

Looking for fundamentals: empirical models of rating agencies and sovereign-bond yield spreads in euro area countries

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Jan contributed to this research during his stay at the ECB as an ESCB/IO expert. Views and conclusions expressed in this paper are those of authors and should not be attributed to the ECB or the CNB.

Motivation

Stiglitz and others argued that the behaviour of rating agencies exaggerated the East Asian 1997 crisis:

1. by being too optimistic in the pre-crisis time (and helping in building imbalances),
2. and by excessive downgrading during the crisis and amplifying thus its effects through the increase in cost of capital.

Does this also apply to the EA sovereign debt crisis?

1. Were sovereign ratings more lenient in the pre-crisis time?
2. Do rating agencies exaggerated the crisis by triggering high bond yields?

The aim of our research:

We investigate the dynamics of sovereign ratings on the sample of EA countries during the sovereign debt crisis:

- ▶ Do changes in sovereign ratings lead or lag changes in macro-fundamentals and/or in sovereign yield-spreads?
- ▶ What are the determinants of ratings?
 - ▶ Is there evidence for a change in rating methodology around 2010?
 - ▶ Can we expect rating improvements anytime soon?
- ▶ Are sovereign bond yields affected by ratings *in addition to* fundamentals?
- ▶ What factors account for the rise of sovereign bond yield spreads?

Methodology

To answer these questions, we use three empirical tools:

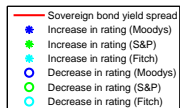
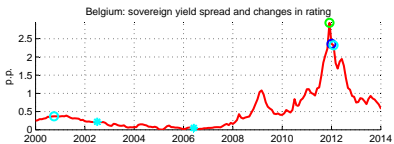
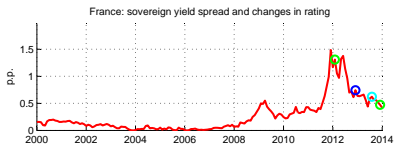
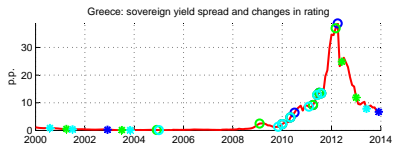
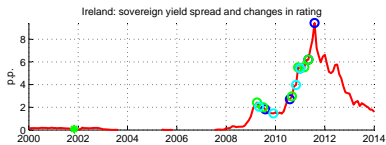
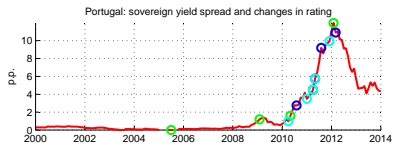
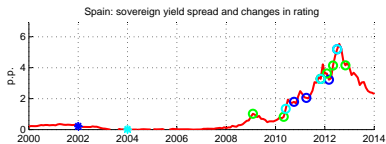
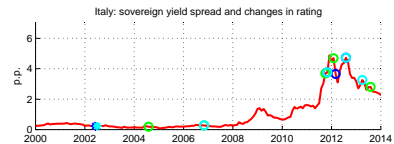
1. Event study
2. Estimation of the rating equation
3. Estimation of the bond-yield spreads

Methodological innovations:

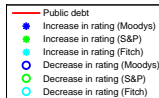
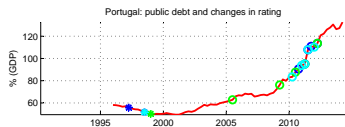
- ▶ our sample includes EA countries:
 - ▶ previous studies usually done on emerging economies;
- ▶ full Bayesian ordered-probit (in addition to the usual OLS).

