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Public-Debt Financing in the case of External Debt

Gianluca Cafiso

Highlights

- The role of foreign investors in the financing of a country's public debt has pros and cons which are relevant for the analysis of its sustainability.

- Foreign investors can be seen as new investors who alleviate the financing burden on the domestic economy, but their involvement can bring risks too because of their softer commitment.

- The analysis over the sample considered points towards the irrelevance of the investors' base, at least in certain periods.

Abstract

The objective of this paper is to assess whether non-residents' holdings of a country's debt make a difference for debt stabilization, where non-residents' holdings are considered external debt according to a Balance of Payments perspective. The analysis is empirical and considers the case of Italy, one of the world's largest debt issuer. We detect two possible channels through which external debt might alter the conditions for debt stabilization. Among these, we focus on the Interest Rate Determination in the primary market of Government Bonds. Our results point out the irrelevance of the investors base for debt stabilization.

Keywords

External Debt, Auction Redemption Yield, Debt Stabilization, Vector Auto Regression, Regime Switch.

JEL

E63, F34, G11, H63.

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Gianluca Cafiso[a b]

1. Introduction

The public debt of an economy is a complex aggregate. It is so because many different instruments are included in such aggregate and because different agents hold those debt instruments. As a consequence, there are several possible dimensions through which to analyze public debt. It is well known that different compositions of public debt imply different risk levels for its financing. In this paper we focus on the *Domestic versus External* dimension with the scope to gain new insights into debt sustainability.

Traditionally, in Debt Sustainability Analysis, external debt is considered to be only the one issued in a foreign currency. The pros, cons and risks of external debt therefore depend upon such issuance in the foreign currency and upon the different interest rate attached to assets denominated in that currency. This is, for example, the approach taken by the IMF in its periodical debt sustainability assessment for Low-Income as well as for Market-Access Countries (IMF, 2008, 2010). Domestic-currency denominated debt held by non-residents is not considered to bring any different risk with respect to domestic-currency debt held by residents. Against this approach, instead, many researchers (Arslanalp and Tsuda, 2012; Burrnside, 2005; Chalk and Hemming, 2000) advocate taking into account the composition of holders and thereby considering as external the portion of debt held by non-residents. This claim is based on the hypothesis that non-residents' holdings might bring different risks to debt sustainability which need to be assessed.

The objective of our analysis is to verify such hypothesis. Then, we will consider as external debt the one held by non-residents regardless of the currency of issuance. As we will explain in the

[a] **University of Catania and CESifo**. E-mail to: gcafiso@unict.it. WebPage: www.sites.google.com/site/giancafiso/

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next section, such definition switch has indeed potential implications for debt sustainability analysis. Among the different channels through which an higher burden might materialize in case of external debt, we focus on the relationship between the yield determined at the auctions of government bonds and the non-residents' holdings share (non-residents' participation in the domestic bond market). The motivation behind our analysis lays also into some developments of the Euro Area debt crisis. In this regard, there have been several statements, particularly in large peripheral countries, suggesting that if a larger amount of national public debt were held by residents, the extent of contagion would have been less as well as the peaks in refinancing costs lower. Our results will test the trustworthiness of such thesis.[1]

In a nutshell, this paper's original contribution to the existing literature consists in the study of how debt sustainability is affected by the holders' composition. We develop this analysis on sustainability considering the effective cost of public debt as resulting from the auctions of government bonds. This is an issue only indirectly investigated by previous works, we therefore believe to bring new insights to this branch of literature. As explained in section 3.1, there are many obstacles to the construction of the data set necessary for this study; indeed, this was possible only for Italy at this time. Then, our empirical analysis is based on the auctions if the Italian Republic's government bonds.

The paper is structured as follows. Section 2 discusses how external debt may endanger debt stabilization. Section 3 describes the variables used for the analysis, particularly the Auction Redemption Yield series. Section 4 discusses the main features of the econometric analysis which we develop in sections 5 and 6. The final conclusions are drawn in section 7. Appendix I reports evidence in favor of our decision to reject market yields as a proxy of the debt's financing-cost.

2. Debt Sustainability and External Debt

Debt sustainability has been object of study since the eighties (Latin American debt crisis) when it became clear that an analytical approach to sustainability was needed for a monitoring and

[1] The case of Italy is remarkable in this regard. With this purpose, the Italian Treasury issued ad-hoc designed bonds addressed mainly to domestic small investors (BTP-Italia).

surveillance purpose. Monitoring Institutions, such as the IMF and the World Bank, have constantly been engaged in debt analysis since then. In Europe, the importance of assessing the sustainability of public debt has been growing as well in the last decade and it is now one of the main objectives of the EU surveillance framework (ECFIN, 2012).

It is well known that the sustainability of the debt stock depends on its structure (maturity, fixed or variable rate, indicization to inflation, ecc.): different compositions involve different risks. In this regard, many recent contributions (Arslanalp and Tsuda, 2012; Gros and Alcidi, 2011) suggest that also the composition of holders matters given that a large portion of public debt is actually *external* in the sense that it is owned by non-residents.

Debt instruments may be issued both in the domestic and in foreign currencies, and they may be held both by residents and non-residents:

$$D_t = D_t^{h.r} + D_t^{h.nr} + e \cdot D_t^{f.r} + e \cdot D_t^{f.nr}$$

where D stands for public debt, the superscripts h and f for domestic and foreign currency respectively, and the superscripts r and nr for residents and non-residents owned. In Debt Sustainability Analysis (DSA) (IMF, 2010, 2008), the external dimension of debt is taken into account only under a simplification: external debt is just the one issued in a foreign currency regardless of its holder. Then, the structure of debt for DSA is:

$$D_t = \left(D_t^{h.r} + D_t^{h.nr}\right) + \underbrace{\left(e \cdot D_t^{f.r} + e \cdot D_t^{f.nr}\right)}_{extDebt} \tag{1}$$

which reduces to $D = D^h + e \cdot D^f$ where e is the nominal exchange rate. Consequently, the debt-equation used in DSA is:

$$D_t = (1 + i_t^h)D_{t-1}^h + (1 + i_t^f)e_t D_{t-1}^f - (W_t + S_t) \tag{2}$$

where i_t^h is the interest rate on domestic-currency debt and i_t^f is the interest rate on foreign-currency debt (Cafiso, 2012). The interest rates in eq. 2 can be re-expressed as a weighted average:

$$i_t = \theta^h i_t^h + \theta^f \cdot (i_t^f + \epsilon_t + i_t^f \epsilon_t) \tag{3}$$

where θ^f is the share of foreign-currency debt ($\theta^h = 1 - \theta^f$) and $\epsilon_t = \Delta e_t / e_{t-1}$ is the rate of depreciation of the local currency. Accordingly, the overall interest rate has two components in the case of foreign-currency debt: (1) a combination of domestic and foreign interest rates; and (2) the exchange-rate induced valuation gains or losses in the foreign-currency debt obligations.

In real-world applications, there is a problem with this approach used in DSA. The portion of foreign-currency public debt (θ^f) is almost zero for advanced economies such as the Euro Area countries (Eurostat, 2012). Then, $\theta^f \cong 0$ and the interest rate from eq.3 turns to be $i_t = i_t^h$. As a consequence, if one relies on this approach to consider the effect of external debt on sustainability, she ends up not considering external debt at all.[2] At the same time, this approach does not consider the composition of holders and how it might endanger sustainability, given that a large portion of public debt is actually held by non-residents as shown in Table 1 for the EU countries.

Generally speaking, the link between public debt sustainability and the composition of holders has been largely neglected by economic research. Differently from the effect of fiscal deficits on the current account evolution (twin deficits), which has been object of intensive research, the relationship between public debt and external debt counts basically one analytical contribution only (Parker and Kastner, 1993). Other authors, such as Burrnside (2005), Chalk and Hemming (2000) and Horne (1991) point out the necessity to explicitly consider the external dimension when assessing debt sustainability in a manner which overcomes the foreign currency simplification by so delivering a more reliable assessment. Along these lines, the EU has recently launched a new Macroeconomic Imbalances Procedure which, among other indicators, monitors external debt (ECFIN, 2012) by

Table 1 – EU27 countries, Currency and Holders composition

year **2011**	Currency		Composition of Holders			
country	**nc**	**fc**	**Cnf**	**Cf**	**H**	**RW**
Austria			4.6	20.6	0.6	74.1
Belgium	100.0	0.0	2.2	41.4	3.4	53.0
Bulgaria	26.2	73.8		51.7		45.5
Czech R.	83.6	16.4	1.7	61.8	1.8	34.7
Estonia	100.0	0.0	3.6	59.7	0.0	36.7
Finland			3.1	14.6	0.8	81.5
France	96.9	3.1	1.3	41.7	0.2	56.7
Germany	97.6	2.4		34.3		54.9
Hungary	48.2	51.8	0.7	30.6	3.5	65.2
Ireland	92.0	8.0	0.6	29.5	9.0	60.9
Italy	99.8	0.2	0.2	45.5	15.7	38.5
Latvia	17.1	82.9		14.7		79.6
Lithuania	13.3	86.7	1.1	22.9	2.3	73.8
Luxembourg	100.0	0.0	0.0	95.2	0.0	1.9
Malta	100.0	0.0		65.3	29.1	4.5
Netherlands	96.9	3.1	1.1	42.3	1.2	55.4
Poland	69.1	30.9	3.8	47.1	1.0	48.1
Portugal	91.5	8.5	1.7	26.8	4.9	66.7
Romania	40.6	59.4	3.2	65.2	0.2	31.5
Slovakia	99.7	0.3	1.0	58.8	0.1	40.1
Slovenia	99.8	0.2				
Spain	99.0	1.0	2.6	55.6	3.2	38.6
Sweden			4.2	59.6	4.5	31.6
U.Kingdom	100.0	0.0				

Notes: "nc" National currency; "fc" Foreign currency; "Cnf" Non-financial corporations; "Cf" Financial corporations; "H" Households & non-profit institutions serving households; "RW" Rest of the world. > Source: Eurostat, "gov_dd_ggd" and "gov_dd_dcur" datasets.

considering the holders' composition.

