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Contagion in Eurozone Sovereign Bond Markets? The Good, the Bad and the Ugly

David Cronin[a], Thomas J. Flavin[b] , Lisa Sheenan[a,*]

[a] *Central Bank of Ireland, Spencer Dock, Dublin 1, Ireland*

[b] *Maynooth University-National University of Ireland Maynooth*

Abstract

We analyse the stability of linkages across Eurozone bond markets during the sovereign debt crisis. We distinguish between contagion and interdependencies as mechanisms for spreading the turmoil across bond markets. Using a three-regime Markov switching VAR, we identify two distinct phases of the crisis - the bad and the ugly - and find differences in shock transmission between them. Overall, evidence of contagion is scant and interdependence is the more common determinant of market comovements.

Keywords: Eurozone Sovereign Debt Crisis; Contagion; Markov-switching VAR.

JEL Classification: G01; G15.

* Corresponding author: David Cronin, The Central Bank of Ireland, P.O. Box 559, Dame Street, Dublin 2, Ireland;
Tel: +353-1-2246803; Fax: +353-1-8944622; Email: dave.cronin@centralbank.ie.
Other email addresses: thomas.flavin@nuim.ie (T. Flavin), lisa.sheenan@centralbank.ie (L.Sheenan).
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I. Introduction

Eurozone sovereign bond markets have experienced considerable and persistent turmoil in recent times. Most sovereigns have suffered downgrades to their credit ratings since 2010. Greece, Ireland, and Portugal required bailout programmes and the European Central Bank (ECB) intervened in the market to purchase the bonds of larger countries like Spain and Italy. We analyse the stability of Eurozone sovereign bond cross-market linkages over the period 2003 - 2014, and empirically test for contagion among member states. Contagion is defined as the excessive co-movement between bond spreads following a shock in one market, while normal levels of comovement constitute 'interdependencies'.

There is already a burgeoning literature on the role of contagion in the spread of the Eurozone sovereign debt crisis. Results differ across studies with, for example, Arghyrou and Kontonikas (2012) and Metiu (2012) both finding extensive evidence of contagion. The former finds that Greece was the main source of contagion in the early stages of the crisis, while the later stages of the crisis were characterised by multiple sources of contagion. The latter finds evidence of contagion emanating from all peripheral countries. In contrast, both Beirne and Fratzscher (2013) and Claeys and Vaš́ßček (2014) find limited evidence of contagion among Eurozone sovereign bond markets. Both document very short periods during which contagion played a role but it is limited in time and markets.

Caporin et al. (2013) attribute the propagation of shocks in Eurozone bond markets to integration (or interdependencies) rather than contagion. Mink and de Haan (2013) focus exclusively on the transmission of the Greek crisis and find that bond prices in other distressed peripheral Eurozone states react to news about Greece. However, this is attributed to a learning process rather than a contagious effect. Blatt et al. (2015) distinguish between contemporaneous contagion and dynamic spillovers. Interestingly, Greece is not found to generate immediate contagion but rather its shocks are transmitted through a change in dynamics. On the other hand, Italy, Spain and Portugal are found to be potentially contagious to other Eurozone countries. Conefrey and Cronin (2015) note a marked increase in spillovers between Eurozone bond markets during the crisis. Their results indicate Greece becoming detached from the other markets after its second bailout in March 2012.

We shed new light on the topic by analysing cross-market relationships in a three-regime Markov-switching model. This allows us to identify two distinct phases of the 'crisis' and provides a more subtle understanding of shock transmission during the different phases. We employ a Markov-switching VAR (MS-VAR) model to date the phases of the crisis and then apply a multivariate test for contagion introduced by Dungey et al. (2005). The crisis is best captured by two distinct regimes and both exhibit different patterns of shock transmission. Contagion plays a limited role in propagating shocks in both phases of the crisis but is relatively more important during the highest volatility regime. In the vast majority of cases, market comovements are due to interdependencies.

Section 2 presents our methodological framework and data. Empirical results are discussed in Section 3, while Section 4 contains our conclusions.

