Sovereign credit and geopolitical risks during and after the EMU crisis

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Abstract

This paper focuses on the sovereign crisis of the Euro debt crisis era, and we address the existence of the relationship of CDS and bond markets sovereign credit risk pricing for selected core and periphery EMU countries, during and after the 2009 EMU crisis. We study this relationship in conjunction to geopolitical risk as a measure of macroeconomic uncertainty. We use daily observations for several bond maturities and CDS premium with reference to the core (France and Germany) vs. periphery EMU countries (Portugal, Italy, Ireland Spain, and Greece) for the period 2009 to 2014. To measure global geopolitical risk, we employ the Caldara and Iacoviello (2018) global geopolitics index (GPR). Using alternative econometric approaches, we find adequate evidence of volatility spillovers between the geopolitical risk index and sovereign risk markets mainly during the crisis period (2009-2012) and weaker during the easing of the eurozone debt crisis period (2012-2014). Moreover, based on Granger causality the estimation of the short- term dynamics reveals a significant linkage during the post-crisis period rather than during crisis.

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1. Introduction

The Euro debt crisis revealed the importance of salvaging periphery EMU countries in sovereign or bank distress or both even if the gravity of their financial magnitude was not in the category of "too-big-too fail" like major periphery countries such as Italy or Spain. These countries' accumulated sovereign debt or insolvent banking sector, in the initial stage of the EMU debt crisis (2009-2012), would threaten the coherence of EMU and potentially lead to its break up. The rationales behind salvaging countries, besides financial and/or macroeconomic reasoning, are also a matter of geopolitics, geography (scale, size, location of a country) and politics or international relations. Hence, countries with geographical and political importance for the safety of international organizations such as NATO (like Greece) or EMU (like Italy and Spain) as global pillars of political and financial stability, will not be let members collapse even if the sovereign risk of default is extensive as measured by credit default swaps (CDS) or bond spreads.

Flint (2016) argues that geopolitics historically has been used to describe the way governments control and compete for territory. Over the last three decades geopolitical risks has become a key element for entrepreneurs, market participants, and central bank officials on investment decision making and stock market dynamics. In addition, the Bank of England considers that the combining geopolitical risk, economic and policy uncertainty could have significant adverse economic effects (see for example Carney, 2016; Caldara and Iacoviello, 2019). The consideration of the effects of geopolitical uncertainties as a significant risk to global economic outlook has also been brought in surface by the European Central Bank (April 2017) and the International Monetary Fund (October 2017, World Economic Outlook).

Geopolitical risk captures both the risk that these events are realized, and the new risks associated with an escalation of existing events. To this end, geopolitics is a term that encompasses multiple definitions, and historically has been used to describe the practice of states to control and compete for territory (Flint, 2016). Geopolitical events could be considered instances of conflict between countries or international organizations that have a disruptive economic impact on at least a continental scale. There are many recent definitions of geopolitics. Brill (1998) defines geopolitics as the "doctrine of the influence of geographic space on the politics of a state". Haushofer *et. al* (1928) define it as the "science of political spatial organisms and their structures insofar as they are conditioned by the Earth". Meier *et al.* (2005) express geopolitics as the "analysis of the influence of geographic conditions of a state on its national and international policies". Jay (1979) defines the term as "the art and the process of managing global rivalry". Finally, Gallois (1990) describes geopolitics as "the study of relations between the conduct of a politics of power oriented toward the international level and the geographic frame in which it is carried out."

In this paper we associate macroeconomic uncertainty in terms of geopolitical risk to sovereign risk for CDS and bond spreads by expanding the paper by Bratis *et al.* (2020). The Euro debt crisis, which threatened the solidity of the EMU, was also associated with political shifts and elections (such as those in Greece). The link between geopolitics and financial markets has not been studied yet in depth and so our paper aims to fill this gap in the literature focusing on the EMU financial crisis period. To measure global geopolitical risk, we use the Caldara and Iacoviello (2018) global geopolitics risk index (GPR). This index is accepted by public, press, global investors and policy makers alike. The index includes armed fights, terrorism as well as state conflicts resulting to uncertainty in international affairs. We expect geopolitical news to dominate global financial markets as a source of uncertainty triggering risk-averse appetite for investments in the economy. Geopolitical shocks trigger government policies concerning the macrofinancial stability concerning markets (CDS and bonds) exhibiting sovereign risk.

We discuss the link between GPR and EMU's sovereign pricing in an effort to determine if the link is one way or mutual. In other words, is this macroeconomic index a determinant of sovereign pricing (as expected in the extended literature for CDS and bond determinants) or the other way around? Further, do sovereign risk dynamics (as measured by CDS or bond spreads) trigger geopolitical risk? Which financial market reflects more sovereign risk and which country is more associated with geopolitical risk during crisis periods? In principle, we expect the CDS sovereign risk to reflect default risk information (by construction) more efficiently than the bond market, which does not explicitly depict sovereign (fiscal) risk.

The present paper attempts to fill the gap in literature concerning the linkages between sovereign risk (in crisis/post-crisis periods) and uncertainty stemming from geopolitical risk. In other words, we expand the "no arbitrage hypothesis" (CDS vs. bond spreads) (Bratis *et al*. 2020) by incorporating geopolitical risk as an endogenous variable and also provide evidence for the association of sovereign volatility and geopolitical uncertainty risk during the Eurozone debt crisis. In general, we found evidence for mutual volatility spillovers from the sovereign risk (CDS or bond spread) and GPR for each country in both subperiods. During crisis, the sovereign risk was more associated with the uncertainty of the geopolitical risk rather than post-crisis, as expected. Country-specific results varied and we attributed these differences to countries' own idiosyncratic features and/or indirect openness to geopolitical risk.

Moreover, short-term Granger dynamics (at the mean level) were found mainly at the easing of the crisis (2012-2014) than during the crisis (2009-2012) as expected. This means that during crisis periods volatility (uncertainty and risk) dominates financial markets than normal periods, where (changes in) levels of magnitudes are predominant.

The remainder of this paper is structured as follows: Section 2 describes the literature. Section 3 presents the data used for the empirical analysis presents and Section 4 presents the methodology. Section 5 concludes.

2 Literature review

There is a great deal of interest, and a correspondingly large literature, of the link between uncertainty and financial markets. Uncertainty could be the result of either economic policy uncertainty or geopolitical uncertainty and risks. As Mishkin (1999) argues there are four sources of financial instability namely, increases in interest rates, deterioration of banks, and non-financial institutions' balance sheets and overall economic uncertainty.

Agoraki et al. (2022) use an unbalanced panel dataset of monthly observations for 22 countries for the period 1985 to 2020. They also control for a set of macroeconomic and market structure variables whereas we also take into consideration the potential effects that the 2007-2009 financial crisis. Agoraki et al. (2022) employ Caldara and Iacoviello (2019) Geopolitical Risk Index (GPR) and it is shown that the impact of geopolitical risks is negative and statistically significant. For comparison we also use alternatively the global economic policy uncertainty index and the economic policy uncertainty country index, and we also find a statistically significant negative relationship although this is weaker in the latter case. Caldara et *al*. (2016), Ludvigson et *al*. (2019), and Berger et *al*. (2019) used structural VAR models and find a two-way relationship between uncertainty and the business cycle. Aslanidis et al. (2020) conduct an international analysis of the cross-sectional risk premiums of uncertainty risk factors in addition to traditional risk factors. They consider the stock markets of five regions separately. The main finding is that internationally, uncertainty has negative risk premiums confirming previous studies that examine only the US case.

Jetter (2017) analyzed the effect of media coverage on terrorist attacks an important dimension of geopolitical risk. With the application of a data set of 61,132 attack days and for 201 days Jetter (2017) argues that increased New York Times coverage encourages further attacks in the same country whereas if terrorists do not receive media attention, they will attack less. Muir (2017) examined the behavior of risk premia in financial crises, wars, and recessions in an international panel spanning over 140 years and 14 countries. Muir (2017) reaches the conclusion that expected returns, or risk premia, increase substantially in financial crises whereas drops in consumption and consumption volatility are larger during wars.

Most of the literature on the effects of geopolitical risks focuses on the effects of stock markets and there is limited number of works on how geopolitical risk affects other financial markets sucha the bond market and the CDS market. Balduzzi et al. (2020) associate political risk and CDS for Italy. Pastor and Veronesi (2013) argue that the Economic Policy Uncertainty (EPU) commands a risk premium whose magnitude is larger during weaker economic conditions. Baur and Smales (2020) analyze the relationship between geopolitical risk and asset prices and show that geopolitical risk is distinct from existing measures of economic, financial, and political risk and that the response of precious metals to geopolitical risk differs considerably from that of other assets. Huang *et al.* (2015) discuss the impact of international political risk on government bond yields (1988-2007); they found a positive and significant link between international political risk and government bond yields which is consistent with global bond investors demanding higher returns at times of high political uncertainty. The present paper contributes in the literature on geopolitics to sovereign pricing under CDS and bond markets.

3 Data and preliminary empirical results

3.1 Data and variable construction

We employ daily, sovereign 5-year CDS (SCDS), since these are the most traded ones, the 5-year sovereign bond yields and the Overnight Interest Spread, OIS. We selected the CDS premium mid-category to reflect the mid-rate average of CDS premium bid and CDS premium offered, and also because it reflects the spread between the entity and the relevant benchmark curve. We use the most indicative countries for core Eurozone (Germany, France) and peripheral Eurozone suffering the ongoing or the aftermath of the financial and debt crisis (Portugal, Italy, Ireland, Spain, Greece). The idea is to incorporate all systemically-important countries (Figure 1, Panel I)[1]. Daily CDS data and interest rates are derived from *Datastream* Thompson Reuters.

Thus, we construct 5-year sovereign bond spreads for each country by subtracting the 5-year OIS (SPROIS) and form spreads for each country (see Figure 1, Panel II). We see that Germany's spread (SPRGEOIS) with reference to the US crisis

[1] GECDS (Germany), FRCDS (France), GRCDS (Greece), IRCDS (Ireland), ITCDS (Italy), PCDS (Portugal), SPCDS (Spain). Since averaged series (core vs. periphery) may produce coarse results we directly test each country's sovereign risk to geopolitical risk.

period and the post-crisis EMU period serves as a safe-haven market)[2]. CDS returns are calculated by scaling series in level form and taking their first differences in percentage points (ΔCDS%).

The geopolitical risk index counts the occurrence of words via an automatic text-search related to geopolitical tensions in the electronic archives of 11 leading international newspapers (Figure 2).[3] The authors calculated the index by counting the number of articles related to geopolitical risk in each newspaper for each month (as a share of the total number of news articles). Since we examine (financial) returns, we use daily data (which reflect more accurately events) and not the monthly, averaged GPR data (which do not indicate when an event happened). The downside of this choice might be the complications added by noise but our concern is primarily the investigation of mean and volatility spillovers which are better reflected in daily data. We took the logarithm of the index (LGPR) in the empirical analysis (because it was stationary).

At the end of 2011, the EMU crisis reached its peak, while from September 2012 and until the implementation of Draghi's policy (OMT programme) in 2012, the crisis appeared to deescalate. Hence, the year 2012 is used as the "transition year" from relevant turmoil period to relevant tranquil period within the post-crisis era. We conduct our analyses considering two sub-periods: the pre-EMU debt crisis (November 3, 2008 to November 27, 2009) and focus especially post-EMU debt crisis

[2] SPRGEOIS (Germany), SPRFROIS (France) SPRGROIS (Greece), SPRIROIS (Ireland), SPRITOIS (Italy), SPRPOIS (Portugal), SPRSPOIS (Spain)

[3] These newspapers are: The Boston Globe; Chicago Tribune; The Daily Telegraph; Financial Times; The Globe and Mail; The Guardian; Los Angeles Times; The New York Times; The Times; The Wall Street Journal; and The Washington Post.

(November 30, 2009 to April 30, 2014) with the breakpoint the date that the Greek Government announced the review of its public finance data[4].

