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Debt Sustainability in the Case of External Debt.
An Analysis Based on Italy's Treasury Auctions.

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Abstract

The objective of this paper is to assess whether external debt makes a difference for public debt stabilization, where external debt is considered through the non-residents' holdings 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 study the potential effects on the interest rate resulting from the auctions of government bonds to account for the effective cost borne by the Treasury. Our results point towards the irrelevance of the composition of the investor base for debt stabilization.

JEL-Code: E630, F340, G110, H630.

Keywords: debt stabilization, external debt, primary market, yields, Italy.

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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 features imply different risks for its financing (Abbas et al. 2014). In this paper we focus on the *Domestic versus External* dimension with the scope to gain new insights into debt sustainability.

In Debt Sustainability Analysis, external debt is usually considered to be only the one issued in a foreign 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).[1] The pros, cons and risks of external debt therefore depend upon exchange rate variations and upon the different interest rate attached to assets denominated in that currency. In this setting, domestic-currency 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, several researchers (among others, Arslanalp & Tsuda 2012, Burrnside 2005, Chalk & 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 next section, such switch in the way to account for external debt has potential implications for debt sustainability analysis. Among the different channels which potentially imply a higher burden 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). Our analysis is also motivated by some developments during the Euro Area debt crisis. In this regard, several statements, particularly in large peripheral countries, suggested that if a larger amount of public debt were held by residents, the extent of contagion would have been less as well as the peaks in refinancing

[1] 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 monitoring and surveillance. 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).

costs lower. [2]

In a nutshell, this paper's original contribution to the existing literature consists in the study of how debt sustainability is affected by the composition of holders. This is an issue only indirectly investigated by previous works, we therefore believe to bring new insights to this branch of literature. As a further point to the originality of our work, we develop an analysis which considers the effective cost of public debt as resulting from the auctions of government bonds, instead of simply using the market yield of the 10-year benchmark bond. Although, as explained in section 3.1, this comes at a cost since 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 of the Italian Republic's fix-rate 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 the sections 5 and 6. The final conclusions are drawn in section 7. Appendix I reports evidence in favor of our decision to reject the market yield of the 10-year benchmark bond as a proxy of the debt's financing-cost.

2 Debt Sustainability and External Debt

It is well known that the debt-stock sustainability depends upon its features: maturity length, fixed or variable interest rate, indicization to inflation, ecc.. Alternative features involve different risks. In this regard, the external dimension of public debt is considered as well (Cafiso 2012*a*). It is common practice to account for that through a Foreign Currency approach. In what follows, we first explain such approach and motivate why it might be not effective to account for the external dimension. Afterwards, we clarify the proposed alternative to account for the external dimension, the Balance of Payments approach, and explain what it brings to the analysis of sustainability.

[2] 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).

2.1 Foreign Currency *versus* Balance of Payments

Debt instruments may be issued both in the domestic and in foreign currencies, and they may be held both by residents and non-residents. Accordingly, the structure of the debt-stock can be described as

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

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 (SAD, IMF 2008 and 2010), 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 (*foreign currency* approach). Then, the structure of the debt-stock for SAD gets

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

which reduces to $D = D^h + e \cdot D^f$ where e is the nominal exchange rate. Consequently, the debt-equation used in SAD 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, i_t^f is the interest rate on foreign-currency debt, W_t is the primary balance and S_t is the stock-flow adjustment term (Cafiso 2012*b*). 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.[3]

[3]Accordingly, the overall interest rate has two components in the case of foreign-currency debt: (i) a combination of domestic and foreign interest rates and (ii) the exchange-rate induced valuation gains or losses in the foreign-currency debt obligations.

Table 1: EU, Foreign Currency (FC) and NRHs shares of public debt, year 2011

country	FC	NRHs	country	FC	NRHs
Austria	n.a	74.1	Lithuania	86.7	73.8
Belgium	0	53	Luxembourg	0	1.9
Bulgaria	73.8	45.5	Malta	0	4.5
Czech R.	16.4	34.7	Netherlands	3.1	55.4
Estonia	0	36.7	Poland	30.9	48.1
Finland	n.a.	81.5	Portugal	8.5	66.7
France	3.1	56.7	Romania	59.4	31.5
Germany	2.4	54.9	Slovakia	0.3	40.1
Hungary	51.8	65.2	Slovenia	0.2	
Ireland	8	60.9	Spain	1	38.6
Italy	0.2	38.5	Sweden	n.a.	31.6
Latvia	82.9	79.6	U.Kingdom	0	n.a.

Notes: · Values are in percentage over the total.

· Source: Eurostat, "gov_dd_ggd" and "gov_dd_dcur" database.

In real-world applications, SAD based on this approach faces two problems. *First*, the portion of foreign-currency public debt is almost zero in advanced economies (such as the Euro Area countries, Eurostat 2012). Then, $\theta^f \cong 0$ and the interest rate from eq.3 reduces to $i_t = i_t^h$. As a consequence, if this approach is applied to include the effect of external debt, no effect at all is considered in the end. *Secondly*, even if θ^f is significantly different from zero, the composition of holders is disregarded. As for this, some researchers (Arslanalp & Tsuda 2012, Gros & Alcidi 2011) point out that a large portion of public debt is truly *external* in the sense that it is owned by non-residents, and this may matter for sustainability. Data regarding the real-world relevance of these points are reported in Table 1 for the EU countries.

The link between sustainability and the composition of holders has been largely neglected by economic research. To our knowledge, only Parker & Kastner (1993) provide information in this direction. Notwithstanding, studies such as Arslanalp & Poghosyan (2014), Burrnside (2005), Chalk & Hemming (2000) and Horne (1991) affirm the need to account for the composition of holders when assessing the sustainability of public debt.[4]

Considering the composition of holders can be regarded as taking a Balance of Payments perspective. Indeed, in Balance of Payments accounting, *external debt* is defined upon a residency criterion for

[4]Along this line, the EU has recently launched a new Macroeconomic Imbalances Procedure which, among other objectives, monitors external debt by considering the composition of holders (ECFIN 2012).

which all liabilities owned by non-residents constitute the external debt of an economy.[5] Accordingly, in opposition to eq. 1, the Balance of Payments approach can be described as

$$\text{BoP approach} \Rightarrow D_t = \left(D_t^{h.r} + e \cdot D_t^{f.r}\right) + \underbrace{\left(D_t^{h.nr} + e \cdot D_t^{f.nr}\right)}_{extDebt}. \tag{4}$$

Given the irrelevance of the amount of foreign-currency debt for advanced economies (Table 1), which are the reference of our analysis, and the motivations behind the request to consider the composition of holders (in the next subsection), we will apply such Balance of Payments approach and study the influence of non-residents' holdings for debt sustainability.

2.2 Non-Residents' Holdings and Sustainability

Three main concerns regard Non-Residents' Holdings (NRHs) for sustainability: (1) their influence on the interest rate which determines the servicing cost, (2) the refinancing risk which they involve (sudden stops), and (3) the transfer of resources which they imply.[6] Also the potentially harmful sovereign-bank linkage is to mention, but this is more directly threatening domestic financial stability than public-debt sustainability; although, most of the times, it is arbitrary to differentiate between the two.

The analysis in this paper regards the effect of NRHs on the interest rate, before starting its discussion in the next sub-section, we briefly explain the others here too. We introduce the just-mentioned potential effects on debt sustainability through the formula of the debt-stabilizing primary balance

$$\underbrace{\frac{T_t}{Y_t} - \frac{E_t}{Y_t}}_{pb_t} = (i_{t-1} - g_t) \cdot \underbrace{\frac{D_{t-1}}{Y_{t-1}}}_{d_{t-1}}, \tag{5}$$

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 Tax revenues, Expenditures, Debt and Gross National Product all in levels (Cafiso 2012*b*). From this point on when we write *sustainability,*

[5] "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 " (IMF 2003).

[6] On the contrary, the foreign-currency approach implies two explicit channels whereby external debt might endanger stabilization: the possibly different interest rate attached to assets in the foreign currency and exchange rate variations (i_t^f and e_t in eq.2).

we mean stabilization as implied by equation 5.

As for the *transfer of resources* effect, when the debt instruments are held by residents the interest-bill paid goes to them. Then, interest payments do not influence aggregate demand but only cause a redistribution among agents of the domestic economy (Gros & Alcidi 2011).[7] On the contrary, in the case of NRHs, payments to non-residents cause a transfer of resources which decreases the aggregate demand and, therefore, causes less current GNP (g_t in eq.5).[8] This is somehow in line with the conclusions in Reinhart & Rogoff (2010) where it is reported that highly-indebted countries experience lower growth rates. Furthermore, a reduction of the tax base occurs in case of NRHs as a side effect of the transfer of resources. Indeed, interest earnings are taxed at destination between White-List countries (MEF 2014). Then, bonds held by non-residents decrease the tax base.[9]

Sudden stops are events when a country faces a quick reduction of demand of its bonds, such reduction may come either from domestic or foreign agents. Assuming that a country sells its bonds through auctions, this would imply the country's inability to run successful auctions even at an increasing yield. An evolution of this kind may take the country to default given its inability to rollover its debt.[10] As said, the reduction of demand may come either from residents or foreigners. However, given the broader pool of assets they can invest in and the home-bias in the portfolio composition, particularly foreign private investors are a less stable source of demand. Accordingly, a rising share of foreign investors can increase the refinancing risk.[11]

The potentially harmful sovereign-bank linkage is a risk present regardless of the non-residents'

[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. 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 a 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; such economies have a higher exposure with respect to the others and their net position is therefore more likely to be negative.