II. Data and methodological framework

II.1 Data

We analyse daily 10-year sovereign bond spreads over Germany for ten Eurozone countries (Austria (AT), Belgium (BE), Spain (ES), Finland (FI), France (FR), Greece (GR), Ireland (IE), Italy (IT), Netherlands (NL), Portugal (PT)) and the US over the period from January 2003 to December 2014. Figure 1 plots the data. Eurozone country spreads over Germany are all negligible up to mid-2007. The emergence of turbulence in the U.S. financial system at that time heralds a change in sovereign bond market conditions which worsens as the Eurozone sovereign debt crisis begins in 2009 and then deepens. During this period, there is a distinct difference in the range of movements between the 'core' countries of Austria, Belgium, Finland, France, and the Netherlands versus the 'peripheral' countries of Greece, Ireland, and Portugal. Italy and Spain lie somewhere in between due to the aggressive bond buying programme of the ECB that were instigated when these countries experienced funding difficulties. The core group continue to have relatively low spreads over Germany, while the risk premium demanded to hold the bonds of peripheral countries soars. These spreads, and fiscal sustainability concerns more generally, forced Greece, Ireland and Portugal out of the international bond markets and into bailout programmes.

Insert Figure 1 about here

We include the US to control for external events and thereby disentangle global from country-specific shocks. All data are sourced from Datastream. Our sample covers the period from 1 January 2003 to 31 December 2014. We begin in 2003 to avoid contamination from earlier bond crises in Russia and Latin America. Unit root tests indicate that the spreads are I(1) processes so we choose to work with first differences. Table 1 presents summary statistics for the variables employed in the analysis.

Insert Table 1 about here

There is a clear difference between the Eurozone 'core' and periphery states, with Greece, Ireland, Italy, Spain and Portugal all exhibiting greater mean changes and volatility than their Eurozone neighbours. Greece records the largest average spread change and the highest volatility. With the exception of Portugal, the other periphery countries all experience negatively skewed spread changes over Germany, in contrast to the positively skewed changes for the core. All variables exhibit fat tails with Greece, in particular, having large measures of kurtosis. The summary statistics suggest that a single state model is not going to be sufficient to capture the characteristics of these daily bond spread changes and that a regime-switching framework may be more suitable to jointly model these variables.

II.2 Methodology

An empirical investigation requires a testable definition of contagion and a method of dating the crisis. Following Forbes and Rigobon (2002), we define contagion as a significant increase in market dependence between normal and crisis periods. We estimate a fixed transition probability (FTP) MS-VAR and use the estimated smoothed probabilities to date the crisis endogenously.[1] Many studies of contagion focus on 'normal' versus 'crisis' periods but we find that a three-regime specification better characterises the evolution of bond market conditions over the sample with the crisis exhibiting two distinct phases.

The model is specified as follows:

$$y_{i,t} = \alpha(s_t) + \sum_{k=1}^{K} \beta_k(s_t) y_{i,t-k} + \epsilon_{i,t}^{st}, \tag{1}$$

$$s_t \in \{1, 2, 3\}, \tag{2}$$

$$\epsilon_{i,t}^{st} \sim i.i.d. N(0, \sigma_s^2), \tag{3}$$

in which $y_{i,t}$ is an n-dimensional time series vector of dependent variables, α is a matrix of state-dependent intercepts, $\beta_1 \ldots \beta_k$ are matrices of the state-dependent autoregressive coefficients and $\epsilon_{i,t}^{st}$ is a state dependent noise vector, which has a zero mean and constant variance within each regime. As s_t is unobserved, we assume that it follows a first-order Markov process, which determines the regime path.

