069.4)	295.2 (331.3)	233.2 (221.5)	452.8 (540.7)
High-income (non OECD)	32.1 (13.9)	330.7 (158.9)	164.0 (90.5)	172.3 (118.4)	222.3 (122.6)
OECD (non Euro)	34.8 (41.5)	260.3 (238.8)	120.3 (103.5)	117.8 (96.4)	166.2 (146.2)
Euro (excluding SWEAP)	11.0 (13.3)	95.1 (40.2)	54.2 (24.6)	101.3 (55.2)	83.5 (40.0)

Country	Public debt/tax base				
	05-07	08	09	10	08-10
Spain	1.1	1.1	1.5	1.7	1.4
Greece	3.2	3.5	4.0	4.5	4.0
Ireland	0.9	1.5	2.2	3.2	2.3
Italy	2.5	2.5	2.8	2.8	2.7
Portugal	1.9	1.9	2.2	2.4	2.2
Middle-income group	2.7 (2.6)	2.2 (2.1)	2.3 (1.9)	2.3 (1.9)	2.3 (2.0)
High-income (non OECD)	1.2 (0.8)	1.0 (0.6)	1.7 (0.1)	1.4 (0.8)	1.4 (0.5)
OECD (non Euro)	1.7 (1.7)	1.7 (1.7)	1.9 (1.8)	1.9 (1.8)	1.8 (1.8)
Euro (excluding SWEAP)	1.4 (0.5)	1.4 (0.5)	1.6 (0.5)	1.7 (0.4)	1.6 (0.5)

Estimated regression

$$Y_{it} = a + \theta Y_{it-1} + X'_{it} \beta + \varepsilon_{it}$$

Panel regression with lagged dependent variable (Dynamic Panel data model)

Dependent variable is sovereign CDS spread of 5 year maturity.

Sample period 2005-2010.

50 countries

X: vector of controls that include fiscal space measures

Estimation method: instrumental variables using Arellano-Bond GMM estimator (to account for correlation btw lagged dependent variable and unobservable error term)

- fixed effect

- clustered standard error

After estimation estimate prediction error in and out of sample

Table 2

Dynamics of CDS spreads.

	Balanced (whole) sample: 2005–10			
	(1) coeff. (s.e.)	(2) coeff. (s.e.)	(3) coeff. (s.e.)	(4) coeff. (s.e.)
t_{2008}	295.6 (78.3)***	334.1 (102.3)***	328.0 (78.0)***	349.3 (97.5)***
t_{2009}	35.4 (27.7)	−4.7 (21.0)	−36.8 (33.7)	−35.5 (16.7)**
t_{2010}	92.9 (27.1)***	58.8 (12.7)***	2.5 (32.6)	42.5 (14.0)***
$t_{2008} \times \text{Euro dummy}$	−209.5 (80.7)***	−216.0 (84.5)**	−225.3 (82.3)***	−238.6 (80.3)***
$t_{2009} \times \text{Euro dummy}$	−15.0 (30.8)	80.5 (30.4)***	14.6 (30.1)	84.2 (29.4)***
$t_{2010} \times \text{Euro dummy}$	−29.1 (28.0)	56.2 (24.3)**	5.2 (26.6)	48.0 (26.5)*
$t_{2008} \times \text{SWEAP}$	−159.3 (82.7)*	−194.4 (93.2)**	−249.5 (98.2)**	−235.6 (86.6)***
$t_{2009} \times \text{SWEAP}$	73.4 (36.1)**	136.1 (30.8)***	18.7 (58.6)	113.8 (34.1)***
$t_{2010} \times \text{SWEAP}$	261.9 (63.7)***	324.4 (58.1)***	174.4 (107.9)	287.7 (53.6)***
TED spread	7.3 (27.8)	−0.8 (13.6)	3.2 (27.3)	1.3 (11.3)
$y(t-1)$	0.3 (0.1)***	0.3 (0.1)***	0.2 (0.1)***	0.3 (0.0)***
Trade/GDP	−118.0 (128.8)	−24.9 (29.2)	−86.1 (150.7)	−41.9 (28.1)
Inflation	19.8 (10.3)*	24.6 (6.2)***	24.5 (11.9)**	23.8 (6.0)***
External debt/GDP	−1.9 (17.9)	7.9 (2.3)***	−36.6 (30.1)	3.7 (2.3)
Public debt/tax base	81.0 (29.9)***	14.7 (3.9)***		
Fiscal balance/tax base			−829.4 (302.0)***	−194.1 (55.9)***
Constant term	−710.7 (347.2)**	−87.7 (25.6)***	286.0 (271.7)	−37.3 (26.0)
R^2	0.46	0.48	0.52	0.48
Observations	300	300	300	300
Countries (i)	50	50	50	50
Fixed effects (i)	Yes	No	Yes	No
Serial correlation	$y(t-1)$	$y(t-1)$	$y(t-1)$	$y(t-1)$
Clustered s.e. (i)	No	Yes	No	Yes

The dependent variable (y) is sovereign CDS 5-year tenor in basis points. South-West Euro Area Periphery (SWEAP) includes Greece, Ireland, Italy, Portugal, and Spain. Tax base is an average tax/GDP over a period of previous 5 years. TED spread (3-month US\$ LIBOR – 3-month US treasury) and Inflation are in percent. All variables are in realtime (t), except the lagged CDS, $y(t-1)$. Standard errors are in parentheses, with *** (**,*) denoting statistical significance at 1 (5,10) level.