3.2 Preliminary statistical investigation

We begin with some descriptive statistics between national sovereign CDS for the sub-samples (Table 1). Pre-crisis, the highest SCDS mean value belongs to Ireland (1.909%) and the lowest to Germany (0.386%). Post-crisis Greece as expected has the highest value (84.903%) while Germany has again the lowest value (0.296%). The latter intuitively supports the "flight to quality phenomenon" for Germany as well as the difference inside core EMU regarding the comparison among core states (France 0.661%).

With respect to countries' SPROIS, pre-crisis, the highest mean value (0.017%) was for Greece, thus providing an intuition on an already stressed domestic sovereign sector, while the lowest value (-0.000%) belonged to Germany. Ireland appears to have the second highest value (0.014), which comes as a surprise, while all others countries exhibit low values. The skewness and kurtosis measures indicate that all series are positively skewed (showing above-average spread variations from one day to another, except Greece with data spanning till 9/3/2012) and highly leptokurtic relative to the normal distribution[5]. The GPR index has a mean of 3.992, exhibits negative skewness and a leptokurtic shape (kurtosis is 3.664). Finally, the 5-year OIS common reference interest rate has a mean of 2.468 and positive skewness.

During the post-crisis subperiod, Greece again had the highest SPROIS value (0.378%), thus providing evidence for a continuous trend of increased sovereign risk, with Germany presenting the lowest value (-0.000%). Nevertheless, periphery bond

[4] Formal announcement concerning deficit over the 3% barrier of Maastricht Pact, was made on October 30, 2009 by the Greek government, which was certified by Eurostat on the 15th of November.
[5] The Bank of Greece discontinued 5-year maturity bonds in March 2012 but reinstated them in April 2014.

spreads surpass in value the corresponding core bond spreads due to the turmoil of the twin crisis nexus. Again, the asymmetry measures indicate that all series are positively skewed (showing above-average spread variations from one day to another, except for Greece) and highly leptokurtic relative to the normal distribution. Furthermore, the Jarque-Bera normality test rejected normality, which can be partially attributed to intertemporal dependencies in the moments of the series. Lastly, the GPR has an increased mean compared to pre-crisis (4.065), as expected.

Table 2 presents the correlation results for the two subperiods. From the during-crisis results, it appears that GPR is always positively correlated to either CDS/bond spreads (with the only exception the negative correlation between bond spreads and GPR for Germany).[6] These positive values make sense since when risk increases, either coming from general geopolitical events (reflected in the GPR index) or country-specific conditions (embedded in sovereign CDS), bond yield spreads as well as CDS increase. From the post-crisis results, we see that these correlations were mostly negative which suggests that risks diminished and thus there was an improvement in the credit risk outlook in these countries, as generally expected.

4. Methodology

4.1 The parametric Granger causality Test

We investigate a short-term, linear Granger-type causality within a reduced-form vector autoregression (VAR) specification. The general model specification is as follows:

$$Y_t = \sum_{i=1}^{k} A_i Y_{t-i} + \varepsilon_t \tag{1}$$

[6] We conducted also stationarity tests for all variables and found mixed results, as some were I(1) and others I(0), and so no cointegration is possible. Results are available upon request.

where $Y_t = [Y_{1t,..,}Y_{kt}]$ the $k \times 1$vector of endogenous variables, A_i the $k \times k$ parameter matrices and ε_t the residual vector, for which $E(\varepsilon_t) = 0$ and $E(\varepsilon_t, \varepsilon'_t) = \Sigma_\varepsilon$, when $t=i$, and 0 otherwise. For a benchmark trivariate model $\{X_t\},\{Y_t\},\{Z_t\} \sim I(1)$ the representation of the model is given by:

$$\begin{aligned} \Delta X_t &= A(k)\Delta X_t + B(k)\Delta Y + \varepsilon_{\Delta X,t} \\ \Delta \Upsilon_t &= C(k)\Delta X_t + D(k)\Delta \Upsilon + \varepsilon_{\Delta \Upsilon,t} \qquad t=1,2,\ldots,N \\ \Delta Z_t &= F(k)\Delta X_t + G(k)\Delta Y + \varepsilon_{\Delta Z,t} \end{aligned} \tag{2}$$

where Δ refers to first differences in the variable, and $A(k), B(k), C(k), D(k), F(k), G(k)$ are lag polynomials with roots outside the unit circle. The error terms are *i.i.d*. processes. The joint test eg. in the baseline bivariate model is whether Y strictly causes X implies that all the coefficients of the lag polynomial $B(k) = 0$. Similarly, the test of whether X strictly Granger causes Y is a test of joint restriction that all the coefficients of the lag polynomial $C(k) = 0$. We would reject the null hypothesis of no Granger causality if we are unable to accept the exclusion restriction. In the case that both $B(k), C(k)$ are statistically different from zero, it would be concluded that bidirectional causality exists.

More specifically we analyze the extent of GPR spillovers of CDS/bonds markets by employing a trivariate VAR model of GPR and each country's sovereign CDS return and the corresponding bond spread of the same maturity (SPROIS). Thus, we expand Bratis *et al.* (2020) by incorporating the GPR in the efficient sovereign price VAR equations.

We plot the generalized volatility impulse response functions (GVIRFs) functions to avoid variable ordering issues (see Pesaran and Shin, 1998) for the two subperiods, the EMU crisis (30/11/2009-25/07/2012) and the post-EMU crisis or tranquil subperiod (26/07/2012-30/4/2014) to examine the dynamic linkages between the CDS and sovereign spreads with the GPR index. The tranquil period refers to the post-Draghi's announcement on doing all it takes to save the Euro.

4.2. BEKK-GARCH

We estimate the variance-covariance transmission mechanism for GPR and the corresponding volatilities of CDS and bond spreads under the context of Multivariate-GARCH setting. That is we address the spillover effects in terms of lagged volatility[7]. We employ a trivariate (n=3) full BEKK model of conditional covariance, proposed by Engle and Kroner (1995). The general BEKK model specification is as follows:

$$\Delta p_{i,t} = \mu + \alpha \Delta p_{i,t-1} + \varepsilon_{i,t} \quad (3)$$

where $\Delta p_{i,t}$ is the change in the rate of GPR, CDS and countries' bond spreads between time t and t-1, μ is a long term drift coefficient and $\varepsilon_{i,t}$ is the error term for the return on GPR, CDS and countries' bond spreads i at time t[8]. The conditional variance equation modeling the error term from the conditional mean equation is the following:

$$H_t = C'C + A'\varepsilon_{t-1}{}'\varepsilon_{t-1}A + B'H_{t-1}B \quad (4)$$

$$A = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix},\ B = \begin{pmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{pmatrix},\ C = \begin{pmatrix} c_{11} & 0 & 0 \\ c_{21} & c_{22} & 0 \\ c_{31} & c_{32} & c_{33} \end{pmatrix}$$

where A is a non-negative and symmetric *3x3* square matrix of parameters that represents the correlation of conditional variances with past squared errors hence it measures the impact of shocks on conditional variances. B is a non negative and symmetric *3x3* square matrix of parameters exhibiting how current levels of

[7] An extended survey on MV-GARCH models is given by Bauwens *et al.* (2006), Silvennoinen and Terasvirta (2008).

[8] We used the AIC criterion to determine the best model [AR(1)-BEKK(1,1)]. For sensitivity reasons we also employed the change on GPR (ΔGPR) and additionally run a bivariate BEKK between CDS-bond spreads with exogenous variable in variance the ΔGPR.

conditional variances are impacted by past conditional variances and C is a *3x3* lower triangular matrix with intercept parameters.

The a_{ij} measure cross-volatility shocks, that is, the effects of the lagged innovations on current co-volatility, or the effect of lagged innovations originating in variable *i* on the current conditional volatility of variable *j*. Terms b_{ij} measure the cross-volatility spillovers or the cross effect of the lagged co-volatilities on current co-volatility or the direct dependence of volatility in variable *j* on that of variable *i*.

We are also interested in the diagonal elements $a_{ii,} a_{jj}$ which capture the own volatility shocks/spillovers (impact of past squared innovations on current conditional return volatility in variable *i*) and the $b_{ii,} b_{jj}$ terms, which capture own volatility shocks/spillovers persistence (impact of past volatilities on current conditional return volatility in variable *i* or else the dependence of volatility in variable *i* on its own past volatility). In general to examine the presence of spillover effects during and at the post-crisis period, we run the BEKK model in order to derive significance over cross terms for the period under consideration. Hence, we categorize as *spillovers* the α_{ij} terms (capturing the degree of transmission from an innovation from variable *i* to *j*) and β_{ij} terms (capturing the persistence in conditional volatility among variable *i* and *j*, where the notion of lagged volatility is present through h_{t-1}). We are interested in spillovers shocks from GPR to sovereign risk markets (b_{3j}) and the reverse (b_{i3}), as well as own spillovers (α_{3j}) and the reverse (α_{i3}).

Finally we augment the model by incorporating asymmetric effects, where the conditional variance equation modeling the error term from the conditional mean equation is now the following:

$$H_t = C'C + A'\varepsilon_{t-1}{}'\varepsilon_{t-1} A + B' H_{t-1} B + D'\eta_{t-1}\eta'_{t-1} D \qquad (5)$$

where $\eta_{i,t} = \varepsilon_{i,t} \times I_{i,t}$, It is an indicator variable which has a value of 1 if ε_t <0 and D is a matrix of parameters as:

$$D = \begin{pmatrix} d_{11} & d_{12} & d_{13} \\ d_{21} & d_{22} & d_{23} \\ d_{31} & d_{32} & d_{33} \end{pmatrix}.$$

Statistically significant and positive d_{ij} represents asymmetric shock spillovers from variable i to j. We are interested in asymmetric shocks from GPR to sovereign risk markets (d_{3j}) and the reverse (d_{i3}).

5. Main Empirical results

To examine the nature of the information flow (the short-term linkages), we begin with a VAR Granger causality test, for the pre- and the post-crisis periods, among (the log of) GPR (*LGPR*), CDS and bonds spreads to the risk-free OIS. It is expected that available public information should be reflected immediately into sovereign CDS prices, which are referred to as the reference sovereign credit risk market instead of the bond market. Thus, we should find this type of causality in our results. Note that the first two letters in the CDS and SPR series denote the country: FR = France, GE = Germany, IT = Italy, PT = Portugal, SP = Spain. We found this evidence during the crisis for GPR leading the Spanish bond spreads at 10% significance level (see Table 3, Panel I).

What is highly unanticipated is that the most short-term connections were found at the post-crisis period and not during the crisis period. That is, uncertainty (under a global geopolitical index) was not directly associated with sovereign risk during the crisis, as expected, but rather at the easing of the crisis. Apparently, global news on geopolitics, from an American investor's angle, does not seem to be relevant to the Euro debt crisis except for the Spanish case (where there was a serious bank crisis). In the absence of other evidence, we tentatively argue that geopolitics is more linked to countries with bank crises than with sovereign crises during crisis periods. Post-crisis, however, the stronger association may intuitively be linked to a looming risk of the breakup of EMU.

Thus, concerning the GPR-CDS risk, GPR leads FRCDS at the 10% significance level, ITCDS, SPCDS and PCDS at 5%, 5% and 10% levels, respectively. Concerning the GPR-bond spread risk, GPR leads SPRIROIS, SPRITOIS, and SPRPOIS at the 5% level. There is also a bidirectional relation for Portugal (Table 3, Panel II). GPR appears to lead more CDS sovereign risk than the bond spread risk as expected. There are limited cases for sovereign risk leading GPR (GECDS at 1% which is expected given that Germany is the anchor economy of EMU and SPRPOIS at 10% level)

Since LGPR is stationary conducting a cointegration test is meaningless and, hence, we proceeded with VAR specifications. Figures 4 and 5, in a panel for each country, depict the GIRFs for the crisis and the post-crisis periods, respectively.[9] Inspecting Figure 4, we note that a shock by the risk index induces a weak, positive and decreasing response by CDS, initially, turning it negative after about a week in all countries except Greece and Portugal. In the case of Portugal, there is only a positive and decreasing impact of the shock, again after six to seven days. Germany's CDS appear to be the least impacted by the shock. Greece appears to be a special case where the shock created turbulence in the country's CDS market by alternating it between very strong (almost 100 times more than most of the countries) positive and negative reactions (compared to the other countries), which do not appear to die out within two (at least, although it is not shown) weeks. This sort of response, following the same shock, is evident in the sovereign spreads (SPR) of Germany, France, and

[9] The results for the pre-crisis subperiod are available upon request.