The consideration of the composition of holders for the study of sustainability can be referred as taking a Balance of Payments perspective. Indeed, in Balance of Payments accounting, *external debt* is defined upon a residency criterion for which all liabilities owed to non-residents are external debt (IMF, 2003).[3] Accordingly, external debt is:

[2] This hypothesis was viable for Low-Income and Emerging countries in the past, at a lesser extent it is still now for them.

[3] "Gross external debt, at any given time, is the outstanding amount of those actual current, and not contingent, liabilities that require payment of principal and/or interest by the debtor at some point in the future and that are owned to nonresidents by residents of an economy "

$$\text{BoP perspective} \Rightarrow D_t = \left(D_t^{h.r} + e \cdot D_t^{f.r}\right) + \underbrace{\left(D_t^{h.nr} + e \cdot D_t^{f.nr}\right)}_{extDebt}$$

Given the irrelevance of foreign-currency debt for advanced economies (Table 1), which are the reference of our analysis, in what follows we take such Balance of Payments perspective to consider external debt and, coherently, we study whether or not *Non-Residents' Holdings* (NRHs) matter for debt sustainability.

The consideration of NRHs for debt sustainability can be framed through the simple formula of the debt-stabilizing primary balance:

$$\underbrace{\frac{T_t}{Y_t} - \frac{E_t}{Y_t}}_{pb_t} = (i_{t-1} - g_t) \cdot \underbrace{\frac{D_{t-1}}{Y_{t-1}}}_{d_{t-1}} \tag{4}$$

where pb is the primary-balance/GNP ratio, i is the interest rate on the outstanding debt stock, g is the current growth rate of the economy; T, E, D and Y are respectively Tax revenues, Expenditures, Debt and Gross National Product all in levels (Cafiso, 2012). From this point on when we write *sustainability,* we mean stabilization as implied by equation 4.

We have in mind two main channels directly related to eq.4 through which external debt may alter debt sustainability with respect to the case that public debt is all held by residents: *first*, a Transfer of Resources effect, to which is linked a Reduction of the Tax-Base effect; *second*, an effect on the determination of the interest rate (i_t). The study of the effect upon the Interest Rate Determination is the object of this paper; here, we briefly discuss the other as well. It is to say that there are other means too through which external debt might endanger debt stabilization, but those do not appear in eq.4. Among the others, the most important is the risk of *sudden stops* related to the debt roll-over (Merler and Pisani-Ferry, 2012a).[4]

As for the *transfer of resources* effect, it is to notice that when the debt instruments are held

[4] Sudden-stops consist in the event when foreigners stop financing a country through purchases of its treasuries. Most of the times, this makes the debt rollover impossible for that country.

by residents the interest-bill paid goes to residents. Then, interest payments to residents do not influence aggregate demand but only cause a redistribution among agents of the domestic economy (Gros and Alcidi, 2011). On the contrary, in the case of NRHs payments to non-residents cause a transfer of resources which decreases Aggregate Demand. This causes less current GNP and possibly less GNP growth in the future (g_t in eq.4) as a consequence. Recalling the definition of Gross National Product:

$$Y = C + I + G + (X - M) \pm YT.B \pm CT.B$$

this is embedded in the Income Transfer term $YT.B = +YT^r - YT^f$; where YT^r stands for transfers from non-residents to residents and YT^{nr} for transfers from residents to non-residents. [5]

As a side effect of the transfer of resources, a reduction of the tax base occurs in case of NRHs. We know that interest earnings are taxed in the destination country between White List countries.[6] Then, the proceeds of bonds held by non-residents decrease the tax base with respect to the case that these were held by residents:

$$T = t \cdot Y^{tbase} \text{ where } Y^{tbase} = \alpha_1 \cdot Y, \alpha_1 < 1 \text{ and } \alpha_2 < \alpha_1$$

where α_2 is the portion quantifying the tax-base in case of NRHs. As a consequence, tax revenues from the interest-bill taxation is lower when the largest portion of your debt is held by non-residents. Given that the debt-stabilizing primary balance (eq. 4) is made of tax-revenues and expenditures, to achieve that specific value of the primary balance, the tax rate t must be comparatively higher in case of large external debt to compensate the relatively-smaller tax base; alternatively, the tax base must be enlarged. In this regard, external public-debt might make public debt sustainability more

[5]In the spirit of Reinhart and Rogoff (2010), we might wonder whether this is not one of the possible explanations of why highly indebted countries grow less.

[6]About this, you can check the information available in the website of the Italian Treasury at the following address: http://www.dt.tesoro.it/it/debito_pubblico/titoli_di_stato/trattamento_fiscale/

difficult to achieve.[7]

2.1. The Interest Rate Determination

We now turn our attention to the Interest Rate Determination (i_t in eq.4). As it emerges from the debt-stabilizing primary balance, the higher the interest rate, the greater the fiscal correction in terms of primary balance to achieve. The question, then, is very simple to grasp: is such synthetic interest rate influenced by the composition of holders? To wit, is its evolution the same when it is entirely held by residents, with respect to the case when it is substantially shared with non-residents? To answer such question we study the relationship between the composition of holders and the interest rate attached to the largest portion of public debt (government bonds), both in terms of levels and volatility.

Our analysis builds on some recent contributions which consider the effect of NRHs on the market-yield of *Government Bonds* (GBs). Beltran *et al.* (2013) study the effect of NRHs on the term premium calculated using the market yield of US zero-coupon Treasury Securities. Andritzky (2012) considers the effect on a lager sample which includes all mayor world economies and focus on the market yield of the 10-year benchmark GBs. Arslanalp and Tsuda (2012) point out the necessity to consider the composition of holders when assessing debt sustainability and propose some risk-indicators related to it. Merler and Pisani-Ferry (2012b) make general considerations about the effect of variations of banks' holdings of GBs with respect to non-residents.

The first two above-mentioned papers primarily focus on market yields and related measures. Our main departure from these contributions is in this regard. Since our focus is on debt sustainability, we want to consider an interest rate which really reflects the financing cost borne by the Treasury.

[7] It is important to highlight two points regarding the relevance of the transfer of resources effect. *First*, what matters is mainly the net position. To wit, if the amount of resources transferred to non-residents is equivalent to the one received from abroad, then there is little to worry about. As a consequence, the same applies to the tax base. However, in Debt Sustainability Analysis, it is common practice to apply a prudential approach which considers only the liabilities side whose size is known and its burden certain. On the contrary, revenues from assets are for different reasons less certain. Then, this is why in the previous discussion we have considered only liabilities. *Second*, the relevance of the above sketched channels clearly depends upon the level of the debt stock. For an highly indebted Euro Area country, their consideration is indeed very relevant. Moreover, apart from the level of debt, their importance is likely to be greater for those countries whose debt-to-GDP ratio is an outlier with respect to the all-countries distribution. Indeed, such economies have an higher exposure with respect to the others and their net position is therefore more likely to be negative.

Indeed, we will show that the market yield cannot be assumed to reflect such cost. As far as we know, data of this kind are not directly available from any provider, we therefore construct a time series from the results of Treasury auctions of government bonds (primary market). Given tight data constraints, our analysis considers only one country: Italy. Our choice falls on Italy for operational reasons. First, Italy is a large debt issuer and it runs many auctions each month. Then, it is possible to construct a monthly series of data. Secondly, differently from what is available for other major EA countries (such as France, Germany or Spain), the Bank of Italy publishes a monthly series of debt holdings data which can be matched with the monthly auction yield series.

The relationship between non-residents' holdings and the auction yield is studied both in levels and volatility. We consider volatility too because this is a measure of the risk associated to debt financing, higher volatility meaning more roll-over risk, and because it will become of interest in the context of the analysis as explained further on.

3. The Dataset

Our analysis requires two main variables: the Auction Redemption Yield (ARY) series and the amount of Non-Residents' Holdings (NRHs) of Government Bonds (GBs). The econometric analysis in the next sections 5 and 6 requires also the inclusion of same control variables. All data and some related considerations are presented in the next subsections.

3.1. The Auction Redemption Yield (ARY)

As aforementioned, we construct a series winch is functional to reflect the financing-cost borne by the Treasury. Indeed, we decide not to use the market yield of the 10-year benchmark government bond, which is the most common variable used in studies not-directly linked to sustainability. The auction yield is constructed using the results of the auctions of GBs executed on behalf of the Italian Treasury by the Bank of Italy. For its construction we consider the two main categories of fix-rate government securities: Treasury Bills named "Buoni Ordinari del Tesoro" (BOT) and Treasury Notes/Bonds named "Buoni del Tesoro Poliennali" (BTP). BOT are zero-coupon bonds sold at a discount price, while BTP make a coupon payment every six months; among all the different categories of BTP, we chose those with a fix rate defined at the issuance.