We then proceed to test for contagion between each pair of markets by implementing the multivariate test of Dungey et al. (2005). This involves

[1] Mandilaras and Bird (2010) use a similar approach.

estimating a system of equations with the following form.

$$\frac{y_{i,t}}{\sigma_{i,N}} = \mu_i + \mu_i * \delta_{1,t} + \mu_i * \delta_{2,t} + \gamma_{i,j} * \frac{y_{j,t}}{\sigma_{j,N}} + \theta_{i,j} * \frac{y_{j,t}}{\sigma_{j,N}} * \delta_{1,t} + \psi_{i,j} * \frac{y_{j,t}}{\sigma_{j,N}} * \delta_{2,t} + \zeta_{i,t}, \forall j \neq i, \quad (4)$$

where the dependent variable is the first-differenced spread over Germany for country i divided by its standard deviation in the 'good' regime. $\delta_{1,t}$ and $\delta_{2,t}$ are dummies which take the value of 1 when we are in the 'bad' and 'ugly' regimes respectively and zero otherwise. During the former (latter), contagion from country j to i is detected by the statistical significance of the $\theta_{i,j}$ ($\psi_{i,j}$) parameter. The system of eleven equations is estimated by the seemingly unrelated regressions (SUR) technique to account for contemporaneous shocks and we further control for autocorrelation and heteroskedasticity in the errors.

III. Discussion of results

Figure 2 presents the smoothed probabilities of each regime extracted from the estimated FTP-MS-VAR model.

Insert Figure 2 about here

Regimes are identified from the estimated asset volatilities. We observe three distinct regimes over the sample. The first is the 'good' period from 2003 to mid-2007, characterised by benign economic and financial environments (top panel, Figure 2). Spreads were low and stable and yields fell in many countries as investors expected convergence towards German rates (Arghyrou and Kontonikas, 2012). Mid-2007 marks a transition to a crisis (bad) regime triggered by uncertainty in the U.S. financial system (middle panel). Spreads widened and volatilities increased. This persists until late 2010 and re-establishes itself from 2013 to the end of the sample. This phase of the crisis book-ends the 'ugly' regime, i.e. the most pronounced period of bond market turmoil: late-2010 to early-2013 (bottom panel). Spreads widened further accompanied by intense volatility coinciding with the emergence of the Greek crisis and bailout programmes for Ireland and Portugal.

These phases of the crisis, nevertheless, had differential impacts across countries. Table 2 reports the ratios of our estimated standard deviations between the crisis regimes and normal market conditions.

Insert Table 2 about here

There is a striking difference between the volatility increases experienced by the peripheral countries, Greece, Ireland, Portugal, and Spain (the PIGS), and core countries like Finland and the Netherlands. The proportional increases endured by the PIGS during the 'bad' regime are, in some cases, greater than those suffered by the core countries in either regime. The U.S. is markedly different from the Eurozone countries. There is little increase in volatility (at least relative to the European states) and there is hardly any difference between the 'bad' and the 'ugly' states.

Having identified the regimes, we test for contagion between each pair of markets using the Dungey et al. (2005) test described in eq. 4. Panels A and B of Table 3 present the results for the 'bad' and the 'ugly' phases of the crisis, respectively. Figures 3 and 4 provide a graphical representation of these results.

Insert Table 3 and Figures 3 & 4 about here

A striking feature of our results is that there are relatively few examples of contagion among the member states. Market interdependencies appear to have been the main shock propagation mechanism during the turmoil. However, when contagion is detected, it occurs more often in the 'ugly' than in the 'bad' regime. This highlights the importance of differentiating between the two phases of the crisis and not treating it as one homogeneous event. Among the 110 bilateral relationships analysed, we only reject the null hypothesis of 'No contagion' at a 5% (10%) significance level in 9 (15) cases during the 'bad' regime and 11 (24) cases during the 'ugly' regime.

The peripheral states of Greece, Ireland and Portugal transmit contagion to other members in some limited instances but the presence of contagion from these countries is not pervasive. There is little evidence of contagion from Spain, suggesting the the bond-buying programmes of the ECB were successful in curbing the international transmission of Spanish shocks. The lack of evidence of widespread contagion from Greece is noteworthy and contrasts with Arghyrou and Kontonikas (2012) and Metiu (2012). Our results are more consistent with Beirne and Fratzscher (2013), Blatt et al. (2015) and Mink and de Haan (2013). Blatt et al. (2015) presents evidence that it was the dynamics of the relationship between the Greek bond market and its Eurozone neighbours that changed and not the contemporaneous reaction, as measured here and in most studies of contagion.