[8] In 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 is transfers from non-residents to residents and YT^{nr} is transfers from residents to non-residents).

[9] As a consequence, tax revenues from duties on the interest-bill are lower when a large portion of public debt is held by non-residents.

[10] This has happened several times in the last decades, particularly in the case of Latin American countries. Argentina in 2002 is the most recent example of an event of this kind which pushed towards default.

[11] Calvo & Talvi (2005) explain how some countries may also be hit by sudden stops in foreign funding simply as a result of increased global risk aversion.

participation in the domestic bond market (Acharya et al. 2012*a*). Nonetheless, with reference to the sudden-stops just discussed, if foreigners reduce their exposition during a turmoil, domestic banks might absorb their share; Merler & Pisani-Ferry (2012) discuss this in the context of the Euro Area debt crisis. An evolution of this kind increases a lot the sovereign-bank linkage in a period when sovereigns are riskier and riskier assets. All this affects directly financial stability in a manner described by Acharya et al. (2012*b*) and indirectly public-debt sustainability.

2.2.1 The interest rate determination

Some researchers affirm that shifts in the composition of the investor base can have significant implications for a government' borrowing costs. The reason for this is clearly stated by Arslanalp & Tsuda (2012): "in the short run, the supply of sovereign debt is set by the government and, therefore, the price (or inversely yield) of debt is set primarily by demand through auctions and other means. Hence, as new investors, such as foreign or institutional investors, join the investor base, demand for government debt can increase (either at the auction or the secondary market) and the government's borrowing costs can decline". Warnock & Warnock (2009) show that a variation of non-residents' holdings (either from private or institutional investors) is associated with a variation of government bond yields . Also Beltran et al. (2013) and Andritzky (2012) investigate the same issue.

As from the debt-stabilizing primary balance formula (eq.5), the higher the interest rate (i_t), the greater the fiscal correction in terms of primary balance to achieve. Then, the question is simple to grasp: is such interest rate influenced by the composition of holders? To wit, is its evolution the same when public debt is entirely held by residents with respect to the case when it is substantially shared with non-residents? The objective of our analysis is to answer to this question. Our analysis differs from the other empirical contributions in this field because of its focus on sustainability. Indeed, all the aforementioned contributions study the effect of shifts in the investor base mainly on the market yield of the 10-year benchmark government bond (among others, Andritzky 2012, Arslanalp & Poghosyan 2014, Arslanalp & Tsuda 2012). Our main departure from the existing literature is in this regard. We want to consider an interest rate which really reflects the overall financing cost borne by the Treasury. With this purpose, we construct a monthly time series from the results of government bond auctions (primary market) and show that the market yield does not reflect accurately the financing cost. Then,

we study the relationship between the composition of holders and such interest rate built out of the auction results.

Given the tight data constraints explained in the next section 3, our analysis turns out to be feasible only for one country: Italy. The relationship between NRHs 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 implying 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 share of Non-Residents' Holdings (NRHs) of Government Bonds (GBs) at a time frequency sufficiently high to capture their interaction. As a consequence, the analysis turned to be feasible only for Italy for the following 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 ARY series.[12] In the next subsections we discuss these two variables and some control variables used in the econometric analysis in the sections 5 and 6.

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, we name it Auction Redemption Yield (ARY). The ARY 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 three main categories of fix-rate GBs: 1) Treasury Bills named "Buoni Ordinari del Tesoro" (BOT) with a 3/12 months maturity, 2) Treasury Bills named "Certificati del Tesoro zero-coupon" (CTZ) with a 24 months maturity, and 3) Treasury Notes/Bonds named "Buoni del Tesoro Poliennali"

[12] We judge the monthly frequency used the minimum acceptable for a study of this kind. Ideally, higher frequency data would be of better use for the scope of the analysis but these are not available.

Table 2: BOT, CTZ, BTP auction results

	BOT			*CTZ*			*BTP*		
year	#auc	A.ary	T.am	#auc	A.ary	T.am	#auc	A.ary	T.am
2002	50	3.25	210513	26	3.65	32876	83	4.47	111428
2003	46	2.18	215720	27	2.34	30885	89	3.52	124277
2004	44	2.07	220050	15	2.38	26928	51	3.63	103156
2005	39	2.16	212916	14	2.26	23706	58	3.01	105592
2006	37	3.17	210583	14	3.34	26468	56	3.81	106550
2007	42	4.01	229552	18	4.10	27846	57	4.33	107628
2008	54	3.73	269599	22	3.91	32449	84	4.45	129006
2009	59	0.95	265996	24	1.70	42251	102	3.67	166409
2010	45	1.13	209837	18	1.85	38393	89	3.38	167718
2011	49	2.77	206518	19	3.83	30543	93	4.97	146667
2012	53	1.89	239712	19	3.15	41600	119	4.59	148465
2013	46	0.85	218261	22	1.56	37910	79	3.44	132627

Notes: "#Auc" stands for the number of auctions in the year; "A.ARY" stands for the yearly average of the monthly ARY; "T.Am" stands for the total amount of bonds sold in the year (millions of Euros).

(BTP) with a 3/30 years maturity. BOT and CTZ are zero-coupon bonds sold at a discount price, while BTPs pay a coupon every six months.[13]

We consider auctions from January 2002 to December 2013. At December 2013 Italy's public debt achieved 132.7% of GDP with a nominal value of 2068.9€ billions. GBs accounted for 83.86% of such value (1735.2€ billions); this is the share of marketable debt over the total. The BOTs, CTZs and BTPs comprised in the analysis account respectively for 8.19%, 4.44% and 65.23% of marketable debt. Hence, we include auctions of Treasury securities which account for 77.86% of marketable debt and for 65.29% of total public debt. We therefore gauge the ARY obtained representative of the financing-cost of Italy's public debt. The monthly ARY series is constructed as the weighted average of the auction results within each month.[14] Summary statistics of the auctions considered are in Table 2.

Our sample comprises Treasury securities spanning from a 3-month to a 30-year maturity. To a limited extent, it is possible to construct ARY series for securities with a similar maturity. These are

[13] Among the different categories of BTPs we considered only those with a fix rate determined at the auction.

[14] To wit, each month several auctions take place whose result is a certain amount of securities sold at a resulting redemption yield; such yield quantifies the yearly cost borne by the Treasury for the loan obtained through the instrument auctioned. We average the redemption yields of all the auctions within the same month by using the amount sold as weight. The Italian Treasury is one of the largest world issuer of GBs, the largest within the Euro Area, then a monthly series is possible to construct when one includes either BOTs, CTZs, BTPs or them altogether as we do. This is similar to the procedure adopted by the Italian Treasury to publish its monthly report on its bonds where a synthetic overall rate is provided: http://www.dt.tesoro.it/export/sites/sitodt/modules/ documenti_it/debito_pubblico/dati_statistici/Principali_tassi_di_interesse_2012.pdf

displayed in the following Figure 1 where in Panel A we report the ARY for BOTs (maturity less than 12 months), for CTZs (maturity equal to 24 months) for BTPs (maturity from 3 months to 30 years). BTPs are the bonds which cover more widespread maturities (3, 5, 10, 15, 30 years), a graph only for BTPs of different maturities is reported in Panel B. In both panels the Market Redemption Yield (MRY) of the 10-year benchmark bond is reported for reference.

As expected, the MRY of the 10-year benchmark bond (which is the 10y BTP for Italy) is a good proxy only for the auctions of the 10-year BTP (Figure 1 - Panel B). On the contrary, it diverges from the ARY of BTPs with a maturity other than 10-year; this is so because the ARY reflects the maturity of the underlying bonds. Moreover, as shown in Appendix I for two randomly-selected BTPs, the MRY of the 10y BTP is a good proxy of the ARY of the 10y BTP mainly in the case of auctions of on-the-run bonds.[15] The ARY for all the GBs considered is in Figure 1 - Panel A (ARY all GBs), this will serve as the measure of the overall debt-financing cost which we use for the sustainability analysis in the following section 5.

