

The Macroeconomic Implications of Credit Rating Shocks in Southern Europe: Identification through Narrative Approach

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Abstract

This paper focuses on the macroeconomic implications of rating announcements for Portugal, Italy, Greece and Spain over the period that goes from March 1999 to March 2014. The objective of the paper is twofold. The identification of the credit rating shocks on one hand and the estimation of their macroeconomic effects on the other. By means of a combination of narrative and high frequency strategy I build an external instrument, the Rating Announcements proxy, that allows the identification of such shocks. The identifying strategy relies on the assumption that the change in daily sovereign bond volatility that occurs around a rating action is due to the announcement itself. Through proxy structural vector autoregression I provide new evidence of the responsiveness of macroeconomic fundamentals to rating announcements. I show how output and government budget responses are negative, of small entity and relatively short-lived. Furthermore, a counterfactual analysis shows how the identified shocks seem to provide a good contribution to the explanation of the variability of the sovereign borrowing costs.

Keywords: Rating announcements, Narrative identification, High frequency identification, Proxy SVAR.

JEL Classification Numbers: E44, G15, G24.

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1 Introduction

What are the macroeconomic implications of rating announcements? More precisely, what are the implications of such announcements on those economies that are already in the spotlight because of the weakness of their macroeconomic fundamentals? The recent European sovereign debt crisis has renewed the debate regarding the role of credit rating agencies (henceforth CRAs) during crisis periods. The mentioned crisis has been mainly characterised by a slow down in the economic activity, a worsening in government balances and increases in both sovereign debts and yields. In addition, an unprecedented number of rating actions, mainly regarding South European countries, was implemented in such a brief time period by the three major agencies, i.e., Moody's, Standard & Poor's and Fitch.

There exists an extensive literature that tries to describe how CRAs play a relevant role in aggravating a country's macroeconomic condition especially if it is already experiencing a crisis. As a matter of fact, it is undoubted how the rating industry would influence investors' required remuneration. This would, in turn, translate into higher interest rates on public debt with ensuing negative effects on output and government budgets.

This paper focuses on how CRAs announcements have an impact on sovereign borrowing costs and subsequently on macroeconomic fundamentals. The main contribution is the construction of a proxy for credit rating shocks to be used as an external instrument within a proxy structural vector autoregression. This is carried out through a combination of high frequency and narrative strategy to extrapolate the exogenous movement in the volatility of a country's bond yield immediately after a rating announcement takes place. The identifying strategy relies on the assumption that the change in bond volatility that is generally observed after a rating action is due to the announcement itself. In order to isolate the exogenous component of bond yield volatility I build a narrative dataset over the period that goes from March 1999 to March 2014. The dataset contains the daily bond yield volatility reactions to rating announcements from Moody's, Standard & Poor's and Fitch. The countries of interest are Portugal, Italy, Greece and Spain because, especially during the European sovereign debt crisis, they were at the center of attention because of the weakness of their fundamentals as well as their uncertain ability to repay the debt. This heightened concern resulted in more than twenty rating actions for each of them. The scope of the analysis is to focus only on the macroeconomic implications of such shocks for each of these countries separately. There is no attempt to disentangle possible spillover effects.

Using the mentioned dataset and proxy SVARs I show how output and government balance respond negatively to the identified rating shocks. Overall, the responses are of small entity and relatively short-lived. Finally, the identified shocks seem to provide a good contribution to the explanation of the variability of the sovereign borrowing costs.

The rest of the paper is organised as follows. Section 2 provides a review of the literature this paper is related to while Section 3 describes the methodology used for the identification of the rating shocks as well as their effects. More precisely, Section 3 justifies the use of a proxy SVAR and outlines the derivation of the Rating Announcements proxy. Furthermore, it discusses the exogeneity and the possible weaknesses of such an instrument. Section 4 provides the benchmark results together with those deriving from two robustness checks. Finally, Section 5 concludes with a summary of the results.

2 Related Literature

This paper is mainly related to two strands of literature. The literature relative to the effect of rating announcements from a theoretical standpoint and the literature relative to the use of narrative methods to identify macroeconomic shocks from a methodological one. The literature about the effect of rating announcements, that has experienced a notable growth in conjunction with the Asian crisis of the late 1990s, can be ideally divided into two strands. The first focuses on the effect that rating announcements have mainly on the sovereign bond yields while the second on the role played by CRAs in aggravating an ongoing economic crisis.

Many works belong to the former. Reisen and Maltzan (1999), with sovereign credit rating data from Standard & Poor's, Moody's and Fitch Ratings, perform an event study for the period that goes from 1989 to 1997. By exploring the market response for 30 trading days before and after rating announcements, they find a significant rating effect on the government bond yield spread when a country is put on review for a downgrade. They also report the existence of a two-way causality between sovereign credit ratings and government bond yield spreads for the set of 29 emerging markets in their study. Kräussl (2005) conducts an event analysis using daily sovereign ratings of long-term foreign-currency denominated debt from Standard & Poor's and Moody's. He builds an index of speculative market pressure to gauge the ratings effect on financial markets over the period that stretches from the 1st of January 1997 to the 31st December 2000. The author shows how sovereign rating changes as well as credit outlooks have a relevant effect on both size and volatility of lending in emerging markets. Such an effect is remarkable in the case of negative rating actions, i.e., rating downgrades and negative outlooks. Afonso, Furceri and Gomes (2012) carry out an event analysis that focuses on the reaction of sovereign yield spreads before and after rating announcements from Moody's, Standard & Poor's and Fitch. They find significant responses of sovereign yield spreads in conjunction with either changes in rating node or outlook especially if such changes are negative. They also find a bi-directional causality between ratings and spreads within 1-2 weeks and, more importantly, they also report that announcements would not be anticipated at 1-2 month horizon.

Notable examples relative to the second strand are Larraín, Reisen and Maltzan (1997) and Ferri, Liu and Stiglitz (1999). The first work, using panel data analysis and event studies relative to 26 OECD and non-OECD countries, provides evidence of how credit ratings have a significant impact on international financial markets. It shows how the rating industry could aggravate an ongoing crisis because negative rating actions would have the potential to dampen private capital inflows into emerging markets. The second shows how CRAs amplified the East Asian crisis by becoming excessively conservative after failing to predict the emergence of the crisis. The assignment of a rating lower than that justifiable by the worsening of the East Asian countries' macroeconomic fundamentals caused a rise in the cost of borrowing abroad with an inevitable shrinkage of supply of international capital. This, at least for some time, contributed to the aggravation of the ongoing crisis.

The link to the empirical macroeconomic literature which uses narrative methods to identify macroeconomic shocks, as previously mentioned, is essentially due to the methodology adopted in this paper. One of the earliest works relative to this strand of literature was Romer and Romer (1989) for the identification of monetary policy shocks¹. The approach entails the careful reading of policy

¹Many other works with a similar approach have been developed. Noteworthy examples are Romer and Romer (2004)

documents, press releases or the analysis of other relevant historical events. The aim is the identification of innovations in economic series that could be used as exogenous regressors and that are separated from the estimated disturbances in a time series model. In this paper the exogenous regressor will be used as an external instrument proxying the underlying shocks of interest within the framework developed by Stock and Watson (2012) and Mertens and Ravn (2013), i.e., the proxy SVAR.

The way this paper aims at identifying the shock of interest belongs to a relatively new strand of literature, i.e., the high frequency identification literature. The approach taken aims at isolating the exogenous reaction of economic time series generated by relevant events through the use of high frequency market data. As a matter of fact, daily and intra-daily data allow to disentangle the exogenous component of a time series more easily. The reason being the fact that the common information about a country's macroeconomic condition should be already incorporated in market prices around the precise moment in which a relevant announcement takes place. A sudden and temporary change in an economic time series may therefore provide evidence of an exogenous shock. Two works that use this identification strategy are worth mentioning. Cochrane and Piazzesi (2002) study the effect of monetary policy shocks defined as changes in the Fed funds target rate, occurring on Federal Open Market Committee meeting days, that surprise bond markets in daily data. Their main finding is a large and persistent response of bond yields to the identified shocks. Gertler and Karadi (2015), instead, provide evidence on the nature of the monetary policy transmission mechanism. They show how their external instrument proxying monetary policy shocks, when used within a proxy SVAR, generates impulse responses of macroeconomic fundamentals, e.g., output and inflation, that are consistent with those that can be obtained in a standard monetary VAR analysis. However, they find small movements in short term rates but large ones in economic activity and credit cost.

Besides these two mentioned works there are some others that try to go even deeper in the nature of the data with the aim of extrapolating their exogenous components. These works rely on intra-day identification. Nakamura and Steinsson (2013) provide evidence of the responsiveness of real interest rates and inflation to monetary shocks. The latter are identified by the increase in the volatility of interest rates following the scheduled Federal Reserve announcements. Their identifying assumption is that the increase in volatility of interest rates, in a 30-minute window around the announcements, is due to monetary news. They argue that their identification scheme, based on "background noise" in interest rates in correspondence of FOCM days, is of paramount importance in identifying monetary policy shocks especially at longer horizons. Finally, Bahaj (2014) estimates the effects of systemic sovereign risk within the Euro Area. His identifying strategy relies on the isolation of exogenous sources of fluctuations in sovereign yields as they would pertain to events that take place abroad and, at least in principle, have no relevance for the economy under analysis. In his work, the instrument developed for a particular country is given by its bond yield reaction around relevant events that happened in other Euro Area countries.

for monetary policy shocks, Ramey and Shapiro (1998) and Ramey (2011) for government spending shocks and Romer and Romer (2010) and Mertens and Ravn (2014) for tax shocks.

