The Impact of Long-Term Refinancing Operation at Eurozone, Evidence from Panel Data and Vector Autoregression Approach

Yiran Wang (427963)

Supervisor: PhD Candidate (Yuhao) Y.Zhu

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Erasmus University Rotterdam

Abstract:

This thesis studies the impact of long-term refinancing operation on the OECD bond price. Panel data and vector autogression evidence are provided for western countries sample and southern countries sample between 2006 and 2016, by using the weekly published ECB financial statement. For both western and southern countries group, I find evidence that the long-term refinancing operation has the positive impact on the government bond price, whereas the effect for the southern group is less prominent than the western group.

Contents:

1. Introduction

The recent global financial crisis is beyond the conventional monetary policy scope (Curdia & Woodford, 2009). The post-war period economics framework has been challenged by the escalating of financial crisis, and the nominal interest rate is trapped within the zero lower bound. The conventional monetary tool, adjusting the nominal interest rate through buying or selling government bonds, is no longer effective when the interest rate near zero, where the bonds can be considered as the substitutes of the money. Central banks started to employ the unconventional monetary policy tool, such as Quantitative Easing (QE), to cope with this liquidity trap. Japan, United states, United Kingdom and European Union are the primary economy implementing QE. The primary purpose of the quantitative easing program is to reduce the long-term interest rate to stimulate the market demand. Government or the central bank use the electronically invented money to purchase the asset such as government bond (Ganley, 2010). In other words, it is an approach of injecting money to the market in response to the low consumption level and disappointing investment rate. Since August 2000, Bank of Japan first officially announced its monetary experiment plan, this strategy has been adopted successively by Federal Reserve, Bank of England and European Central Bank.

There are three major quantitative easing tools adopted by ECB, Main Refinancing Operation (MRO), Long-term Refinancing Operation (LTRO), and Security Held for Monetary Policy Purposes (SHFMPP), together they aim to stimulate the investment and consumption through a higher bond price. Both the Main Refinancing Operation and Long-term Refinancing Operation provides liquidity to the market with the bank bidding system. The difference between MRO and LTRO is the maturity, the normal maturity of MRO is between two weeks and one month, and LTRO holds a broader maturity from three months to thirty-six months. The expansion of refinancing operation is dramatic: at the beginning of 2006, the outstanding of LTRO is just above 100 billion euro, and the outstanding has kept increasing with the deepening of financial crisis and sovereign debt crisis. At the end of 2011, the total outstanding of LTRO had reached 1100 billion euro. However, the problem with the unconventional monetary approach is the inadequacy of solid theoretical framework functioning as support to help the public understand why the implementation of quantitative easing can help stabilize the market. The major academic research is mostly focused on the bedding behavior in the ECB refinancing policy (Linzert et al., 2007; Eisenschmidt et al., 2009; Linzert & Bindseil, 2004), or the possible theoretical channel of how quantitative easing influence the nominal expenditure (Joyce, 2011).

This thesis is going to analyze the impact of LTRO on the government bond adopting both panel data approach and vector autoregression (VAR) approach. Its result indirectly provides the view of how LTRO sufficiently help the growth of investment and consumption. I only focus on the total outstanding of LTRO reported at the weekly-published ECB financial statement, because the repo auction and bidding rate cannot be acquired by the public. Therefore, I focus on the relatively macro perspective and study how much LTRO influence the bond price. Through the asset purchasing plan, the demand of the asset goes up, and the asset price also goes up

accordingly. An increasing asset price followed by a decreasing yield. When the yield decreases, the cost of borrowing decreases. Consequently, consumers are more willing to spend and investors have high incentive to invest (Krishnamurthy, Vissing-Jorgensen, 2011). The most common asset purchasing component is the government debt, but it also includes the other financial asset and corporate bonds. The reason for focusing on LTRO instead of MRO is that, the LTRO is targeting on the mid-term interest which has a more pronounced influence to the economy: whether the LTRO does have an impact on the asset price, and how long the impact would last. In addition, since the end of 2007, the outstanding of LTRO had largely surpassed MRO, which make the analysis on LTRO is quantitatively more interesting. The panel data approach is served as a benchmark to measure the level of the impact. The VAR approach help to understand the country specific time series structure.

The thesis is structured as follows. Section two briefly introduces the history of quantitative easing implementation, with both the theoretical appraisal and criticism. Section three discusses the ECB open market operation history, and introduces hypothesis and data. Section four and section five describe the methodology and results of panel data and VAR separately. Section 6 serves as conclusion.

2. The history of quantitative easing and the experience from the past

2.1 The experience from Japan

As the first country who experimentally operate quantitative easing policy, Japan was aimed to response to the sustained deflation which was provoked by the financial distress in 1990s. After the collapse of 'bubble economy', both the economic growth rate and employment rate stayed at a relatively disappointing level (Ahearne et al., 2002). The sudden drop of the asset price brought on the so-called structural problem. On the banking side, they were busy dealing with the non-performing loans (NPL), and on the other side, the corporate was holding excessive debts (Drake et al., 2009). The damages led by the NPL had been proved by Inaba et al. (2005). Even though the interest rate have cut from 4.5 to 1.7 percent from 1991 to 1994, the economy was still stagnant for the following three years. When the 1997 financial crisis spread to Japan, two major commercial banks and one credit institution: Hokkaido Takushoku, Nippon Credit Bank and Long-term Credit, failed. Japanese economy headed into another recession. The credit ability was very limited in Japan. BOJ had been struggling to make any interest rate reduction since then. In 1999, Japan started to implement its zero-interest rate policy (ZIRP), and in February, the government unprecedentedly announced that they would continue ZIRP "until deflation concern is subsides" (Ito & Mishkin, 2006).

ZIRP was ceased in August 2000, and almost right after it, the interest rate increased followed by another recession (Ito, 2009). There were supporters who in favor of going back to ZIRP, but eventually BOJ decided to implement easing policy, given the fact that there was still no indication of a positive inflation sign (Hutchison et al., 2006).

On October 5th, 2010, the policy board of Bank of Japan published 'Comprehensive monetary easing' and declared that there are three measures would be operated by QEP. The three measures are: encouraging the uncollateralized overnight rate remain at the 0 to 0.1 percent range, understanding the medium to long-term price stability and establishing the asset purchasing program. In its appendix, the documents further illustrated that the program size was about 35 trillion yen, and asset purchasing items include 'long-term government debt, treasury discount-bills, asset-backed CP, commercial paper, exchange-traded funds, corporate bonds, and Japan real estate investment trusts'. These series of the policy were renewable because of their higher weighting on the risky asset, which was aimed to help to reduce the term premium (Lam, 2011).