3.2 Non-Residents' Holdings of Debt (NRHs)

The second main variable which we use to develop our analysis is Non-Residents' Holdings (NRHs) of marketable debt. Data on such holdings are released on a monthly basis by the Bank of Italy. The Bank of Italy considers the following groups: (A) Non-Residents and (B) Residents. Within the residents group, the bank distinguishes the following subgroups: (B.1) the Bank of Italy, (B.2) Financial and Monetary Institutions, (B.3) Non-banking Financial Institutions, (B.4) Other Residents.[16]

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 GBs from June 2011. The amount dismissed by non-residents seems to have been absorbed mainly by private residents and domestic banks (AIFM in Figure 2).

It is to remember that shares are the result of a ratio, their variation might not truly represent a change in non-residents' portfolio; to wit, the share might decrease because the new debt issued is

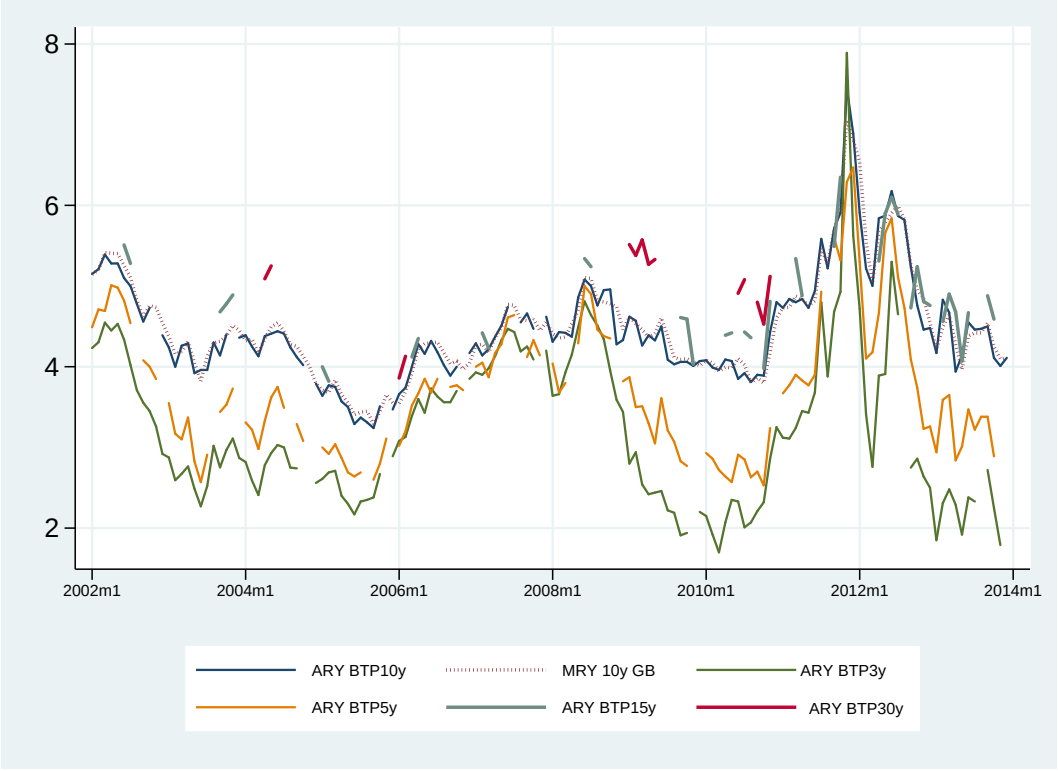
[15] Nonetheless, it is to notice that the ARY of bonds with different maturities converged during the episodes of turmoil in the January 2002 - December 2013 period.

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

Figure 1: ARY and MRY

Panel A: ARY for BOTs, CTZs and BTPs

Panel B: ARY for different BTPs



acquired by residents while non-residents do not change their portfolio composition. However, this in not likely in our case.[17] Hence, as customary in this literature, we proceed by using shares and talk of non-residents' participation into Italy's GBs market.[18]

3.3 Control Variables

In the following econometric analysis we use a set of control variables which are meant to account for the economic environment and how it might affect the relationship under study. We use the Euribor 3-month rate (ebr) to account for interest rates dynamics in the Euro Area (from the ECB). The VSTOXX index (vtx) for the Euro Area to reflect market expectations of near up to long-term volatility; this is a measure of implied volatility and works as an ex-ante indicator (from stoxx.com, STOXX 2013). The debt-to-GDP ratio (dgr), originally quarterly but linearly interpolated to a monthly frequency (from the OECD), to account for the fiscal stance.[19]

To support the following discussion, we display two other variables in Figure 3: Italy's spread with respect to the German-bund (IT spread) and an adjusted version of the same (IT riskier). The adjusted-spread is the difference between Italy's spread and the average spread of all the other Euro Area countries with respect to the same 10-year German Bund. In the crisis period almost all the EA countries' spread toward Germany increased, by considering the difference with respect to the EA average, we aim to show Italy's higher risk-profile with respect to its EA partners.[20]

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,

[17] We prove this by considering the stock of NRHs and compare its growth rate with the one of the share. Values are plotted in Figure 2 - Panel B, the stock is normalized at its January 2007 value. Over the 144 observations available, the NRHs-stock decreases while the NRHs-share increases 10 times, the NRHs-stock increases while the NRHs-share decreases 19 times, both move in the same direction in 115 observations.

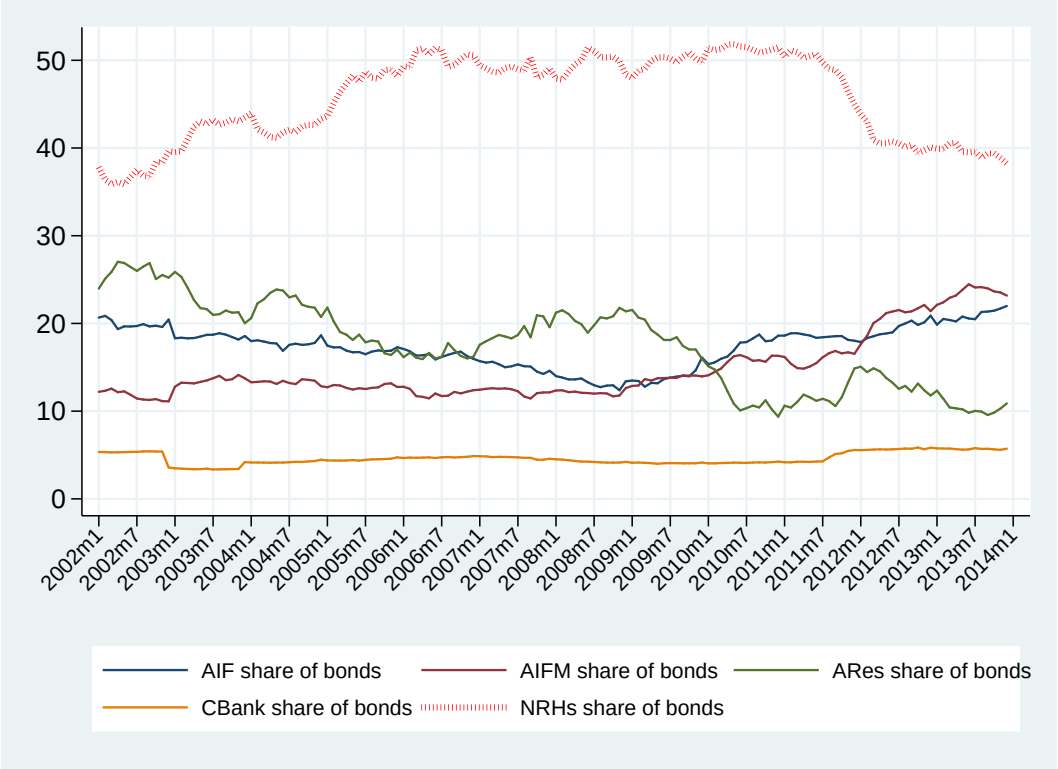
[18] It is to say that the NRHs share reflects holdings of outstanding debt, and not the portion of foreigners who buy new bonds at the auction. The latter information does not exist. Truly, it is not clear whether that would be a relevant information anyway because it is more likely to be foreigners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

[19] The DGR evolution is specular to the GDP's, for this reason we did not include any GDP index in the end.

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

Figure 2: Non-Residents' Holdings

Panel A: Marketable Debt Holdings by sector



Notes: "CBank" Bank of Italy, "AIFM" financial and monetary institutions, "AIF" non-banking financial institutions, "ARes" other residents, "NRHs" non-residents' holdings.