3 Econometric Methodology

This section lays out the econometric methodology. It justifies the use of a proxy SVAR and provides an example that motivates the construction of the Rating Announcements instrument. Furthermore, it deeply explains the construction of this narrative measure and discusses its exogeneity and possible weaknesses. Finally, it shows how the proxy SVAR estimates the shocks of interest and their macroeconomic implications.

3.1 Motivation of the Approach

The use of a proxy SVAR for the estimation of rating shocks is mainly due to two reasons. First, it reflects the necessity to link a narrative approach with the flexibility of VAR models. On one hand narrative methods achieved remarkable results in studies focusing on the transmission of news between both countries and markets during the Euro crisis², on the other VAR models have always proven to be a suitable econometric tool for modelling macroeconomic phenomena as they easily allow for dynamic interactions among variables. In their recent work, Stock and Watson (2012) show how powerful proxy SVARs are in identifying the several shocks that produced the 2007-2009 recession in the United States.

Second, it would denote how other commonly used identifications schemes do not seem suitable for the aims of this paper. The identification of shocks through short run restrictions seems implausible mainly because in a period of high turbulence variables respond to one another quite fastly. This problem becomes even more relevant when financial variables are included in the VAR or data are at higher frequency. As a matter of fact, it seems too restrictive to assume that a rating shock would have no contemporaneous effect on macroeconomic variables within one month or one quarter especially in a turbulent period. Long run restrictions, instead, are excluded because the assumption that only some of the endogenous variables have a null response in the long run seems too strong. Moreover, such an identification works properly only when all the variables in the VAR are integrated. Finally, identification via sign restrictions is ruled out simply because, in order to have responses with a predetermined sign, it would be necessary to refer to a theoretical framework. Furthermore, the mentioned three identification schemes present a major problem. All of them would require the insertion of an instrument proxying the rating shocks among the endogenous variables. Unfortunately, this would cause the estimated VAR coefficient to suffer from attenuation bias due to the likely measurement error made during the instrument construction.

3.2 The Rating Announcements Proxy

The key contribution of this work is the construction of a narrative series that tries to identify the shocks that announcements from the three major CRAs had on sovereign bond yields. To my knowledge, no other instrument with the same aim has been developed in the empirical macroeconomic literature.

The way the Rating Announcements proxy is developed stems from the observation of how sovereign bond yields show a sudden change in volatility immediately after a rating action is implemented. The aim of the proxy is not to directly measure the shock, say, of a downgrade from AAA to AA+ or

²See for example Beetsma, Giuliodori, de Jong and Widijanto (2013) and Brutti and Saure (2012).

of a downgrade from investment grade to speculative grade or even of a credit outlook. In fact, two equivalent rating actions may generate different effects once they reach the market simply because they are released in two different periods when the country’s economic conditions were totally different. By the same token, a simple credit watch or outlook may have a stronger impact than a rating upgrade or downgrade if, for example, it was released in a period of high market turbulence. The Rating Announcements proxy tries to gauge what was the bond market response to each rating action made in each point in time regardless of the kind of announcement. As a narrative measure, it represents a measure of the latent structural shocks. To support this identifying assumption, it is worth showing the following example.

3.2.1 Evidence from Specific Rating Actions

The example chosen wants to show the different market reactions to four rating announcements regarding Greece during March and April 2010. Figure 1 shows the Greek 10-year bond yield volatility³ and highlights its behaviour in correspondence of the rating actions.

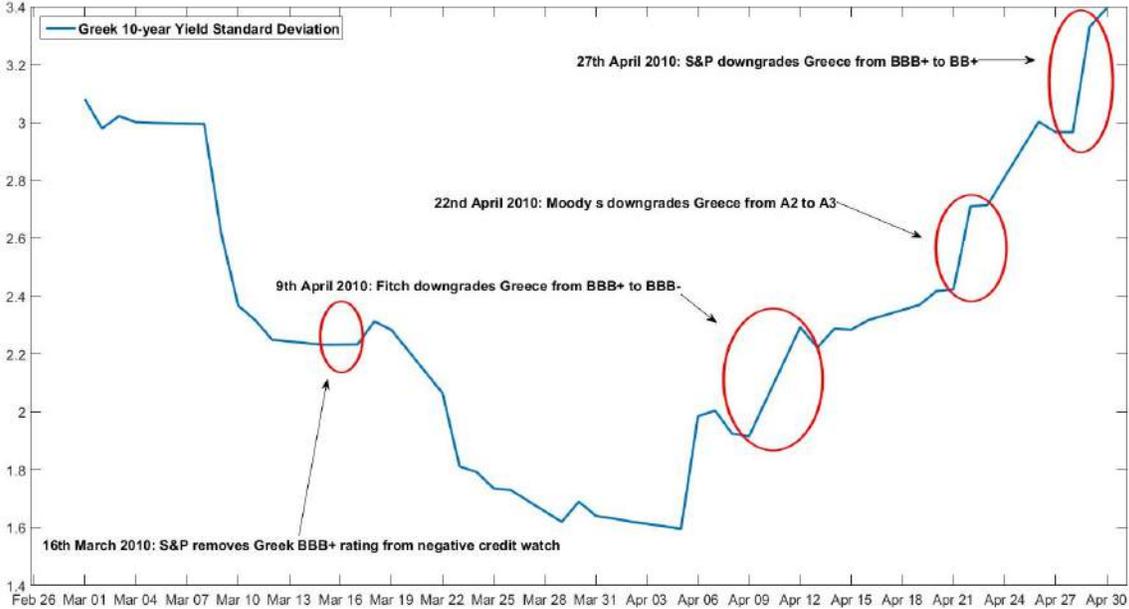


Figure 1: Greece is downgraded by the three CRAs over March and April 2010

The picture clearly shows how the four market reactions were somehow different from one another. On the 16th of March Standard & Poor’s reaffirms the Greek BBB+ rating and, in addition, removes it from a negative credit watch. The market seems to react very little as the volatility does not appear to significantly change. Conversely, more evident market reactions are detected in April 2010 following the downgrades operated by all the three agencies. The Fitch’s downgrade from BBB+ to BBB- on the 9th of April seems to cause an increase in volatility of nearly 0.3% while that operated by Moody’s, from A2 to A3 on the 22nd of April, an increase of nearly 0.2%. Finally, after Standard & Poor’s

³Measured as the standard deviation of the percentage change in the yield over the preceding 30 days.

downgrades Greece from BBB+ to BB+ on the 27th of April, the volatility goes up of nearly 0.3%.

3.2.2 Proxy Construction

The narrative and high frequency strategy used in this paper attempts to isolate events like those reported in the example above. As already stated, it tries to gauge the bond market reaction by looking at how the volatility changes in correspondence of a rating action operated by the three major CRAs. The credit rating announcements considered in this work are upgrades and downgrades, credit watches and outlooks regarding both the long-term foreign-currency denominated debt and the long-term foreign-currency issuer default.

For the construction of my proxy I start from a natural index of sovereign bond market volatility, i.e., the volatility of the 10-year sovereign bond yield. I use such an index because, to my knowledge, there is no a measure like a Treasury Yield VIX available for the four countries of interest over the years from 1999 to 2014. Volatility here is simply measured as the standard deviation of the percentage change on the daily yield calculated over the preceding 30 days. The choice of a 30-day window reflects the necessity of a measure of volatility that does not give weight to observations that are too far back in time. A “short term” volatility seems an appropriate and reliable starting point for proxying rating shocks as it would reduce the possibility to consider changes in volatility caused by past events⁴.

In order to capture the effect of each announcement, the measure of the shock is given by the difference between the average volatility over the 5 days preceding the announcement and the average volatility over the subsequent 5 days including the day of the announcement. The 5-day window relies on the will to capture the difference in volatilities occurring between the financial week preceding and following the rating action. A financial week is deemed to be a reasonable period of time to gauge the shock of interest. Furthermore, this would lower the possibility to include portions of change in volatility that are not directly imputed to the rating announcement considered⁵.

From what outlined, it follows that the daily measure of the proxy is given by the following formula:

$$Daily\ Proxy = e_{dt}^r = \frac{1}{5} \sum_{i=0}^4 v_{d+i} - \frac{1}{5} \sum_{j=1}^5 v_{d-j} = \bar{v}_{after} - \bar{v}_{before} \quad (1)$$

where v_d denotes the daily value of the bond yield volatility and the subscript d the exact day in which a rating action occurred. Moreover, \bar{v}_{before} and \bar{v}_{after} respectively denote the average volatilities over the 5 days before and after the announcement. Finally, the aggregation of such daily values at monthly frequency yields the Rating Announcements proxy:

$$Monthly\ Proxy = Rating\ Announcements_t = e_t^r = \sum_{d=1}^M e_{dt}^r \quad (2)$$

where d denotes a day in the month t and M is the number of days in the month. It is clear how the proxy is censored as in some days it is not observed as no rating actions occurred.