▶ Data

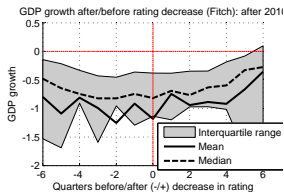
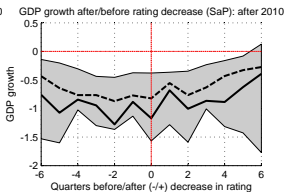
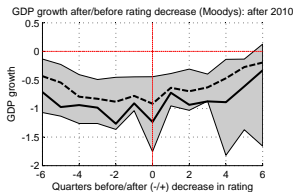
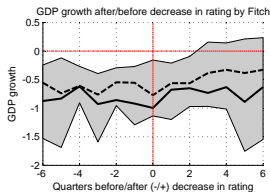
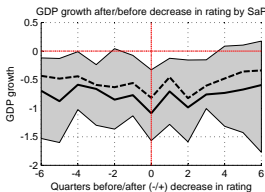
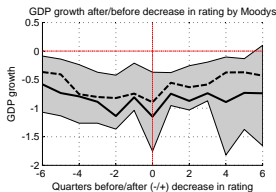
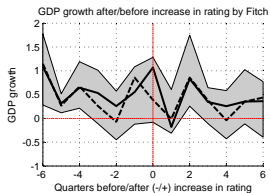
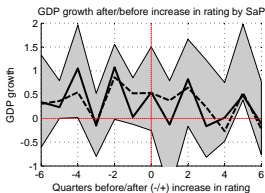
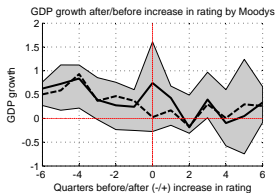
Bond yield spreads and changes in ratings



Debt-gdp ratio and changes in ratings



Event window: GDP growth and changes in ratings



The rating equation

We use the *ordered probit model* to estimate the behaviour of rating agencies:

$$y_{it} = k \Leftrightarrow y_{it}^* \in [c_{k-1} \ c_k), \quad (1)$$

where y_{it} is the rating of country i at time t (such as AA+), y_{it}^* is the latent numerical variable, and c_k are cut-off values.

The latent variable follows an ARX model:

$$y_{it}^* = X_{it}\beta + \beta_0 + \phi y_{it-1}^* + \varepsilon_{it}, \quad (2)$$

where X_{it} are observed macroeconomic and institutional variables.

The model is estimated using [Bayesian techniques](#)

The rating equation: estimation results

Rating equation estimated on a sample of 7 stressed EA countries (1995Q1 – 2014Q2):

- ▶ we succeed in fitting the ratings using a low number of regressors:
 - ▶ debt-to-gdp level, a change in debt-to-gdp trend, a structural indicator (WGI), output trend growth, and the autoregressive terms;
 - ▶ this does not mean that rating agencies looked at few variables only,
 - ▶ rather this is the results of common dynamics among a large set of macro and structural variables.
- ▶ there is a substantial inertia in ratings:
 - ▶ we evaluate the fit also using the predictive exercise for longer horizons.
- ▶ Evidence for the change in ratings after 2010:
 - ▶ the estimated autoregressive coefficient ϕ is lower,
 - ▶ fundamentals became more important.

The posterior means of the coefficients (for our preferred specification) are reported [▶ here](#)

RMSE: relative to the random-walk predictions

Estimated on	RMSE computed on	Moody's			S+P			Fitch		
		+1q	+4q (1y)	+8q (2y)	+1q	+4q (1y)	+8q (2y)	+1q	+4q (1y)	+8q (2y)
Full sample	full sample	0.92	0.80	0.67	0.89	0.97	0.76	0.83	0.85	0.75
	Pre-2010	1.03	0.98	0.96	0.87	0.95	0.80	0.94	1.28	1.29
	Post-2010	0.90	0.77	0.64	0.90	0.97	0.76	0.81	0.79	0.68
Pre-2010	full sample	1.26	1.22	0.87	1.00	1.02	0.93	0.97	1.02	0.93
	Pre-2010	1.09	1.25	0.98	0.92	1.08	1.06	0.91	1.36	1.40
	Post-2010	1.29	1.22	0.86	1.02	1.01	0.91	0.99	0.97	0.87
Post-2010	full sample	0.98	0.87	1.13	1.06	1.05	0.84	1.25	0.98	0.75
	Pre-2010	1.74	2.09	2.88	1.78	2.15	2.01	2.59	2.44	2.13
	Post-2010	0.80	0.61	0.84	0.86	0.84	0.62	0.80	0.63	0.48