Panel B: NRHs, Stock and Share, growth rate

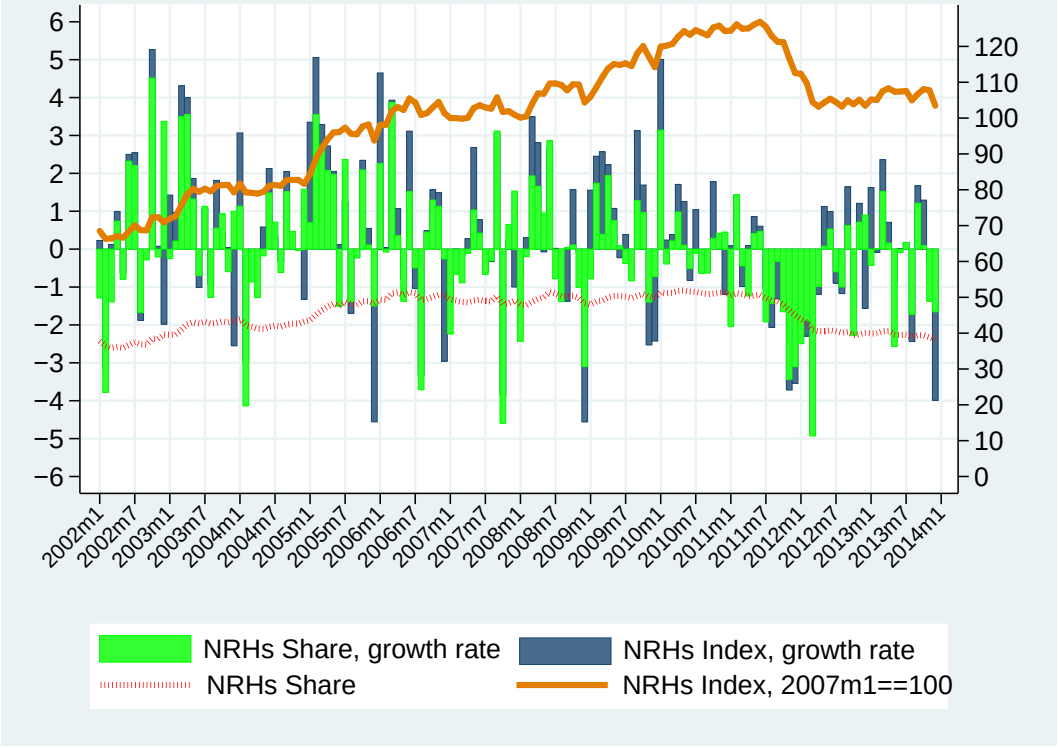
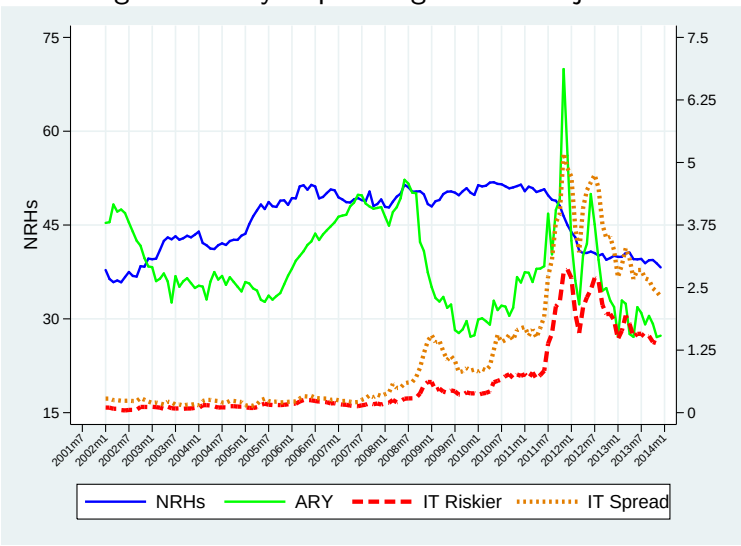


Figure 3: Italy's spread: gross and adjusted



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.[21] 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 model. 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 2002m1-2013m12. 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 entire period available (2002m1-2013m12) and for a smaller one, named "No-Crisis Period" (2002m1-2011m6), which rules out the second-wave of the EA debt crisis. By so doing, we aim to check the robustness of our results with respect to the crisis; this will turn out important.[22]

[21] 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? Moreover, 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).

[22] 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

The analytical framework which we apply is a Vector Auto-Regression with exogenous variables (Lutkepohl 2005):

$$\begin{bmatrix} ARY_t \\ NRH_t \end{bmatrix} = \sum_{k=1}^{n} \underset{2\times 2}{\Gamma_k} \begin{bmatrix} ARY_{t-k} \\ NRH_{t-k} \end{bmatrix} + \underset{2\times 3}{\Psi} \begin{bmatrix} ebr_t \\ vtx_t \\ dgr_t \end{bmatrix} + \underset{2\times 1}{\nu_t}, \tag{6}$$

the exogenous variables are included to account for the economic environment and its influence on the relationship between the ARY and $NRHs$. We included only those variables which can be reasonably regarded as exogenous with respect to the dependent ones. ebr_t is the inter-bank rate for the Euro Area-wide market, then it is unlikely to be endogenous with respect to the auction results in Italy's primary market. The same reasoning applies to the VSTOXX index (vtx) which reflects expectations about the evolution of stocks in Europe. As for the debt-to GDP ratio (dgr), we believe the auction results exogenous with respect to the fiscal stance since auctions have a high frequency, while fiscal data are quarterly at best; moreover, the fiscal stance is not determined by the auction results.

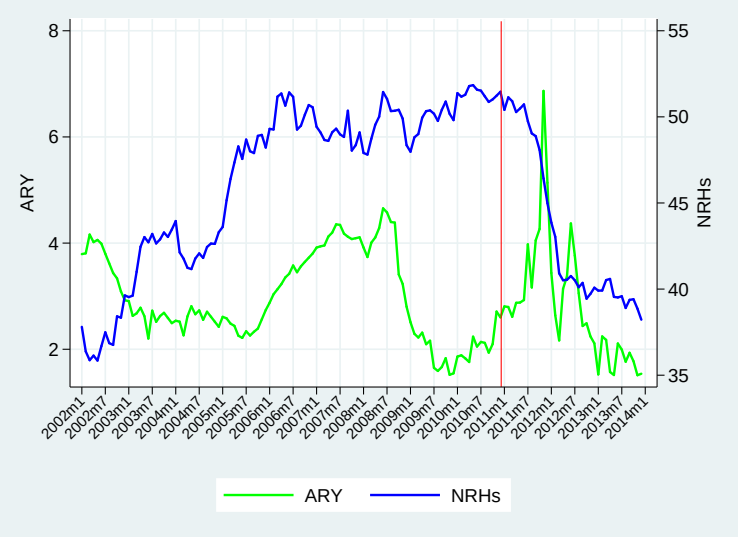
The number of lags included (k) is selected on the basis of information criteria and on the rejection of the auto-correlation test in a VAR setting. The VARX in eq.6 refers to the estimations which use the ARY and NRHs variables in levels (section 5), we do also estimate a version of the VARX using the volatility of ARY and the first difference of NRHs as dependent variables (section 6); the motivations for this are made clearer at the beginning of that section.

ADF Test (Dickey & Fuller 1979) and the PPerron test (Phillips & Perron 1988); 2) "H0: no unit root" using the KPSS test (Kwiatkowski et al. 1992). When the output of the different tests was not unanimous, we preferred the DF-GLS test. On the whole, the ARY series 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. 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 available upon request.

5 Analysis of ARY and NRHs: levels

The plot of the ARY and NRHs series is in Figure 4, the red line marks the end of the no-crisis period. The estimation output for the entire and no-crisis periods is in Table 3. Based on several information criteria and on the auto-correlation test, we include lags up to the 4th in the estimation over the entire period, while only the 1st lag in the estimation over the no-crisis period.[23] This difference in the proper number of lags may suggest already that the crisis has altered somehow the relationship under study. The VAR stability test indicates that the VAR is stable, the Auto-Correlation test does not reject the no auto-correlation hypothesis at the selected lag order; both tests are at the bottom of Table 3 for each estimation.[24]

Figure 4: ARY and NRHs in levels



As for the estimation over the entire period (column 1), both the ARY and $NRHs$ series display a strong autoregressive nature (significance of their own lagged values). The Euribor (ebr) is positively significant in both equations, the debt-to-GDP ratio (dgr) is positively significant only in the ARY equation, while the VSTOXX index (vtx) is in neither.[25]

At this point, our objective is to assess whether there is causality between the two series and

[23] The routine used sums up the results of the final prediction error (FPE), Akaike's information criterion (AIC), Schwarz's Bayesian information criterion (SBIC), and the Hannan and Quinn information criterion (HQIC).

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

[25] We tested the option to rule vtx out of the VAR estimation through an F-test of joint significance; the test does not reject the null. Then, as a robustness check, Column 2 reports the estimation output of the VAR which excludes vtx from the exogenous regressors. As expected, the information criteria signal an improvement, but no distorting effect of vtx emerges when comparing the estimations in column 1 and 2. We executed only one estimation for the no-crisis period since there are no exogenous regressors which are jointly not-significant.

Table 3: VARX - levels, Full and No-Crisis periods.