⁴Other measures of volatility are commonly used in the financial markets. An example could be the daily squared yield. However it does not seem recommendable for this work as the average daily yield is far from being equal to zero.

⁵Needless to say, the usage of higher frequency data would lower even more the possibility of such a problem to arise. For example, the usage of intraday data would allow to determine the precise moment in which a news reached the market and to gauge its reaction in an more precise way. See Nakamura and Steinsson (2013) and Bahaj (2014).

3.2.3 Exogeneity of the Rating Announcements Proxy

At this juncture one may wonder whether the Rating Announcements proxy can be considered as an exogenous instrument. First, even though rating actions are generally related to changes in a country's macroeconomic prospective conditions, the proxy does aim at identifying which rating actions were fully expected (in terms of timing and magnitude) and which others, instead, were not. Conversely, it aims at disentangling only the "visible" effect that such announcements have on the sovereign bond market volatility. This takes place in two ways: by timing the exact day in which a rating action is implemented and by looking only at the portion of change in volatility that may be directly imputed to the announcement. If only a tiny change in volatility is observed then the action was somehow expected or irrelevant. The idea of identifying rating announcement shocks from actual volatility, as a matter of fact, relies on the assumption that if rating announcements do not contain "valuable and unexpected" information there would be little reason for the market to immediately react after such information releases. In other words, there should not be any significant reason for the bond yield volatility to vary immediately after the announcement. If this is the case, the announcement would represent a minor shock or it would not represent a shock at all.

Second, even though the market may to some extent expect a rating action, it does not know precisely what action will be implemented. As a matter of fact, the latter may be an upgrade or downgrade or simply a credit watch or outlook. This means that the rating action may well be above or below the market expectations, if there were any. If this is the case, again, the market could react by significantly increase the volatility and such a reaction may be interpreted as the unanticipated component of the announcement that is orthogonal to shocks that the market is already aware of.

Finally, the exogeneity of the instrument is further validated by the nature of the volatility jumps utilised for its construction as, most of them, appear temporary as they occur in conjunction with the announcements. For this reason, the proxy cannot be strictly and directly linked to (or even caused by) changes in macroeconomic conditions or fundamentals that, instead, are longer-lived and publicly known.

3.2.4 Remarks and Possible Problems

Three main remarks are worth making about this identification scheme. The first regards what happens in the case of two (or more) rating announcements that are released close to each other. Suppose the first is a downgrade that is perceived as valuable information by the market. Given the identifying assumption used in this paper, the sovereign bond market would be expected to react by increasing the yield volatility. Suppose now that the second announcement is an analogous downgrade operated by another CRA that does not represent relevant information. In this case, the market should react less (or even not react at all) because it already knew that piece of information. If this happens, the effect of the second rating action, and therefore the second shock, would be very small or even negligible. In other words, the second action may have a lower informational content or may be entirely anticipated by the time of the announcement.

The second remark is related to the possibility for the proxy not to be able to disentangle the shock of interest in the case of simultaneous events. This problem is generally overcome by the nature of the data used. Given the high frequency of the dataset, there is a very little probability for two

relevant events to happen on the same day. Nevertheless, whenever this was not the case, those rating actions that took place in conjunction with more relevant events happening in the country analysed were excluded from the narrative⁶. The sudden increases in volatility that follow are not deemed to be caused by the rating actions but by the events themselves.

The third regards the possibility for this proxy to capture not only temporary changes in bond yield volatility due to rating actions but also broader changes in volatility of the country. First, this possibility should be avoided by the way the proxy is built. The proxy attempts to disentangle only that portion of increase in volatility imputable to the announcement. This would be ensured by the brief windows used in the calculation of the volatility (30-day) and that used to compare the average volatility before and after the announcement (5-day). Second, it is possible to run an ex-post test. The estimated structural shocks may be subsequently compared with those obtained by using an instrument proxying a country's volatility or European uncertainty innovations. A low correlation would be evidence of how the Rating Announcements is not proxying a generic increase in volatility⁷.

3.3 Proxy Structural Vector Autoregression

The proxy SVAR is an approach recently developed by Stock and Watson (2008) and Mertens and Ravn (2013). It is a structural approach that uses proxy variables as external instruments rather including them directly among the endogenous variables. Consider the following VAR model:

$$Y_t = c + \sum_{i=1}^p B_i Y_{t-i} + A_0 \varepsilon_t \quad (3)$$

where Y_t is a vector of economic and financial variables, ε_t a vector of structural white noise shocks such that $A_0 \varepsilon_t = u_t$ and u_t the reduced form shocks. Y_t does not contain the proxy variable. The latter, conversely, is used as an external instrument whose scope is the estimation of the structural shock of interest, i.e. ε_t^r . It follows that, in order to compute the variance decomposition and the impulse response to the impact of a structural shock ε_t^r , it is not necessary to identify all the coefficients of the A_0 matrix. It is only necessary to identify the column $A_{0,r}$ corresponding to the impact of the structural shock of interest on each element of the vector of reduced form residuals u_t . Therefore, the model to estimate is the following:

$$Y_t = c + \sum_{i=1}^p B_i Y_{t-i} + A_{0,r} \varepsilon_t^r \quad (4)$$

Denoting ε_t^{nr} the remaining structural shocks, this approach requires the Rating Announcements proxy e_t^r to meet the following conditions:

$$\left\{ \begin{array}{l} E(e_t^r, \varepsilon_t^r) = \alpha \\ E(\varepsilon_t^r, \varepsilon_t^{nr}) = 0 \\ Var(\varepsilon_t) = D = \text{diag}(\sigma_{\varepsilon_{1t}}, \dots, \sigma_{\varepsilon_{Nt}}) \end{array} \right. \quad (5)$$

⁶An example is the Fitch's downgrade of Greece from C to Restricted Default on the 9th of March 2012. According to the Fitch's rating action commentary, the downgrade follows "today's confirmation from the Greek government and eurozone officials that the exchange of Greek government bonds will proceed".

⁷See section 4.2 for a more detailed explanation.

The first two conditions in 5 state that in order for e_t^r to be a valid instrument it must be correlated with the structural shock of interest ε_t^r and uncorrelated with the remaining ones ε_t^{rr} . Together, they establish the exogeneity of the instrument. Finally, the third condition guarantees that the structural shocks are contemporaneously uncorrelated.

If these conditions are met it is possible to derive a GMM estimator for the column of A_0 that correspond to e_t^r . Let $A_0 = [A_{0,1}, \dots, A_{0,N}]$ and $Var(u_t) = \Omega$ where $A_0\varepsilon_t = u_t$. Stock and Watson (2008) and Mertens and Ravn (2013) show how ε_t^r can be estimated via a regression of e_t^r on u_t . Note that $E(u_t e_t^r) = E(A_0 \varepsilon_t e_t^r) = [A_{0,1}, \dots, A_{0,N}] [E(\varepsilon_{1t} e_t^r), \dots, E(\varepsilon_{Nt} e_t^r)]' = A_{0,1} \alpha$. Moreover, denote Π the coefficient on u_t . It follows that the fitted value Πu_t equals the structural shock of interest up to sign and scale:

$$\begin{aligned} \Pi u_t &= E(e_t^r u_t') \Omega^{-1} \\ &= \alpha A_{0,1}' (A_0 D A_0')^{-1} u_t \\ &= \alpha (A_{0,1}' A_0^{-1}) D^{-1} (A_0^{-1} u_t) \\ &= \alpha \varepsilon_{1t} D_{11}^{-1} \end{aligned} \tag{6}$$

It is worth noticing how the conditions in 5 are less stringent than those required for an unbiased estimation if the proxy is inserted directly in the VAR as an endogenous variable. In the latter case, the narrative shock series is required to be perfectly correlated with the structural shock. Conversely, the conditions in 5 can be satisfied even if the proxy e_t^r is measured with error. This stresses the difference between a proxy SVAR and a pure narrative approach in which the narrative measure is treated as an endogenous variable. Finally, equation 6 shows how the shock identified using the instrument e_t^r is the predicted value from the population regression of e_t^r on the innovations u_t , i.e. Πu_t up to sign and scale.

4 Empirical Results

This section outlines the VAR specification, the reliability of the Rating Announcements proxy in identifying rating shocks and the main results from the proxy SVAR that uses this proxy as an external instrument. As with most VARs, the results of interest are essentially three. The impulse response analysis provides an assessment of the propagation of the shocks of interest to the endogenous variables, the variance decomposition gives an indication of their relative importance in explaining the fluctuations of the endogenous variables and the historical decomposition shows the importance of the identified shocks in driving the endogenous variables. Finally, two robustness checks are presented. Throughout this section, all the VAR lag lengths are calculated by the Bayesian Information Criterion with a maximum lag of 4 in order to capture a complete quarter of data plus one month.