Interestingly, contagion does not exclusively emanate from the PIGS. There is at least as much evidence of contagion stemming from 'core' countries. This is consistent with Kaminsky and Reinhart (2003) who explain how larger markets process information more efficiently and transmit the 'news' to more peripheral markets. For example, adverse shocks in the Austrian bond market appear to have generated as many cases of contagion within the Eurozone as larger disturbances in the PIGS.

There is also some limited evidence of contagion to and from the US but this is predominantly with the 'core' Eurozone countries. For example, Finland suffers contagion from the US in the first, 'bad' phase, while the US imports contagion from Belgium and the Netherlands during the more intense, 'ugly' crisis period.

IV. Conclusion

We investigate the role of contagion in propagating shocks across countries during the Eurozone sovereign debt crisis. We show that the crisis was not a single homogeneous event but is better modelled as two distinct regimes. The regimes exhibit different patterns of shock transmission. Overall, the evidence of contagion is limited but is relatively stronger during the more intense, 'ugly' phase of the crisis. Transmitting contagion is not exclusively a phenomenon associated with the PIGS and it also spreads from the core group of countries. However, the vast majority of pairwise relationships remained stable over the sample period and, consequently, market comovements are more often due to interdependencies rather than to contagion.

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Table 1: Summary statistics

Bond Market	Mean (x10^{-3})	Std.dev.	Skewness	Kurtosis
Austria	0.034	0.026	0.754	21.411
Belgium	0.053	0.037	0.294	17.310
Finland	0.071	0.016	2.894	45.695
France	0.075	0.025	0.058	22.112
Greece	8.400	0.338	-5.422	328.554
Ireland	0.206	0.080	-0.959	39.212
Italy	0.355	0.067	-0.485	24.302
Netherlands	0.036	0.016	1.094	19.316
Portugal	0.647	0.116	1.028	53.779
Spain	0.316	0.066	-0.997	20.399
U.S.	0.639	0.049	-0.232	5.317

Notes: This table reports summary statistics for the daily changes in the 10-year government bond spread over Germany for each country for the entire sample period. The sample consists of daily data from January 1, 2003 to December 31, 2014. Std.dev. denotes standard deviation.

Table 2: Ratio of Standard Deviations between Regimes

Bond Market	Bad Regime : Good Regime	Ugly Regime : Good Regime
Austria	7.17	24.17
Belgium	7.79	30.99
Finland	5.08	13.30
France	6.90	23.87
Greece	27.22	183.34
Ireland	17.02	68.03
Italy	9.89	33.63
Netherlands	6.40	15.50
Portugal	19.56	76.15
Spain	16.24	50.59
U.S.	1.27	1.25

Notes: This table presents the ratio of the standard deviations, between crisis and good regimes, generated from our estimated FTP-MS-VAR model.

Table 3: Testing for Contagion

Panel A: Contagion during the 'Bad' regime											
Contagion from:	AT	BE	FI	FR	GR	IE	IT	NL	PT	ES	US
To:											
AT	-	0.215	0.293	0.371	0.694	0.690	0.321	0.124	0.119	0.116	0.010
BE	0.344	-	0.044**	0.360	0.108	0.858	0.783	0.143	0.224	0.854	0.946
FI	0.614	0.043**	-	0.855	0.069*	0.822	0.342	0.498	0.369	0.497	0.011**
FR	0.463	0.328	0.568	-	0.096*	0.789	0.567	0.933	0.018**	0.169	0.166
GR	0.911	0.207	0.016**	0.176	-	0.013**	0.554	0.599	0.951	0.399	0.140
IE	0.667	0.658	0.734	0.622	0.004***	-	0.472	0.832	0.116	0.178	0.560
IT	0.268	0.985	0.155	0.473	0.312	0.507	-	0.938	0.079*	0.367	0.452
NL	0.007***	0.134	0.209	0.323	0.473	0.741	0.673	-	0.682	0.932	0.217
PT	0.315	0.289	0.589	0.030**	0.358	0.112	0.098*	0.597	-	0.350	0.954
ES	0.318	0.990	0.288	0.440	0.225	0.288	0.258	0.632	0.216	-	0.479
US	0.063*	0.363	0.196	0.254	0.501	0.608	0.416	0.092*	0.977	0.479	-