	Full Period: 2002m1-2014m12		No-Crisis: 2002m1-2011m6
ary	1	2	3
L.ary	0.812**	0.810**	0.577**
L2.ary	0.002	0.002	
L3.ary	-0.276**	-0.275**	
L4.ary	0.156*	0.148*	
L.nrh	-0.035	-0.035	-0.016**
L2.nrh	0.007	0.007	
L3.nrh	-0.019	-0.02	
L4.nrh	0.055	0.056	
ebr	0.208**	0.211**	0.365**
vtx	-0.001		-0.012**
dgr	0.013*	0.014*	0.043**
cons	-1.388	-1.444	-3.310**
nrh			
L.ary	-0.142	-0.138	-0.854**
L2.ary	-0.116	-0.115	
L3.ary	-0.02	-0.023	
L4.ary	-0.264*	-0.242*	
L.nrh	0.916**	0.916**	0.943**
L2.nrh	-0.087	-0.088	
L3.nrh	0.289**	0.292**	
L4.nrh	-0.160**	-0.163**	
ebr	0.267**	0.258**	0.638**
vtx	0.004		-0.007
dgr	-0.01	-0.011	0.056
cons	3.991**	4.144**	-2.25
aic	461.607	458.318	178.647
bic	532.207	523.034	211.269
N	140	140	112
$R^2 - ary$	0.821	0.82	0.958
$R^2 - nrh$	0.98	0.98	0.975
stab. T	stable	stable	stable
auto. T	0.595	0.484	0.276

which direction it takes. Our conclusions are drawn by considering the Instantaneous-causality test, the Granger-causality test, Orthogonalized Impulse Response Functions (OIRFs) and the Forecast Error Variance Decomposition (FEVD) based on the estimation in Column 1 for the entire period and on the estimation in Column 3 for the no-crisis period. For the OIRFs and the FEVD there is need to identify the VAR. Since we have no theoretical prior regarding the timing of the effects across the two endogenous variables, and we do not want to bias the analysis by setting an ordering arbitrarily, we present OIRFs and the FEVD for the two possible orderings of the Cholesky decomposition.[26]

The Instantaneous and the Granger-causality tests are in Table 4. The Instantaneous-causality test (Lütkepohl 1991) does not reject the null of no-contemporaneous correlation either over the entire period or the no-crisis one.[27] The Granger-causality test (Amisano & Giannini 1997) suggests causality from the ARY to NRHs over the entire period, while mutual causality emerges in the no-crisis one.

The FEVD for the two possible orderings of the Cholesky decomposition is in Table 5; those for the entire period estimation are in Panel A, those for the no-crisis period are in Panel B.[28] Shocks in the ARY series are much more explicative of the forecast error variance of NRHs than the other way around (Column 2 versus Column 3). This is true regardless of the ordering applied (A1 versus A2) and it holds both over the entire period and the no-crisis one (Panel A versus Panel B). OIRFs for the two possible orderings of the Cholesky decomposition are in Table 6; those for the entire period estimation are in Panel A, those for the no-crisis period are in Panel B. Regardless of the ordering, OIRFs suggest only an effect from ARY to $NRHs$; this holds true both over the entire period and when the estimation is restricted to the no-crisis one.[29]

[26] The two possible orderings are: 1) ARY has a contemporaneous effect on $NRHs$, but $NRHs$ has only a lagged effect on ARY; 2) $NRHs$ has a contemporaneous effect on ARY, but ARY has only a lagged effect on $NRHs$.

[27] The test checks the non-zero correlation of v_{1t} and v_{2t} in eq. 6, this is a Wald test.

[28] The FEVD determines how much of the forecast error variance of each of the variables can be explained by an exogenous shock in 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. The FEVD is obtained through the orthogonalization of the residuals based on the Cholesky decomposition.

[29] Even though in the no-crisis period mutual (Granger) causality emerges across the two variables, the OIRFs signal a much stronger effect of ARY on NRHs.

Table 4: Granger and Instantaneous causality tests (VARX - levels)

Panel A: Full Period (2002m1-20123m12)

A1: Granger Causality Test

X	Y	H0: Y does not Granger cause X
nrh	ary	Chi2: 21.81; PValue: 0.002
ary	nrh	Chi2: 4.35; PValue: 0.402

A2: Instantaneous Causality Test

		H0: No instantaneous causality
nrh	ary	Chi2: 0.3123; P-Value: 0.5763

Panel B: No-crisis (2002m1-2011m6)

B1: Granger Causality Test

X	Y	H0: Y does not Granger cause X
nrh	ary	Chi2: 5.586; PValue: 0.018
ary	nrh	Chi2: 12.061; PValue: 0.001

B2: Instantaneous Causality Test

		H0: No instantaneous causality
nrh	ary	Chi2: 2.813; P-Value: 0.093

5.1 Considerations from the estimations in levels

The objective of the analysis in this section was to study the relationship between the ARY and NRHs in order to draw conclusions about the effect of NRHs on public-debt sustainability. If NRHs had a beneficial influence, we should observe a negative effect from NRHs to the ARY: an increase of NRHs would reduce the financing-cost. The estimation in levels does not provide evidence in this direction, this conclusion seems to be robust with respect to the happening of the Euro Area debt crisis and with respect to the different orderings possible for the VAR identification via the Cholesky decomposition. NRHs do not seem to influence the dynamics of the public-debt's financing-cost.

On the contrary, a negative-pull effect emerges from the ARY to NRHs. Our analysis is not the only one which suggests such dynamics for Italy, Arslanalp & Poghosyan (2014) and Andritzky (2012) provide a similar result too. Its explanation is likely to require an analysis of non-residents' portfolio strategies, something which is beyond the scope of this paper. Nevertheless, it is possible to imagine that the *perceived risk* plays an important role: likely, during a turmoil a higher risk determines a higher yield to which non-residents react negatively with respect to the composition of their international portfolio. Such perceived risk can be valued by considering Italy's spread in the secondary market and its higher risk profile with respect to its EA partners; these are shown in Figure 3 (IT Riskier and IT Spread). We observe a decrease of non-residents' holdings when these two variables start to increase.

Table 5: Forecast Error Variance Decomposition (VARX - levels)

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

$A1:\ ARY_{t0} \rightarrow NRH_{t0}\ \&NRH_{t0} \rightarrow ARY_{t1}$

step	1	2	3	4
0	0.000	0.000	0.000	0.000
1	1.000	0.002	0.000	0.998
2	0.998	0.002	0.002	0.998
3	0.994	0.014	0.006	0.986
4	0.985	0.030	0.015	0.970
5	0.982	0.074	0.018	0.926
6	0.982	0.129	0.018	0.871
7	0.982	0.178	0.018	0.822
8	0.982	0.218	0.018	0.782
9	0.982	0.253	0.018	0.747

$A2:\ ARY_{t0} \rightarrow NRH_{t1}\&NRH_{t0} \rightarrow ARY_{t0}$

step	1	2	3	4
0	0.000	0.000	0.000	0.000
1	0.998	0.000	0.002	1.000
2	0.998	0.004	0.002	0.996
3	0.997	0.021	0.003	0.979
4	0.989	0.043	0.011	0.957
5	0.987	0.093	0.013	0.907
6	0.987	0.154	0.013	0.846
7	0.987	0.207	0.013	0.793
8	0.987	0.251	0.013	0.749
9	0.987	0.287	0.013	0.713

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

$B1:\ ARY_{t0} \rightarrow NRH_{t0}\&NRH_{t0} \rightarrow ARY_{t1}$

step	1	2	3	4
0	0.000	0.000	0.000	0.000
1	1.000	0.020	0.000	0.980
2	0.996	0.013	0.004	0.987
3	0.989	0.020	0.011	0.980
4	0.979	0.030	0.021	0.970
5	0.968	0.040	0.032	0.960
6	0.957	0.048	0.043	0.952
7	0.946	0.055	0.054	0.945
8	0.935	0.060	0.065	0.940
9	0.925	0.065	0.075	0.935

$B2:\ ARY_{t0} \rightarrow NRH_{t1}\&NRH_{t0} \rightarrow ARY_{t0}$

step	1	2	3	4
0	0.000	0.000	0.000	0.000
1	0.980	0.000	0.020	1.000
2	0.987	0.020	0.015	0.980
3	0.980	0.047	0.016	0.953
4	0.970	0.070	0.022	0.930
5	0.960	0.090	0.029	0.910
6	0.952	0.105	0.038	0.895
7	0.945	0.118	0.047	0.882
8	0.940	0.127	0.056	0.873
9	0.935	0.135	0.065	0.865