Ireland. For the remaining countries, the reactions of their bond spreads surfaced as weak, initially positive and turning negative after approximately a week, and gradually fading away (by the 10th day).

Turning to the reactions of the geopolitical risk index (LGPR) to shocks from CDS, we can say that they were always positive (with the exception of Germany where briefly turned negative before changing to positive again within a couple of days) and in all cases the shock was absorbed by the 10th day. In addition, the initial reaction from the shock was the same in all countries with the (marginal) exception of Ireland where the response was a bit higher. Finally, as far as the reactions of the risk index to innovations from the sovereign bond spreads are concerned, it is noted that the initial reaction was negative for the cases of Germany and France, but negative for the rest of the countries. Moreover, in the cases of Germany, France, and Greece, the index's response was weak (small) but larger in the remaining countries.

Regarding the post-crisis results (Figure 5), we remark that the reaction of CDS to innovations from the geopolitical risk index is null for France, Italy, and Spain but seen a bit positively changing for Germany, Ireland, and Portugal. Also, we essentially observe the same type of response from the bond spreads to the same shock for all countries except Portugal and Spain where the response was negative and amplifying. Finally, the reactions of the risk index to innovations from either CDS or bond spreads were mostly negative for all countries except for Germany and Portugal, where it appeared to be alternating between positive and negative and slightly positive, respectively.

Panels I and II of Table 4 contain selected and statistically significant results from the BEKK-GARCH estimations for the two subperiods. The coefficients of interest are those that reflect mutual spillovers from GPR to sovereign risk markets (β_{3j}, β_{i3}), own volatility spillovers $a_{ii,} a_{jj}$ as well as mutual asymmetric shocks from GPR to sovereign risk markets (d_{3j}, d_{i3}). The GPR index is number 3, CDS is number 1 and SPR is number 2. Looking at the crisis period (Panel I), we observe significant mutual GPR-SPR volatility spillovers in the cases of France, Germany, and Greece, while unidirectional GPR-CDS spillovers in the cases of Germany (bidirectional), Spain and Portugal. As regards own spillovers, we note some unidirectional, from GPR to CDS, for France, Greece, and some from CDS to GPR, for Germany and Portugal. Finally, we detect presence of asymmetric shocks only in the case of Portugal.

In Panel II, we see the results for the post-crisis period. In general, we observe more volatility spillovers than during the crisis period but for fewer countries. Specifically, in the case of Ireland we additionally observe own spillovers, between CDS and SPR, and spillovers from SPR to GPR. For Germany, we see only one case of own spillovers and one for cross-spillovers (from CDS to GPR). While Spain exhibited fewer volatility spillovers compared to the crisis period, France remained the same in terms of such spillovers. Finally, it is worth noting that the magnitude of own volatilities is smaller than those during the crisis, an expected result.

In sum we find more spillover cases from GPR to sovereign risk during crisis than post-crisis. The above result is in line with Pástor and Veronesi (2013) concerning the presence of high economic uncertainty during times of recessions for financial markets. The mixed cases of volatilities for each country may be due to the country's idiosyncratic features and its openness to various geopolitical risks (for example, investments in perilous territories with conflicts, threat of breakup of a union). While GPR has more extreme events at the easing of the crisis (2012-2014) than during the crisis (2009-2012), the results above highlight the gravity of the EMU crisis and the possibility of a breach of the union. Two prime examples are Greece, which endangered the stability and cohesion of EMU with its banking and sovereign crises, and Italy and Spain, whose similar problems triggered the ‘too-big-to-fail” argument for rescue. Both cases highlight potential threats that fuel uncertainty (risk) from the prospective of geopolitics.

5.2. Robustness test

To account for country heterogeneity, we addressed the same approach to UK and US (Table 3). US bond spread (SPRUSFFR: the US 5 year yield minus the federal funds rate, as proxy to OIS) leads GPR and data also reveal a bidirectional causality relation between GPR and US sovereign risk in terms of CDS. The above results show that the benchmark country US has a continuous feedback loop with GPR at the majority of cases which is expected during the EMU crisis and the possibility of Euro Area countries failing due to the bank-sovereign crisis nexus (in parallel countries with increased trade openness and investments for US, as also important for NATO alliance). Post-crisis (at the easing period) we observe a bidirectional relation for UK bond spreads and GPR.

Finally for the BEKK-GARCH results (Table 4), during crisis (US) we found cross-spillovers form GPR to US sovereign risk (CDS or bond spreads). At the easing of the crisis both US and UK spillovers from GPR to the corresponding bond spreads.

6. Summary and concluding remarks

We examined the dynamic linkages among a geopolitical risk index (GPR), and selected EMU countries’ CDS and sovereign bond spreads for the period of the financial crisis of 2009 to 2014. Using causality tests, VAR, and BEKK-GARCH specifications, we found that few cases for short-term relations during the post-crisis period (2012-2014). During crisis (2009-2012), the risk index led Spanish bond spreads only, whereas post-crisis GPR led CDS more often than bond spreads. That is, GPR tend to move first in the news and the CDS or/and bond spread to adjust towards the geopolitical news.

Overall, we found evidence for mutual volatility spillovers from the sovereign risk (CDS or bond spread) and GPR for each country in both subperiods. During crisis, the sovereign risk was more associated with the uncertainty of the geopolitical risk rather than post-crisis, as expected. Country-specific results varied and we attributed these differences to countries' own idiosyncratic features and/or indirect openness to geopolitical risk. The magnitude of volatility spillovers from geopolitical risk (macroeconomic uncertainty) is essential for policy makers as investments and financial stability is questioned.

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Table 1. Descriptive statistics for Sovereign CDS (SCDS) and Bank CDS (BCDS)

Panel I. Pre-crisis (SCDS)

	GECDS	FRCDS	GRCDS	IRCDS	ITCDS	PCDS	SPCDS	UKCDS	USCDS
Mean	0.386	0.435	1.645	1.909	1.070	0.753	0.884	0.855	0.456
Max.	0.925	0.965	2.890	3.800	1.900	1.490	1.635	1.650	0.950
Min.	0.200	0.210	0.880	1.050	0.480	0.370	0.470	0.420	0.196
Std.Dev.	0.182	0.196	0.554	0.637	0.444	0.280	0.282	0.337	0.211
Skewness	1.227	0.932	0.570	1.083	0.477	0.752	0.766	0.566	0.751
Kurtosis	3.981	3.215	1.949	3.922	1.726	2.475	2.733	2.345	2.516
JB	81.572	41.086	28.072	64.687	29.583	29.622	28.259	19.977	29.080
Prob.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Panel II. Pre-crisis (SPROIS)

	SPRGEOIS	SPRFROIS	SPRGROIS	SPRIROIS	SPRITOIS	SPRPOIS	SPRSPOIS
Mean	-0.000	0.002	0.017	0.014	0.008	0.008	0.006
Max.	0.002	0.006	0.032	0.029	0.013	0.016	0.012
Min.	-0.003	-0.000	0.008	0.005	0.004	0.004	0.002
Std. Dev.	0.001	0.001	0.007	0.006	0.002	0.003	0.002
Skewness	-0.610	0.590	0.379	0.693	0.105	0.498	0.727
Kurtosis	2.723	3.414	1.847	2.354	1.770	2.414	2.480
JB	18.320	18.342	22.314	27.403	18.212	15.671	27.978
Prob.	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Panel III. Post-crisis (SCDS)

	GECDS	FRCDS	GRCDS	IRCDS	ITCDS	PCDS	SPCDS	UKCDS	USCDS
Mean	0.296	0.661	84.903	3.400	2.145	5.141	2.187	0.528	0.386
Max.	0.792	1.715	149.117	11.911	4.986	15.214	4.920	0.949	0.650
Min.	0.091	0.254	1.521	0.536	0.720	0.611	0.667	0.196	0.155
Std.Dev.	0.150	0.337	66.373	2.441	1.066	3.352	0.931	0.189	0.088
Skewness	0.796	1.034	-0.159	0.623	0.893	0.904	0.595	0.078	-0.155
Kurtosis	2.965	3.147	1.129	2.257	2.744	2.534	2.811	1.923	2.563
JB	122.113	206.571	173.019	101.169	156.450	167.673	69.912	56.870	13.792
Prob.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001

Panel IV. Post-crisis (SPROIS)

	SPRGEOIS	SPRFROIS	SPRIROIS	SPRITOIS	SPRPOIS	SPRSPOIS
Mean	-0.000	0.003	0.038	0.023	0.065	0.025
Max.	0.002	0.015	0.159	0.064	0.224	0.071
Min.	-0.004	0.000	0.007	0.003	0.005	0.004
Std. Dev.	0.001	0.002	0.027	0.012	0.045	0.012
Skewness	0.135	1.914	1.129	0.758	0.915	0.662
Kurtosis	3.009	6.691	4.063	2.905	2.686	3.364
JB	3.547	1359.122	299.267	110.873	165.775	90.809
Prob.	0.169	0.000	0.000	0.000	0.000	0.000
Obs.	1153	1153	1153	1153	1153	1153

Panel V. Geopolical risk and 5-year OIS

	LGPR-Pre	LGPR-Post	5y OIS-Pre	5y OIS-Post
Mean	3.992	4.065	0.024	0.012
Max.	5.361	6.040	0.034	0.028
Min.	2.079	1.609	0.020	0.004
Std. Dev.	0.623	0.649	0.002	0.006
Skewness	-0.700	-0.399	1.547	0.544
Kurtosis	3.664	3.776	5.979	1.979
JB	28.176	59.559	216.059	106.959
Prob.	0.000	0.000	0.000	0.000
Obs.	281	1153	281	1153

Table 2. Correlation matrix

	CDS vs GPR		BOND SPREADS vs GPR	
	During	Post	During	Post
FRANCE	0.0465	-0.1591	0.4040	-0.0054
GERMANY	0.0095	-0.0027	-0.1038	0.0407
GREECE	0.0427	N/A	0.1005	N/A
IRELAND	0.1035	0.0261	0.5508	-0.1946
ITALY	0.0336	-0.1929	0.6758	0.9617
PORTUGAL	0.0820	-0.0036	0.5262	-0.1535
SPAIN	0.0586	-0.1947	0.6869	-0.1826

Table 3. VAR Granger causality

Panel A. during-crisis (2009-2012)

Causality direction	F-Statistic	Prob.
GPR → SPRSPOIS	9.353	0.095*
SPRUSFFR → GPR	8.040	0.045**
USCDS → GPR	11.573	0.072*
GPR →USCDS	16.521	0.011**

Panel B. Post-crisis (2012-2014)

Causality direction	F-Statistic	Prob.
GPR →FRCDS	4.418	0.010*
GECDS →GPR	10.344	0.000***
GPR → SPRIROIS	5.699	0.057**
GPR → SPRITOIS	6.890	0.031**
GPR → ITCDS	6.439	0.040**
GPR → ITCDS	6.439	0.040**
GPR →PCDS	4.706	0.095*
GPR → SPRPOIS	6.068	0.048**
SPRPOIS → GPR	4.932	0.084*
GPR →SPCDS	6.482	0.039**.
SPRUKSONIA →GPR	15.232	0.018**
GPR →SPRUKSONIA	18.563	0.005***

Notes: *.**.*** denotes 10%,5%,1% significance level, respectively. → means that variable X Granger cause variable Y.