Table 3: continued

Panel B: Contagion during the 'Ugly' regime											
Contagion from:	AT	BE	FI	FR	GR	IE	IT	NL	PT	ES	US
To:											
AT	-	0.766	0.087*	0.034**	0.291	0.033**	0.612	0.811	0.080*	0.812	0.640
BE	0.936	-	0.107	0.853	0.735	0.322	0.004***	0.492	0.162	0.700	0.761
FI	0.212	0.131	-	0.213	0.040**	0.053*	0.373	0.661	0.956	0.323	0.444
FR	0.065*	0.994	0.680	-	0.129	0.576	0.482	0.778	0.049**	0.997	0.379
GR	0.522	0.977	0.187	0.193	-	0.095*	0.289	0.712	0.313	0.547	0.076*
IE	0.034**	0.915	0.145	0.889	0.012**	-	0.282	0.542	0.801	0.114	0.274
IT	0.764	0.386	0.450	0.570	0.957	0.226	-	0.241	0.246	0.702	0.694
NL	0.752	0.038**	0.945	0.464	0.284	0.341	0.321	-	0.535	0.184	0.063*
PT	0.051*	0.632	0.524	0.068*	0.004* * *	0.252	0.413	0.632	-	0.076*	0.253
ES	0.751	0.501	0.919	0.664	0.615	0.411	0.459	0.072*	0.084*	-	0.722
US	0.060*	0.020**	0.624	0.293	0.559	0.487	0.747	0.037**	0.551	0.292	-

Notes: This Table reports the *p*-values for the test of the null hypothesis of 'No Contagion' as described in Eq. 4. Contagion is defined as a statistically significant change in bond yield spread relationships between low-volatility 'good' regime and the two high-volatility (the bad and the ugly) regimes. ***, **, * denote significance at the 1%, 5% and 10% levels, respectively.