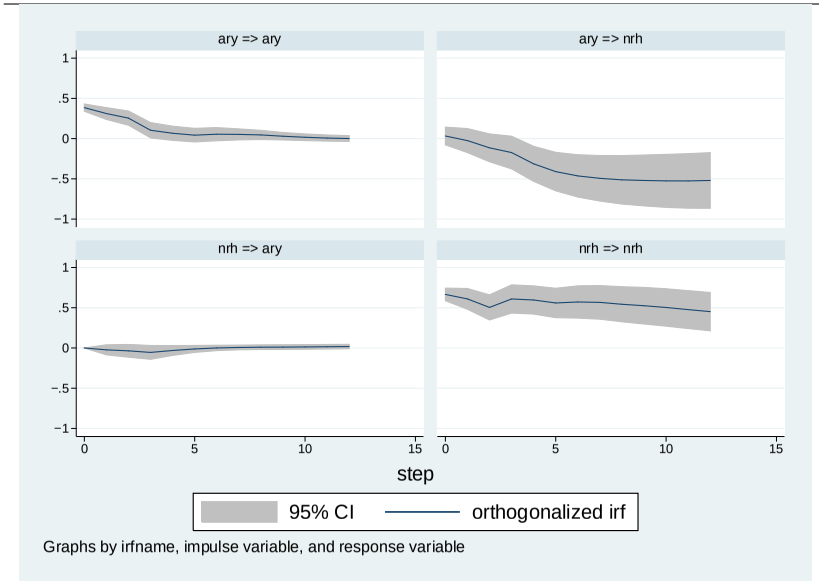
(1) impulse = ary, response = ary; (2) impulse = ary, response = nrh

(3) impulse = nrh, response = ary; (4) impulse = nrh, response = nrh

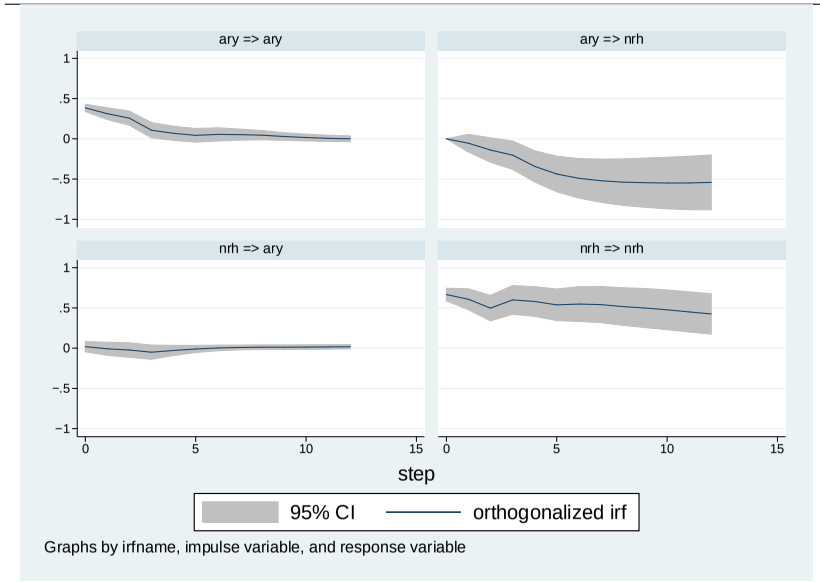
Table 6: Orthogonalized IRFs (VARX - levels)

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

$A1: \ ARY_{t=0} \rightarrow NRH_{t=0}$ &$NRH_{t=0} \rightarrow ARY_{t=1}$

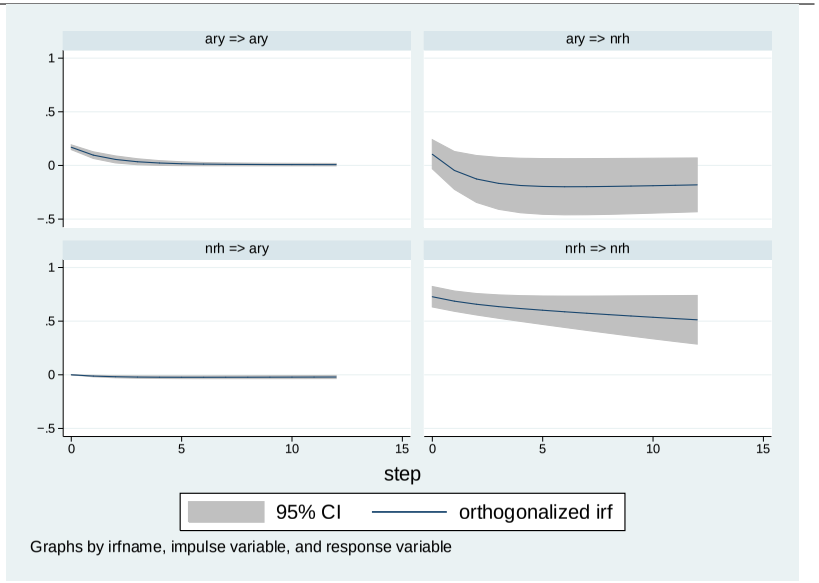


$A2: \ ARY_{t=0} \rightarrow NRH_{t=1}$&$NRH_{t=0} \rightarrow ARY_{t=0}$

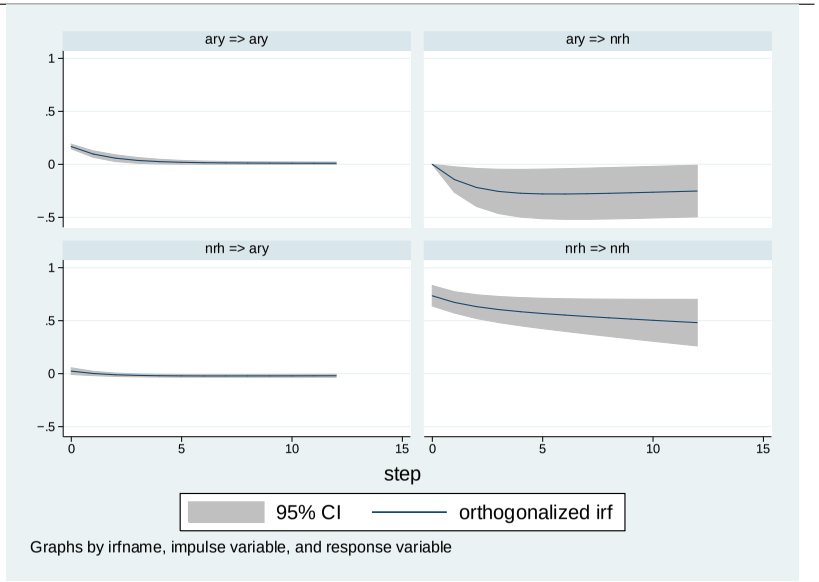


Panel B: No-Crisis (2002m1-2011m6)

$B1: \ ARY_{t=0} \rightarrow NRH_{t=0}$&$NRH_{t=0} \rightarrow ARY_{t=1}$



$B2: \ ARY_{t=0} \rightarrow NRH_{t=1}$&$NRH_{t=0} \rightarrow ARY_{t=0}$

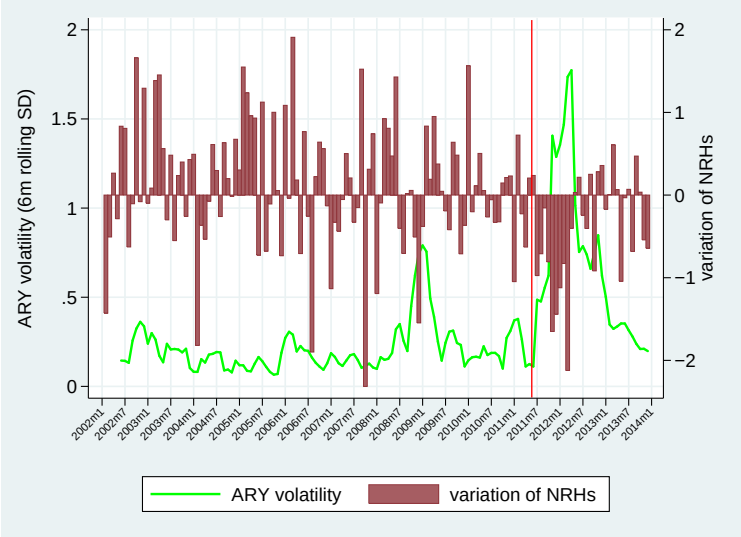


In the following section we will discuss an estimation which provides an indirect way to check the role of the risk perceived by market participants.

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 auction yield, calculated as the 6-months backward standard deviation *(historical volatility)*, and the change of NRHs (first difference); the two series are plotted in Figure 5. The motivation for this analysis are the followings. *First*, assuming that the volatility reflects the refinancing risk of the debt rollover, it is of interest to check whether non-residents' participation has a stabilizing effect. *Second*, to the extent that volatility reflects the risk perceived by market participants, the analysis provides an indirect check of the explanation of the negative pull-effect found in the estimations in levels (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 entire period available (2002m1-2013m12) and the no-crisis period (2002m1-2011m6). The analytical framework is a VAR with exogenous variables (VARX) similar to the one in eq.6, the control variables are now included in first-difference for coherence. The estimation output is reported in Table 7.

As for the estimation over the entire period, the information criteria do not provide a clear information

about the lags to include. We opted for the inclusion of two lags; the estimation output is Column 1.[30] The estimation over the no-crisis period is reported in Column 3; in this case the information criteria clearly suggested the inclusion of two lags. At such lag order the auto-correlation tests do not reject the null and the VARs result to be stable.