Table 4. BEKK-GARCH results

Panel I. During crisis (2009-2012)

FRANCE	**coefficient**	**st.error**	**T-stat**
α_{31}	0.004***	0.001	2.603
β_{23}	-28.209*	15.372	-1.835
β_{32}	-0.000**	0.000	-2.417
IRELAND			
α_{32}	0.000*	0.000	1.743
β_{32}	-0.000***	0.000	-4.534
GERMANY			
α_{13}	-1.523*	0.790	-1.952
α_{32}	-0.000**	0.000	-2.420
β_{13}	2.434***	0.618	3.934
β_{23}	147.798***	43.397	3.405
β_{31}	-0.005***	0.001	-2.989
β_{32}	-0.000***	0.000	-4.999
GREECE			
α_{31}	0.616***	0.030	20.016
α_{32}	0.001***	0.000	4.365
β_{23}	3.422*	1.903	1.798
β_{32}	0.001***	0.000	6.188
SPAIN			
β_{13}	0.917*	0.481	1.906
β_{31}	0.050***	0.011	4.309
β_{32}	0.000*	0.000	1.631
PORTUGAL*			
α_{13}	0.170***	0.061	2.788
β_{13}	-0.111**	0.044	-2.515
d_{23}	16.483***	5.732	2.875

USA			
β_{13}	-1.094**	0.536	-2.037
β_{31}	-0.012***	0.002	-4.861
β_{32}	0.000***	0.000	2.973

Notes: Table depicts only selected statistical significant results concerning α_{ij} and β_{ij}. Portugal model is calculated under the augmented specification (asymmetric effects, for GED instead of normal distribution). *,**,*** denotes 10%,5%,1% significance level, respectively.

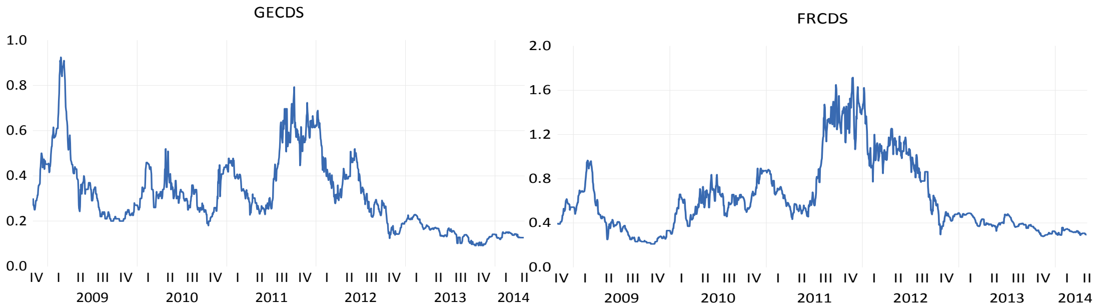
Panel II. Easing of crisis (2012-2014)

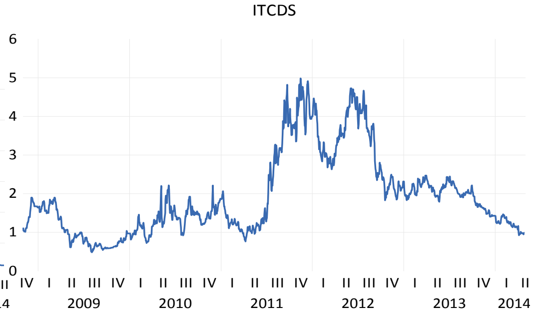
FRANCE	**coefficient**	**st.error**	**T-stat**
α_{13}	-0,555***	0.211	-2.630
β_{13}	0.663**	0.301	2.203
β_{23}	105.112**	46.826	0.024
IRELAND			
α_{23}	-5.983*	3.083	-1.940
α_{32}	-0.000***	0.000	-2.176
β_{31}	-0.000***	0.000	-3.379
β_{32}	0.000***	0.000	3.814
PORTUGAL			
α_{23}	-5.219***	1.865	-2.836
α_{31}	0.018***	0.006	2.780
β_{31}	-0.073***	0.015	-4.899
β_{32}	-0.000***	0.000	-4.481
GERMANY			
α_{31}	0.000**	0.000	2.410
β_{32}	0.000***	0.000	3.665
SPAIN*			
α_{13}	-0.288**	0.139	-2.068
d_{13}	1.844***	0.646	2.853
UK			
α_{32}	-0.000***	0.000	-3.013
β_{32}	0.000***	0.000	11.536
US			
α_{32}	-0.000***	0.000	-3.578
β_{32}	0.000***	0.000	9.008

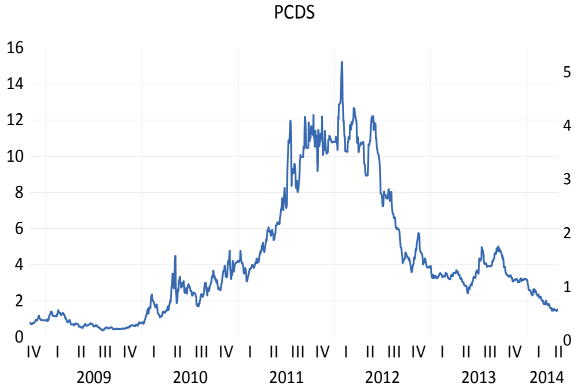
Notes: Table depicts only selected statistical significant results concerning α_{ij} and β_{ij} (where the ij notation represents CDS(1), bond spreads(2) and GPR (3),). Spain model is calculated under the augmented specification (asymmetric effects). *,**,*** denotes 10%,5%,1% significance level, respectively.

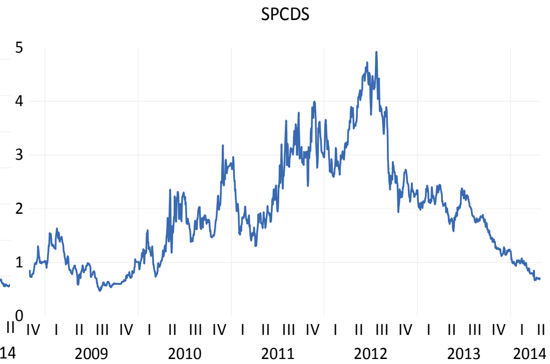
Figure 1. Sovereign risk

Panel I. CDS

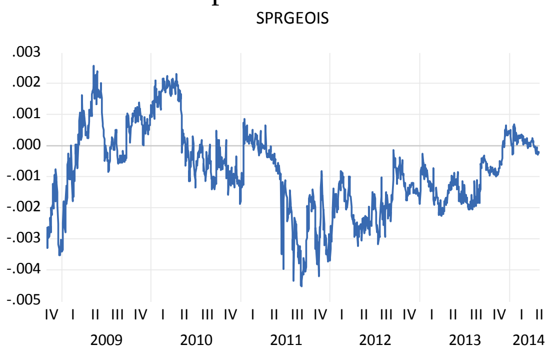


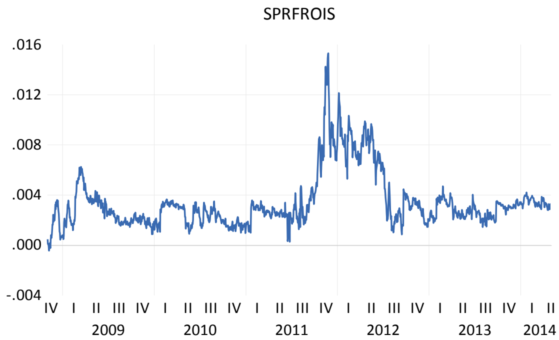


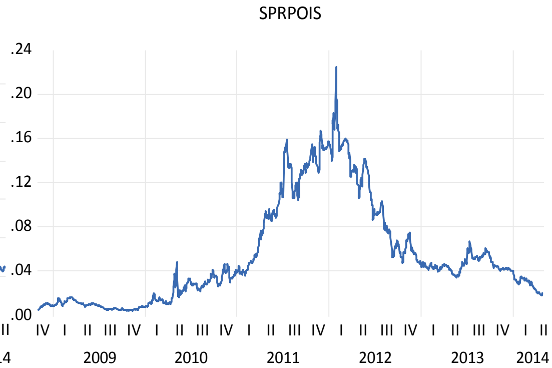




Panel II. Bond spreads







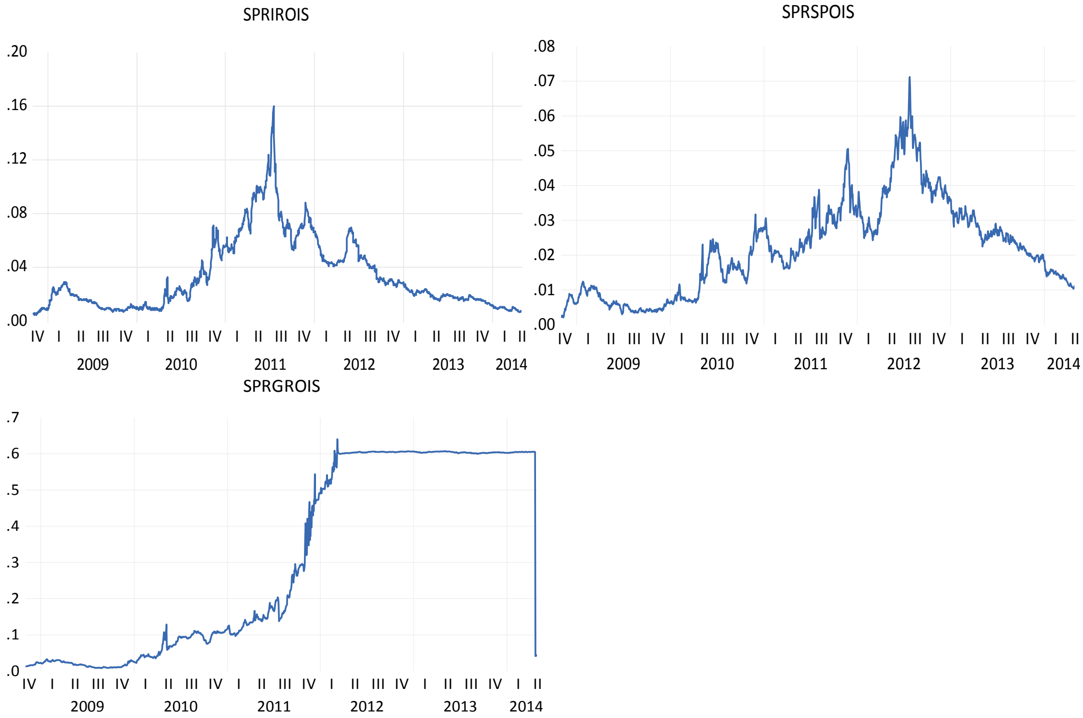
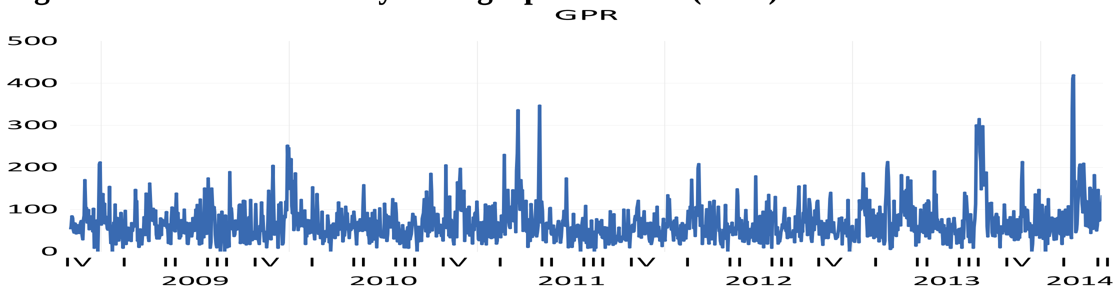
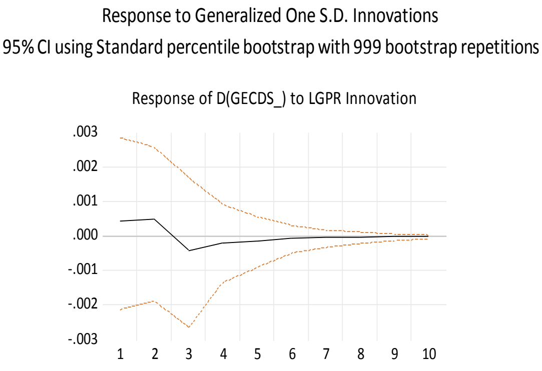