4.1 VAR Specification

The VAR described in section 3.3 is run using a sample of data, regarding Portugal, Italy, Greece and Spain, that runs from March 1999 to March 2014. Monthly data are chosen because they are more suitable to shed light on the responsiveness of macroeconomic and financial variables to a structural shock. The sample essentially aims at covering the period that goes from the introduction of the Euro

currency till the last observations available from the Eurostat Database. Even though the sample starts well before the beginning of the crisis, and thus different macroeconomic environments are captured, the inclusion of the pre-crisis period helps ensure a more consistent estimate of the parameters of interest⁸.

Bearing in mind that for a proxy SVAR the ordering is not relevant, the endogenous variables of the baseline model are the following {dYield, IP Growth, Tot Gov Bud, Inflation, dEuribor}. dYield is the first difference of the monthly average 10-year yield of the sovereign bond. It aims at capturing the country's long term sovereign borrowing cost. As this is the variable relative to the shock of interest, for computational reasons it is ordered first. IP Growth is a monthly proxy for output and represents the year-on-year growth rate of a broad index of industrial production. Tot Gov Bud represents the total government budget, i.e. government budget including interest payments, as a percentage of GDP. The inclusion of the interest payment within a measure of government budget is necessary to provide evidence of a likely change in a country's financial burden. A positive value of this variable indicates a total government surplus while a negative indicates a deficit. As for this measure the maximum frequency available is quarterly, monthly data were obtained by means of cubic spline interpolation. Inflation represents the year-on-year growth rate of the broadest consumer price index, i.e. the CPI that includes all items. Finally, as a measure of short term interest rate capturing the monetary policy stance, dEuribor, represents the first difference of the 3-month Euribor⁹. The datasets are mostly provided by Eurostat and by the Organisation for Economic Cooperation and Development¹⁰.

4.2 Proxy Reliability and Alternative Instruments

When working with a proxy SVAR, the process of checking the goodness of an instrument is essentially carried out in two steps. The first entails the calculations of two reliability statistics, the R_M and the F-statistic, respectively developed by Mertens and Ravn (2014) and Stock and Watson (2012). The R_M is defined as the squared correlation between the narrative measure and the estimated structural shock. As such, it takes value between 0 and 1 with larger values indicating a higher reliability of the instrument¹¹. The second measure is simply the F-statistic in the first-stage regression in equation 6. Even in this case, the higher the estimated value the stronger the instrument. A comparison of these measures across instruments proxying the same shock provides a quantitative evaluation of their quality relatively to one another. For this reason, they can be considered as an instrument selection tool. The second step, entails the calculations of the correlations among structural shocks estimated by using instruments that are meant to proxy different shocks. A high correlation might be a symptom that an instrument is not proxying the shocks it was meant to.

⁸Including only the crisis sample does not substantially change the results which are proven to be robust to subsample analysis. See section 4.4.2.

⁹For Italy and Spain the first difference of the 3-month Libor was used as a measure of short term interest rate.

¹⁰For a more detailed explanation of data sources and variable construction please read the Data Appendix.

¹¹More precisely, in order to estimate their reliability measure, Mertens and Ravn explicitly assume that the proxy variable is built with measurement error. They assume that the relation between proxy e_t^r and structural shock ε_t^r is given by $e_t^r = E[D_t](\Gamma\varepsilon_t^r + v_t)$ where v_t is the measurement error, D_t is a dummy variable tracking the zero observation of the proxy and Γ is a scalar to estimate. Subsequently, they augment the VAR model in 3 with the relation for e_t^r to form a measurement error model. Finally, the expression of their reliability statistic is

$$R_M = (\Gamma^2 \sum_{t=1}^T D_t \varepsilon_t^r + \sum_{t=1}^T D_t (e_t^r - \Gamma \varepsilon_t^r)^2)^{-1} \Gamma^2 \sum_{t=1}^T D_t \varepsilon_t^r^2.$$

As to my knowledge no other instruments aiming at identifying rating shocks have been developed in literature, three additional instruments will be here considered. They would represent the simplest instruments one may think of when considering rating shocks. The comparison of their performances with that of the Rating Announcements proxy will provide evidence of the superiority of the latter.

The first of the three, Dummy, is simply a dummy variable that takes value 0 if no rating actions were implemented and 1 otherwise. Bloom (2009) inserts a dummy within the endogenous variables of a VAR model in order to identify uncertainty shocks in correspondence of relevant historical events that entailed a sudden increase in volatility. Here, similar reasoning is followed for the proxy construction. However, differently from Bloom (2009) this measure is used as external instrument because of the likely measurement error. The idea behind this extremely simple instrument is that a rating action can, somehow, represent a shock.

The second instrument, Count, represents an improvement over the previous one. It simply counts the number of rating actions that occurred over each month. With respect to Dummy, this instrument tries to give a higher weight to those observations relative to the months in which more rating actions took place.

Finally, the third instrument is developed in a similar vein to Baker, Bloom and Davis (2012) and Mumtaz, Pinter and Theodoridis (2015) where measures to estimate changes in uncertainty are suggested. However, rather than being based on newspapers coverage, it is based on “internet coverage”. The instrument is the Google Trends’s Search Volume Index (SVI). This monthly index, provided by the most popular research engine with more than one billion visitors each month, is based on a search for the words “Portugal rating”, “Italy rating”, “Greece rating” and “Spain rating”. It does not represent the absolute search volume because the data are normalised and then presented on a scale from 0 to 100. Conversely, it is a measure of popularity in (nearly) real time as it shows the total searches for a term relative to the total number of searches done on Google over time¹². As such, for the aim of this work, it may also be interpreted as a measure of concern about ratings and it may be somehow proxying a rating shock. The reason being the fact that if ratings do not represent a concern there would be little reason for them to be more googled during a specific month rather than another.

Figures 4, 5, 6 and 7 show the three instruments, compared with the Rating Announcements proxy, for the each of the four countries separately. The SVI is depicted on a scale from 0 to 1 to allow a better comparability with the others.

¹²Whenever the data are not sufficient the value 0 is automatically assigned. The search was performed considering the entire world as region of interest. As no data are available prior to January 2004 they are supposed to be equal to zero. This should not represent a problem as they are related to a tranquil period well before the Great Recession.

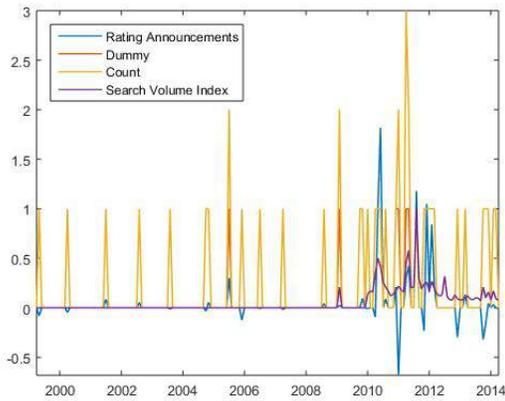


Figure 2: Portugal: Instruments

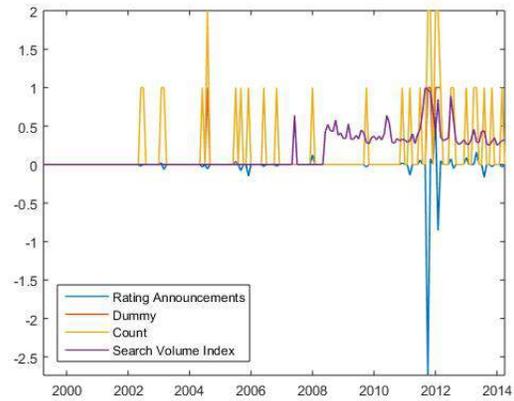


Figure 3: Italy: Instruments

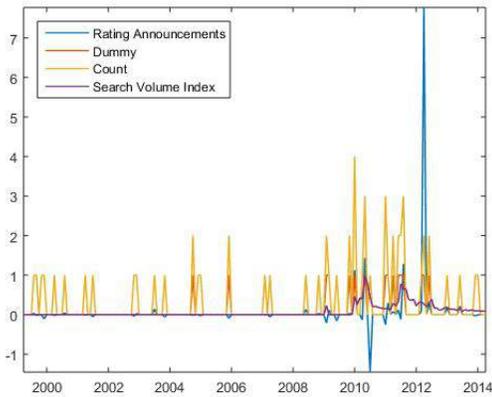


Figure 4: Greece: Instruments

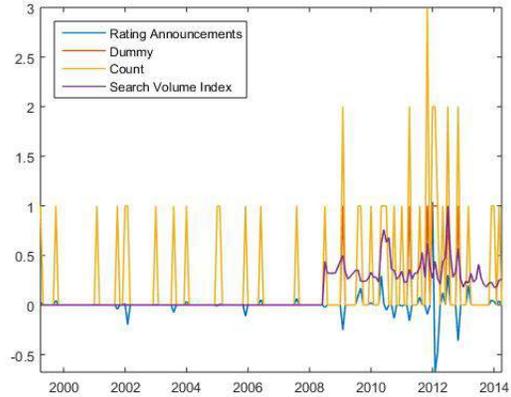


Figure 5: Spain: Instruments

To some extent, for all the countries, the four instruments present a similar evolution. Most of the shocks are concentrated and of higher intensity from 2008 on, that is, during the most turbulent years of the Great Recession. Conversely, prior to this prolonged crisis they are of minor intensity. With particular regard to the Rating Announcements proxy, it is evident how it gauges large market reactions to a small proportion of events rather than more moderate reactions to every piece of news. Once again, this evidences how certain rating actions have a higher informational content than others. Moreover, looking at the its magnitude, one may easily notice how the instrument for Greece presents some values (early 2012) that are much larger than those for the other countries. This somehow reflects how the impact of rating actions on bond yield volatility was stronger in Greece than elsewhere in South Europe in that particular period.