Table 7: VARX - Volatility&Variations, Full and No-Crisis Periods

	Full Period: 2002m1-2013m12		No-Crisis: 2000m1-2011m6	
$Vary$	1	2	3	4
L.Vary	1.018**	1.018**	0.983**	0.981**
L2.Vary	-0.146*	-0.157*	-0.305**	-0.312**
L.Dnrh	-0.025*	-0.028**	-0.004	-0.004
L2.Dnrh	0.003	0.002	0.000	0.000
D.ebr	-0.163**	-0.134**	-0.209**	-0.203**
D.vtx	0.003		0.005**	0.005**
D.dgr	-0.011		-0.005	
cons	0.040**	0.042**	0.066**	0.067**
$Dnrh$				
L.Vary	-1.176**	-1.198**	0.851	0.865
L2.Vary	0.597	0.664	0.144	0.202
L.Dnrh	-0.002	0.002	-0.049	-0.049
L2.Dnrh	-0.064	-0.063	-0.042	-0.042
D.ebr	0.559	0.447	1.272**	1.228**
D.vtx	-0.004		-0.008	-0.006
D.dgr	0.072		0.044	
cons	0.191*	0.187*	-0.057	-0.068
aic	123.314	117.826	-62.942	-66.161
bic	170.034	152.866	-20.176	-28.742
N	137	137	107	107
$R^2 - Vary$	0.867	0.865	0.854	0.854
$R^2 - \Delta nrh$	0.095	0.091	0.063	0.061
stab. T	stable	stable	stable	stable
auto. T	0.463	0.250	0.099	0.076

As for the overall fitting of each equation in the VAR, this is high for the ARY-volatility equation, but it drops for the NRH-variations ($R^2 - Vary$ and $R^2 - \Delta nrh$). The low fitting of the NRHs-variation equation is not surprising if we think about the nature of the variable itself.[31] Over the entire period, only the Euribor (ebr) is statistically significant, but just in the ARY-volatility equation (Column 1).[32]

[30] We tried also with the inclusion of one lag, the results of the tests and of the OIRFs change only marginally.

[31] The analysis of how non-residents adjust their portfolio is likely to 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 for debt-sustainability.

[32] We tested the exclusion of the other two control variables ($D.vtx$ and $D.dgr$) equation by equation and in the VAR

The estimation over the no-crisis period is in Column 3.[33]

The Instantaneous and Granger-causality tests for the estimation in Column 1 are in Table 8 - Panel A, those for the estimation in Column 3 are in Table 8 - Panel B. The instantaneous-causality test suggests a simultaneous effect across the two series, but this seems to depend upon the crisis since the same test over the no-crisis period does not reject the null (Table 8 - Panel B2). Hence, the crisis might have somehow determined a co-movement of the two series. As for the Granger-causality test, the one over the entire period points towards causality from the ARY-volatility towards NRH-variations, but not the other way around. However, also the result of the Granger-causality test seems to depend upon the crisis since the same does not suggest causality in either direction when the sample is restricted to the no-crisis period.

The Forecast Error Variance Decomposition (FEVD) for the two possible orderings of the Cholesky decomposition is in Table 9.[34] The FEVD for the entire-period estimation does not provide useful information since it depends on the ordering. On the contrary, for the no-crisis estimation, shocks in the ARY-volatility series are more explicative of the forecast error variance of NRHs variations than the other way around regardless of the ordering.

Finally, the Orthogonalized Impulse Response Functions (OIRFs) for the two possible orderings of the Cholesky decomposition are reported in Table 10. Again, regardless of the ordering, the impact from $Vary$ to $Dnrh$ is definitively stronger than from $Dnrh$ to $Vary$; the latter is almost negligible. However, it is to notice that the direction of the response changes across the two periods: a one-unit impulse of $Vary$ has a negative effect on $Dnrh$ when the entire period is considered; on the contrary, its effect is positive when we restrict the observations to the no-crisis period.

altogether, the WALD tests do not reject exclusion. The simplified estimation is reported in Column 2. By comparing the estimations in column 1 and 2, the control variables do not show any distorting effect on the estimation of the autoregressive components. In this regard, the estimation can be considered robust with respect to their inclusion.

[33] In this case, only the debt-to-GDP ratio is statistically non-significant in both equation of the VAR. For coherence, we report the estimation which excludes it in column 4. By comparing the estimations in column 3 and 4, the dgr does not show any distorting effect on the estimation of the autoregressive components.

[34] Ordering 1:$Vary$ has a immediate effect on $Dnrh$, but $Dnrh$ has only a lagged effect on $Vary$ (A1, B1). Ordering 2: $Dnrh$ has an immediate effect on $Vary$, but $Vary$ has only a lagged effect on $Dnrh$ (A2, B2).

Table 8: Instantaneous and Granger-causality tests (VARX - Volatility&Variations)

Panel A: Full Period (2002m1-2013m12)

A1: Granger Causality Test

X	Y	H0: Y does not Granger cause X
$Dnrh$	$Vary$	Chi2: 6.940; PValue: 0.031
$Vary$	$Dnrh$	Chi2: 3.185; PValue: 0.203

A2: Instantaneous Causality Test

		H0: No instantaneous causality
$Dnrh$	$Vary$	Chi2: 9.510; P-Value: 0.002

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

B1: Granger Causality Test

X	Y	H0: Y does not Granger cause X
$Dnrh$	$Vary$	Chi2: 1.833; PValue: 0.400
$Vary$	$Dnrh$	Chi2: 0.335; PValue: 0.846

B2: Instantaneous Causality Test

		H0: No instantaneous causality
$Dnrh$	$Vary$	Chi2: 0.032; P-Value: 0.856

Table 9: Forecast Error Variance Decomposition (VARX - Volatility&Variations)

Panel A: Full Period (2002m1-2013m12)

$A1: \ Vary_{t0} \rightarrow Dnrh_{t0}$ & $Dnrh_{t0} \rightarrow Vary_{t1}$

step	1	2	3	4
0	0.000	0.000	0.000	0.000
1	1.000	0.075	0.000	0.925
2	0.989	0.105	0.011	0.895
3	0.986	0.112	0.014	0.888
4	0.986	0.115	0.015	0.885
5	0.985	0.118	0.015	0.882
6	0.985	0.120	0.015	0.880
7	0.985	0.122	0.015	0.878
8	0.984	0.123	0.016	0.877
9	0.984	0.124	0.016	0.876

$A2: \ Vary_{t0} \rightarrow Dnrh_{t1}$ & $Dnrh_{t0} \rightarrow Vary_{t0}$

step	1	2	3	4
0	0.000	0.000	0.000	0.000
1	0.925	0.000	0.075	1.000
2	0.877	0.031	0.123	0.969
3	0.864	0.039	0.136	0.961
4	0.859	0.042	0.141	0.958
5	0.857	0.045	0.143	0.955
6	0.856	0.047	0.144	0.953
7	0.855	0.048	0.145	0.952
8	0.854	0.049	0.146	0.951
9	0.854	0.050	0.146	0.950