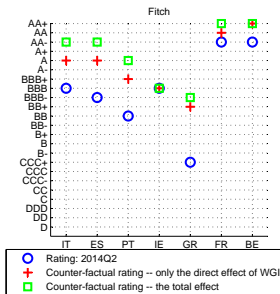
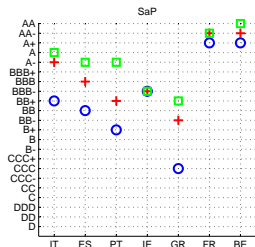
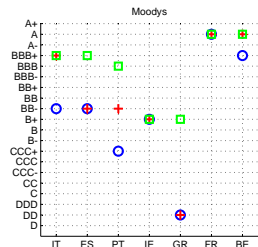
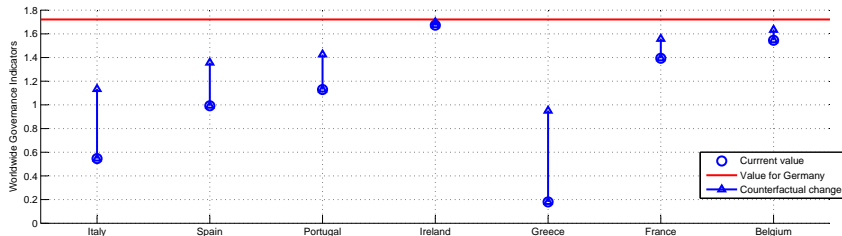
Simulation exercise: upgrading triggers

Based on our estimates, estimates, we can conduct simulation experiments:

We chose a situation of halving the gap between country's WGI and the current German WGI under **two** assumptions:

1. only the WGI improves, but not the rest of fundamentals;
2. the change in WGI translates to improvements of fundamentals:
 - ▶ for this assumption, we rely on research by Brůha and Pierluigi on PCA-based forecasting regressions.

Upgrading triggers experiment



Estimation of the spread equation

In this part of our research, we try to explain the spread of sovereign yields vis-a-vis yields of German bonds.

Two motivation points:

1. Originally, we considered the hypothesis that the yield spread may be influenced by ratings (*in excess to what fundamentals would suggest*):
 - ▶ we abandoned this hypothesis early (recall results of the event analysis): rating changes do not seem to lead spread yields (at frequencies of interest).
 - ▶ What (other) factors drive sovereign bond yield spreads?
2. Bond yields exhibit ▶ very strong degree of comovements
 - ▶ stronger than for fundamentals.

Specification of the model

Given comovements in spreads, it is hard to explain spreads using standard linear models:

- ▶ literature often use time-varying or switching parameters;
- ▶ we opt for a generalization of factor models, where factor loadings depend on observable country characteristics.

Our model for yield spread y_{it} of country i at year t is given as follows:

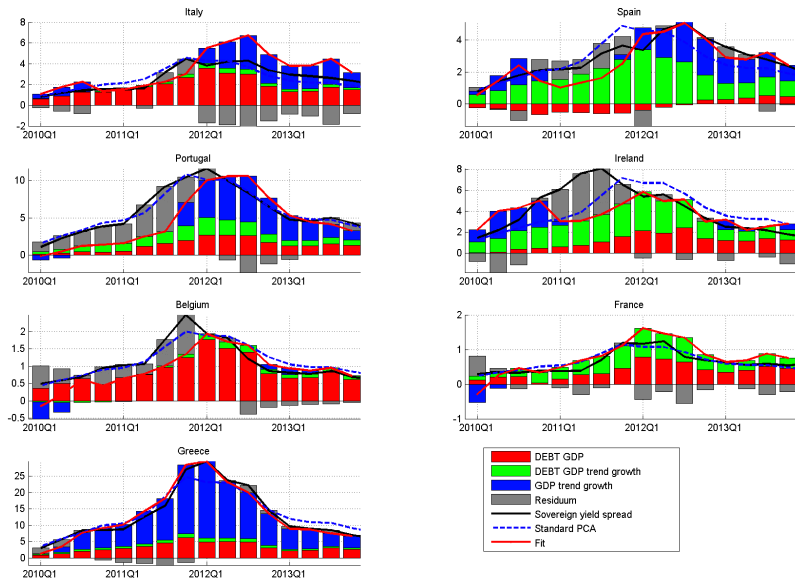
$$y_{it} = \left(\sum_{k=1}^K \lambda_k (x_{ikt} - \bar{x}_{kt}) \right) f_t + e_{it},$$

where x_{ikt} is the k -th fundamental of country i , and \bar{x}_{it} is its German counterpart.