The detailed strategy includes targets on the current balance instead of overnight call rate, purchasing both government bond and other assets to help to achieve current balance target, and committed to continue the QEP until CPI back to the normal level (Bowman et al., 2011). BOJ focused on the liability side of the balance sheet. This decision making was largely due to the different economic environment they were facing. One view to explain why BOJ was focusing more on the liability side of the balance sheet is that, while the asset focus more on the private sector, the liability side help to work as a buffer in the financial markets (Shiratsuka, 2010).

The consequences and effectiveness of quantitative easing have been widely discussed, and yet no consensus was reached. Even though the liability focused project was no doubt provided enough liquidity to Japanese financial markets (Bowman et al., 2011), the relationship did not mainten after the QEP period. Nevertheless, this does necessarily imply a side effect led by QEP. Instead, it may suggest that the QEP period was the most stressed period for the banking sector. Another grounded critique on QEP argues that with the short-term interest rate became sustainably zero, the short-term bonds can be used as the alternative to the currency, and therefore the expansion of M2 may not have a real impact on the market (Ito & Mishkin, 2006). Therefore, although the QEP could be convincing in the signaling channel, it seems to be insufficient for the liquidity injection to the economy.

The general opinion on the result of the quantitative easing policy is that it failed to meet the initial expectation. However, it is not clear whether the effectiveness was deluged by the post-bubble economy or it is because the policy itself is not efficient. Bowman et al. (2011) prove that the liquidity injection helped the Japan's economic boost, although the magnitude of recovery was small. With the applying of the bank-level data, the study showed that the QEP provide the bank lending a more liquidity position. Regarding their portfolio rebalancing target, Oda and Ueda (2007), make a backward looking assumption and show that there is no clear relationship between QEP and portfolio rebalancing. Asset price is another factor which needs to be paid special attention to, the bust of asset price bubbles led to a huge drop in price, and one of the main targets of the quantitative easing program was to push up the asset price again to stimulate the economic growth. Ueda (2012) shows that although the results are multidimensional. In general, the asset price did rebound, and the liquidity injection, as explained earlier, should push

the real interest rate upwards, while this expectation did not appear in the later QE period. In general, the Japanese QEP had a fair impact on the confidence level, provide a positive impact through signaling channel to the financial markets.

2.2 The quantitative history of Federal Reserve

Even though Japanese is widely considered as the first country that officially runs the quantitative easing program in this century, United States already adopted QE back to 20th century. In 1932, when American fell into the longest recession ever since the history, the Federal Reserve tried to lose the interest rate without deepening the recession. Clearly, banks interest rate reducing alone did not make interest rate met the committee's expectation (Meltzer, 2004). Later, Congress approved the Fed purchasing plan for one billion outstanding, and in 1933 this figure was up to three billion. The program was suspended in October, however the program was recovered with the gold purchasing plans soon after that.

In 2004, Bernake and Reinhart discussed the possibility of monetary policy conducting in the small interact rate boundary. They proposed three possible solutions. First is to keep long-term interest low. However this may indicate a negative signal to the long-run economic growth, the credibility of the promising largely depends on the political and economic environment. The second suggestion is the reorganizing of the central bank balance sheet. Bernake and Reinhart suggested that this policy may not have a significant impact on the economy and it should only be adopted as a supplement. The third suggestion is the central bank balance sheet expanding, typically named as quantitative easing. They pointed out that comparing with the first two alternatives, the advantages of the quantitative easing are more 'visible and aggressive' than the 'verbal promise.'

In 2007, with the escalating of the subprime crisis, Federal Open Market Committee (FOMC) begun to cut the policy rate (Federal Reserve Board, 2007 September). During the first stage of the crisis, Fed did not choose to expand the balance sheet and only adjusted its composition (Blinder, 2010). At this juncture, Fed bailed out the market though purchasing the low-quality good and paying with gold. However, with the collapse of Lehman Brothers, it became difficult for Fed purchasing the low-quality assets further without expanding the balance sheet, since the Treasury rates were running low (Begus & Schiml, 2009). Federal Reserve started to adopt the quantitative easing policy at 2008, and general opinion recognizes that there are three stages of Fed Quantitative easing operation, QE1, QE2, and QE3. The first Quantitative Easing phrase start from November 2008, FOMC first suggest to expand the balance sheet, and in 2009, FOMC started to purchase the long-term government asset, including agency debt and Mortgage-backed Securities (MBS) (Fawley & Neely, 2013). The amount was extended in 2009 and the funds' rate was reduced nearly to zero. This stage is recognized as QE1 and the period was last till 2010. The second round of quantitative easing started from 2010 November, with 600 billion treasuries

purchasing in total. The third period is from 2012 June to December, with another 45 billion supplements (Fawley & Neely, 2013).

The Federal Quantitative Easing program certainly had a significant impact on the financial markets, especially in the bond markets. To start with, the signaling channel has a significant impact on the bonds markets (Christensen & Rudebusch, 2012). As explained earlier, a credible policy implementation should change the public option towards future economics condition. As its implementation lower the yields for all bonds, the signaling channel did perform as the expectation (Bauer & Rudebusch, 2013). The program also had a significant impact on government bonds along the findings that the changes in the asset yield diverse from each other and it depends on the content of quantitative easing. In other words, the different asset purchasing operation had the different impact on the specific asset category. During the QE1 period, the majority purchasing was focusing on the MBS. While the 500 billion was spent on MBS, only 100 billion used for the Government-Sponsored Enterprise debt. Krishnamurthy and Vissing-Jorgensen found out that within this stage, the quantitative easing program had a significant influence on the MBS yield. Whereas in the QE2 period, MBS yield did not show a significant change since the focus of QE2 is on US Treasuries (Krishnamurthy & Vissing-Jorgensen, 2011). The liquidity injection work through the adjustment of bonds premium, during crisis, the premium typically remains high as the compensation of the potential risk (Fabozzi et al., 2006). Therefore, to encounter with the signaling channel, the liquidity injection stimulates the bonds yields, which eventually reflect on the rise of the interest rate.

2.3 The Journey of Monetary Policy Committee

At the end of the year 2008, Monetary Policy Committee (MPC), the British committee whom mainly responses for interest rate adjustment and monetary policy making, decided to cut interest rate by three percent, as a response of financial crisis escalating. Followed by the second-round of interest rate reduction, the bank rate reached its lower bound (Joyce et al., 2011). In order to stimulate consumption and achieve the mid-term CPI target, the MPC decided to launch Large-scale Purchasing Program, explained by MPC as 'injecting money into the economy' (Ganley, 2010). The program officially started at the beginning of 2009 with an initial £50 billion purchasing plan, and in the first quarter of 2010, Bank of England (BOE) had purchased £200 billion of gilts in total (Joyce et al., 2011). Notably, there are some disagreements regarding the official starting point of British quantitative easing program. In January 2009, Her Majesty' Treasury released the statement that BOE will purchase £50 billion of 'high-quality private sector asset,' which is financed through the issuance of short-term gilts (Fawley & Neely, 2013). Consequently, the liability side of BOE balance sheet remained the same, and the initial QE program started from March 2009, after the first QE expansion announcement by MPC.