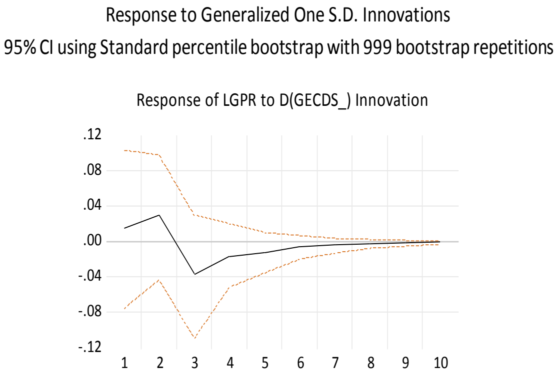
Figure 2. Global uncertainty from geopolitics risk (GPR)

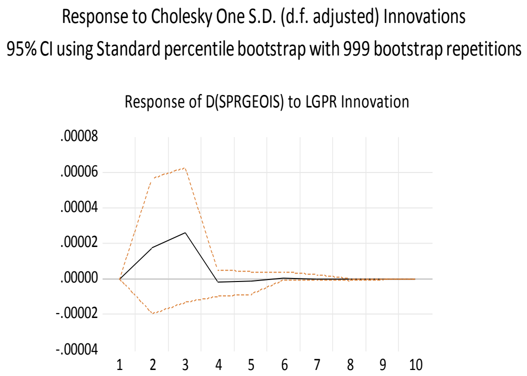


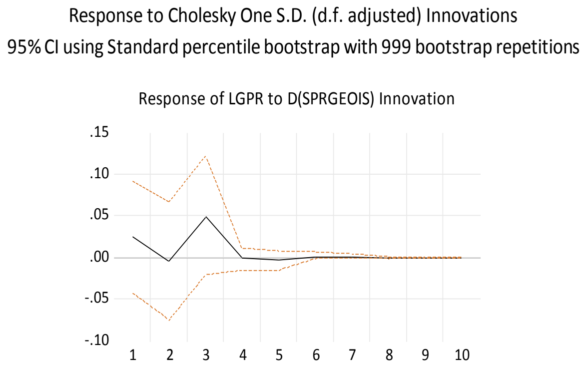
Notes: Data source https://www2.bc.edu/matteo-iacoviello/gpr.htm

Figure 3. Pre-crisis bivariate Generalised IRFs
Panel I. Germany



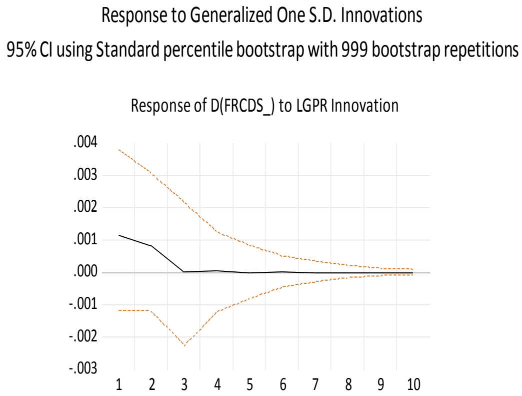


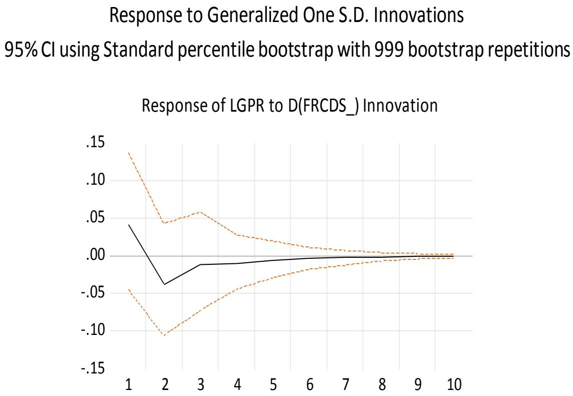


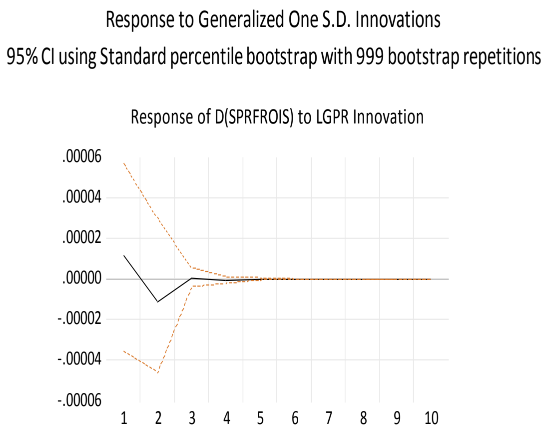


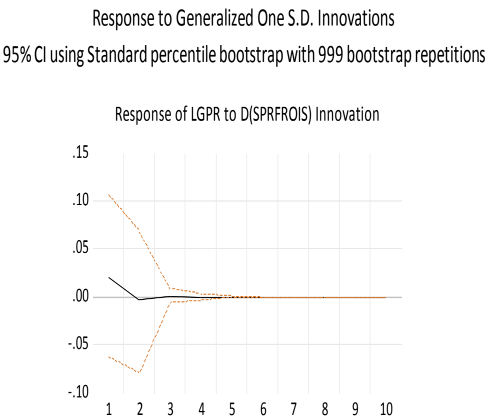
Notes: VAR has 2 lags based on Akaike.

Panel II. France



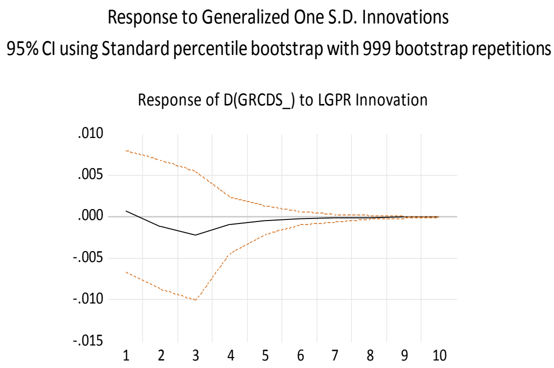


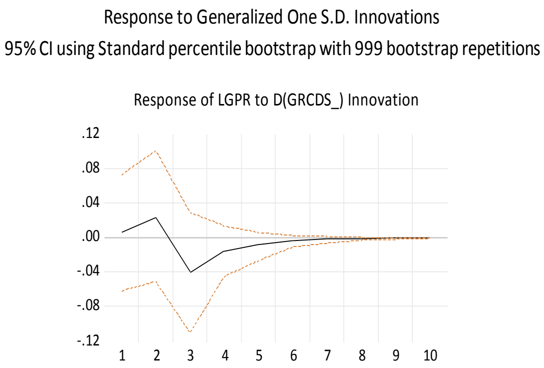


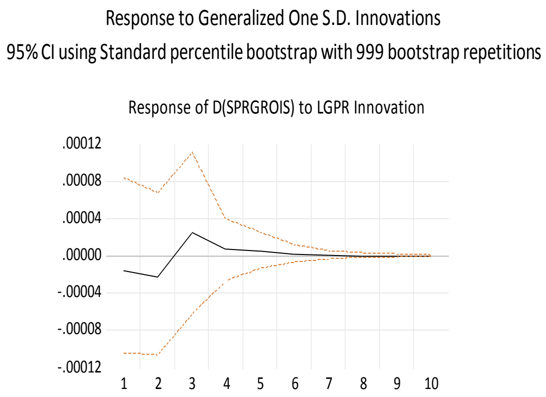


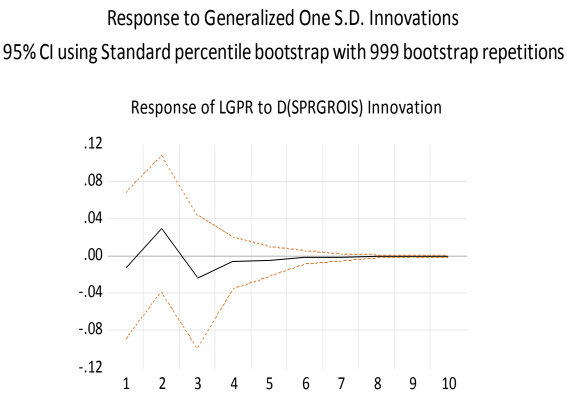
Notes: VAR has 1 lag based on Akaike.

Panel III. Greece

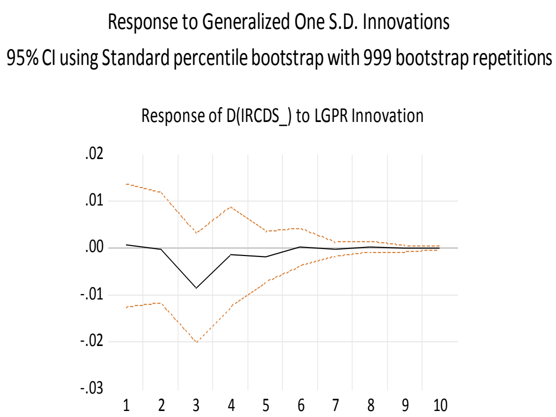


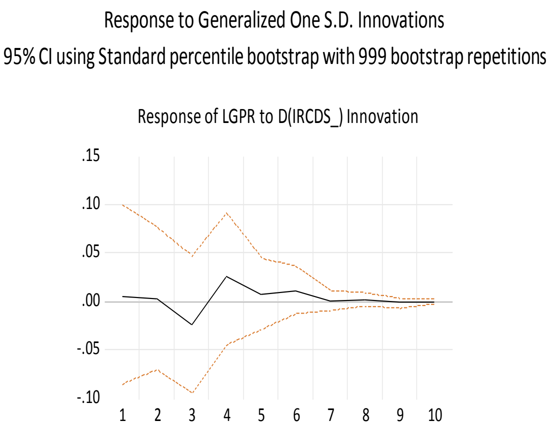






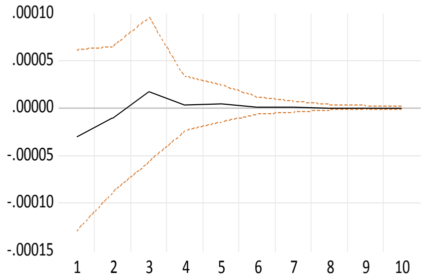
Panel IV. Ireland





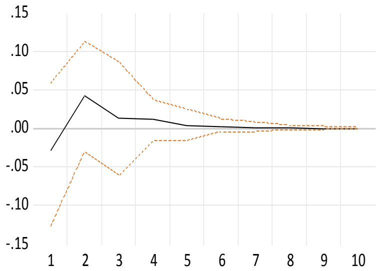
Response to Generalized One S.D. Innovations
95% CI using Standard percentile bootstrap with 999 bootstrap repetitions

Response of D(SPRIROIS) to LGPR Innovation



Response to Generalized One S.D. Innovations
95% CI using Standard percentile bootstrap with 999 bootstrap repetitions

Response of LGPR to D(SPRIROIS) Innovation

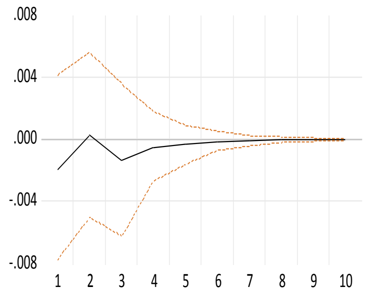


Notes: VAR has 2 lags based on Akaike.