The last available figure used for this analysis is for December 2012, when Italian Public Debt achieved 127.1% of GDP with a nominal value of 1'988€ billions. Around 83.24% of such value (1'655€ billions) was constituted by GBs; this is the percentage of marketable debt over the total. The BTP and BOT considered account for 65.00% and 9.72% respectively of total Marketable Debt. Then, to sum up, we consider auctions of Treasury securities which account for 74.72 % of total Marketable Debt and around 62.59% of total Public Debt. We therefore gauge the ARY calculated using the BOT and BTP selected very representative of the financing-cost of the Italian Public Debt.

The monthly ARY series is constructed as the weighted average of the auction results within each month.[8] To wit, each month several auctions take place whose result is a certain amount of securities sold with a resulting redemption yield; this represents the yearly effective cost borne by the Treasury for the loan obtained through the auctioned instrument. We average the redemption yield of all the auctions within the same month using the amount sold as weight. The Italian Treasury is one of the largest world issuer of government securities, and the largest within the Euro Area, then a monthly series is possible to construct when one considers either BTP or BOT, or both as we do. Data availability is from January 2002 (2002m1) to December 2012 (2012m12). Summary statistics for the auctions considered are in Table 2, while the ARY series and its volatility are shown in Figure 1 (Panel A and B respectively).

Figure 1 reports the auction yields (ARY) and the market yields (MRY) of Italian GBs (secondary market transactions) in levels for comparison (Panel A).[9] Not surprisingly the joint BOT&BTP ARY is in between the one for BOT (short-term bonds) and the one for BTP (long-term bonds), where the one for BTP is constantly higher and the one for BOT is constantly lower apart during peaks. This is the expected pattern given that BTPs are medium-to-long term bonds which imply an higher interest rate, while BOTs are short-term bonds. The dynamics of the market yield and the auction yield are alike, nevertheless relevant differences in magnitude emerge particularly in non-turmoil

[8]This is the same procedure adopted by the Italian Treasury to public its monthly report on Government Bonds where a synthetic overall rate is indicated: http://www.dt.tesoro.it/export/sites/sitodt/modules/ documenti_it/debito_pubblico/dati_statistici/Principali_tassi_di_interesse_2012.pdf

[9]Market redemption yields data are extracted from DataStream.

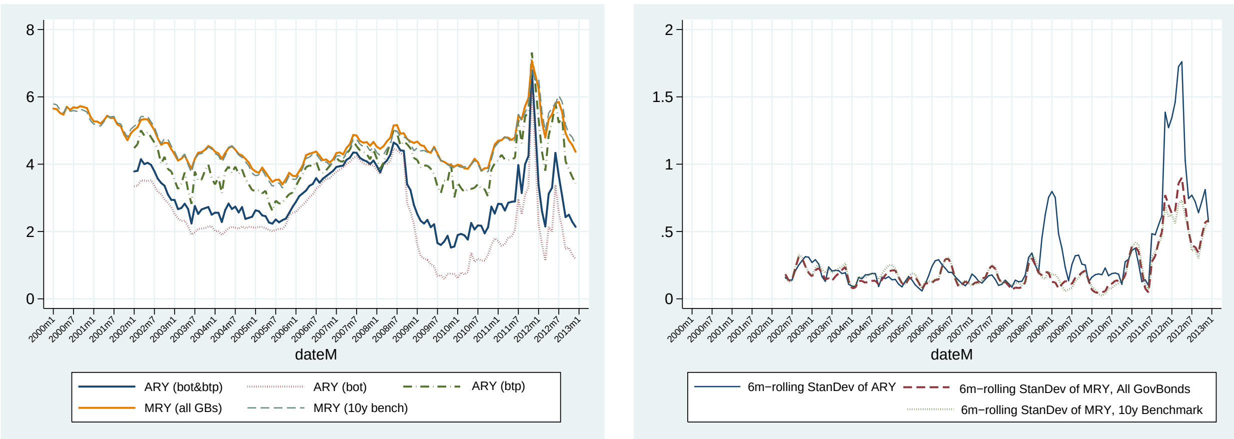
Table 2 – BOT and BTP auction results

	BOT					BTP				
year	#Auc	M#Auc	M.ARY	T.Am	M.Am	#Auc	M#Auc	M.ARY	T.Am	M.Am
2002	50	4.17	3.25	210513	17542.75	83	6.92	4.47	111428	9285.67
2003	46	3.83	2.18	215720	17976.67	89	7.42	3.52	124277	10356.42
2004	44	3.67	2.07	220050	18337.50	51	4.64	3.63	103156	9377.82
2005	39	3.25	2.16	212916	17743.00	58	4.83	3.01	105592	8799.33
2006	37	3.08	3.17	210583	17548.58	56	5.09	3.81	106550	9686.36
2007	42	3.50	4.01	229552	19129.33	57	4.75	4.33	107628	8969.00
2008	54	4.50	3.73	269599	22466.58	84	7.00	4.45	129006	10750.50
2009	59	4.92	0.95	265996	22166.33	102	8.50	3.67	166409	13867.42
2010	45	3.75	1.13	209837	17486.42	89	7.42	3.38	167718	13976.50
2011	49	4.08	2.77	206518	17209.83	93	7.75	4.97	146667	12222.25
2012	53	4.42	1.89	239712	19976.00	119	9.92	4.59	148465	12372.08

Notes: "#Auc" stands for Number of Auctions in the year; "M#Auc" stands for Average Number of Auctions in each month of the respective year; "M.ARY" stands for Average of the Monthly Auction Redemption Yield; "T.Am" stands for Total Amount of Bonds sold in the year (millions of Euros); "M.Am" stands for Average Monthly amount of Bonds sold (millions of Euros).

Figure 1 – ARY and MRY

Panel A: ARY and MRYs in levels *Panel B: ARY and MRYs volatility*



periods.

As for the volatility of the ARY (Figure 1, Panel B), this is computed as the 6-months rolling standard deviation and therefore represents *Historical Volatility*. It strikes that in periods of turmoil the ARY volatility is much higher than the MRY volatility both when considering the MRY based on the basket of all the GBs and the 10-year benchmark GB only.

In Appendix I we provide econometric analysis suggesting that it is the ARY to influence the MRY, and not the other way around. Furthermore, the MRY seems to be a viable proxy of the ARY only for the first tranches auctioned of a new bond, on the contrary, there is a growing divergence between the ARY and the MRY for later tranches of the same title; see Appendix I for more about this. These findings support our construction and use of the ARY series for the study of sustainability.

3.2. Non-Residents Holdings of Debt (NRHs)

The second main variable which we use to develop our analysis is Non-Residents' Holdings of public debt (NRHs). Data on holders of Italian Total Public Debt and Marketable Debt (alias, government bonds) are released on a *monthly basis* by the Bank of Italy; original values are in million of Euros. The Bank of Italy considers the following groups: (A) Non-Residents and (B) Residents. Within the residents group it distinguishes further between: (B.1) Bank of Italy, (B.2) Other Financial and Monetary Institutions, (B.3) Other Financial Institutions, (B.4) Other Residents.[10]

The evolution of the shares over the total is reported in Figure 2 - Panel A. The chart shows that in the context of the Euro Area debt crisis, non-residents started to decrease their exposition towards Italian securities from 2011m6. The amount dismissed by non-residents seem to have been absorbed mainly by private residents and domestic banks (other financial and monetary institutions: AIFM in Figure 2).

It is to remember that shares are the result of a ratio. Then, their variation might not represent a true change in non-residents' portfolio.[11] We show this by considering the stock of bonds and compare its growth rate with the one of the share; the stock is normalized at its January 2007 value; values are plotted in Figure 2 - Panel B. Over 195 observations available, the NRHs-stock decreases while the NRHs-share increases in 11 obs, the NRHs-stock increases while the NRHs-share decreases in 19 obs, the NRHs-stock and the NRHs-share move in the same direction in 165 observations. As customary in this literature, we go along with shares and therefore talk about non-residents' participation into the the Italian GBs market.[12]

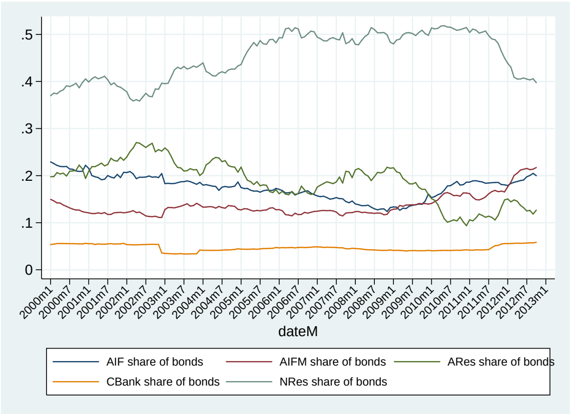
[10]The category B.2 "Other Financial and Monetary Institutions" mainly comprises all the resident banks excluding the Bank of Italy itself.

[11]To wit, the share might decrease because the new debt issued is acquired by residents while non-residents do not change their portfolio composition.