In general, after the announcement of QE program and QE expanding program, gilts yields fell as well as term premium. However, the market responded differently to the six MPC

announcements. Joyce et al. (2011) use event study to evaluate the market reaction after each MPC announcements. They found market react significantly after the initial announcement at 2009, indicated by the falling of both the yield rate and the overnight index swap. However, the reaction may also associate with the bank rate decreasing decision in March. The following announcements, on the other hand, did not receive a comparable active reaction. The impact on overnight index swap and yields are less noticeable in May 2009, November 2009 and February 2010. The asset prices recording also shows the price was increasing during the first quantitative easing program period, Pesaran & Smith (2016) prove that this increase was led by the QE operation, using the counterfactual analysis approach.

Comparing to the focus on the financial markets, there is insufficient study focus on lending channel study of British quantitative easing program (Butt et al., 2014) and the different approach draws the different conclusion. Joyce et al. (2014) adopt Dynamic Auto Regressive Distributed Model and concluded QE has "small but significant" effect on bank lending growth rate, and the impact is stronger on small banks. However, by adopting difference-in-difference and instrument variable approach, Butt et al. (2014) show that no significant relationship between Quantitative Easing program and banking lending behavior. They suggest that, instead of lending channel, QE stimulate the economy through portfolio rebalancing channel. This finding is consistent with Joyce at al. (2011).

The consumption and economic growth are also stimulated by QE. Bridges &Thomas (2012) showed that QE helps to stimulate demand, which helps to increase inflation and GDP. Kapetanios et al., (2012) make a thorough study measuring the policy impact on the GDP and CPI. The following models are adopted by this research: Bayesian vector autoregression (BVAR), Structural Vector Autoregression with Markov Switching (MV-SVAR), and Time-varying parameter structural vector autoregression (TVP-SVAR). The consistent result was reached with the different approaches. The BVAR applied for the large-scale datasets test, assuming the financial markets as a random walk environment. The MV-SVAR and TVP-SVAP are both in the reduced form and use for measure the outcome of policy changes. The three model provide the same conclusions that the QE indeed help the economic growth, around estimated two-point-five percent.

3. Preliminary Discussion

3.1 Literature review and hypothesis

While the Bank of England and Federal Reserve focusing more on the asset purchasing plan, ECB has expanded the bank lending program since it started adopting quantitative easing plan (Fawley & Neely, 2013). The lending program is also referred as FRFA, which stands for fixed-rate tender, it is full allotment, and its rate is determined by bank repo auction (Linzert et al. 2007). The outstanding of refinancing operation had quickly expanded, to help the economy cope with the euro lower bound trap.

At the beginning of 2006, the outstanding amount of LTROs only remains around one-hundred million level. With the initial inception of the financial markets, at October 2007, the LTRO increase its level to 265 million, and the outstanding increases while the crisis deepened. At the beginning of December 2008, the outstanding amount had reached above 600 million. On 2008 March 3rd, LTRO maturity expansion was announced at the first time. On 2009 June 23rd, the maturity was extent again to 12 months, as the correspondence of the longer period banking bowering (Fawley & Neely, 2013). With the gradual recovery of the economy, the change of LTRO had been stable, and between the third quarter of 2010 and the fourth quarter of 2011, the outstanding amount had remained below 400 million level. The maturity of LTRO has also started to change at this phrase. LTRO target into the three to twelve months' maturity, however on December 2011 and February 2012, there were two allotment of LTRO announced with 36 months' maturity and it reached the amount of 1100 million euro. Comparing MRO with LTRO, the outstanding of LTRO has largely surpassed the outstanding of MRO since 2007, and therefore I would like to focus on the measurement of the impact of LTRO on the economy over the crisis period and overall period. The total outstanding change of MRO and LTRO are presented in Appendix, Figure A.

The ECB summarized three channels that the unconventional monetary policy can help economics recovery (Constancio, 2015). The first channel is through the adjustment of short-term interest rate. To stimulate the spending, central bank lowers the short-term interest rate. In general, this conduction details is summarized in its accommodative monetary policy. The unconventional monetary policy also helped to lower the borrowing cost, and it will again help the growing of non-financial sector. The second channel is through the liquidity injection; the refinancing operation is the typical example which is also the key focus of this thesis. Del Negro et al. (2016) had given the discussion by applying the DSGE model, Negro shows that the liquidity facility provides a significant impact in the preventing deepen the financial crisis. The asset purchasing program granted the price of the less liquid asset and accordingly decrease the asset yield. Therefore, the investors may adjust their investment portfolio choose the asset with optimal returns, which in turn stimulate the aggregate demand. This is consistent with the intuitive elaboration from Benford et al., (2011). The extra liquidity injection steers the asset price which helps to increase the bond price, which accordingly decreases the yield of the interest. The third major channel is through signaling. The announcement of the quantitative policy provides

the public with the evaluation of the economic outlook. Normally the announcement aims to sooth the tension. Therefore, I assume the hypothesize as follow:

The long-term refinancing operation have a positive impact on the government bond during financial crisis period.

3.2 Data

The data set for the Panel data study comprises five variables, and the period is from January 2006 to July 2016. The five variables included in the analysis are: the clean price index of government bond price, weekly balance sheet outstanding of Long-Term Refinancing Operation from ECB, Inflation rate of Euro area 19, The overall government deficit level of Euro area 19, and Unemployment rate.

The dependent variable in this analysis is the weekly clean price index of government bond for nine euro-area countries: Germany, France, Netherlands, Belgium, Australia, Italy, Spain, Ireland, and Portugal. The dataset is from DataStream. The analysis consists bond with different maturity of 1-3-year, 3-year and 10-year. The purpose of enclosing different maturity is to test the consistency and duration of the impact of LTRO. The summary of the government bond prices is presented in Table 1. The overall weekly data points between January 2006 and July 2016 are 549. Furthermore, I distinguish the overall period between the financial crisis and sovereign debt crisis period. The financial crisis period is between 2007 August and 2009 May, and the sovereign debt crisis is between 2009 July and 2013 May. The figures show that the government bond price is more volatile during sovereign debt crisis than during financial crisis. Comparing within this data group, Portugal had the most severe impact from sovereign debt crisis.

The LTRO outstanding is from the weekly financial statements which are officially published by the ECB. The LTRO outstanding is presented on the asset side of the current accounts of euro area credit institutions. The outstanding amount indicated the total amount of lending from ECB to euro area credit institutions.