Panel V. Italy

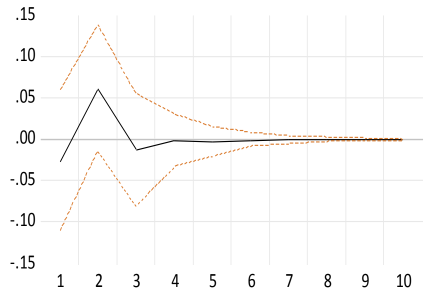
Response to Generalized One S.D. Innovations
95% CI using Standard percentile bootstrap with 999 bootstrap repetitions

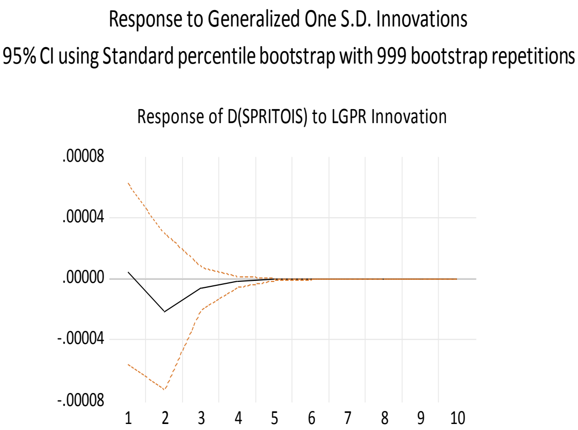
Response of D(ITCDS_) to LGPR Innovation

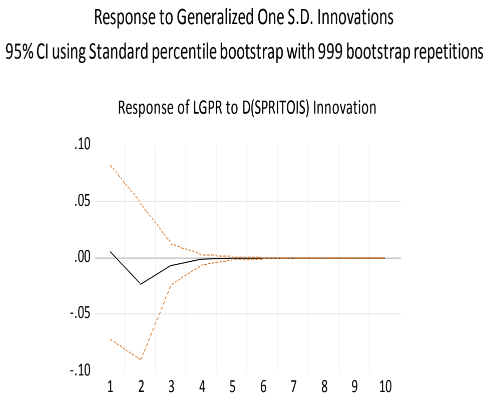


Response to Generalized One S.D. Innovations
95% CI using Standard percentile bootstrap with 999 bootstrap repetitions

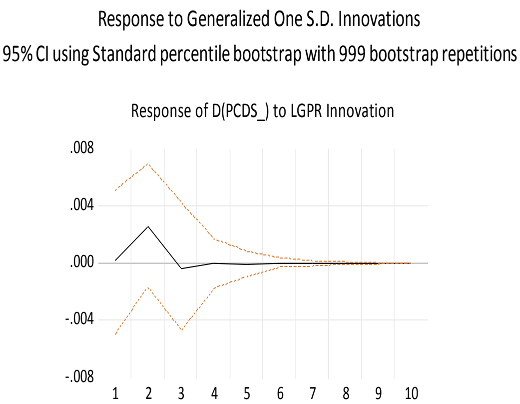
Response of LGPR to D(ITCDS_) Innovation

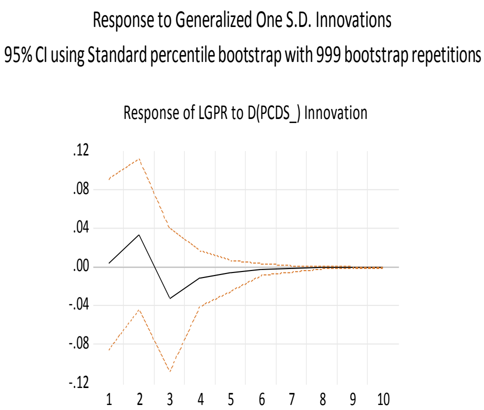


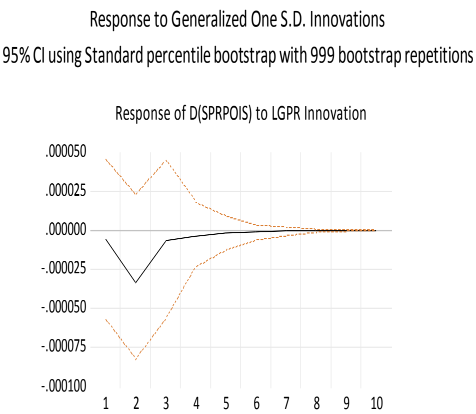


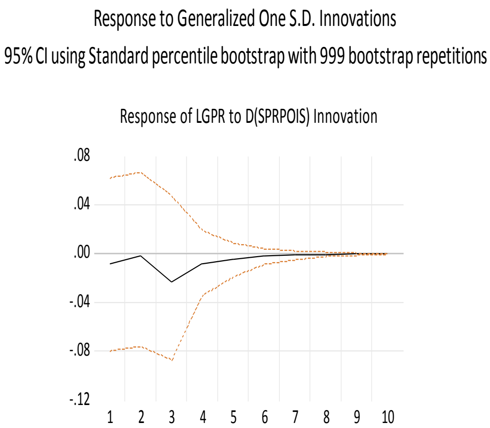


Panel VII. Portugal

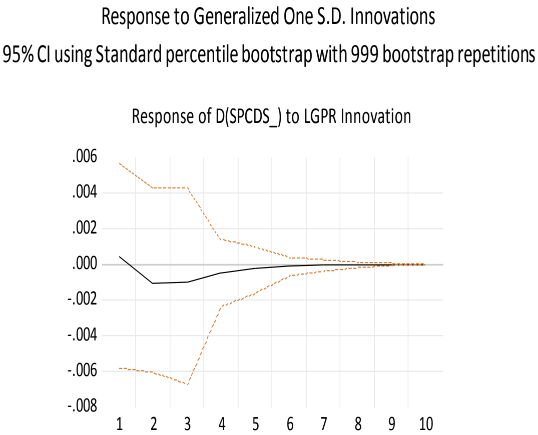


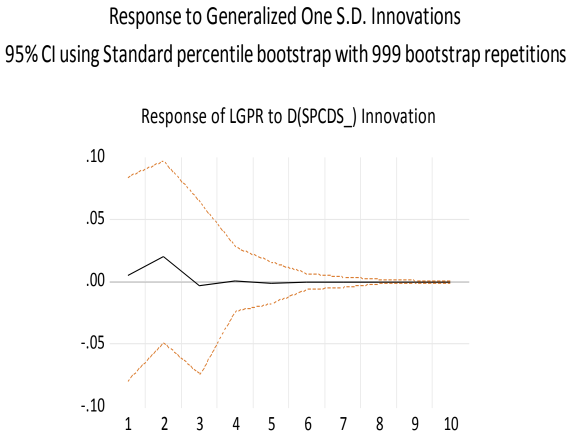


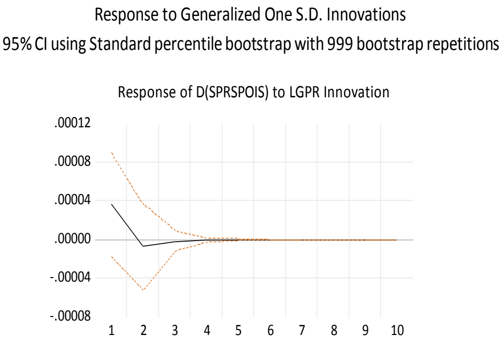




Panel VIII. Spain







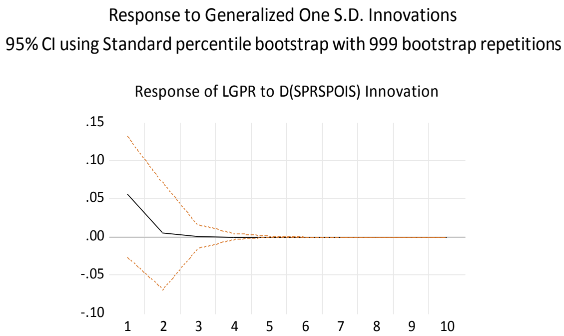
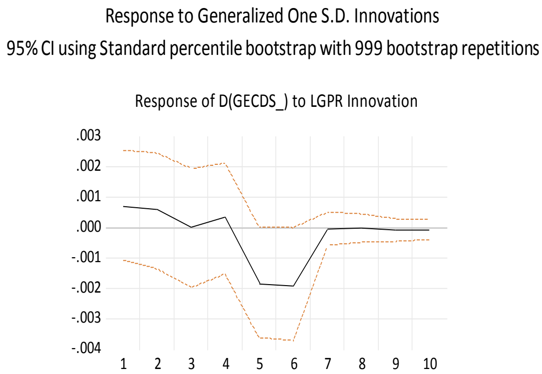
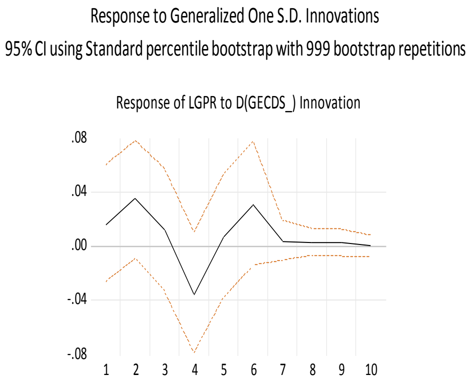
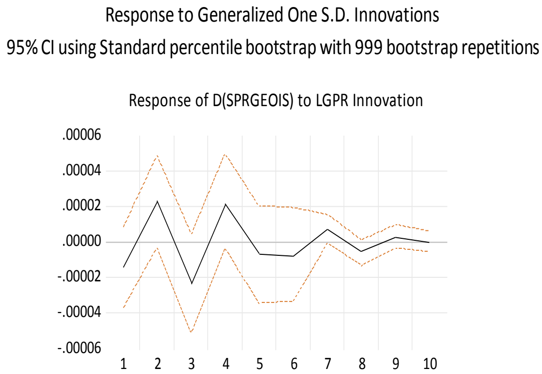


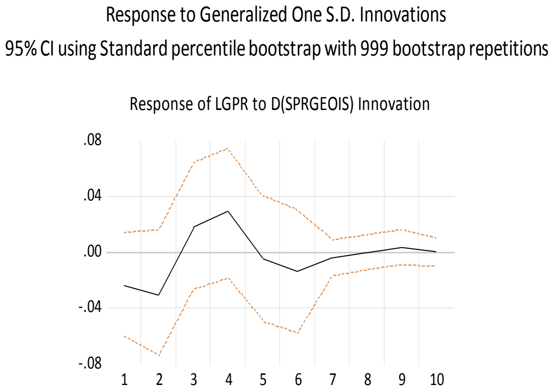
Figure 4. During crisis bivariate Generalised IRFs (30/11/2009- 25/7/2012)

Panel I. Germany

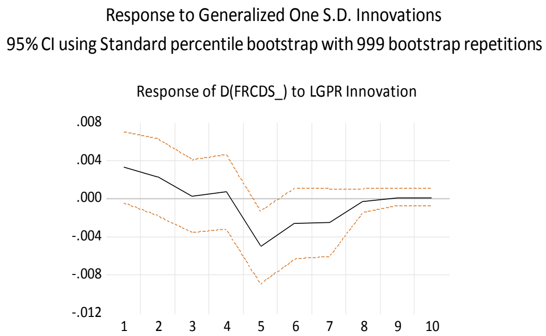


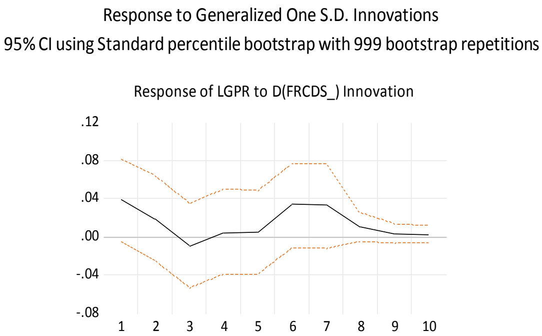


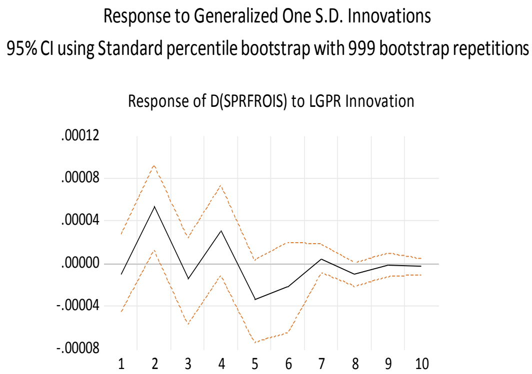


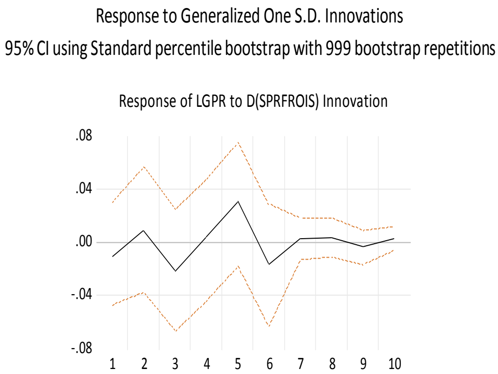


Panel II. France



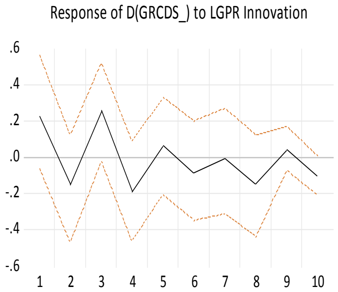




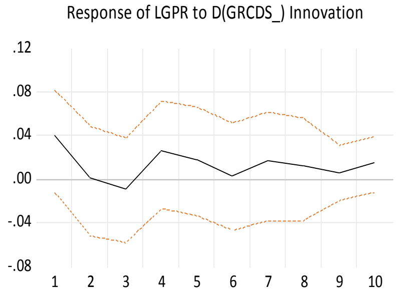


Panel III. Greece (till 9/3/2012)