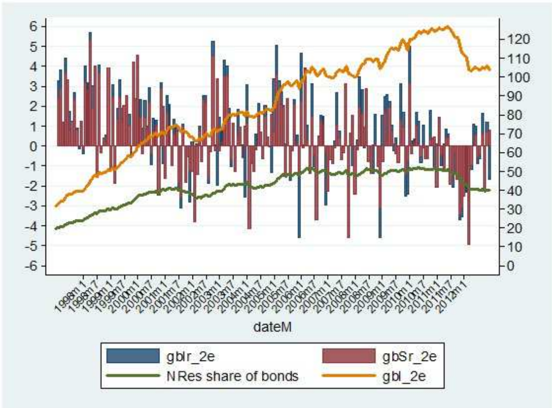
[12]It is to say that the NRHs share reflects holdings of outstanding debt, and not the portion of foreigners who buy new bonds at the auction. The latter information does not exist. Truly, it is not clear to us whether that would be a relevant information anyway because it is more likely to be foreigners' participation in the secondary market to matter, also because this is what to consider as external debt.

Figure 2 – Non-Residents' Holdings

Panel A: Marketable Debt Holdings by sector



Panel B: NRHs, growth rate of the Stock and of the Share



3.3. Control Variables

In the following econometric analysis we use a set of control variables, these are:

- *ebr3m*: Euribor 3-month rate, short term rate to account for interest rates dynamics in the Euro Area.
- *vtxln*: VSTOXX index for the EURO-Area, to reflect market expectations of near-term up to long term volatility; based on option prices for 50 blue-chips stocks from 12 EA countries. This is a measure of implied volatility and works as an ex-ante indicator.
- *gdpln*: Italy's GDP index, to account for the business cycle. Originally quarterly, linearly interpolated to monthly.
- *dgr*: Italy's Debt-to-GDP ratio, to account for the fiscal stance. Originally quarterly, linearly interpolated to monthly.
- *hcpln*: Italy's Consumer Price Index, to account for real interest rate considerations in the portfolio composition.
- *sprAd*: Italy's Adjusted Spread, to account for Italy's higher risk-profile with respect to to the EA countries during the crisis.
- *Lags of the Endogenous Variables*: the number is selected through information criteria and residual auto-correlation test.

Apart for the Euribor and VSTOXX index, the variables are specific to Italy. All the variables but $sprAd$ are taken from a data provider. We construct the adjusted-spread measure as the difference between Italy's spread with respect to the 10-year German Bund, and the average spread of all the Euro Area countries with respect to the same 10-year German Bund. In the crisis period almost all EA spreads with respect to Germany increased, by considering only the difference with respect to the average spread we aim to account for Italy's higher risk-profile with respect to its EA partners.[13]

4. Outline of the Econometric Analysis

In the following two sections we develop the econometric analysis to study the relationship between the auction yield and non-residents' holdings. The study of their relationship poses two main challenges, we provide some information on the analytical approach taken.

First, the study of the effect of NRHs on the auction yield would require to set a specific direction of causality: from NRHs to the yield. However, as explained by Beltran *et al.* (2013) and Andritzky (2012), it is not clear whether it is a certain amount of investment by non-residents to influence the yield or the other way around. To wit, this is a simple dilemma of the price-demand kind: is it the price to determine the demand or the other way around?[14] As a consequence, imposing one of the two as dependent variable is problematic on a theoretical ground. Accordingly, we take direct account of the uncertain causality direction through a Vector Auto Regression. Such framework starts without imposing a specific causality direction on which we will draw conclusions as an outcome of the estimation and proper tests.

Second, our analysis covers the period 2002m1-2012m12. It is well known that Italy, together with Spain, was hit by the second-wave of the Euro Area debt crisis during that period (second-half of 2011 onwards). Then, we cannot exclude that as a consequence of the turmoil the relationship between the ARY and NRHs has changed somehow. For this reason, we run the estimation both for the Full-Period available (2002m1-2012m12) and for a smaller one, named "No-Crisis Period"

[13] From the computation of the average spread we rule out those EA countries which ended up into a EU-IMF financial assistance programme (Ireland, Portugal, Greece).

[14] GBs are peculiar assets, used as safety ones and investors therefore might be less sensitive to the interest rate than for other securities. This is true also because of the zero-risk weight assigned to GBs in banks' portfolio (Gros, 2013).

(2002m1-2011m6), which rules out the second-wave of the EA debt crisis. By so doing, we check the robustness of our results to the occurrence of the crisis; this will turn out very important. Furthermore, in the case of volatility and variations (section 6) we also present the estimation of a Markov-Switching VAR to account for a regime-switch suggested by the two linear estimations over the nested samples.

The analytical framework which we apply is a Vector Auto-Regression with Exogenous Variables (Lutkepohl, 2005):

$$\begin{bmatrix} ARY_t \\ NRHs_t \end{bmatrix} = \sum_{k=1}^{n} \underset{2\times 2}{\Gamma_k} \begin{bmatrix} ARY_{t-k} \\ NRHs_{t-k} \end{bmatrix} + \underset{2\times 6}{\Psi} \begin{bmatrix} ebr3m_t \\ vtxIn_t \\ gdpIn_t \\ dgr_t \\ hcpIn_t \\ sprAd_t \end{bmatrix} + \underset{2\times 1}{\nu_t} \tag{5}$$

the exogenous variables are included to account for the evolution of the economic environment and how this might influence the relationship between the ARY and $NRHs$. In the following, our stress is to select the best specification possible in order to produce efficient estimations which can be used to make inference about the results obtained. Then, particularly in relation to the number of lags included (k), we select it on the basis of information criteria and the rejection of the auto-correlation test in a VAR setting.[15]

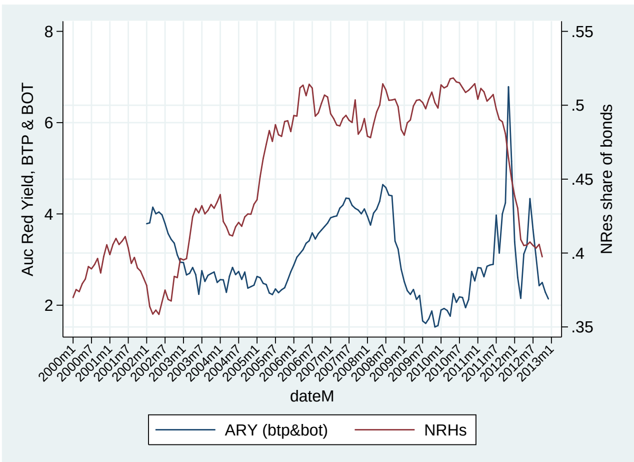
[15] As a matter of fact, there was a third issue as well. Indeed, caution was needed because of the odds that the ARY and NRHs series are non-stationary. We have checked this by testing the stationarity of the series in levels, and of the volatility of the ARY. The hypotheses tested were: 1) "H0: unit root" using the DF-GLS test (Elliott *et al.*, 1996), the ADF Test (Dickey and Fuller, 1979) and the PPerron test (Phillips and Perron, 1988); 2) "H0: no unit root" using the KPSS test (Kwiatkowski *et al.*, 1992). When the different tests' output were not unanimous, we preferred the DF-GLS test. On the whole, the ARY series in levels and its volatility seem to be stationary, while this was more dubious for NRHs. We investigated also the possibility of cointegration through the Johansen's Approach based on a Vector Error Correction Model. Both the Trace and Maximum-Likelihood statistics suggest no cointegration; this ruled out the case for an Error Correction Model a-là Beltran *et al.* (2013). In the end, we decided to proceed with the variables in levels. This decision was taken considering the scope of our analysis and the nature of the variables themselves. Indeed, it makes more sense to believe that the auction yield and non-residents' holdings are mean-reverting processes. Furthermore, we consider the variables over a 10-year period, such relatively-short sample should soften the problem anyway. Nevertheless, we also used the first-differences of NRHs in the estimation of volatility and variations to check the robustness of our results (section 6). The output of each test is promptly

The VARX in eq.5 refers to the estimations which use the ARY and NRHs variables in levels (section 5). Nonetheless, we do also estimate a version of the VARX using the ARY volatility and NRHs variations as dependent variables (section 6); the motivations for this are made clear at the beginning of that section.

5. Analysis of ARY and NRHs: levels

In this section we report the estimation of the the VARX in eq.5 using the ARY and NRHs variables in levels. The plot of the two series is in Figure 3, the estimation output for the full and no-crisis periods is in Table 3. An automatized routine based on multiple information criteria suggests inclusion up to the 4th lag in the estimation over the full period, while inclusion of the 1st lag only in the estimation over the no-crisis period. Two estimations are reported for each period: the firsts include all the explicatives (columns 1 and 3 in Table 3), while only those jointly-significant in both equations of the VARX are maintained in the seconds (columns 2 and 4 in Table 3); this was done to develop the following inference on more efficient estimations. The output of the VAR stability test and of the Auto-Correlation test at the specified lag-order is reported in the same Table for each estimation. The Stability Test suggests that the VAR is stable, the Auto-Correlation Test signals no auto-correlation at the selected lag order.[16]

Figure 3 – ARY and NRHs in levels



We now draw conclusions about the causal relationship between the *ARY* and *NRHs* through

available upon request.

[16]References to these two tests in a VAR framework are in Lutkepohl (2005).

Table 3 – Linear-VARX, levels, no-crisis and full period.