The government deficit is defined as the percentage of GDP of EURO area (19 countries, fixed composition defined by ECB), with the quarterly frequency. For the inflation rate I use Harmonised Indices of Consumer Prices (HICPs) which is often used by ECB as the inflation monitoring index. The inflation dataset is in the monthly frequency. The unemployment rate is also in monthly and it is in EU-19 fixed composition. The dataset of government deficit, inflation rate and unemployment rate are all from ECB statistics warehouse, and together they are served as macroeconomics control variables to avoid the endogeneity. Both panel data and Vector Autoregressive approach use the same dataset and same segment method, to avoid the inconsistency problem. The summary of LTRO outstanding, Inflation rate, government deficit ratio and unemployment rate are included in Appendix, Table(A).

	Total (549 obs)				Financial Crisis (549 obs)				Financial Crisis (549 obs)			
Government Bonds Price Index, 1-3-year	Mean	St. dev.	Min	Max	Mean	St. dev.	Min	Max	Mean	St. dev.	Min	Max
Austria	82.053	3.813	73.376	88.031	85.081	0.896	83.18	86.389	80.179	3.503	73.376	85.854
Belgium	70.155	2.896	63.581	74.621	72.465	1.095	70.387	74.085	68.852	2.783	63.581	73.59
France	83.184	2.633	77.077	87.362	85.162	1.497	82.734	87.362	82.180	2.655	77.077	86.714
Germany	89.712	2.824	83.854	94.323	91.846	1.579	89.312	94.323	88.717	2.942	83.854	93.52
Netherlands	83.000	2.257	77.788	86.681	84.606	1.465	82.355	86.681	82.376	2.428	77.788	86.311
Italy	99.681	1.962	91.467	102.757	99.279	1.848	96.514	102.152	100.182	1.962	91.467	102.757
Spain	93.822	1.849	87.299	96.918	93.875	1.651	91.256	102.152	93.801	2.037	87.299	96.918
Portugal	96.618	8.619	71.914	109.97	93.471	1.550	90.782	95.864	98.479	10.264	71.914	109.97
Ireland	108.605	6.676	81.593	119.235	105.19	3.566	94.37	110.47	105.231	4.881	81.593	110.47

Table 1. Summary Statistics: Government Bond Prices, 1-3-year

4. The Panel Data aspects of LTRO and bond price

4.1. Methodology

The outstanding of LTRO is only available at the overall level, and the bank specific repo auction amount is unknown to the public. Therefore, inside of looking into the country specific reaction to the change of the monetary policy, this thesis use panel data in order to avoid the influence from institutions and policy. Therefore, the panel data approach help to discuss the general relationship between the outstanding of LTRO and bond price, with the consideration of both country fixed effect and time fixed effect, which helps to reduces the omitted variables biases (Wooldridge, 2015). The impact on LTRO on the government bond can be estimated as:

$$\ln(P_{i.t}) = \alpha + \beta L_t + \Gamma_t + \epsilon_{i,t} \quad (1)$$

Where $P_{i.t}$ stands for the government bond price for each country between 2006 and 2016, $L_t$stands for the outstanding of long-term refinancing operation on the weekly ECB balance sheet, Γ_t is the control variables composed by government deficit, inflation rate and unemployment rate, $\epsilon_{i.t}$ is error term. The estimation is in log-level form, which provides the percentage change of bond price for one unit increase in LTRO outstanding.

This test try to provide an overview of how LTRO performed in both the crisis and the general period. Therefore the study is divided into three periods: the financial crisis, sovereign debt period and overall periods. The financial crisis period covers from August 2007, when the BNP Paris announced the freezing their funds, and it is generally considered as the inception to the financial crisis, till the May of 2009. This period segmentation is aligned with the change of the growth rate government deficit in the European Union, when in the later stage of 2009, the deficit expansion grew beyond the public expectation (Popov & Van Horen, 2013), and in the late 2011, the debt ratio became unconvergence (Gartner, 2003), and by the end of the first quarter, 2013. The ten year yields of sovereign government bonds had back to the pre-crisis level. Therefore in this study, the sovereign debt crisis is defined between July 2009 and March 2013. The division is based on the discussion of Lane (2012) and Popov & Van Horen (2013), who introduce that the global financial crisis had little impact on the sovereign bonds before 2009.

There are nine countries included in the analysis, Austria, Belgium, France, Germany, Netherlands, Italy, Spain, Portugal and Ireland. However, it is unknown that for each individual countries and banks, for how much they are sponsored from repo auctions, and it is difficult to evaluate by how many percentage does LTRO have an influence on the government bond price for each country. Therefore, I would like to discuss the LTRO on the entirety-level and discuss if there is the difference between the impact on western Europe countries and sountern countries. Janoudi (2014) distinguishs diversity of cost efficiency with OECD area, where the GIIPS countries are less cost efficient comparing with western countries. Consequently, whether the LTRO outstanding had been handling efficiently is a question worth to be discussed. The divergence can be estimated using the equation (2):

$$\ln(P_{i.t}) = \alpha + \beta lnL_t + \beta L_t \times Western + \Gamma_t + \epsilon_{i,t} \quad (2)$$

Where Western is a dummy variable, representing western countries when it equals to one and southern countries when it equals to zero. The western countries group include Germany, Belgium, France, Netherlands and Austria. The southern countries group include Spain, Italy, Portugal and Ireland. It is needed to be mentioned that even though geographically speaking, Ireland does not belong to southern group, it is categories as the GIIPS countries since European debt crisis, where the GIIPS uses to refer Portugal, Ireland, Italy, Greece, and Spain, the countries fail to manager their deficit ratio at the sustainable level. The Government bond price of Greece is not obtained therefore I categories the other four countries as southern countries group.

4.2 The results

The estimation of equation (1) are summarized in Table 2. The estimation of the LTRO impact on the euro government bonds market is split into two periods, the financial crisis and sovereign bonds crisis with robustness test included. The table 3 estimates the equation (2) with dummy variable included.

By table 2 and table 3, there is a positive impact of LTRO outstanding and government bond price during the financial crisis period for both western countries and southern countries group. In the financial crisis period, the estimation results showed that overall there is a positive relationship between the outstanding of LTRO and the bond's price, with the control variables and fixed effect included. This result is intuitive and consistent with Bauer & Rudebusch (2013), Joyce et al. (2012) and Christensen & Rudebusch (2012). The model is in level-log construction. The unit of LTRO outstanding is initially in EUR billions, however the coefficient between LTRO and bond price is small, in order to avoid the miscounting of decimal, I rescale the LTRO outstanding to EUR Trillion for the panel data section. Therefore, as column (A) suggests, one trillion LTRO increase on the ECB weekly balance sheet led to a 4.26% significantly increase of 1 to 3-year government bonds price. The test shows that the LTRO coefficient is cumulative for the 1 to 3-year government bonds, 3-year government bonds and 10-year government bonds which is 4.26%, 4.27%, and 4.46% respectively: the coefficient increases when the term grows. This result is intuitive and even though the more detailed data on the different maturity level is not obtained, we can see that the corresponding result is consistent with Fabozzi et al. (2006), since the bonds yields should be accumulative and thus prove the efficiency of LTRO.