Aware of the weaknesses of the three alternative instruments I proceed with the evaluation of their performances through the two reliability measures previously mentioned. Table 1 reports the results relative to all of the four available instruments.

<i>Instrument</i>	<i>Portugal</i>		<i>Italy</i>		<i>Greece</i>		<i>Spain</i>	
	R_M	$F - stat$	R_M	$F - stat$	R_M	$F - stat$	R_M	$F - stat$
<i>Rating Announc.</i>	0.3436	2.1422	0.3009	1.6908	0.7009	16.6881	0.2841	2.0523
<i>Dummy</i>	0.0787	0.3749	0.1106	0.6786	0.0457	0.3731	0.0285	0.1804
<i>Count</i>	0.1894	0.9544	0.0640	0.4994	0.0535	0.4534	0.0122	0.1081
<i>SVI</i>	0.0755	0.5732	0.0660	0.9657	0.1571	1.7604	0.0686	0.8068

Table 1: Reliability Statistics and the first stage F-statistics for proxy variables

Table 1 clearly evidences how, according to both measures, the Rating Announcements proxy represents the most reliable instrument for all the four countries. The other three instruments, instead, show lower values of both R_M and F-statistic. Furthermore, it is interesting to note how, with a R_M of 0.70 and a F-statistic of 16.69, the proxy here developed is strongly reliable for Greece.

Even though the results in Table 1 are in favour of the Rating Announcements proxy, it is necessary to move to the second step of the assessment of its goodness. This is so because the two reliability measures alone may not be sufficient to assess how suitable the instrument is in estimating the shock of interest. Stock and Watson (2012) point out that the possible correlation between structural shocks identified by using different instruments provides additional information regarding both strength and reliability of the instruments themselves. Suppose due instruments are constructed in order to identify two different shocks. If they are both valid, then, the estimated structural shocks will be uncorrelated. If, instead, they yield highly correlated estimated shocks then one of the two (or both) is not a valid instrument. If this is the case then one of the two the instruments (or both) is not identifying the shocks it was built for. Conversely, it might be identifying something else. In order to verify whether the proxy here developed may be identifying something different from shocks directly imputed to rating announcements, correlations among estimated structural shocks derived from different instruments are presented. The analysis is carried out by using a selection of instruments available in literature that were purposely built to identify two particular shocks: uncertainty shocks and liquidity and financial shocks.

As a matter of fact, two are the main concerns related to the Rating Announcements proxy, especially for the way it was built. The first is that it may capture (not only the effect of rating actions on bond volatility but also) a broad increase in the market volatility. The second is that, since credit rating announcements were mainly effectuated during moments of higher financial risk, the estimated structural shocks may somehow coincide with this higher risk perception. Other kinds of shock (e.g. oil shock, productivity shock, etc.) are not considered as they do not seem to have played a relevant role during the time period considered¹³.

In order to identify uncertainty shocks two different instruments are used. The first, motivated by Bloom (2009), is given by the innovations in a country's volatility index. To my knowledge, a proper volatility measure (e.g. VIX) covering at least the period that goes from March 1999 till March 2014 is not available for the countries analysed. For this reason, the country's uncertainty is here calculated as the return standard deviation of the main country's stock index: the PSI 20 Index, the FTSE MIB Index, the Athens Stock Exchange General Index and the IBEX 35 Index. The exogenous variation of such a measure, that will be called Vol. Innov., is given by the AR(3) residuals, respectively, for Portugal

¹³See Stock and Watson (2012) for a detailed discussion regarding instruments and shocks identified in literature.

(1993M2-2015M4), Italy (1998M2-2015M4), Greece (1985M2-2015M4) and Spain (1987M2-2015M4)¹⁴. The second instrument is the innovation in the common component of the European policy uncertainty index of Baker, Bloom and Davis (2009). The exogenous variation of this uncertainty measure, that will be called EU Uncert. Innov., is calculated as the residuals from an AR(2) (1997M3-2015M5). This instrument, differently from the previous one, tries to verify whether the estimated structural shocks are highly correlated with those generated by an increase in European uncertainty and not only in the country's.

With regard to liquidity and financial risk shocks only one instrument is used. It is the TED spread and is calculated as the difference between the interest rates on short-term interbank loans (3-month Euribor) and on short-term (3-month) government debt. The TED spread is an indicator of perceived credit risk in the general economy as the short-term government bonds are generally considered risk-free while the Euribor reflects the credit risk of lending to commercial banks¹⁵.

Tables 2, 3, 4 and 5 report the sample correlations of the estimated shocks. The focus is on the first columns, that is, on the correlations between Rating announcements-estimated shocks and all the others separately.

<i>Instrument</i>							
<i>Rating Announcements</i>	1.0000						
<i>Dummy</i>	0.9321	1.0000					
<i>Count</i>	0.9500	0.9111	1.0000				
<i>SVI</i>	0.8754	0.8910	0.9394	1.0000			
<i>PORVol. Innov.</i>	0.2044	0.0824	0.3765	0.1269	1.0000		
<i>EU Uncert. Innov.</i>	0.4967	0.2434	0.2523	0.1624	-0.2030	1.0000	
<i>TED Spread</i>	0.5645	0.7180	0.5985	0.4374	0.4190	-0.1744	1.0000

Table 2: Portugal: Sample Correlations among Estimated Structural Shocks

Table 2 shows how the Rating Announcements proxy identifies shocks that have high correlation with those identified by Dummy, Count and SVI (respectively 0.93, 0.95 and 0.88). This evidences how they are somehow proxying the same shock. Moreover, the Rating Announcements proxy estimates structural shocks that present much lower correlations with those identified by the Portuguese market volatility innovations (0.20), European uncertainty innovations (0.50) and TED spread (0.56).

<i>Instrument</i>							
<i>Rating Announcements</i>	1.0000						
<i>Dummy</i>	0.4679	1.0000					
<i>Count</i>	0.1089	0.9016	1.0000				
<i>SVI</i>	0.3824	0.2327	-0.0352	1.0000			
<i>ITAVol. Innov.</i>	-0.0472	0.3362	0.4977	0.3012	1.0000		
<i>EU Uncert. Innov.</i>	-0.1812	-0.2452	-0.1583	0.3355	0.6998	1.0000	
<i>TED Spread</i>	0.5124	0.6828	0.4405	0.8574	0.4502	0.2229	1.0000

Table 3: Italy: Sample Correlations among Estimated Structural Shocks

¹⁴See Data Appendix for a more detailed explanation.

¹⁵Another reliable measure of liquidity and financial shocks would be the Gilchrist and Zakrajšek's (2012) excess bond premium series as it tries to deparure the TED spread of those components not associated with predictable default probabilities.

The results relative to Italy differ from those found for Portugal. In Table 3 the structural shocks estimated by using the Rating Announcements proxy present much lower correlation with those deriving from Dummy (0.47), Count (0.11) and SVI (0.38). This would mean that, in this case, the four instrument are no longer estimating similar shocks. Moreover, the Rating Announcements proxy estimates structural shocks that present a very low, and surprisingly negative, correlation with those identified by the Italian market volatility innovations (-0.05) and European uncertainty shocks (-0.18). Finally, Rating Announcements-identified shocks display a higher correlation with those deriving from the TED spread (0.51).

<i>Instrument</i>							
<i>Rating Announcements</i>	1.0000						
<i>Dummy</i>	0.0852	1.0000					
<i>Count</i>	0.1678	0.8167	1.0000				
<i>SVI</i>	0.2874	-0.1474	-0.6043	1.0000			
<i>GRE Vol. Innov.</i>	0.3349	0.0965	-0.2539	0.6087	1.0000		
<i>EU Uncert. Innov.</i>	0.5661	0.3535	-0.0384	0.6185	0.7864	1.0000	
<i>TED Spread</i>	0.2363	-0.2332	0.0337	-0.4262	-0.1637	0.0870	1.0000

Table 4: Greece: Sample Correlations among Estimated Structural Shocks

Table 4 displays how, for Greece, low correlations were found between shocks estimated by the Rating Announcements proxy and the three alternative instruments (respectively 0.09, 0.16 and 0.29). Slightly higher correlations are found with shocks estimated by using innovations in country's volatility (0.33) and European uncertainty (0.57) while, finally, a low correlation is found with respect to liquidity and financial risk shocks (only 0.24).