	Full Period **2002m1-2012m12**		No-Crisis **2002m1-2011m6**	
ary	(1)	(2)	(3)	(4)
L.ary	*0.370****	*0.379****	*0.491****	*0.531****
L2.ary	*-0.188**	*-0.179**		
L3.ary	*-0.289***	*-0.286***		
L4.ary	*0.056*	*0.034*		
L.nrhS	*-0.002*	*-0.001*	*-0.015*	*-0.010*
L2.nrhS	*0.010*	*0.009*		
L3.nrhS	*-0.050*	*-0.053*		
L4.nrhS	*0.072**	*0.073**		
ebr3m	0.858***	0.816***	0.407***	0.400***
vtxln	-0.006		-0.011***	-0.011***
dgr	0.064***	0.061***	0.046***	0.047***
gdpln	-0.016		0.018	
hicpln	-0.059***	-0.056***	-0.012	-0.006
sprAd	1.004***	0.971***	0.290	
cons	-0.049	-1.413	-4.254*	-3.480***
nrhS				
L.ary	*-0.256*	*-0.272*	*-0.533*	*-0.702**
L2.ary	*0.073*	*0.054*		
L3.ary	*-0.044*	*-0.046*		
L4.ary	*-0.619****	*-0.604****		
L.nrhS	*0.807****	*0.804****	*0.860****	*0.886****
L2.nrhS	*-0.047*	*-0.041*		
L3.nrhS	*0.263***	*0.268***		
L4.nrhS	*-0.170***	*-0.164***		
ebr3m	0.366	0.503**	0.065	0.413
vtxln	0.008		0.004	-0.010
dgr	0.000	0.005	0.010	-0.002
gdpln	0.065		0.134	
hicpln	0.085**	0.081**	0.091**	0.070**
sprAd	-0.582*	-0.507	-1.401	
cons	-6.611	-1.089	-15.481	-0.241
aic	372.300	367.990	194.799	194.177
bic	457.861	442.142	243.892	232.36
N	128	128	113	113
R2.eq1	0.867	0.864	0.955	0.954
R2.eq2	0.980	0.980	0.976	0.976
Stability T.	not reject	not reject	not reject	not reject
AutoCor.T.	0.311	0.340	0.215	0.180

the estimations in columns 2 and 4 in Table 3. We rely on two standard techniques for this: the Granger-causality Test and Forecast Error Variance Decomposition.

The Granger causality test (Amisano and Giannini, 1997) is a Wald-Test on the significance of the lagged variables as explicatives, the test output is in the following Table 4 both for the full-sample and no-crisis estimations (Panel A1 and B1). From the test output it emerges that the ARY is more likely to Granger-cause NRHs, and not the other way around; this is more evident when the full-sample is considered.

Another way to gain insights into the causality direction is to consider the Forecast Error Variance Decomposition.[17] The values of the FEVD at different forecast steps are reported in Table 4, Panel A2 and B2. As it emerges by comparing column 2 with column 3, the portion of the forecast error variance of $NRHs$ explained by ARY is much higher than the portion of the forecast error variance of ARY explained by $NRHs$, but this is true only when the full sample is considered. Then, once again, the causality direction seems to be stronger from the ARY to $NRHs$ when the turmoil period is considered.

Bearing in mind the results about the Granger-causality in Table 4, we look now at the dynamics of the system in response to a shock to the variables under consideration. This is done through *Simple* Impulse Response Functions (IRFs) which summarize the effect on single variables as derived through the VAR estimation; these are reported in Figure 4 together with bootstrap confidence intervals.[18] The IRFs show a significant effect on $NRHs$ in case of an impulse in ARY, but not the other way around. From the results in Table 4, we know that this is however more significant when the turmoil period is taken into account.

[17] The FEVD determines how much of the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables. To wit, if the portion of the FEV of the y series due to a shock in the x series (i) is greater than the portion of the FEV of the x series due to a shock in the y series (ii), then x is more likely to cause y than the other way around.

[18] Simple IRFs are obtained through the auto-regressive coefficients of the Moving Average representation of the estimated stable VAR. Here, these are preferred to Orthogonalized IRFs via the Cholesky decomposition because they do not require an ordering reflecting the assumptions on the causal relationship on which, instead, we try to get insights. Moreover, for the same reason, these are more coherent with the concept of Granger-causality, which we refer to and test in Table 4, since this is not based on contemporaneus identifying restrictions but on the significance of lagged variables.

Table 4 – Linear-VAR, levels, Granger-causality and FEVD

Panel A: Full-Period (2002m1-2012m12)

A1: Granger Causality Test

X	Y	"H0: Y does not Granger cause X"
nrhS	*ary*	PValue: 0.000 $\Longrightarrow$ reject
ary	*nrhS*	PValue: 0.103 $\Longrightarrow$ does not reject

A2: FEV Decomposition

step	(1)	(2)	(3)	(4)
0	0.000	0.000	0.000	0.000
1	1.000	0.001	0.000	0.999
2	1.000	0.008	0.000	0.992
3	1.000	0.013	0.000	0.987
4	0.994	0.014	0.006	0.986
5	0.994	0.056	0.006	0.944
6	0.988	0.096	0.012	0.904
7	0.984	0.113	0.016	0.887
8	0.983	0.118	0.017	0.882
9	0.982	0.120	0.018	0.880
10	0.982	0.122	0.018	0.878
11	0.982	0.125	0.018	0.875
12	0.982	0.128	0.018	0.872

(1) impulse = ary, and response =ary
(2) impulse = ary, and response = nrhS
(3) impulse = nrhS, and response = ary
(4) impulse = nrhS, and response = nrhS

Panel B: No-Crisis-Period (2002m1-2011m6)

B1: Granger Causality Test

X	Y	"H0: Y does not Granger cause X"
nrhS	*ary*	PValue: 0.059 $\Longrightarrow$ close to reject
ary	*nrhS*	PValue: 0.283 $\Longrightarrow$ does not reject

B2: FEV Decomposition

step	(1)	(2)	(3)	(4)
0	0.000	0.000	0.000	0.000
1	1.000	0.020	0.000	0.980
2	0.999	0.012	0.001	0.988
3	0.996	0.016	0.004	0.984
4	0.993	0.021	0.007	0.979
5	0.990	0.027	0.010	0.973
6	0.987	0.031	0.013	0.969
7	0.985	0.035	0.015	0.965
8	0.983	0.037	0.017	0.963
9	0.981	0.039	0.019	0.961
10	0.980	0.041	0.020	0.959
11	0.979	0.042	0.021	0.958
12	0.978	0.043	0.022	0.957

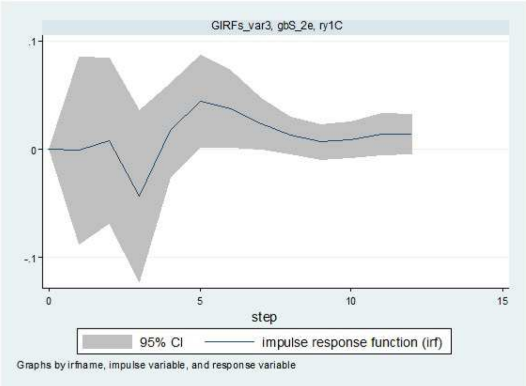
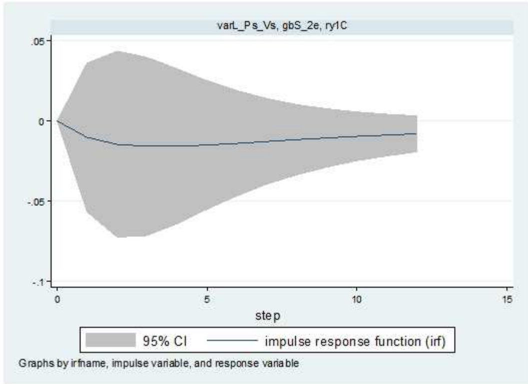
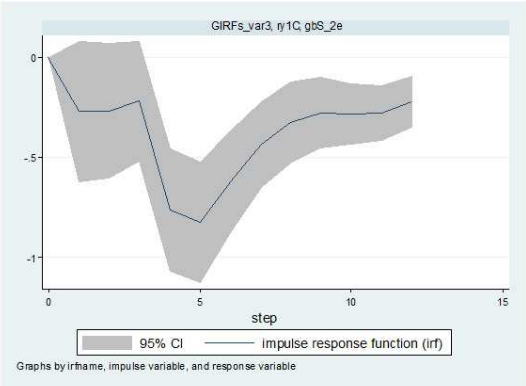
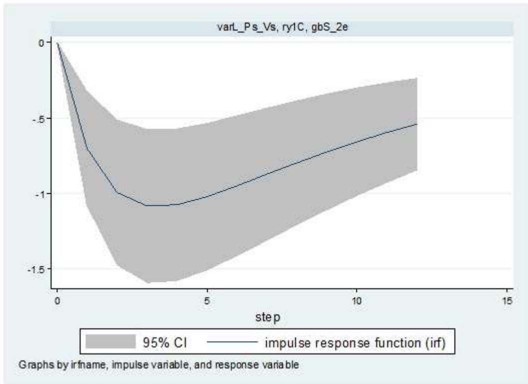
(1) impulse = ary, and response =ary
(2) impulse = ary, and response = nrhS
(3) impulse = nrhS, and response = ary
(4) impulse = nrhS, and response = nrhS

5.1. Considerations from the estimations in levels

External debt would affect sustainability favorably in case of a negative effect from NRHs to the ARY: an increase of NRHs reduces the financing-cost. The estimations in levels do not provide evidence in this direction. Then, NRHs do not seem to affect the dynamics of the public-debt's financing-cost. Consequently, from this perspective, we should not be worried about the composition of holders.