However, in the sovereign debt crisis period, the Performance of the LTRO is less satisfying, from 1 to 3-year government bonds to the 10-year government bonds, these coefficients are not significant. These findings may seem surprising since the LTRO outstanding amount reach the summit during the sovereign debt crisis and reducing the bonds yields was the primary task. However, this finding is consistent with Krishnamurthy & Vissing-Jorgensen (2014), who use the event-study approach and conclud that the impact of LTRO on sovereign yields are small.

The overall periods (2006 - 2016) show that for the mid-term interest, the performance of LTRO was effective. As shown in the column G and H, the one billion increase of LTRO balance significantly increase the 1 to 3-year government bonds and three year government bonds 1.82% and 1.88%, respectively. However, the price of 10-year government bonds do not show a significant change. In all periods, the country fixed effect shows a significant result. Szczerbowicz (2015) finds that during the sovereign debt crisis, the OMT and SMO are more effectively tool comparing with LTRO.

Bond Px	Financial Crisis			Sovereign Debt Crisis			Overall Period		
Column	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)
	1-3 Yr GB	3 Yr GB	10 Yr GB	1-3 Yr GB	3 Yr GB	10 Yr GB	1-3 Yr GB	3 Yr GB	10 Yr GB
ln(LTRO)	0.0426***	0.0427***	0.0446***	0.0105	-0.493	-0.097	0.0182***	0.0188**	-0.0254
	(0.374)	(0.528)	(0.014)	(0.939)	(0.014)	(0.063)	(0.702)	(0.904)	(0.035)
Inflation	-.0091***	-.0118***	-.0244***	-0.011***	-.0153***	-.0513	-.0041**	-.0058***	-.0301***
	(0.0007)	(0.0011)	(0.0017)	(0.0024)	(0.0038)	(0.0198)	(0.0013)	(0.0014)	(0.0059)
Government Deficit	-0.026	-0.071	-0.395**	-0.357***	-0.248**	-0.947	-0.359***	-0.301***	-0.482
	(0.04)	(0.05)	(0.16)	(0.1)	(0.15)	(0.76)	(0.07)	(0.08)	(0.34)
Unemployment	-.0035**	-.0011	-0.016**	0.024***	0.052***	0.095	0.023***	0.028***	0.023
	(.0016)	(.0024)	(.0071)	(.0059)	(0.0086)	(0.0334)	(0.0041)	(0.0049)	(0.018)
Constant	4.49***	4.63***	5.25***	4.48***	4.29***	4.89	4.48***	4.53***	5.19
	(0.021)	(0.028)	(0.083)	(0.069)	(0.107)	(0.473)	(0.033)	(0.035)	(0.162)
Country Fixed Effects	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***
Time Fixed Effects	Yes***	Yes***	Yes***	Yes	Yes	Yes	Yes	Yes*	Yes
N	819	819	910	1,719	1,719	1,910	4941	4941	5,490
R2	0.9962	0.9960	0.9865	0.9227	0.9048	0.7431	0.891	0.9114	0.7417

Table 2. Panel Data Equation (1) estimation. LTRO is rescaled to EUR Trillion.

Note: During financial crisis period, the estimation shows the consistent result. For the 1 to 3-year government bond, the price increase 4.26% percent when the LTRO increase 1 trillion outstanding on the balance sheet, and the 3-year and 10-year price increase 4.27% and 4.46%, which is consistent with the estimation. The result in the sovereign debt group is not significant. Overall, the increase of one unit LTRO outstanding leads to the 3% increase of 1 to 3-year government bond price. The country fixed effect and time fixed effects are included to reduce the biases.

Bond Px	Financial Crisis			Sovereign Debt Crisis			Overall Period		
Column	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)
	1-3 Yr GB	3 Yr GB	10 Yr GB	1-3 Yr GB	3 Yr GB	10 Yr GB	1-3 Yr GB	3 Yr GB	10 Yr GB
ln(LTRO)	0.04***	0.0292***	7.78e-03	4.27e-03	-0.0179	-0.1591	0.0219**	0.0221**	-0.0368
	(0.47)	(0.609)	(0.0157)	(0.0175)	(0.027)	(0.101)	(0.991)	(0.013)	(0.051)
Ln(LTRO) X WESTERN	0.0047***	0.0243**	0.0736***	0.0113***	0.0234	0.124	-0.0066***	-0.006***	0.0227*
	(0.424)	(-0.657)	(.00001)	(0.244)	(0.398)	(0.997)	(0.255)	(0.286)	(0.654)
Inflation	-0.0076***	-0.0111***	-0.0221***	-0.0246***	-.0361***	-0.1027**	-0.0075**	-0.0111***	-0.0531***
	(0.0008)	(0.0011)	(0.0027)	(0.0057)	(0.0087)	(0.0326)	(0.0022)	(0.0029)	(0.0114)
Government Deficit	0.117	-0.163	-0.0211	-0.0328	-0.0332	-0.246*	-0.0472***	-0.0499**	-0.114*
	(0.0054)	(0.007)	(0.018)	(0.0233)	(0.0359)	(0.135)	(0.0122)	(0.0161)	(0.0631)
Unemployment	-0.000394	-0.00036	-0.027***	0.0518***	0.0882***	0.101*	0.0334***	0.0419***	0.0192
	(0.00224)	(0.0029)	(0.00746)	(0.099)	(1.52e-02)	(5.71e-02)	(0.00561)	(0.0074)	(0.029)
Constant	4.63***	4.78***	5.11***	4.44***	4.20***	5.21***	4.72***	4.76***	5.12***
	(0.029)	(0.038)	(0.098)	(0.143)	(0.221)	(0.829)	(0.061)	(0.081)	(0.317)
Country Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
N	364	364	364	764	764	764	2196	2196	2,196
R2	0.9825	0.9945	0.9908	0.7910	0.8288	0.8020	0.7591	0.8558	0.8006

Table 3. Panel Data Equation (2) estimation. LTRO is rescaled to EUR Trillion.

Note: The inclusion of the dummy variable shows that for each period, the change of the outstanding of LTRO has a prominent impact on the western countries than southern countries. The coefficient of the dummy variable is positive and significant except for the sovereign debt crisis, 3-year bond and 10-year bond group. During financial crisis period, the increase of one trillion LTRO outstanding on the ECB balance sheet leads to a 4.47% increase in the bond price, and southern countries group only have a 4% increase. Compare with estimation of equation (1), the western groups shows that the 1 to 3-year government bond increase significantly during the sovereign debt crisis.