<i>Instrument</i>							
<i>Rating Announcements</i>	1.0000						
<i>Dummy</i>	0.4489	1.0000					
<i>Count</i>	-0.0167	-0.3049	1.0000				
<i>SVI</i>	0.6042	0.2164	-0.7110	1.0000			
<i>SPA Vol. Innov.</i>	0.0924	-0.4926	0.0470	0.0750	1.0000		
<i>EU Uncert. Innov.</i>	0.4428	-0.5166	-0.1174	0.6222	0.6086	1.0000	
<i>TED Spread</i>	-0.1082	-0.4925	0.3248	-0.2516	0.2152	0.2388	1.0000

Table 5: Spain: Sample Correlations among Estimated Structural Shocks

Finally, for Spain, Table 5 shows a quite high correlation between Rating Announcements and SVI-estimated shocks (0.60), a lower value with Dummy-estimated ones (0.45) and a surprisingly low and negative value with those stemming from Count (-0.02). Very low correlations are found with shocks estimated by considering innovations in country's volatility (0.09) and liquidity and financial risk (-0.11). Finally, a slightly higher correlation is found with regard to European uncertainty innovations-estimated shocks (0.44).

On the basis of the results displayed in Tables 1, 2, 3, 4 and 5, the proxy developed in this work seems to perform the best. When compared with Dummy, Count and SVI, it is associated with higher values of the two reliability measures. Moreover, the sample correlations of the estimated structural shocks

with those deriving from country's and European volatilities and financial risk are not particularly high even though, in some cases, they hover 0.50.

Overall, given its superior performance, impulse response, forecast error variance decomposition and historical decomposition are all calculated by running a proxy SVAR that uses the Rating Announcements proxy as an external instrument.

4.3 Benchmark Results

As the main objective of this work is to disentangle to effect of rating shocks, then, impulse responses, forecast error variance decomposition and historical decomposition relative only to these particular shocks will be considered.

Figure 6 shows the impulse responses for both countries using the Rating Announcements proxy. The shock is normalised to increase the 10-year sovereign bond yield by 1% on impact and the blue area represents the 95% confidence interval calculated using the bootstrap described in Goncalves and Kilian (2004). The focus is mainly on the responses of the bond yield itself, the industrial production and the total government budget as they are of primary interest for this paper.

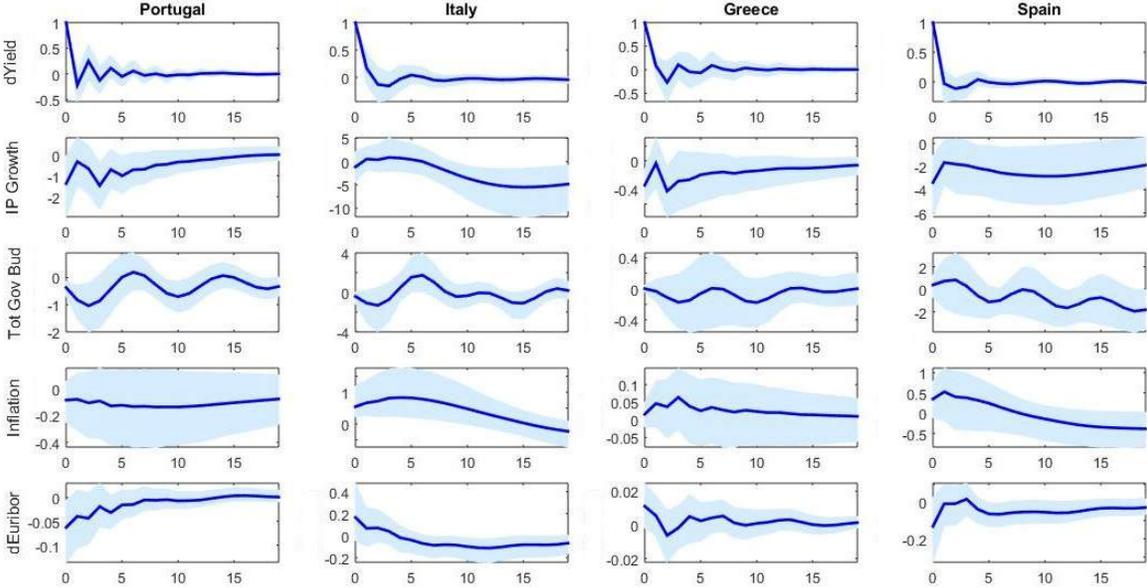


Figure 6: Impulse Responses to a rating announcement shock

For all the countries a rating shock produces a reduction in industrial production. The contemporaneous responses are nearly of -1%, -1%, -0.4% and -3% respectively. While for Portugal and Greece such a reduction fades away after nearly four months, for Italy and Spain the responses are more persistent. The considerations for the total government budget are slightly different. Even though the contemporaneous responses are close to zero, the government budgets of Portugal and Italy worsen for nearly four months while the Greek one for nearly twelve. Afterwards, the responses fluctuate around

zero. The negative responses of both the Portuguese and Italian government budgets reach their peaks of nearly -1% after two month while the Greek one reaches -0.2% after four months. Finally, for Spain, the government budget tends to worsen over time. Note how for bond yield and industrial production growth the confidence bands do not cross the zero line at impact thus indicating that the responses are statistically significant. However, for the government budget, this is true only for Portugal. The responses of both inflation are not significant for Portugal and Greece, while, for Italy and Spain they are and show positive sign. Finally, responses of the short-term interest rates turn not significant after one quarter.

Impulse response analysis would therefore suggest that shocks derived by CRAs announcements contribute significantly to the deterioration of South European countries' fundamentals. More precisely, a slow down in economic activity and a worsening of the public budget.

Figure 7 shows the forecast error variance decomposition relative to the 10-year bond yield, i.e., the proportion of forecast error in each endogenous variable that is due to rating shocks at various horizons. In other words, it helps understand, from a forecasting point of view, which are the drivers of the sovereign financing costs and in which proportion.

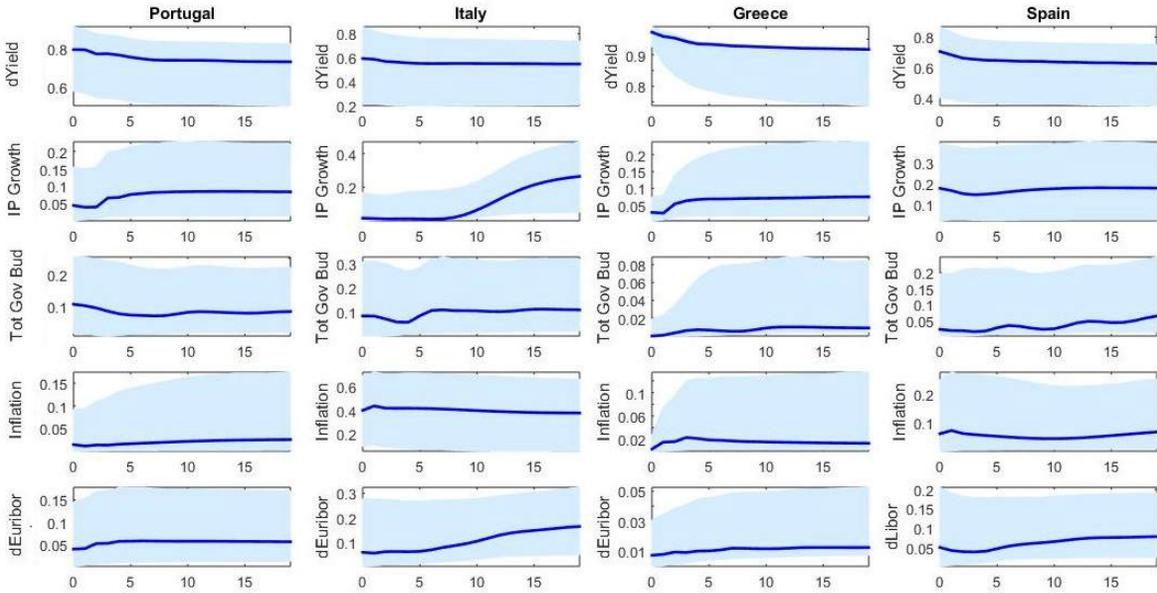


Figure 7: Forecast Error Variance Decomposition of the 10-year sovereign bond yield

The picture clearly shows how the unexpected variation of the bond yields is mainly explained by the identified shocks (always above 60%) over the entire 20-month horizon considered. Nevertheless, the decomposition reveals how the percentage of unexpected variation explained by other shocks varies from country to country. For Portugal industrial production and total government budget explain also nearly 10% of the unexpected variation of the sovereign borrowing costs. For Italy, instead, inflation seems to play a relevant role together with industrial production growth especially at longer horizons. The Greek unexpected variation of sovereign yield is mainly explained by its own shocks while, for Spain, the second most important driver is industrial production. All the remaining variables in the

autoregression play a less significant role as drivers of the sovereign bond yield at all horizons.

Finally, Figure 8 displays the historical decomposition. It provides a further clue of the contribution of rating shocks as it helps understand their importance in driving the endogenous variables in the autoregression over the period considered. The solid line represents the actual data while the red dotted one the counterfactual estimates under the assumption that only the shock of interest is working.