Figure 1: 10-year Bond Spreads over Germany

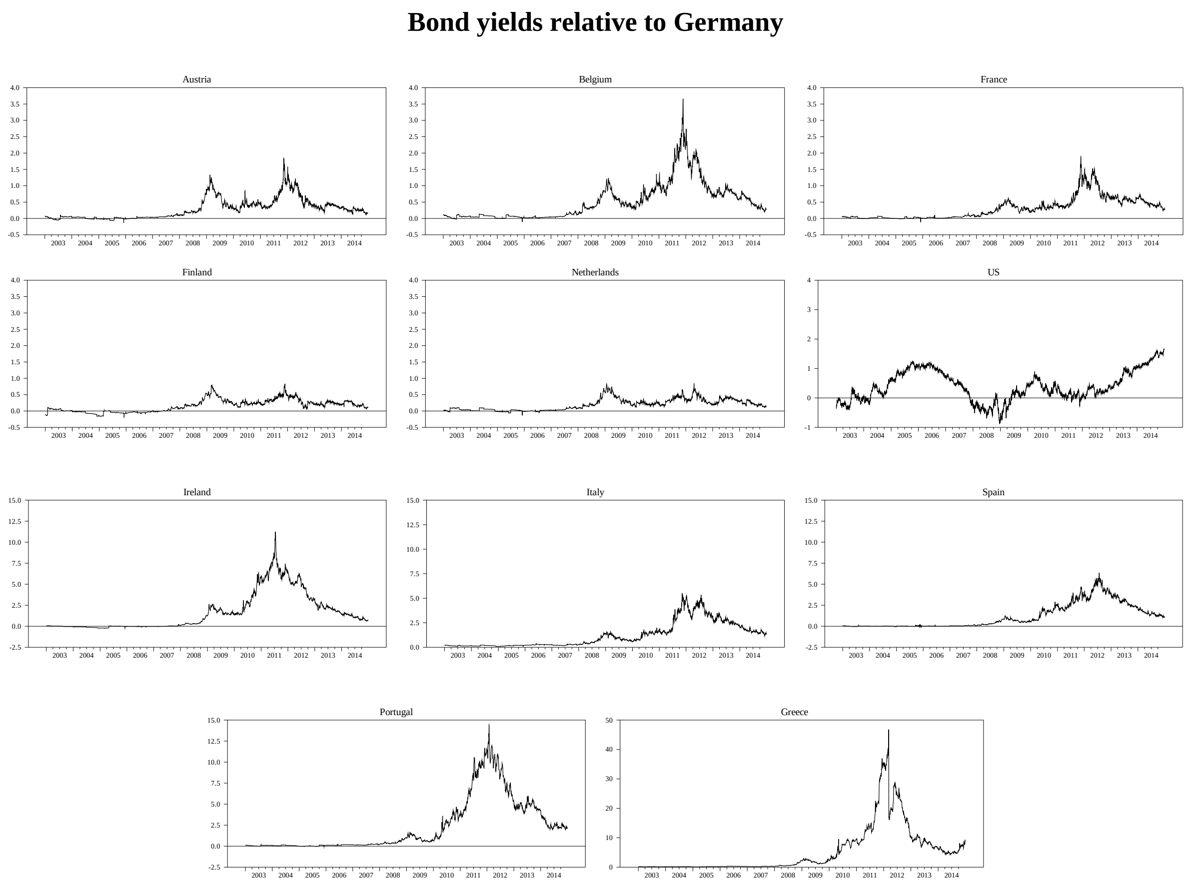

Figure 2: Smoothed Probabilities

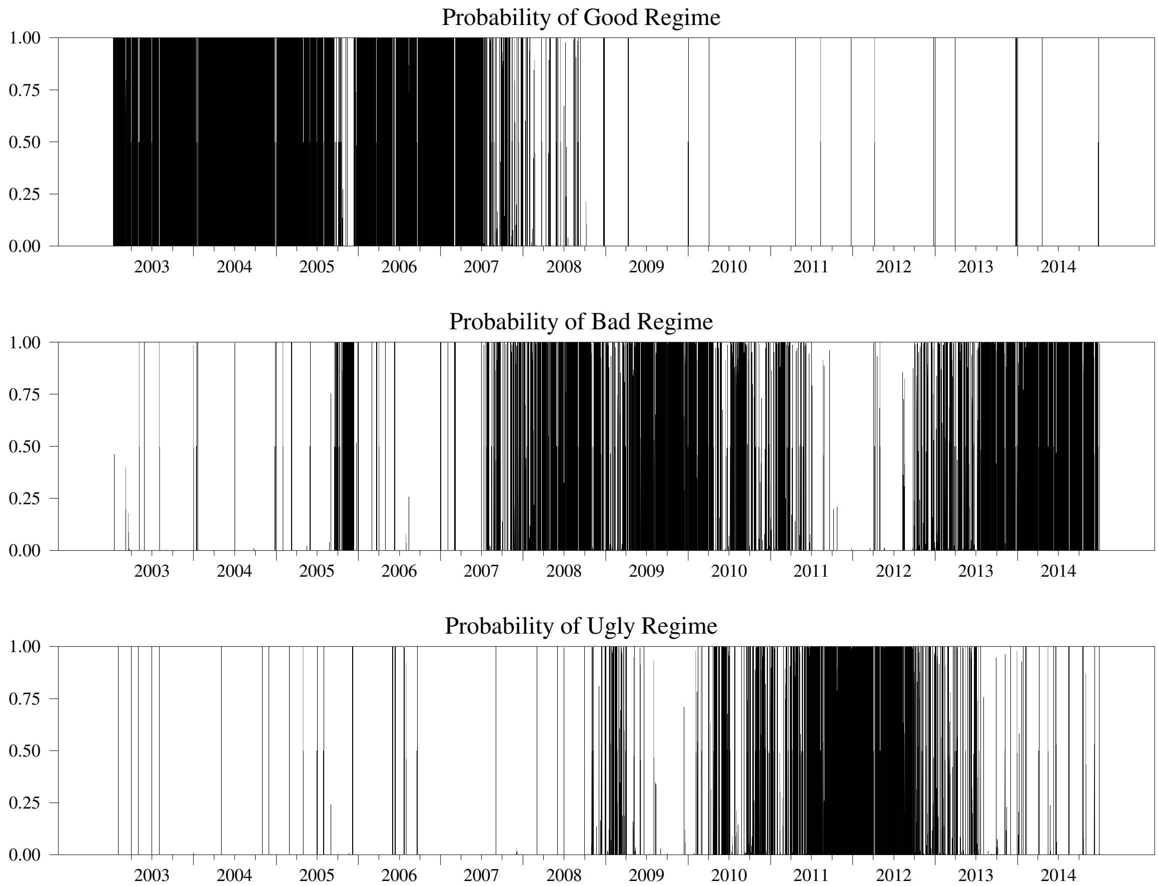