5. Vector Autoregression evidence

Nevertheless, one problem often appeared in the capital market related study is that most factors are intertwined with each other, and it is hard to avoid the exogenous and inter-correlated problem. Often, when seeking the answer in the multivariate times series research which mingled with the exogenous problem, Vector Autoregressive Model is the most popular tool to help to solve the problem (Zivot &Wang, 2006; Enders, 2004). Therefore, I would like to extend the discussion by using the VAR model and study the relationship between the government bonds price and LTRO outstanding. However, there is also some drawbacks and ambiguousness in VAR model. VAR is not constructed under prudent theoretical framework; therefore the interpretation of the coefficient could be difficult (Brooks, 2014). Instead, VAR helps to understand the tendency of the impluse response. This study use vector autoregressive approach and present with impulse response function on the time series, country specific level.

5.1 Model

The VAR is often used for the multivariate times series model, and it is often applied to the policy analysis study (Rubio-Ramirez et al., 2010). Its reduced-form can be expressed as:

$$y_t = A_1 y_{t-1} + \cdots + A_n y_{t-n} + \epsilon_t, \tag{3}$$

with $E(\epsilon_t) = 0$, $E(\epsilon_t \epsilon'_{t-m}) = 0$.

y_t is n lag of 4×1 vector, A is 4×4 parameters matrix, and $\epsilon_t$stands for exogenous shock. n is determined by Akaike Information Criterion test and Bayesian Information Criterion test. y_t is comprised Government bond price, LTRO outstanding, government deficit and inflation rate. The construction is under the consideration that the interaction among the government deficit, the liquidity financial market, and the corresponding policy rate. The government deficit level influences government bond price, the bond price and yield influence the liquidity position and interest rate expectation, which help to determine the nominal inflation rate. By using VAR model, the endogeneity and erogeneity problems are to some extent avoided, and it is help us to observe the intercommunication among the above factors.

5.2. The Determination of lag length

Determine the optimal lag length is an important step to build VAR model (Gutierrez et al., 2009). The result of the lagged length can be found in Appendix 1. The most often used selected information criterion is Akaike Information Criterion (AIC) (Akaike, 1973), Bayesian Information Criterion (BIC) (Akaike,1979), and Hannan-Quinn Information Criterion (HQC) (Hannan and Quinn, 1979).

The test result shows that for the overall periods, both HQIC and SBIC suggest a VAR process of VAR(2), and AIC suggests VAR(3). The selection among the model has been discussed and yet few conclusions had reached. $AIC = -2\log(L) + 2K$; and $BIC = -2logL + \log(n) * K$, where L denotes the log likelihood. Their only difference, $\log(N)$, indicates that BIC depends on the

sample size. The opinion regarding whether to adopt AIC or BIC is quite diverse. Brunham and Anderson (2004) explained that the BIC assume "equal prior probability for each model" and for when to determine whether BIC or AIC is the "true model" depends on the natural of the model and the target model of AIC and BIC is different, when they face the bigger sample size, and as for term of mean square error, AIC is lower than BIC. Many researchers concluded that AIC helps to provide the best fit model for the unknown process which often serves for the predictive purposes, while BIC is more suitable for the explanation purposes. However, since the test is conducted under Stata, which suggest that the lag length should be the take the smaller number between AIC, BIC and HQC (Stata, 2015), therefore the lag length is determined as VAR(2) (Liew, 2004).

5.3 Unit Root and Stationarity Test

According to Chris (2014), the stationary test is necessary for the time series test. For the two stage autoregression, normally there are two types of non-stationary:

The random walk with drift:

$y_t = y_{t-1} + n_2 y_{t-2} + \epsilon_t$

And the random walk with drift where $\mu_1 \neq 0$:

$y_t = \mu_1 + n_1 y_{t-1} + n_2 y_{t-2} + \epsilon_t$

y_t has a unit root if n = 1. Therefore, the null hypothesis can be expressed as

H_0: n=1

H_1: n<1

The most often used test is Dickey-fuller test. The test result shows that I failed to reject H_0. However, this result is predictable since for most financial time series, they are also non-stationary (Sim, Stock and Watson, 1990). The most often method is to use Vector Error Correction Model (VECM) which often use to solve this problem. However, many researchers already mentioned that the station test is not necessary for the capital market related study. The focus of the VAR is to provide the estimated shock on the bond price.

5.4 Impulse Response

The study use impulse response function analysis estimating the effect of LTRO on government bond price. It helps to visualize the change of the reaction to the shock over time. Even though the government deficit and inflation rate are also included in the model, I only depict the relationship between LTRO and government bond price, because I would like to focus on the key question here. The figure 1 plots the impose response separately for 1 to 3-year government bond, 3-year government bond and 10-year government bond of nine countries, and for each group, the test is divided by financial crisis period, sovereign debt crisis period, and the overall time period (2006-2016) which are successively presented in Figure 1.1, 1.2 and 1.3, with weekly

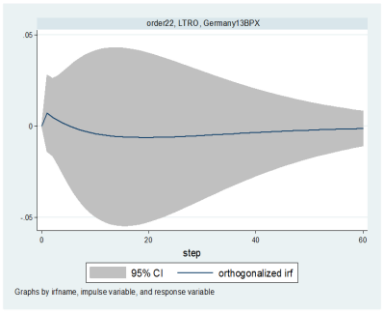
frequency. The upper and bottom boundary depict the asymptotic standard error. The impulse response graphs show the test results are consistent with the conclusion from panel data approach.

In response to the increasing outstanding of LTRO, the price of government bonds increase and gradually drop back to the original level within ten month. As the panel data approach showed, the impulse during the financial crisis is most extraordinary comparing with the other two groups. For the 1 to 3-year government bond price group, all countries show a positive impulse response after the increase outstanding of LTRO, except only Germany shows a more volatile standard error boundaries. For western countries, the impact from LTRO peaks at week ten and drop to zero within forty weeks. For southern western countries, Ireland shows an acute response and reaches the peak in around a month, and Portugal shows a gentle response and the impact on its bond price maintained for around one-hundred-and-fifty weeks. The estimated effect on the 3-year government bond and 10-year government bond during the financial crisis period is persistent with the 1 to 3-year government bond group, and the 3 and 10-year government show a more volatile trend. This result is consistent with the panel data estimation, for the higher maturity bonds, although the estimated coefficient is higher, it is less significant.

During the sovereign debt crisis, however, the estimated impulse response is more volatile and less consistent comparing with financial crisis period. This result is not surprising since the panel data approach already help to conclude that the increase of government bond price is not significant. Krishnamurthy & Vissing-Jorgensen (2014) also state that the influence on LTRO during the sovereign debt period is small and Szczerbowicz (2015) concludes that for the sovereign debt crisis, Outright Monetary Transactions is more effective comparing with LTRO. In the overall period estimation, we can see that even though the response is more volatile, it takes longer to drop off to the zero, and for each group, the impulse response on the western countries group is more consistent than southern countries group, suggesting that the persistency of the bond price change is longer for western countries than the other. The detailed estimated coefficient is presented in Appendix, Table C.