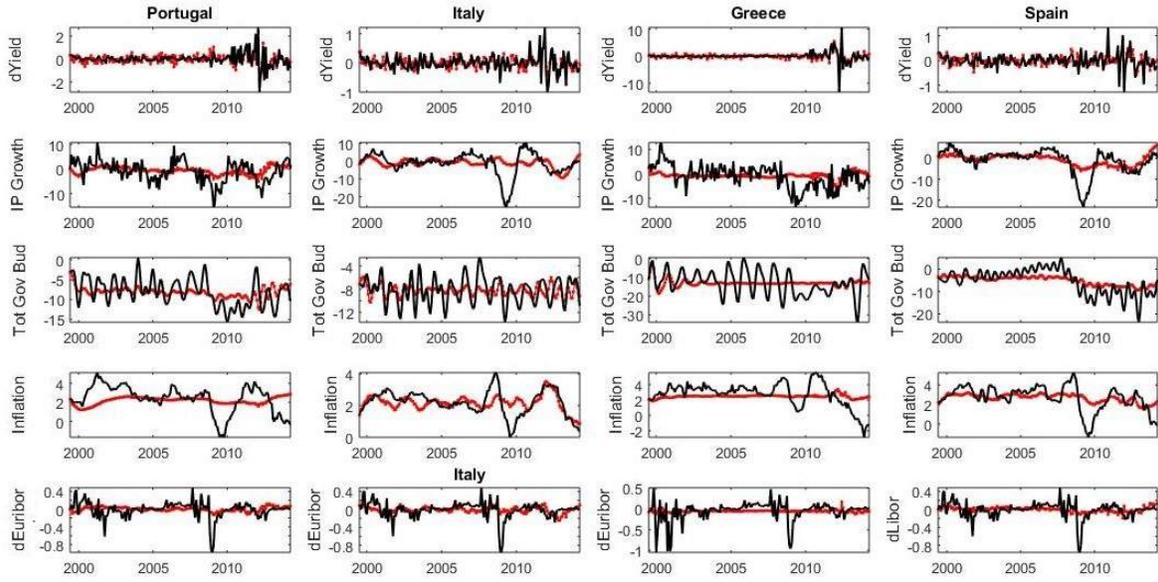


Figure 8: Historical Decomposition

The picture shows how the identified rating shocks play a remarkable role in driving the change in the 10-year bond yield. This is particularly evident from 2010 onwards especially for Greece. Moreover, the identified shocks are able to explain part of the decline in industrial production growth occurred in 2012. With regard to the total government budget, instead, the contribution of the estimated shocks is not as relevant as for yield and industrial production. The counterfactual estimates do not seem to explain much of the variability of the government budget. Finally, the contribution of the identified shocks does not seem relevant for the explanation of the variability of inflation and short-term interest rate. This, apart from a very few exceptions, is true over the entire period considered and for all the countries.

4.4 Robustness Checks

This subsection presents two sensitivity analyses to assess the robustness of the results outlined previously. The first aims at understanding whether the inclusion of two relevant variables may change the outcome of the model. The second is simply a subsample analysis. For the sake of brevity the results are presented just as impulse responses. It is sufficient to focus on this aspect of the model as variance decompositions and counterfactual estimates are functions of the impulse responses.

4.4.1 Detecting the Effects on Unemployment and Foreign Direct Investment

The two variables are now added to the model: unemployment and foreign direct investment. The new VAR ordering is $\{dYield, IP\ Growth, Unemp, FDI, Tot\ Gov\ Bud, Inflation, dEuribor\}$. Unemp serves as a further indicator of a country's economic performance, while, FDI represents the direct investment in the economy as a percentage of the gross domestic product¹⁶. The response of the latter provides an idea of how foreign capitals may crowd out following a credit rating shock. As for FDI the maximum frequency available for its calculation is quarterly, monthly data were obtained by cubic spline interpolation.

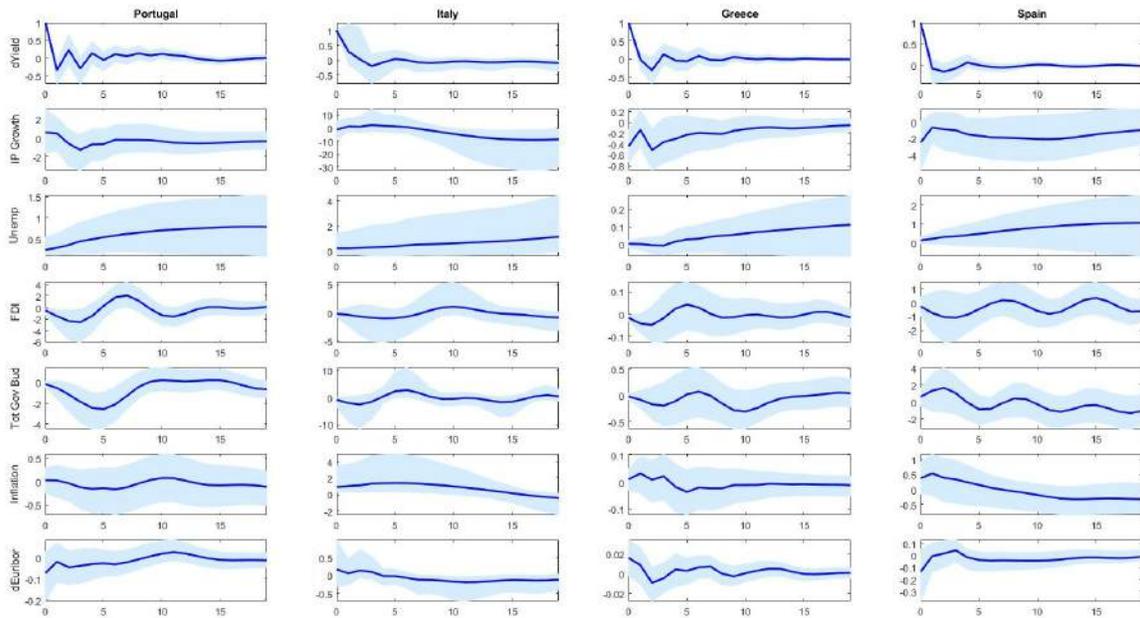


Figure 9: Impulse Responses to a rating announcement shock

Figure 9 shows how the response of unemployment appears similar for all the countries. Employment rises over time even though the initial response is almost null. After 20 months it increases by nearly 1% in Portugal, Italy and Spain while, for Greece, it increases by only 0.1%. This looks consistent with the responses of IP Growth which are essentially negative over the entire horizon considered. Differently from unemployment, the response of foreign direct investment displays a different behaviour. For all the countries foreign direct investment goes down during the months immediately after the shock. Afterwards, the responses hover zero. This seems particularly accentuated for Portugal and Spain whose responses reach, respectively, -2% and -1% after three months. Finally, the responses of all the remaining variables do not change significantly from those displayed in Figure 6.

4.4.2 Evidence from the Recent Sovereign Debt Crisis

This subsample analysis is carried out by running the baseline VAR outlined in subsection 4.1

¹⁶See Data Appendix for further details.

considering data from January 2007 to March 2014. The use of such a smaller sample allows to focus on the macroeconomic implications of rating shocks considering only the turbulent years of the recent sovereign debt crisis. Due to the shorter sample, the measures of unemployment and foreign direct investment are no longer included in the VAR in order to avoid the estimation of too many parameters.

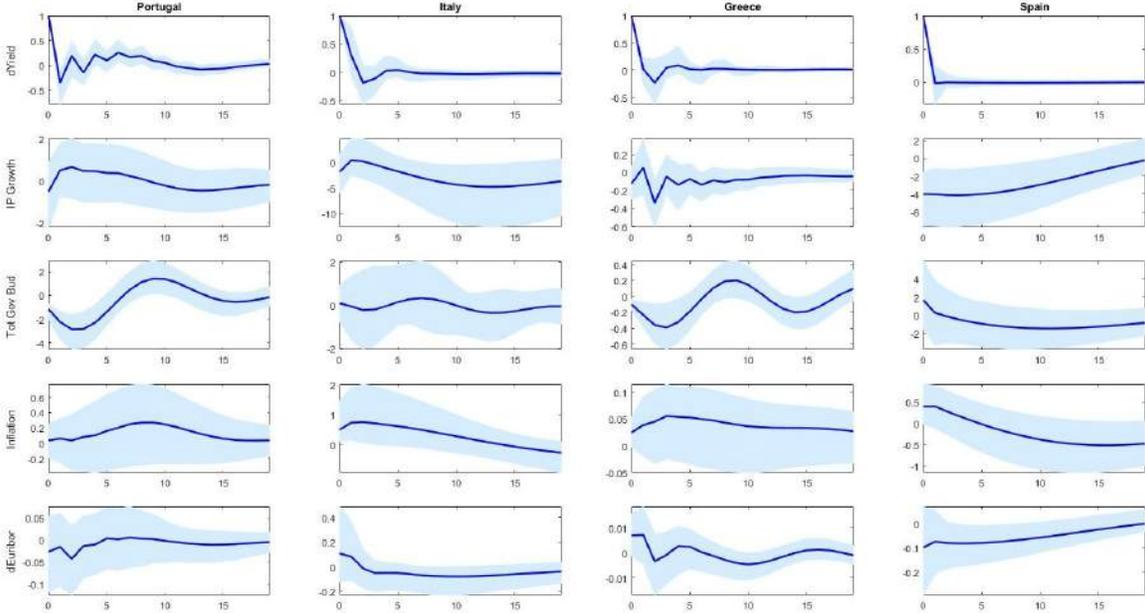


Figure 10: Impulse Responses to a rating announcement shock

Overall, the responses of all the variables do not differ substantially from those found with the baseline model. However, the initial negative responses of Portuguese and Greek total government budgets are now more accentuated as they respectively reach nearly -3% and -0.4% after three months. Finally, it is interesting to notice how, surprisingly, the immediate response of the Spanish government budget is positive but it turns slightly negative after only two months.