Figure 3: Contagion during the Bad Regime

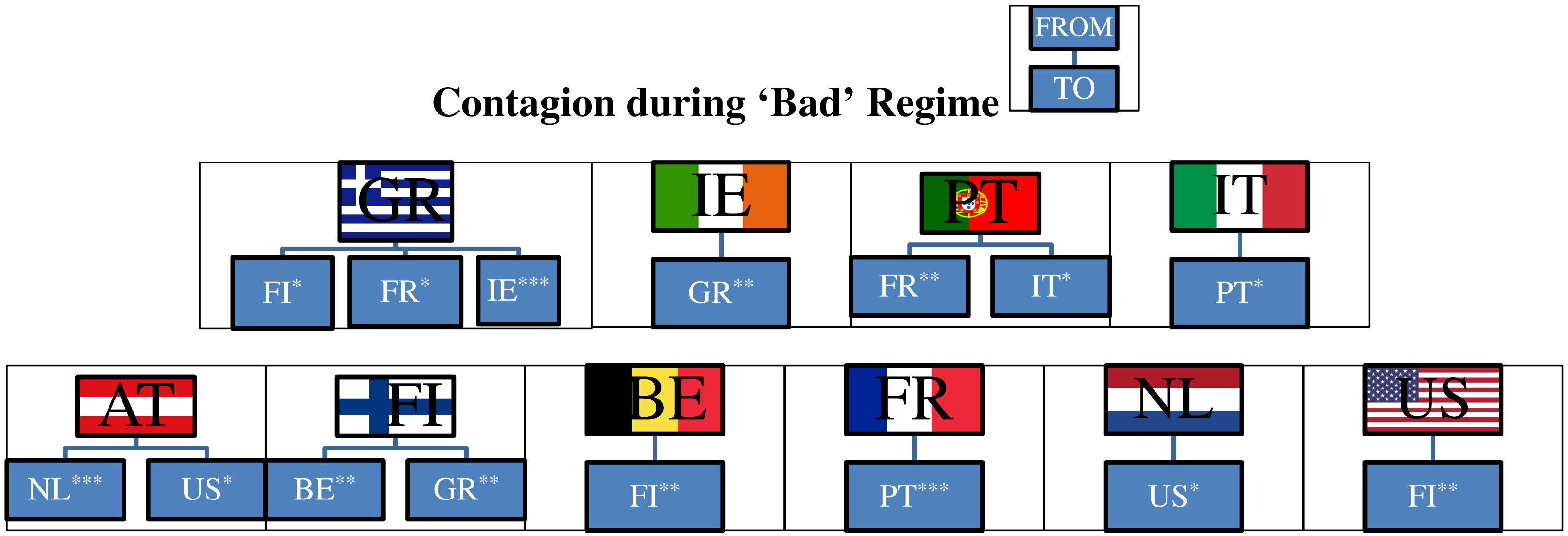

Figure 4: Contagion during the Ugly Regime