6. Conclusion

The outstanding of operation market operation has been increasing over the years, and long-term refinancing operation has taken the prominent position as the ECB monetary policy tool. Therefore, it is important to appraise the impact of long-term refinancing operation on the capital market. This study use panel data method and vector autoregression approach to estimate the impact of long-term refinancing operation on the OECD government bond price. Both the panel data and VAR show that the change of LTRO outstanding has a positive impact on the government bond price. I divide the sample into two groups: Western countries group and southern countries group, and the result shows that the LTRO have a more prominent impact on western countries group comparing with the southern group. Between 2006 and 2016, I find that comparing with the overall period, the LTRO have the biggest impact during the financial crisis period.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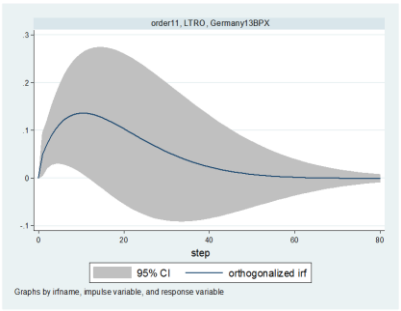
Graphs by irfname, impulse variable, and response variable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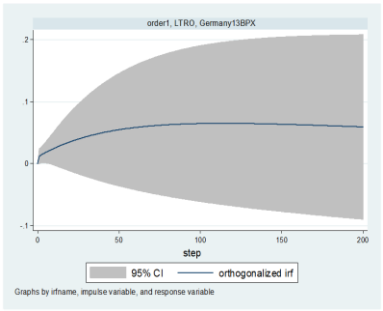
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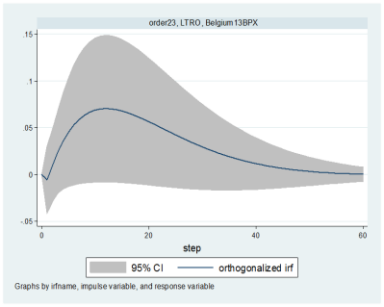
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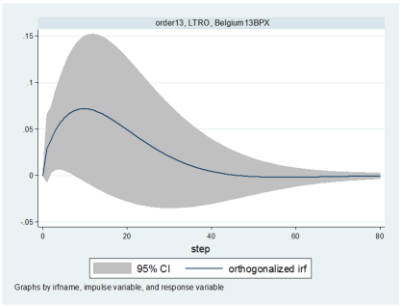
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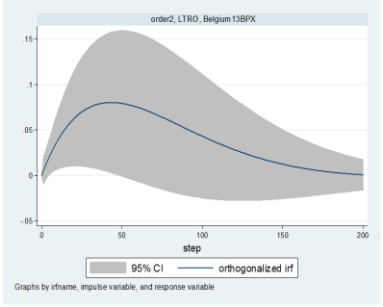
Graphs by irfname, impulse variable, and response variable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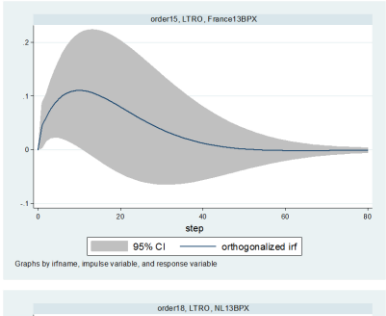
Graphs by irfname, impulse variable, and response variable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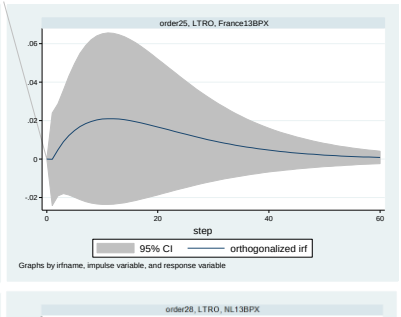
Graphs by irfname, impulse variable, and response variable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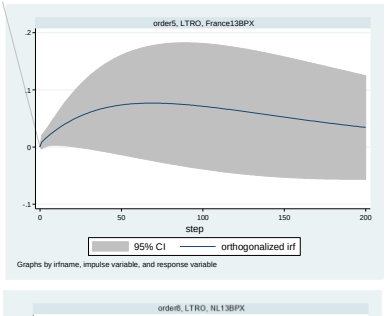
Graphs by irfname, impulse variable, and response variable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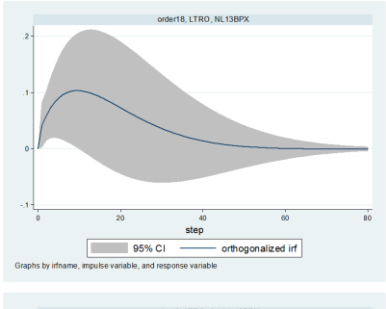
Graphs by irfname, impulse variable, and response variable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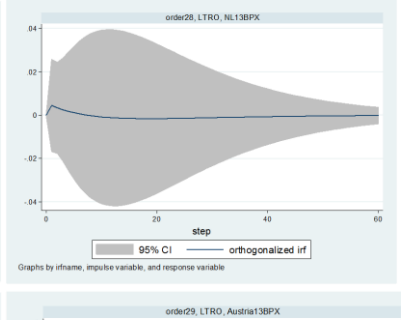
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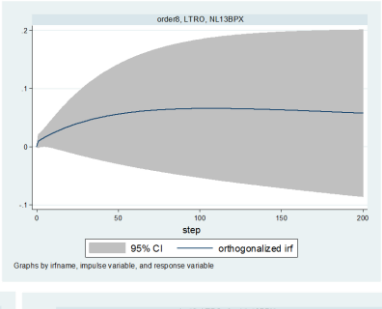
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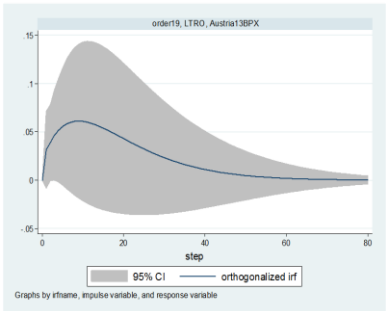
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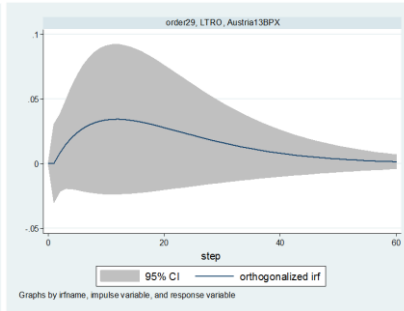
orthogonalized irf
Graphs by irfname, impulse variable, and response variable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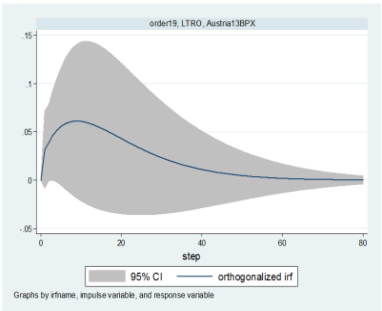
orthogonalized irf
Graphs by irfname, impulse variable, and response variable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Graphs by irfname, impulse variable, and response variable