- One percentage point rise in the debt/tax ratio is estimated to increase the 5-year CDS spread by between 15 and 81 basis points
- One percentage point rise in the fiscal balance to tax base ratio is estimated to lower the spread by 194–829 basis points.
- Estimates are highly statistically significant, vary with the specific estimation methodology
 - low estimates are associated with estimation with clustered standard errors
 - high estimates associated with fixed effects estimation.
- Consider also the estimated coefficients on the time dummies and on their interactions with EZ dummy and SWEAP dummy

Prediction results

- In-sample and out-of-sample prediction errors were very substantial across countries and country-groups during the crisis period, with out-of-sample errors particularly large.
- Average errors over 2008–10, for example, indicate that actual CDS spreads exceeded out-of-sample forecast spreads with multiples ranging from 2.3 (Middle Income countries) to 12.9 (non-Euro OECD).
- Under predictions of CDS spreads of this magnitude are extraordinary.
- Under predictions (out-of-sample) for the SWEAP countries are not particularly high in relative terms, ranging from 2.6 (Italy) to 5.3 (Ireland).
- However, the **pattern across years of the crisis** sample shows a divergence between the SWEAP and other country groups.
- SWEAP prediction errors were relatively low in 2008 but climbed in 2010 compared to other regions (except the non-SWEAP Euro area).
- The financial crisis that emerged in 2008 struck the OECD (non-Euro) area particularly hard, with very high out-of-sample prediction errors (31.6). These errors were only 1.6 in 2009 and climbed to 5.4 in 2010.
- By contrast, the SWEAP area did not experience such dramatic prediction errors in 2008 but these errors rose marked in 2009 and especially 2010. Perhaps reflecting some contagious effect

Table 4

Prediction errors of sovereign CDS spreads.

Country/group	Out (in) sample prediction	Prediction error = actual CDS values divided by predicted CDS values			
		2008	2009	2010	2008–10
Spain	out	3.9	3.6	6.5	4.7
	in	3.5	4.0	4.1	3.8
Greece	out	2.7	2.2	3.3	2.7
	in	2.3	1.8	1.7	1.9
Ireland	out	4.2	3.8	7.9	5.3
	in	0.8	1.7	2.6	1.7
Italy	out	2.6	1.6	3.6	2.6
	in	2.3	1.9	3.3	2.5
Portugal	out	2.8	2.9	6.9	4.2
	in	3.2	4.0	4.5	3.9
Middle-income group	out	3.9	1.0	1.8	2.3
	in	2.7	1.2	1.2	1.7
OECD (non Euro)	out	31.6	1.6	5.4	12.9
	in	2.6	1.2	1.4	1.7
Euro (excluding SWEAP)	out	5.0	5.8	13.7	8.2
	in	2.1	4.2	3.2	3.2

Based on the predicted values from estimation in Table 3 (eqs. (3) and (9)) using CDS 5-year tenor. The out-sample prediction uses 2005–07 (pre-crisis period) observations. The in-sample prediction uses 2005–10 (whole sample) observations. Where actual CDS > predicted CDS, there is a signal of under-prediction (i.e. the sovereign default risk is over-priced). The min and max provide lower and upper bounds of prediction errors extracted from the all the specifications with fiscal balance/tax base and macro controls. The bold numbers indicate in-sample prediction errors, as opposed to out-of-sample errors.

- One interpretation of these findings is that the CDS market is pricing default risk not primarily on current fundamentals but **future fundamentals**, expecting the SWEAP fiscal space to deteriorate markedly.
- This interpretation is consistent with the selective default on Greek sovereign bonds in early 2012. The **adjustment challenges of the SWEAP** 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.

- An alternative explanation, consistent with the multiple equilibrium model of Calvo (1988) and the Euro Area picture painted by De Grauwe and Ji (2012), 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.
- In this view, sovereign risk was initially underpriced as **contagious optimism**, somewhat divorced from fundamentals, predominated market expectations in the Euro Area, especially at the time of the 10-year celebration of the success of the Euro Area.
- However, the **“good” (optimistic) expectational equilibrium quickly switched to a “bad” (pessimistic) expectational equilibrium** in the SWEAP countries in 2010 as markets overreacted to fiscal deterioration and generated extraordinarily high CDS. Accordingly, persistent pessimism, manifested in high-risk premia, induces further deteriorations of the balance sheet of a country, leading to **a self-fulfilling prophecy crisis**

Questions

- If the investors risk perceptions are driven by panic and contagion effects, how can they be measured/captured in an empirical model?
- What are the economic fundamentals used by De Grauwe and Ji (2013)? Compare with those used by Aizenman et al. (2013) and comment
- Comment on the possible reasons why investors priced CDS higher for the European periphery countries (SWEAP) compared to control group.
- Does De Grauwe and Ji (2013) empirical analysis support a self-fulfilling debt crisis?