On the contrary, a negative-pull effect emerges from the ARY to NRHs, but this seems to be relevant only because of the turmoil period. This result calls for an explanation which would require an analysis of non-residents' portfolio strategies, something which is beyond the scope of this paper. Nevertheless, it is possible to imagine why such effect emerges: likely, an higher yield comes with an higher *perceived risk* to which non-residents react negatively with respect to the composition of

Figure 4 – Linear-VAR, Full Period (Panel A) and No-Crisis (Panel B), Simple IRFs

Panel A: Full-Period (2002m1-2012m12) ↓	Panel B: No-Crisis Period (2002m1-2011m6) ↓
$A1: NRHs \rightarrow ARY$	$B1: NRHs \rightarrow ARY$
	
$A2: ARY \rightarrow NRHs$	$B2: ARY \rightarrow NRHs$
	

their international portfolio.[19] An alternative way to check such explanation is to consider directly a measure of risk linked to public-debt and see whether it influences negatively NRHs. We do this in the next section where the volatility of the ARY serves for this purpose and it is matched with variations of NRHs.

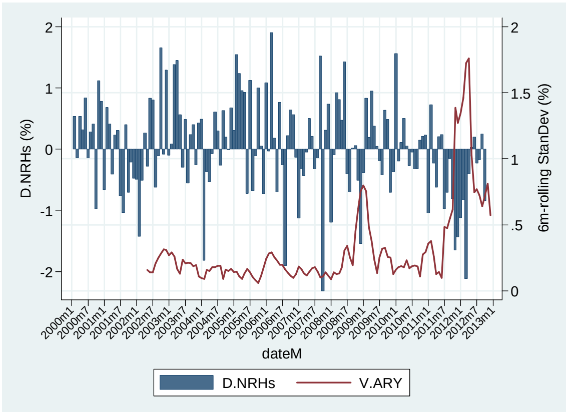
6. Analysis of ARY and NRHs: Volatility and Variations

In this section we take the study of the relationship between the auction yield and non-residents' holdings through a deep transformation of the data. We use now the volatility of the ARY (calculated as the 6-months backward standard deviation, *historical volatility*) and the first-differences of NRHs;

[19] The effect on the ARY of such perceived risk is partially reflected by the "sprAd" variable which we include in the estimation. Indeed, it has a strongly positive effect on the ARY. However, "sprAd" does not seem to have a direct effect on NRHs. In support of this explanation, we have attempted to estimate the effect of Default Probabilities on NRHs. Unfortunately, Default Probabilities data do not go back in time enough to develop a proper analysis.

the two series are plotted in Figure 5. The motivations behind the analysis with such transformed variables are the followings. *First*, to the extent that volatility reflects the refinancing-risk for the debt rollover, it is of interest to check whether or not non-residents' participation in the domestic bond market has a stabilizing effect. *Second*, this can provide support for the suggested explanation of the negative pull-effect found through the estimations in levels and discussed in the previous sub-section 5.1. *Third*, we mean this as a mayor robustness check of the relationship studied.

Figure 5 – Volatility of ARY and variations of NRHs



Once again, the analysis in this section considers both the full period available (2002m1-2012m12) and the no-crisis period (2002m1-2011m6) to check the robustness of the results with respect to the occurrence of the EA debt crisis. The analytical framework is a VAR with exogenous variables (VARX) similar to the one in eq.5, the control variables are now included in levels or in first-difference for their contribution in raising the explicative power of the regressions within the VAR. The estimation output is reported in Table 5, again, two estimations for each period. The inclusion of lags and the exclusion of some explicatives from the estimations used for the following inference (columns 2 and 4 in Table 5) are decided in the same way as for the estimation in levels. The estimation over the full period is well specified with the inclusion of the 1st lag only, the one over the no-crisis period requires 2 lags; at the selected lag order the auto-correlation test rejects the null and the VAR results to be stable.[20]

Conclusions about the estimations are drawn through the Granger-causality Test, Forecast Error

[20] The low explicative power of the regression for $\triangle NRHs$ is not surprising if we think about the nature of the variable itself. Indeed, the analysis of how non-residents adjust their portfolio would require a different approach which is beyond the scope of the current analysis. Here, we are simply interested in the relationship between variations and volatility in accordance with the objective of the analysis which is debt-sustainability.

Table 5 – Linear VAR, Volatility&Variations, Selected & Full Period

	2002m1-2012m12		2000m1-2011m6	
	all exogen.	selected exog.	all exogen.	selected exog.
Vary	(1)	(2)	(3)	(4)
L.Vary	*0.890****	*0.881****	*0.922****	*0.928****
L2.Vary			*-0.283****	*-0.287****
LD.nrhS	*-0.027**	*-0.028**	*-0.004*	*-0.004*
L2D.nrhS			*-0.001*	*-0.001*
D.ebr3m	-0.116	-0.154**	-0.109**	-0.113**
vtxln	0.001		0.002***	0.002***
gdpln	0.004	0.003	0.004*	0.004*
D.hicpln	-0.013		-0.023**	-0.024**
D.dgr	-0.007		0.005	
D.sprAd	0.116	0.158**	0.072	
cons	-0.401	-0.301	-0.417*	-0.417*
DgbS2e				
L.Vary	*-0.781***	*-0.695***	*-0.029*	*-0.072*
L2.Vary			*0.236*	*0.465*
LD.nrhS	*-0.010*	*-0.011*	*-0.061*	*-0.065*
L2D.nrhS			*-0.064*	*-0.067*
D.ebr3m	0.873*	0.725*	1.066*	1.023*
vtxln	0.006		0.006	0.004
gdpln	-0.057*	-0.063**	-0.053	-0.055
D.hicpln	0.120		0.198*	0.199*
D.dgr	0.083		0.033	
D.sprAd	-0.291	-0.425	-1.098	
cons	5.806*	6.549**	5.265	5.460
aic	120.894	113.982	-73.31	-79.638
bic	172.089	148.113	-14.303	-31.36
N	127	127	108	108
R2.eq1	0.870	0.869	0.864	0.863
R2.eq2	0.245	0.221	0.225	0.220
Stability T.	not reject	not reject	not reject	not reject
AutoCor.T.	0.182	0.176	0.405	0.217

Variance Decomposition and Simple Impulse Response Functions based on the estimations in columns 2 and 4 in Table 5. The output of the Granger-causality test and FEVD are reported in the following Table 6. The Granger-causality test reports a clear effect from the ARY volatility to NRHs variations, but such causal effect is clearly dependent on the turmoil period (panel B1 against panel A1); otherwise, the two series do not seem associated. This also emerges from the FEVD output which signals the contribution of the ARY volatility in explaining the forecast error variance of NRHs variations to be much higher than the other way around.

Table 6 – Linear-VAR, Volatility&Variations, Granger-causality and FEVD

Panel A: Full-Period (2002m1-2012m12)

A1: Granger Causality Test

X	Y	"H0: Y does not Granger cause X"
$\triangle.nrhS$	$V.ary$	PValue: 0.006 $\Longrightarrow$ reject
$V.ary$	$\triangle.nrhS$	PValue: 0.062 $\Longrightarrow$ does not reject

A2: FEV Decomposition

step	(1)	(2)	(3)	(4)
0	0.000	0.000	0.000	0.000
1	1.000	0.084	0.000	0.916
2	0.985	0.095	0.015	0.905
3	0.981	0.104	0.019	0.896
4	0.979	0.111	0.021	0.889
5	0.978	0.117	0.022	0.883
6	0.977	0.122	0.023	0.878
7	0.977	0.126	0.023	0.874
8	0.977	0.129	0.023	0.871
9	0.976	0.131	0.024	0.869
10	0.976	0.133	0.024	0.867
11	0.976	0.135	0.024	0.865
12	0.976	0.136	0.024	0.864

(1) impulse = Vary, and response =Vary
(2) impulse = Vary, and response = DnrhS
(3) impulse = DnrhS, and response = Vary
(4) impulse = DnrhS, and response = DnrhS

Panel B: Selected-Period (2002m1-2011m6)

B1: Granger Causality Test

X	Y	"H0: Y does not Granger cause X"
$\triangle.nrhS$	$V.ary$	PValue: 0.832 $\Longrightarrow$ does not reject
$V.ary$	$\triangle.nrhS$	PValue: 0.853 $\Longrightarrow$ does not reject

B2: FEV Decomposition

step	(1)	(2)	(3)	(4)
0	0.000	0.000	0.000	0.000
1	1.000	0.003	0.000	0.997
2	0.999	0.003	0.001	0.997
3	0.997	0.003	0.003	0.997
4	0.997	0.004	0.003	0.996
5	0.997	0.004	0.003	0.996
6	0.997	0.004	0.003	0.996
7	0.997	0.004	0.003	0.996
8	0.997	0.004	0.003	0.996
9	0.997	0.004	0.003	0.996
10	0.997	0.004	0.003	0.996
11	0.997	0.004	0.003	0.996
12	0.997	0.004	0.003	0.996

(1) impulse = Vary, and response =Vary
(2) impulse = Vary, and response = DnrhS
(3) impulse = DnrhS, and response = Vary
(4) impulse = DnrhS, and response = DnrhS

The Simple Impulse Response Functions (IRFs) are reported in Figure 6; confidence intervals are once again bootstrap-obtained ones. The IRFs show an effect from the ARY volatility to NRHs variations over the full sample, that we know to be bound to the emergence of the Turmoil from July 2011. Through a quick look at the IRFs, a shock in NRHs variations seems to have an effect also on the ARY volatility but this is likely to emerge because of the feedback effect given that we consider simple IRFs.