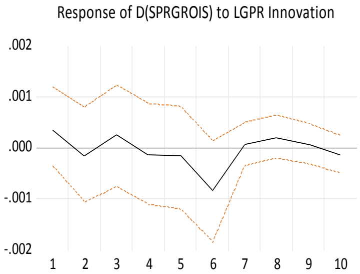
Response to Generalized One S.D. Innovations
95% CI using Standard percentile bootstrap with 999 bootstrap repetitions



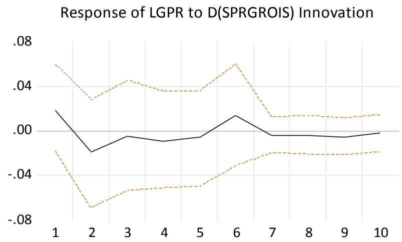
Response to Generalized One S.D. Innovations
95% CI using Standard percentile bootstrap with 999 bootstrap repetitions



Response to Generalized One S.D. Innovations
95% CI using Standard percentile bootstrap with 999 bootstrap repetitions

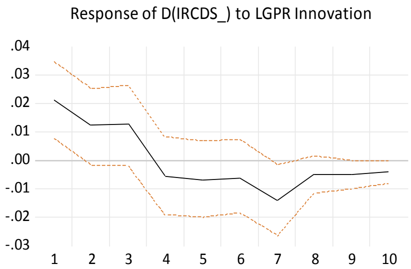


Response to Generalized One S.D. Innovations
95% CI using Standard percentile bootstrap with 999 bootstrap repetitions

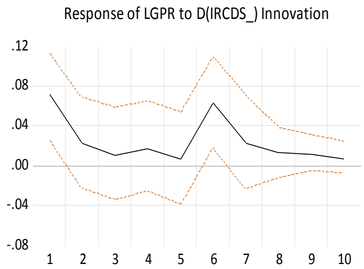


Panel IV. Ireland

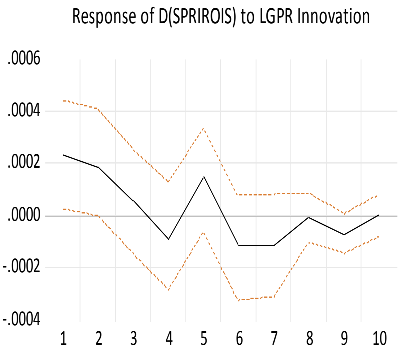
Response to Generalized One S.D. Innovations
95% CI using Standard percentile bootstrap with 999 bootstrap repetitions



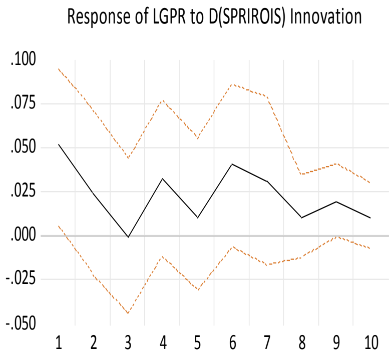
Response to Generalized One S.D. Innovations
95% CI using Standard percentile bootstrap with 999 bootstrap repetitions



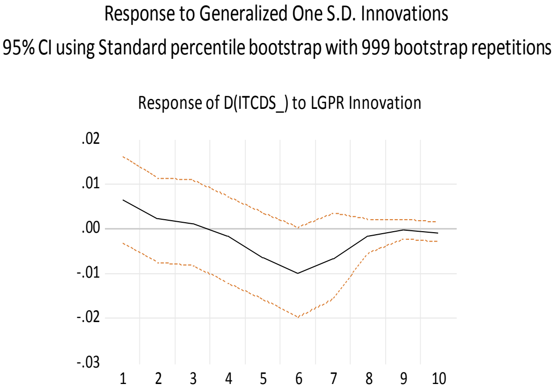
Response to Generalized One S.D. Innovations
95% CI using Standard percentile bootstrap with 999 bootstrap repetitions

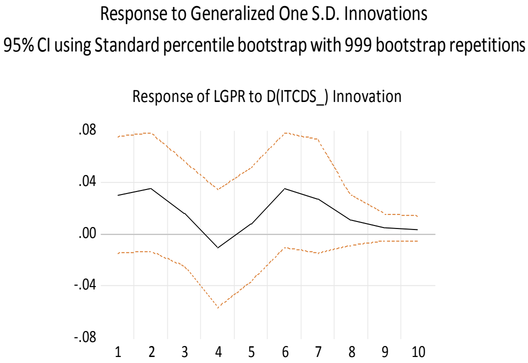


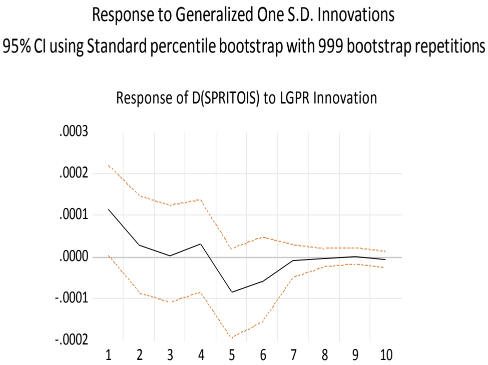
Response to Generalized One S.D. Innovations
95% CI using Standard percentile bootstrap with 999 bootstrap repetitions

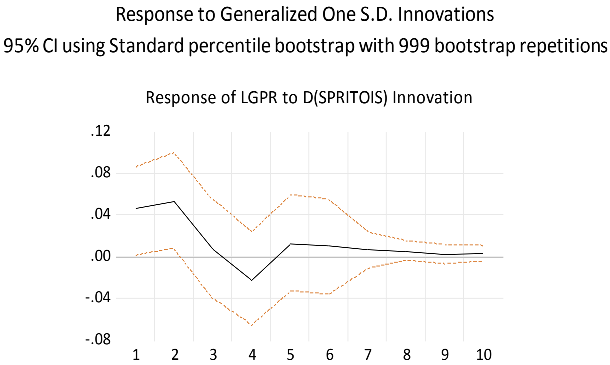


Panel V. Italy

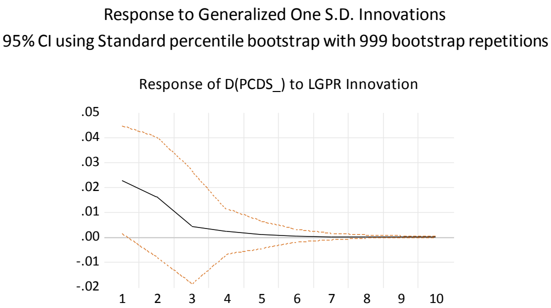


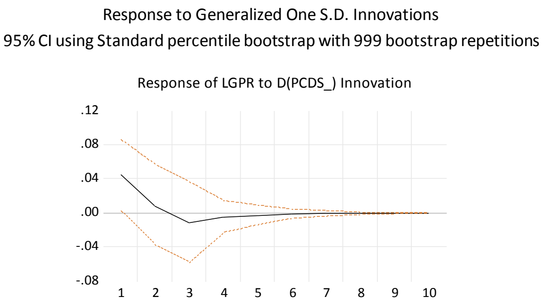


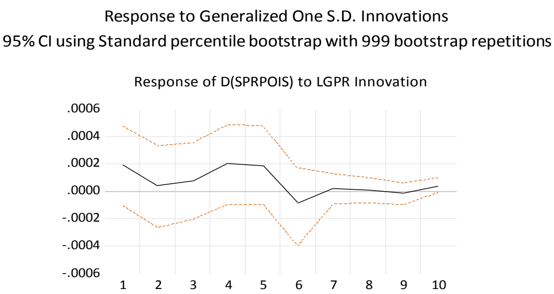


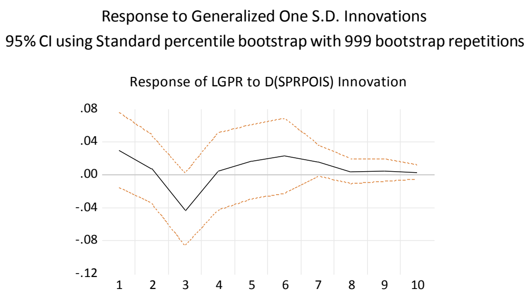


Panel VI. Portugal





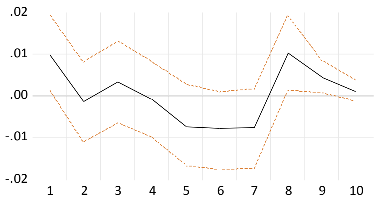




Panel VII.Spain

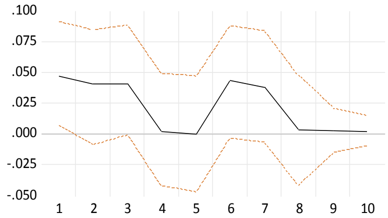
Response to Generalized One S.D. Innovations
95% CI using Standard percentile bootstrap with 999 bootstrap repetitions

Response of D(SPCDS_) to LGPR Innovation



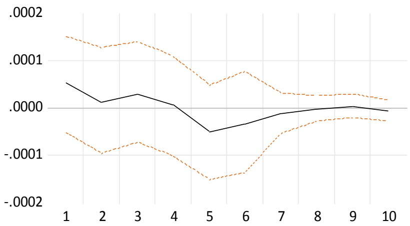
Response to Generalized One S.D. Innovations
95% CI using Standard percentile bootstrap with 999 bootstrap repetitions

Response of LGPR to D(SPCDS_) Innovation



Response to Generalized One S.D. Innovations
95% CI using Standard percentile bootstrap with 999 bootstrap repetitions

Response of D(SPRSPOIS) to LGPR Innovation



Response to Generalized One S.D. Innovations
95% CI using Standard percentile bootstrap with 999 bootstrap repetitions

Response of LGPR to D(SPRSPOIS) Innovation

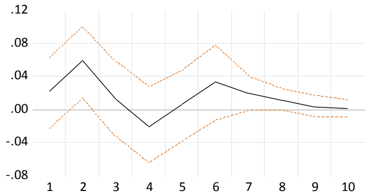
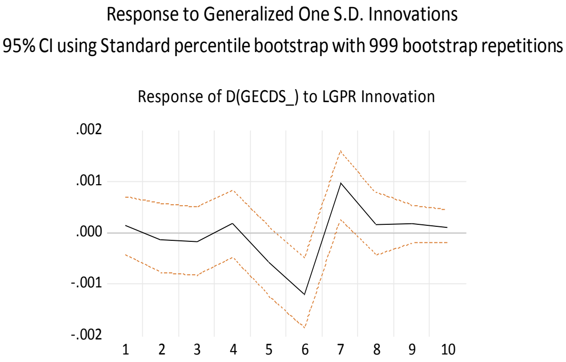
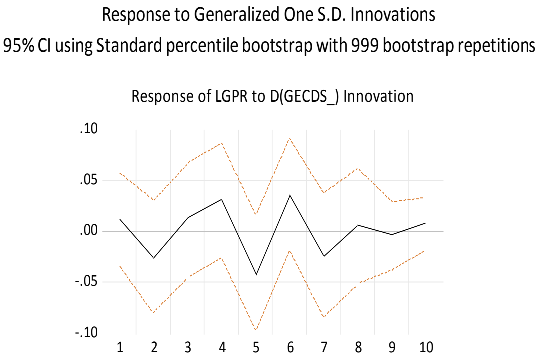