f_t is unobserved factor that affects all yields (and is possibly driven by global investors' risk appetite):

- ▶ note that if the number of observables is lower than the number of countries, the model extension is actually more parsimonious than the standard PCA

Spread equations: results



Spread equations: interpretations

Fit (R^2):

Country	IT	ES	PT	IE	BE	FR	GR
Standard PCA	0.95	0.91	0.97	0.81	0.92	0.93	0.95
Our model	0.81	0.89	0.85	0.82	0.69	0.60	0.98

- ▶ relatively worse fit for countries with smaller spread;
- ▶ largest residua for the year 2011;
- ▶ government debt (both level and trend) and trend output growth are the main drivers:
 - ▶ identification of other factors difficult because of colinearity.

The review of our findings (I)

(1) Changes in ratings do not seem to lead changes in bond spreads or in macroeconomic fundamentals:

- ▶ Rating agencies cannot be blamed to 'cause' surges in sovereign yields as rating changes tend to follow not to lead the changes in yields:
 - ▶ we look at monthly data as we are interested in longer-horizon and more stable effects,
 - ▶ we do not deny existence of high-frequency short-lived effects.
- ▶ Rating changes do not help to predict changes in fundamentals (it is the other way around).

The review of our findings (II)

(2) We estimated the rating equation:

- ▶ it is well fitted by a small number of fundamentals:
 - ▶ due to co-movements in fundamentals.
- ▶ there is evidence for a change around 2010:
 - ▶ after 2010, higher weight on fundamentals, lower inertia.

(3) We estimated a model for sovereign yields-spreads:

- ▶ spreads co-move, and the loadings on the common factor can be explained by fundamentals (xxxx).

Comments welcome!

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Back-up slides

Data overview

- ▶ Data for BE, DE, IE, GR, ES, FR, IT and PT
- ▶ National Accounts: 1990Q1-2014Q2 with ESA95 (subject to availability)
 - ▶ For realtime: 2005Q4-2014Q2 notably for RGDP growth
- ▶ Financial Market Data (incl. ratings by Moodys, S & P, Fitch): business day
- ▶ Institutional indicators (World Bank Governance Indicators): annual
- ▶ Sources: Eurostat, Datastream, Bloomberg, World Bank, Moody's, S&P, Fitch.

Estimation of the ordered probit model

We slightly modified the Gibbs sampler algorithm of Müller and Czado(2005) J. Comp. Gr. Stat.

Priors:

- ▶ β uninformative: $\beta \sim N(\mathbf{0}, \Sigma_\beta)$ with $\Sigma_\beta^{-1} \rightarrow \mathbf{0}$;
- ▶ ϕ truncated normal distribution to ensure stationarity:
 $\phi \sim TN_{(-1, 1)}N(0, 0.1)$:
 - ▶ the prior on ϕ is shrunk to zero to avoid complications due to obvious inertia in ratings.

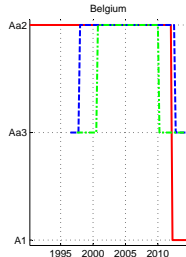
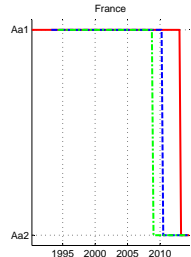
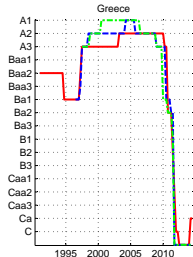
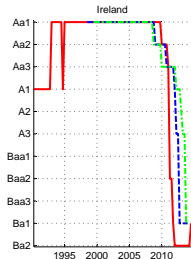
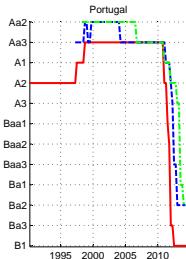
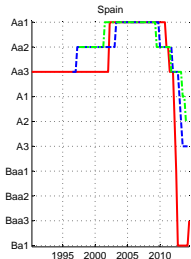
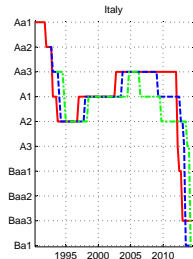
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Estimation results: posterior means