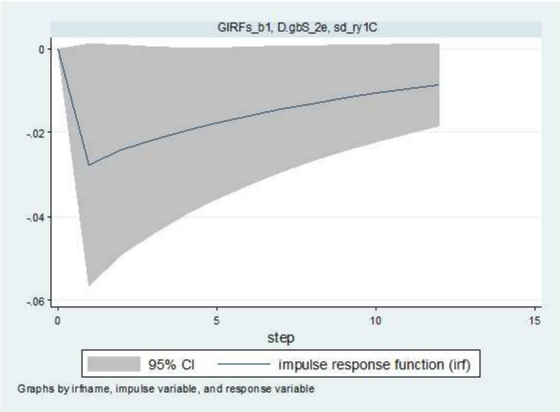
6.1. Regime-Switch Estimation

On the whole, the estimations using volatility and variations show, again, that a relationship between the two series emerges only because of the inclusion of the turmoil period. The emergence of the Turmoil seems therefore to be a major event in the study of their relationship, an event which is

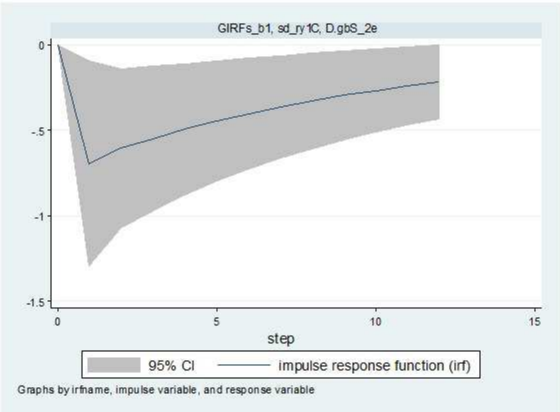
Figure 6 – L-VARX, Volatility & Variations, Simple IRFs

A: Full-Period (2002m1-2012m12)

A1: $\triangle.NRHs \rightarrow V.ARY$

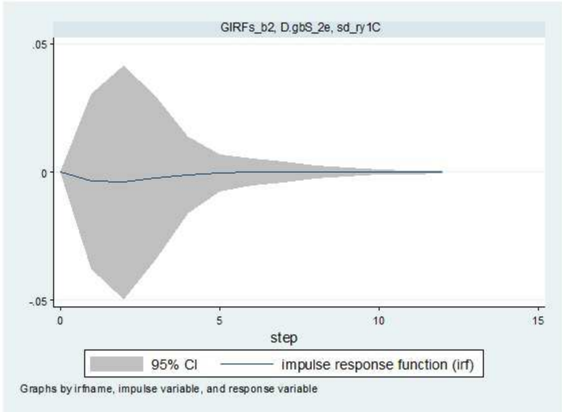


A2: $V.ARY \rightarrow \triangle.NRHs$

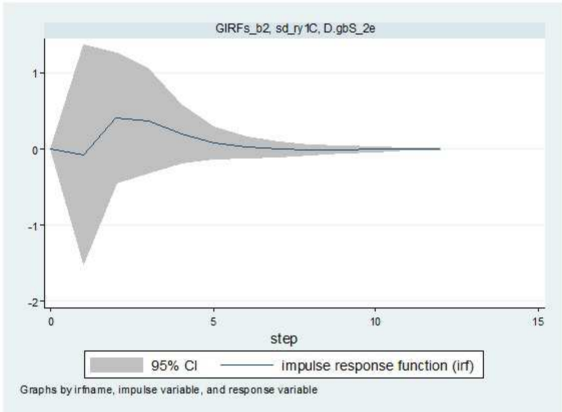


B: Selected Period (2002m1-2011m6)

B1: $\triangle.NRHs \rightarrow V.ARY$



B2: $V.ARY \rightarrow \triangle.NRHs$



indeed able to alter it through a regime switch. For this reason, we believe worthwhile to explicitly consider a regime switch in the estimation framework and see whether the output of a non-linear method used over the full sample is comparable to what obtained through the linear VARs over the two nested samples.

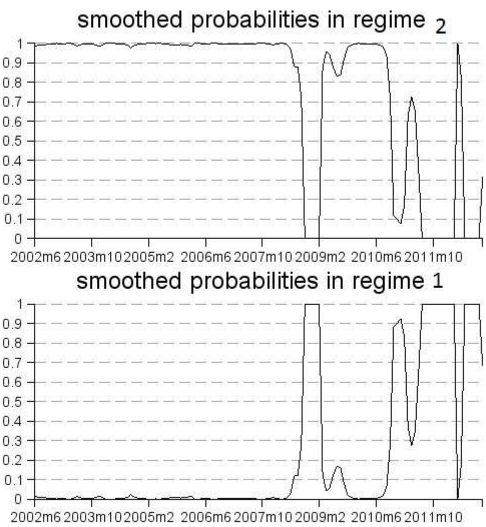
Contrary to what happens in levels, the estimation of the linear VAR which uses volatility and variations over the full period (column 2 in Table 5) provides us with a benchmark specification which can be translated into a Markov-switching VAR (Krolzig, 1998); then, the two specifications are directly comparable. The Markov-Switching VAR is:

$$\begin{bmatrix} V.ARY_t \\ \triangle.NRH_t \end{bmatrix} = \Lambda + \Gamma_k \begin{bmatrix} V.ARY_{t-1} \\ \triangle.NRH_{t-1} \end{bmatrix} + \Psi \begin{bmatrix} \triangle.ebr3m_t \\ gdpIn_t \\ \triangle.sprAd_t \end{bmatrix} + \nu_t \tag{6}$$

we perform the estimation with the inclusion of two regimes ($k = 1, 2$). The switching parameters are the auto-regressive ones ($\Gamma_k = \Gamma_1$ if k=1 *or* $\Gamma_k = \Gamma_2$ if k=2) and the VC matrix. The estimation is a Maximum-Likelihood one, central to the method is the concept of transition probabilities linked to the Markov-Chain (Hamilton, 2008). The MS-VAR estimation output is reported in Table 7, smoothed probabilities for the two regimes are in Figure 7.

The MS-VAR estimation confirms the results of the linear-VAR estimations. A negative pull-effect from *V.ARY* to $\triangle.NRHs$ emerges only in the Turmoil period. It is to notice that the assignment of each time-observation to a specific regime (Regime 1 = turmoil, Regime 2 = quiet) makes sense when compared against the developments of the Euro Area debt crisis in Europe.

Figure 7 – MS-VAR, smoothed probabilities



6.2. Considerations from the estimation of Volatility and Variations

The estimation which uses the ARY volatility and NRHs variations shows, again, a negative pull-effect from the auction yield to non-residents' holdings which depends upon the emergence of the

Table 7 – MS-VAR, Volatility&Variations,

MS var: Volatility&Variations, Full Period, Selected Variables			
Vary			
	switching	Reg1	Reg2
	L.Vary	0.940***	0.541***
	L.D.nrhS	-0.030	0.001
	non-switching		
	d.ebr3m	-0.096**	
	gdpIn	0.000	
	d.sprAd	0.182**	
	cons	0.108	
d.nrhS			
	switching	Reg1	Reg2
	L.Vary	-0.989***	0.052
	L.D.nrhS	-0.159	-0.060
	non-switching		
	d.ebr3m	0.498	
	gdpIn	-0.057**	
	d.sprAd	-0.523	
	cons	5.944	
Regime 1 =>	*turmoil*	*Regime 2 =>*	*quiet*
estimation period: 2002m6-2012m12			
number of observations: 127			
number of variables: 24			
Degree of freedom: 103			
Matrix of Transition Probabilities		Ergodic Probabilities	
0.8653521	0.0404389	0.230965	
0.1346479	0.9595611	0.769035	

Turmoil. On the contrary, the two series do not seem significantly associated in the no-crisis period. The negative pull-effect found using volatility and variations confirms the results obtained through the estimations in levels (section 5), which therefore turns out to be robust.

To the extent that volatility reflects the refinancing-risk linked to the debt rollover, variations of NRHs do not seem to have a stabilizing effect. On the contrary, the risk linked to the debt rollover seems to discourage non-residents' participation during the Turmoil. This finding supports our explanation of the negative pull-effect found in levels: when the volatility in the primary market increases, non-residents' holdings decrease because foreigners respond negatively to the higher perceived risk.

7. Conclusions

In this paper we have investigated the potential additional burden of external debt for debt sustainability with respect to the case that public debt is all held by residents. Among the possible channels, we have focused on the Interest Rate Determination in the primary market. The objectives of our analysis were achieved through the study of the relationship between the dynamics of the auction yield and of non-residents' holdings, both in levels and using volatility and variations.