5 Conclusions

This paper focuses on the identification of credit rating shocks regarding Portugal, Italy, Greece and Spain over the period that goes from March 1999 to March 2014. It provides evidence of the effect on these countries' costs of financing as well as other fundamentals. The analysis is implemented by using a combination of high frequency and narrative methods to identify the exogenous sovereign bond market reaction around the days in which a rating action took place. The rating actions considered are downgrades, upgrades or simply credit watches or outlooks, relative to the long-term foreign-currency denominated sovereign debt and long-term foreign-currency issuer default, implemented by the three major credit rating agencies, i.e., Moody's, Standard & Poor's and Fitch. The instrument developed in this work, the Rating Announcements proxy, relies upon a measure of daily sovereign bond yield volatility and tries to gauge the changes in such a measure that appear attributable to the previously

mentioned announcements. The Rating Announcements proxy is then used as an external instrument within a proxy SVAR.

Both the Rating Announcements instrument and proxy SVAR perform quite well in identifying such shocks for a number of reasons. The Rating Announcements proxy complies with the exogeneity condition required for any instrument to identify any kind of shock. This would be mainly validated by the particular technique used to build it. The volatility changes occurring around rating announcements would evidence how they have little to do with current and prospective economic conditions and how, instead, they are more related to the announcements themselves.

For all the countries analysed the two reliability measures agree on the superior performance of the Rating Announcement proxy over the alternative instruments, i.e., Dummy, Count and SVI. This is particularly evident for the case of Greece where the R_M , taking value of 0.70, indicates a high squared correlation between proxy and estimated shocks, and the F-statistic, with a value of 16.69, shows how the Rating Announcements proxy is a strong instrument in identifying the structural shocks of interest.

Overall, the structural shocks estimated by the Rating Announcements proxy do not present high sample correlation with those obtained from instruments that in literature were explicitly developed to identify different kinds of shocks, i.e., country's volatility, European uncertainty and financial risk shocks. The highest values found hover 0.50 with regard to European uncertainty shocks for Portugal, Greece and Spain. Conversely, for Italy, the highest correlation found, equal to 0.51, regard the financial risk shocks.

The impulse response analysis provides responses that appear plausible from an economic point of view. More precisely, both direction and magnitude of the main fundamentals' responses seem to be plausible with the shock that originates them as they are mostly short-lived and relatively small. The responses of the 10-year sovereign bond yield reverse to zero after four or five months following a unitary shock while industrial production growth responses are negative over the horizon considered. Total government budgets of Portugal, Italy and Greece respond negatively but after nearly one quarter their responses turn to zero. Conversely, the response of the Spanish government budget seems more persistent. Finally, the remaining endogenous variables' responses appear of minor importance.

The historical decomposition estimated by the proxy SVAR confirms how the identified shocks play a relevant role in explaining the behaviour of the change in the sovereign cost of financing. Such an ability appears remarkable when considering the years from 2010 onwards. The estimated structural shocks seem to contribute to part of the industrial production decline in 2012 while the counterfactual estimates do not seem to explain the behaviour of the total government budget. The identified shocks play a minor role when considering the remaining endogenous variables.

Finally, the impulse responses relative to the two robustness checks further confirm what found with the baseline model. The first, conducted by including two additional relevant variables among the endogenous ones, suggests how unemployment increases persistently while foreign direct investment decreases over the first months following a rating shock. The second, conducted restricting the sample to the years of the recent sovereign debt crisis, i.e., from 2007 onwards, shows how the results are robust to a subsample analysis as they do not change significantly. However, differently from the baseline model, the responses of the Portuguese and the Greek government budgets appear more accentuated.

6 Data Appendix

This appendix describes the variable definitions, the way they have been derived as well as the data sources. For ease of exposition, this appendix is divided into two parts according to whether the data were directly included in the Vector Autoregression or, instead, used or for the construction of the instruments.

The time series were mainly collected from the Macrobond Database, the Main Economic Indicators held by the Organization for Economic Cooperation and Development (OECD MEI), the Eurostat Database, the European Banking Federation Statistics (EBF Statistics) and Bloomberg.

Data for the vector autoregression:

dYield - first difference of the monthly average 10-year yield of the sovereign bond (Government Benchmarks, Macrobond, 10 Year, Yield).

IP Growth - year-on-year growth rate of industrial production (OECD MEI, Production Of Total Industry, SA, Index).

Unemp - harmonised unemployment rate (OECD MEI, Harmonised Unemployment Rate All Persons (all Ages), SA).

FDI - foreign direct investment as a percentage of GDP calculated as direct investment in the reporting economy (OECD MEI, BOP Direct Investment In Reporting Economy, EUR) divided by nominal gross domestic product (Gross Domestic Product, Total, Current Prices, SA, Market Prices, EUR).

Tot Gov Bud - total government budget as a percentage of GDP calculated as Net Lending/Net Borrowing¹⁷ (Eurostat, General Government Quarterly Non-Financial Accounts, Percent of GDP, Net Lending (+) /Net Borrowing (-)) plus Interest Receivable (Eurostat, General Government Quarterly Non-Financial Accounts, Percent of GDP, Interest, Receivable) minus Interest Payable (Eurostat, General Government Quarterly Non-Financial Accounts, Percent of GDP, Interest, Payable).

Inflation - year-on-year growth rate of the Consumer Price Index that includes all items (OECD MEI, CPI All Items, Index).

dEuribor - first difference of the 3-month Euribor (EBF Statistics, Interbank Rates, 3 Month, Fixing, EURIBOR).

Data for the instruments:

Rating Announcements - rating actions (upgrades/downgrades, credit outlook/watch) relative to long-term foreign-currency denominated debt and long-term foreign-currency issuer default and days in which they were implemented by Standard&Poor's, Moody's and Fitch were obtained from Bloomberg.

SVI - Google Trend's Search Volume Index (available at <https://www.google.co.uk/trends>) updated to November 2015.

POR, ITA, GRE and SPA Vol. Innov. - AR(3) residuals respectively from PSI 20 Index Volatility (Portugal, Equity Indices, Euronext Lisbon, PSI 20 Index, Close, EUR), FTSE MIB 20 Index Volatility (Italy, Equity Indices, FTSE Italia, MIB Index, Price Return, Close, EUR), Athens Stock Exchange

¹⁷Which, in turn, is equal to the difference between Government Revenue (Eurostat, General Government Quarterly Non-Financial Accounts, Percent of GDP, Total General Government Revenue) and Government Expenditure (Eurostat, General Government Quarterly Non-Financial Accounts, Percent of GDP, Total General Government Expenditure).

General Index Volatility (Greece, Equity Indices, Athens Stock Exchange, General Index, Close, EUR) and IBEX 35 Index Volatility (Spain, Equity Indices, Madrid Stock Exchange, IBEX 35 Index, Close, EUR). The four volatility series were calculated as the daily return standard deviations over the preceding 30 days. Monthly data were obtained by averaging the daily observations of the month of interest.

EU Uncert. Innov. - AR(2) residuals from European Policy Uncertainty Index (European News-Based Index available at http://www.policyuncertainty.com/europe_monthly.html).

TED Spread (Portugal) - difference between 3-month Portuguese Government bond yield (Bloomberg, Portuguese Government Bonds, 3M Bill, Portugal, PL, Mid Yield) and 3-month Euribor (EBF Statistics, Interbank Rates, 3 Month, Fixing, Portugal, EURIBOR). Due to the shorter length of the 3-month Government bond yield, for observations preceding February of 2004 the difference between the 2-year Portuguese Government bond yield (Portugal, Yield, Government Benchmarks, Macrobond, 2 Year) and 3-month Euribor is utilised as TED Spread. The 2-year Government bond yield series is the one with the shortest horizon among those that cover the entire time period used in this work.

TED Spread (Italy) - difference between 3-month Italian Government bond yield (Italy, Government Benchmarks, Bank of Italy, Auction Rate, Yield, 3 Month) and 3-month Euribor (EBF Statistics, Interbank Rates, 3 Month, Fixing, Italy, LIBOR).

TED Spread (Greece) - difference between 3-month Greek Government bond yield (Greek Ministry of Finance, Greece, Public Debt, Treasury Bills, Treasury Bills, Auction Rate, Yield, 13 Week) and 3-month Euribor (EBF Statistics, Interbank Rates, 3 Month, Fixing, Greece, EURIBOR).

TED Spread (Spain) - difference between 3-month Spanish Government bond yield (Government Benchmarks, Bank of Spain, Treasury Bills, 34-94 Days, Yield) and 3-month Euribor (EBF Statistics, Interbank Rates, 3 Month, Fixing, Spain, LIBOR).

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