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

$B1: \ Vary_{t0} \rightarrow Dnrh_{t0}$ & $Dnrh_{t0} \rightarrow Vary_{t1}$

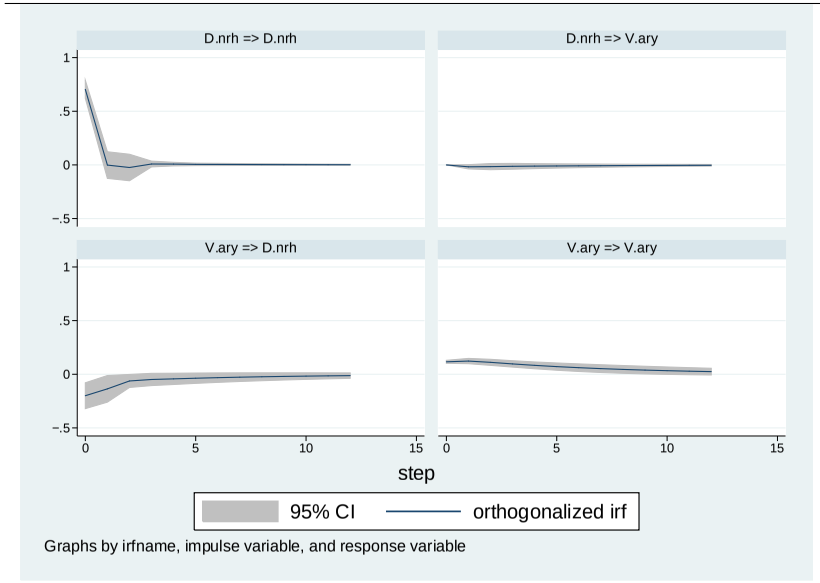
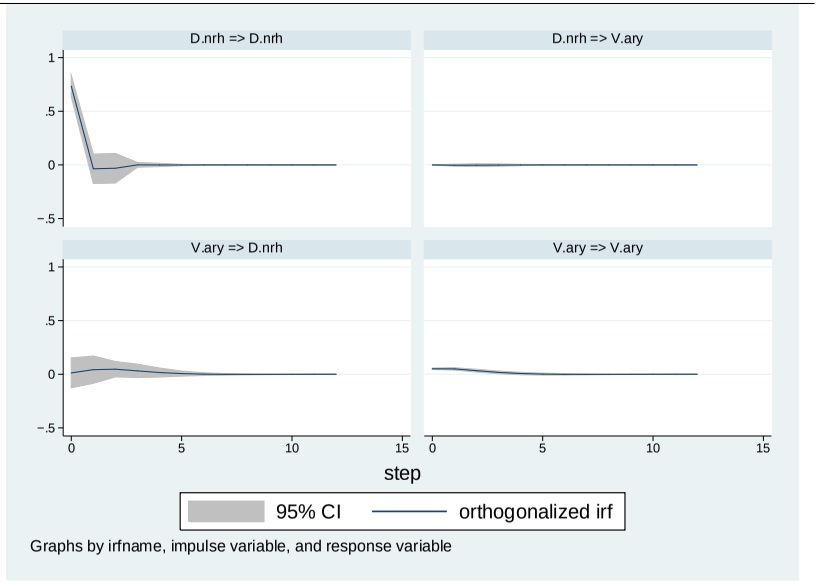
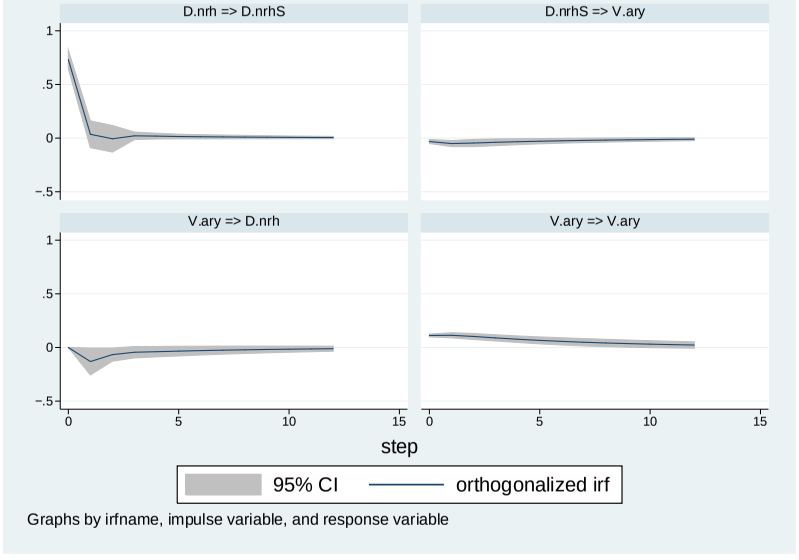
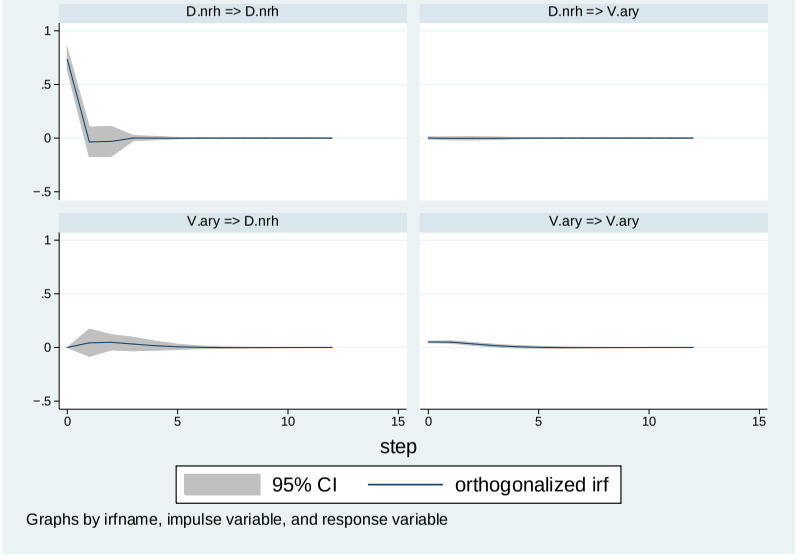
step	1	2	3	4
0	0.000	0.000	0.000	0.000
1	1.000	0.000	0.000	1.000
2	0.998	0.004	0.002	0.996
3	0.998	0.008	0.002	0.992
4	0.998	0.010	0.002	0.990
5	0.998	0.010	0.002	0.990
6	0.998	0.010	0.002	0.990
7	0.998	0.010	0.002	0.990
8	0.998	0.010	0.002	0.990
9	0.998	0.010	0.002	0.990

$B2: \ Vary_{t0} \rightarrow Dnrh_{t1}$ & $Dnrh_{t0} \rightarrow Vary_{t0}$

step	1	2	3	4
0	0.000	0.000	0.000	0.000
1	1.000	0.000	0.000	1.000
2	0.999	0.003	0.001	0.997
3	0.999	0.008	0.001	0.992
4	0.999	0.009	0.001	0.991
5	0.999	0.010	0.001	0.990
6	0.999	0.010	0.001	0.990
7	0.999	0.010	0.001	0.990
8	0.999	0.010	0.001	0.990
9	0.999	0.010	0.001	0.990

(1) impulse = Vary, response = Vary; (2) impulse = Vary, response = Dnrh
(3) impulse = Dnrh, response = Vary; (4) impulse = Dnrh, response = Dnrh

Table 10: Orthogonalized IRFs (VARX - Volatility&Variations)

A: Full Period (2002m1-2013m12)	B: No-Crisis (2002m1-2011m6)
$A1: \ Vary_{t0} \rightarrow Dnrh_{t0}$ & $Dnrh_{t0} \rightarrow Vary_{t1}$	$B1: \ Vary_{t0} \rightarrow Dnrh_{t0}$ & $Dnrh_{t0} \rightarrow Vary_{t1}$
	
$A2: \ Vary_{t0} \rightarrow Dnrh_{t1}$ & $Dnrh_{t0} \rightarrow Vary_{t0}$	$B2: \ Vary_{t0} \rightarrow Dnrh_{t1}$ & $Dnrh_{t0} \rightarrow Vary_{t0}$
	

6.1 Considerations from the estimation of Volatility and Variations

The estimations which use the volatility of the auction yield and the variations of non-residents' holdings suggest a deep effect of the crisis on their relationship since some statistics provide different results over the two periods. Nonetheless, the conclusions to draw are similar to what affirmed regarding the estimations in levels over the entire period: causality seems to go from the ARY-volatility to NRHs-variations and a negative pull-effect emerges in the same direction, but both depend upon the crisis. On the contrary, the two series do not seem significantly associated in the no-crisis period.

To the extent that volatility reflects the refinancing-risk of the debt rollover, variations of NRHs do not seem to have a stabilizing effect neither in normal times nor during the crisis. On the contrary, high volatility seems to have discouraged non-residents' participation during the crisis. This is in line with the explanation of the negative pull-effect found in the estimations in levels: if the volatility in the primary market reflects the risk perceived by market participants, then, when it increased non-residents reduced their holdings because they responded negatively to the higher risk.

7 Conclusions

The objective of this paper was to study the role of non-residents' holdings (alias, external debt) for the sustainability of public debt. After clarifying the different ways in which non-residents' holdings might endanger sustainability, we focused on the interest rate in the primary market and studied its relationship with the evolution of non-residents' holdings. Our analysis used the variables of interest 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. From this perspective, external debt does not seem neither to endanger nor to ease sustainability. On the contrary, a negative effect from the auction results to non-residents' holdings appeared during the second phase of the Euro Area debt crisis in the case of Italy. We have suggested an explanation based on the likely adverse effect of the risk perceived by market participants during the turmoil.

The findings of our analysis are obtained using data for Italy, it is dubious how much such results can be extended to other countries. Nonetheless, they show that the general statement affirming the

positive effect of non-residents' participation (in terms of lower borrowing costs) does not always apply. Hence, we advice caution and country-specific analysis to investigate this issue.

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Appendix I. Auction yield *versus* market yield

The check of the Market Redemption Yield (MRY) as a proxy of the financing-cost borne by the Treasury was relevant for 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). Indeed, as explained in section 3.1, the MRY is not a good proxy of the overall cost because it reflects mainly the 10-year benchmark bond and not the cost of bonds with different maturities. Moreover, when we restrict the focus on 10y-benchmark bond only, auction by auction checks show that the difference between the ARY and the MRY is low in auctions of *on-the-run* bonds (first tranche 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 the older is the bond auctioned. For space-constraints, this is shown only for two 10-year benchmark bonds in Table 11; we selected randomly these two bonds among those with the longest auction history.

Table 11: 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.