Our findings suggest that non-residents' holdings do not influence the financing-cost borne by the Treasury. Then, external debt seems not to matter for debt stabilization. On the contrary, an effect going from auction results to non-residents' holdings emerges during the second phase of the Euro Area debt crisis (the turmoil period) in the case of Italy. We have suggested an explanation for this based on reductions of non-residents' holdings due to an higher perceived risk during the Turmoil, as reflected by higher and more volatile auction results.

The findings of our analysis are obtained using data for Italy, the extent to which such results can be extended to other countries is dubious. Perhaps, a generalization is possible to countries which have a similar risk-profile. However, we advice caution and country-specific analyses, when possible, about this.

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Appendix. Auction Yields *versus* Market Yields

The question of whether it is the secondary market dynamics to determine the auction results, or the other way around, and if the Market Redemption Yield (MRY) is a good proxy for the financing-cost borne by the Treasury is relevant in the context of our analysis. Our ex-ante expectation was that the MRY is not a good proxy, this is why we embarked in the construction of the Auction Redemption Yield (ARY).

In this appendix we check this through a VAR estimation which includes the ARY and the MRY; we use the MRY for a representative basket of bonds (not just the 10-year benchmark) as provided by DataStream (AITGVAL code series). The VAR is correctly specified with the inclusion of 4 lags; at such lag-length, the Auto-Correlation Test does not reject the null of no auto-correlation. The estimation output is in Table 8.

Table 8 – Linear VAR, ARY & MRY, 2002m1-2012m12

ary		mryALL	
L.ary	0.756***	L.ary	0.025
L2.ary	0.131	L2.ary	0.101
L3.ary	-0.342*	L3.ary	-0.377***
L4.ary	0.401**	L4.ary	0.259***
L.mryALL	0.421	L.mryALL	1.279***
L2.mryALL	-0.426	L2.mryALL	-0.471**
L3.mryALL	0.087	L3.mryALL	0.313
L4.mryALL	-0.221	L4.mryALL	-0.208
cons	0.772**	cons	0.355**
R2.eq1	0.791	R2.eq2	0.909
N	128		

Building on the estimation output in Table 8, we perform the Granger-causality test and calculate the Forecast Error Variance Decomposition (FEVD) to gain information about the causality direction; both are in the following Table 9. The output of the Granger-causality test and of the FEVD provide evidence suggesting that the auction results drive the MRY, and not the other way around. This supports our use of an ad-hoc series to focus our study on sustainability as done in this paper.

Furthermore, when we restrict the range to 10y-benchmark bond, auction by auction checks show that the difference between the ARY and MRY is low in auctions of *on-the-run* bonds (first tranche

Table 9 – L-VAR, ARY&MRY, Granger-causality and FEVD.

Panel A: Granger Causality Test

X	Y	"H0: Y does not Granger cause X"
ARY	*MRY*	PValue: 0.274 $\Longrightarrow$ does not reject
MRY	*ARY*	PValue: 0.000 $\Longrightarrow$ reject

Panel B: FEV Decomposition

step	(1)	(2)	(3)	(4)
0	0.000	0.000	0.000	0.000
1	1.000	0.617	0.000	0.383
2	0.992	0.632	0.008	0.368
3	0.988	0.681	0.012	0.319
4	0.984	0.644	0.016	0.356
5	0.985	0.616	0.015	0.384
6	0.985	0.601	0.015	0.399
7	0.985	0.597	0.015	0.403
8	0.983	0.595	0.017	0.405
9	0.980	0.596	0.020	0.404
10	0.976	0.596	0.024	0.404
11	0.970	0.596	0.030	0.404
12	0.962	0.597	0.038	0.403

(1) impulse = ARY and response =ARY ; (2) impulse = ARY and response = MRY ; (3) impulse = MRY and response = ARY; (4) impulse = MRY and response = MRY.

auctioned of a new bond). On the contrary, for auctions of *off-the-run* bonds (later tranches auctioned), the difference between the ARY and the MRY gets larger and larger, the older is the bond auctioned. For a space-constraints motivation, this is shown only for two 10-year benchmark bonds in Table 10; we selected randomly these two bonds among those with the longest auction history.

Table 10 – Comparison of ARY with MRY, selected bond auctions

MRY	ARY	diff	nt	O/S	auction day	description	isin code
3.742	3.740	0.002	1	O	27-feb-06	BTP 3,75% 1.2.2006 - 1.8.2016	IT0004019581
3.702	3.740	0.038	2	S	28-feb-06	BTP 3,75% 1.2.2006 - 1.8.2016	IT0004019581
3.990	4.000	0.010	3	O	30-mar-06	BTP 3,75% 1.2.2006 - 1.8.2016	IT0004019581
4.239	4.280	0.041	5	O	27-apr-06	BTP 3,75% 1.2.2006 - 1.8.2016	IT0004019581
4.211	4.280	0.069	6	S	28-apr-06	BTP 3,75% 1.2.2006 - 1.8.2016	IT0004019581
4.168	4.160	0.008	7	O	30may2006	BTP 3,75% 1.2.2006 - 1.8.2016	IT0004019581
4.398	4.320	0.078	9	O	28jun2006	BTP 3,75% 1.2.2006 - 1.8.2016	IT0004019581
4.372	4.320	0.052	10	S	30jun2006	BTP 3,75% 1.2.2006 - 1.8.2016	IT0004019581
4.209	4.180	0.029	11	O	28jul2006	BTP 3,75% 1.2.2006 - 1.8.2016	IT0004019581
4.207	4.180	0.027	12	S	31jul2006	BTP 3,75% 1.2.2006 - 1.8.2016	IT0004019581
4.078	4.020	0.058	13	O	30aug2006	BTP 3,75% 1.2.2006 - 1.8.2016	IT0004019581
4.042	4.020	0.022	14	S	31aug2006	BTP 3,75% 1.2.2006 - 1.8.2016	IT0004019581
3.968	3.890	0.078	15	O	28sep2006	BTP 3,75% 1.2.2006 - 1.8.2016	IT0004019581
4.057	4.000	0.057	17	O	30oct2006	BTP 3,75% 1.2.2006 - 1.8.2016	IT0004019581
3.995	4.000	0.005	18	S	31oct2006	BTP 3,75% 1.2.2006 - 1.8.2016	IT0004019581
4.495	3.810	0.685	19	O	13-mar-09	BTP 3,75% 1.2.2006 - 1.8.2016	IT0004019581
4.505	3.810	0.695	20	S	16-mar-09	BTP 3,75% 1.2.2006 - 1.8.2016	IT0004019581
4.351	3.610	0.741	21	O	14jul2009	BTP 3,75% 1.2.2006 - 1.8.2016	IT0004019581
4.343	3.610	0.733	22	S	15jul2009	BTP 3,75% 1.2.2006 - 1.8.2016	IT0004019581
4.526	4.650	0.124	1	O	29-apr-08	BTP 4,50% 1.2.2008 - 1.8.2018	IT0004361041
4.491	4.650	0.159	2	S	30-apr-08	BTP 4,50% 1.2.2008 - 1.8.2018	IT0004361041
4.808	4.860	0.052	3	O	29may2008	BTP 4,50% 1.2.2008 - 1.8.2018	IT0004361041
4.769	4.860	0.091	4	S	30may2008	BTP 4,50% 1.2.2008 - 1.8.2018	IT0004361041
5.021	5.080	0.059	5	O	27jun2008	BTP 4,50% 1.2.2008 - 1.8.2018	IT0004361041
4.917	5.000	0.083	7	O	30jul2008	BTP 4,50% 1.2.2008 - 1.8.2018	IT0004361041
4.866	5.000	0.134	8	S	31jul2008	BTP 4,50% 1.2.2008 - 1.8.2018	IT0004361041
4.806	4.760	0.046	9	O	28aug2008	BTP 4,50% 1.2.2008 - 1.8.2018	IT0004361041
4.803	4.760	0.043	10	S	29aug2008	BTP 4,50% 1.2.2008 - 1.8.2018	IT0004361041
4.857	4.950	0.093	11	O	29sep2008	BTP 4,50% 1.2.2008 - 1.8.2018	IT0004361041
4.887	4.950	0.063	12	S	30sep2008	BTP 4,50% 1.2.2008 - 1.8.2018	IT0004361041
5.694	5.590	0.104	13	O	13sep2011	BTP 4,50% 1.2.2008 - 1.8.2018	IT0004361041
5.596	5.590	0.006	14	S	14sep2011	BTP 4,50% 1.2.2008 - 1.8.2018	IT0004361041
5.817	5.620	0.197	15	O	13oct2011	BTP 4,50% 1.2.2008 - 1.8.2018	IT0004361041
5.794	5.620	0.174	16	S	14oct2011	BTP 4,50% 1.2.2008 - 1.8.2018	IT0004361041
6.652	5.750	0.902	17	O	13jan2012	BTP 4,50% 1.2.2008 - 1.8.2018	IT0004361041
4.968	4.060	0.908	19	O	11oct2012	BTP 4,50% 1.2.2008 - 1.8.2018	IT0004361041
4.914	4.060	0.854	20	S	12oct2012	BTP 4,50% 1.2.2008 - 1.8.2018	IT0004361041

Notes: “MRY” stands for Market Redemption Yield, “ARY” for Auction Redemption Yield, “diff” is equal to the difference between the ARY and the MRY, “nt” for auctioned Tranche Number, “O/S” for Ordinary/Supplementary auction.