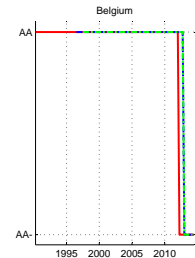
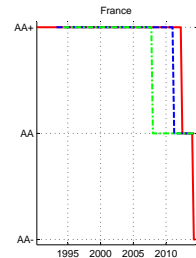
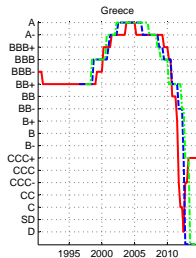
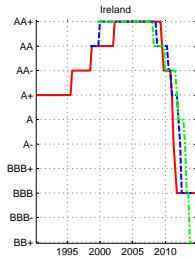
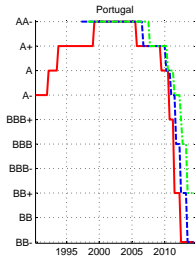
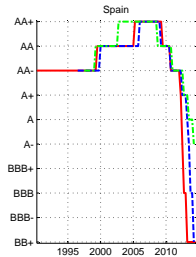
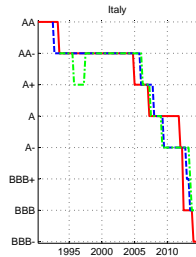
Variable	Moody's Sample:			S & P Sample:			Fitch Sample:		
	full	< 2010	> 2010	full	< 2010	> 2010	full	<2010	>2010
debt_gdp	-0.92	-0.79	-1.02	-0.52	-0.45	-0.93	-1.00	-0.96	-1.47
trn_dbt_gdp	-0.11	-0.04	-0.32	-0.11	-0.66	-0.31	-0.13	-0.06	-0.40
wgi	0.24	0.53	0.34	0.25	0.43	0.52	0.21	0.34	0.67
trn_gdp	0.03	0.03	0.04	0.03	0.03	0.04	0.03	0.03	0.04
Constant	1.14	1.18	1.94	0.83	0.74	1.86	1.88	1.88	3.14
Lagged value	0.87	0.85	0.82	0.93	0.92	0.85	0.90	0.89	0.83

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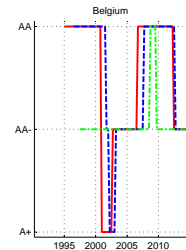
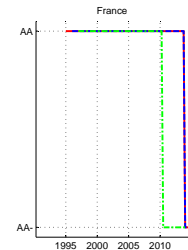
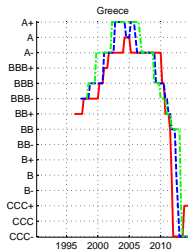
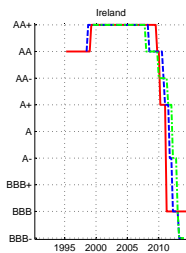
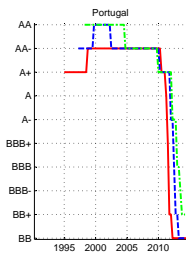
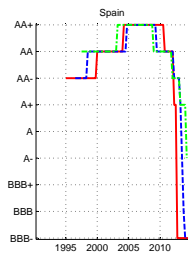
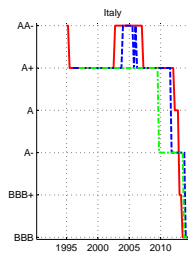
Predictions – Moody's



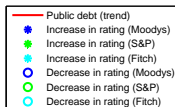
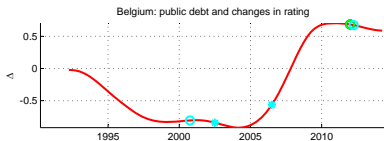
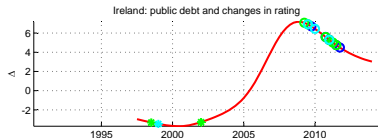
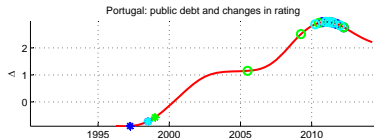
Predictions – S & P



Predictions – Fitch



Changes in trend in the debt-gdp ratio



Bond yield spreads