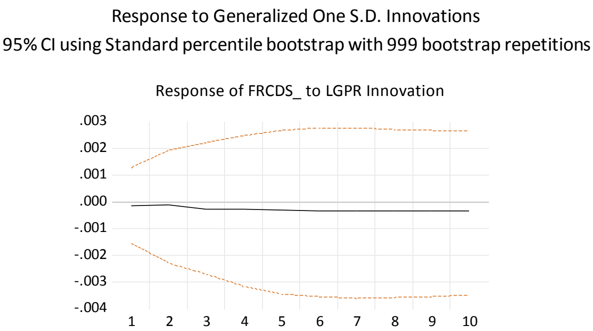
Figure 5. Post-crisis (26/7/2012-30/4/2014)

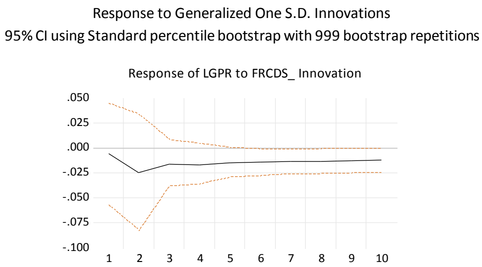
Panel I. Germany

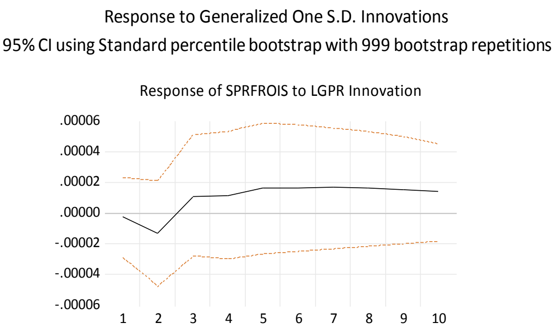


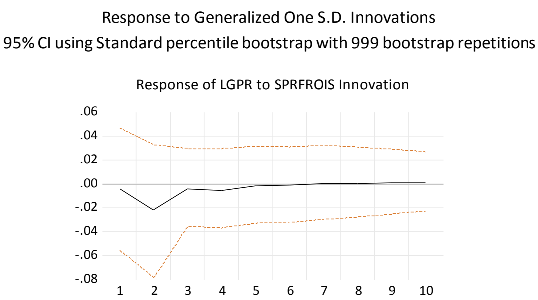


Panel II. France

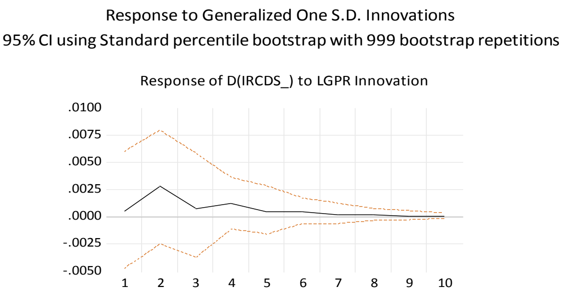


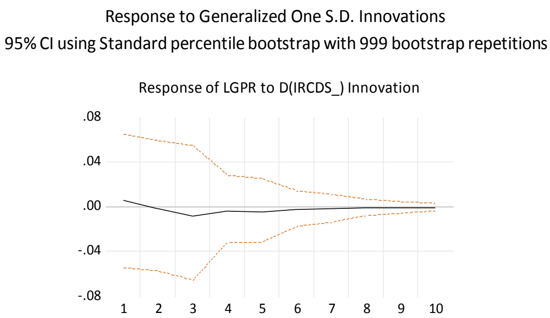


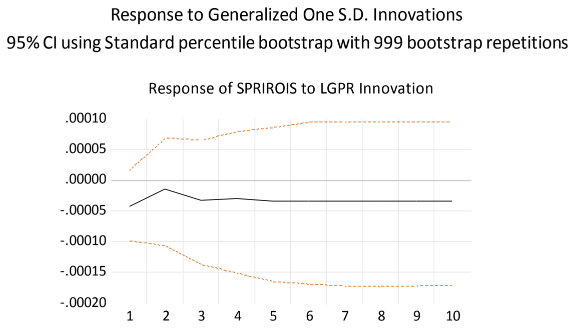


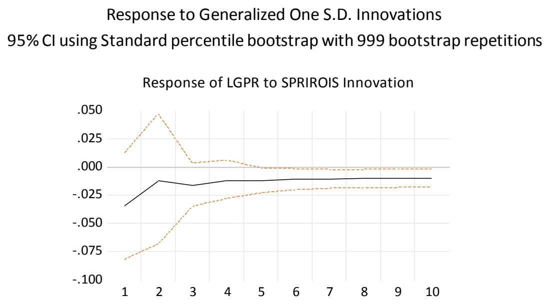


Panel III. Ireland

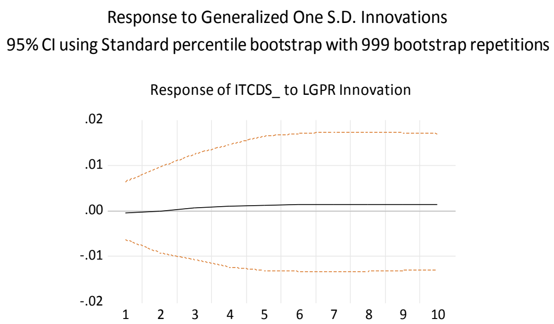


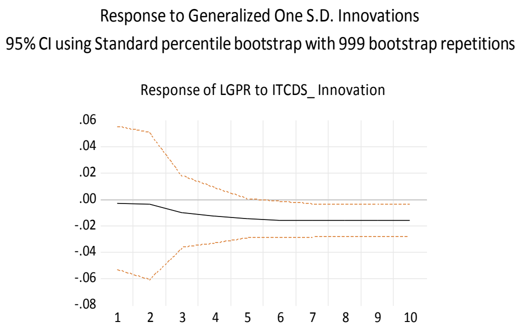


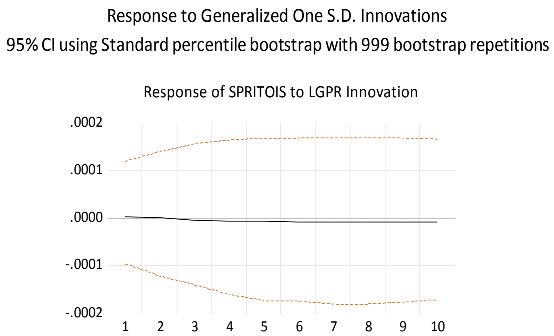


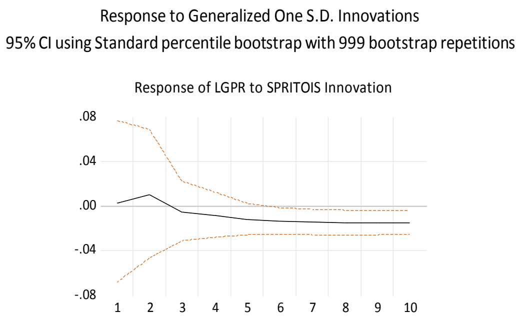


Panel IV. Italy

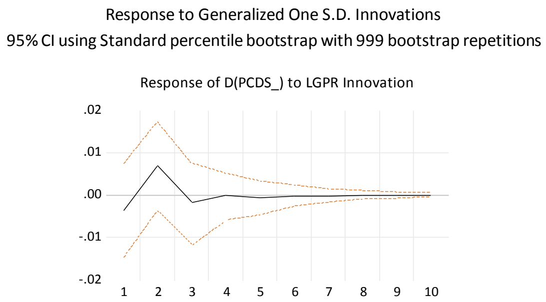


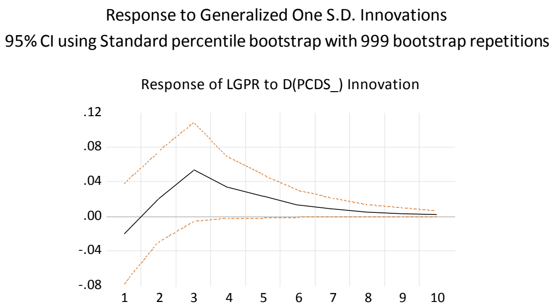


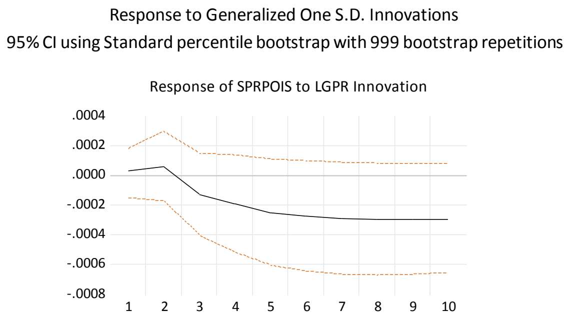


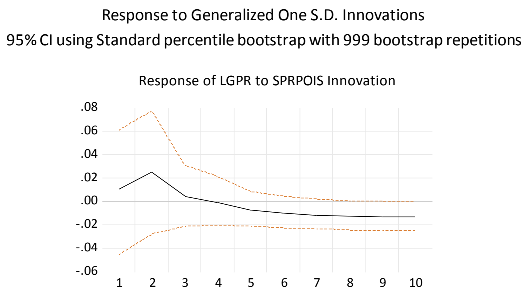


Panel V. Portugal

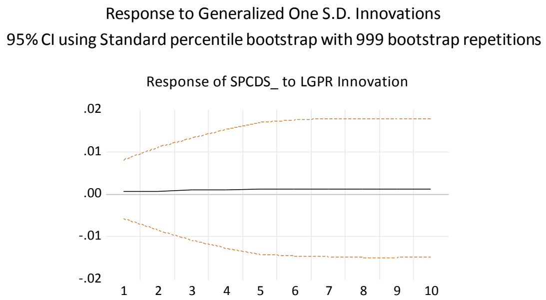


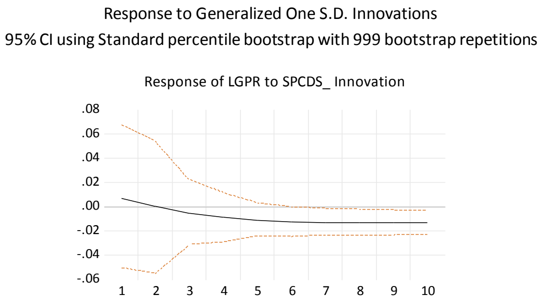


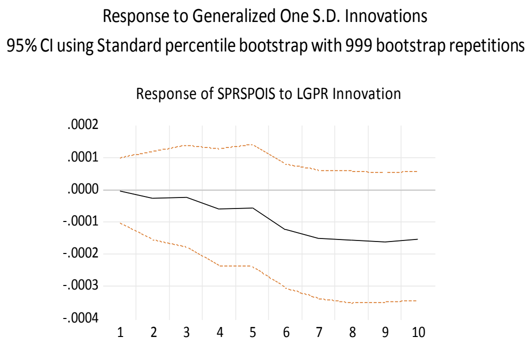


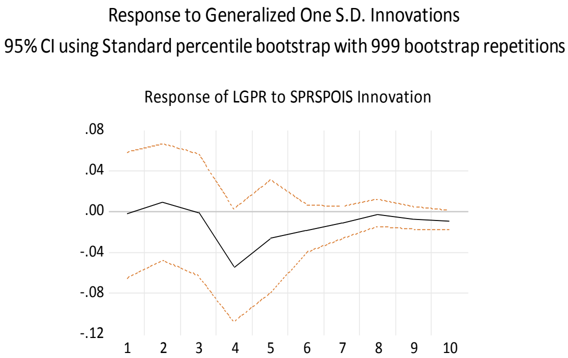


Panel VI. Spain









Notes: Greece has been excluded from the analysis (discontinuity of series)