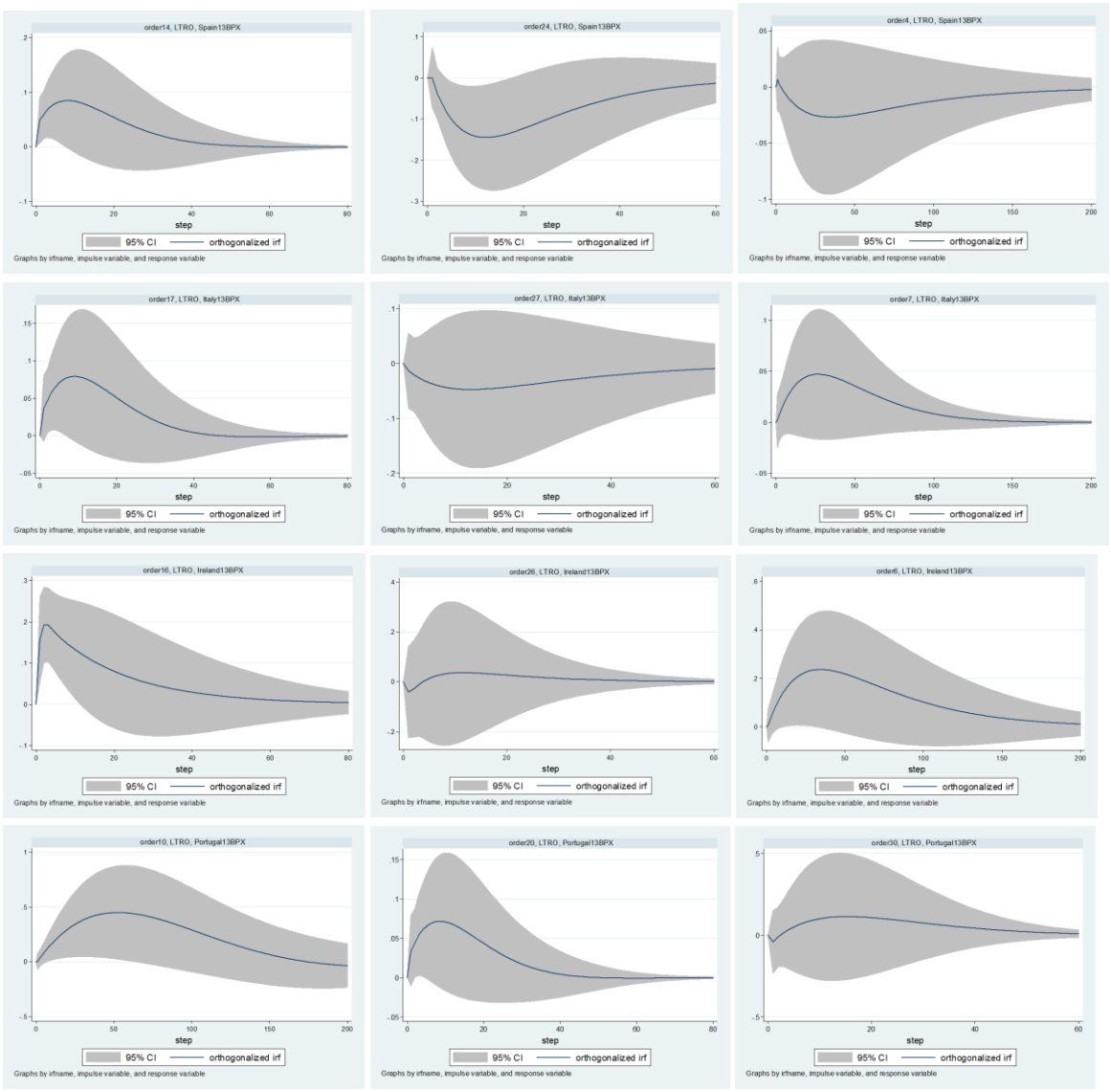
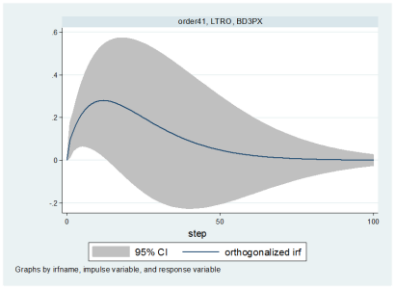


Figure 1.1. Impulse response to LTRO: 1-3yr Government Bond Price.

Note: from left to right: Financial Crisis group; Debt Crisis group; Overall Period group. During the financial crisis period, response of government bond price to LTRO are positive for both western countries and southern countries. However, during sovereign debt crisis period, the response of western countries group to LTRO is stronger than the response of southern countries group. Comparing with the two-segment period, the overall periods shows a more volatile trend.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step
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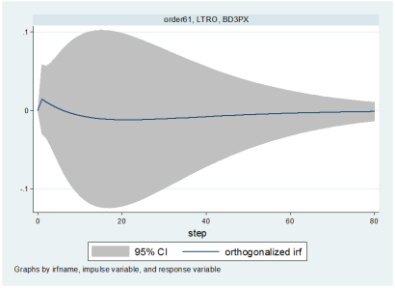
Graphs by irfname, impulse variable, and response variable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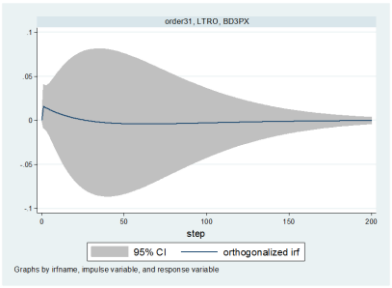
Graphs by irfname, impulse variable, and response variable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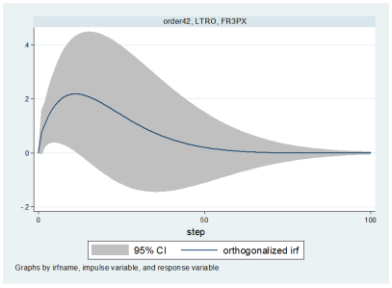
orthogonalized irf
Graphs by irfname, impulse variable, and response variable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step
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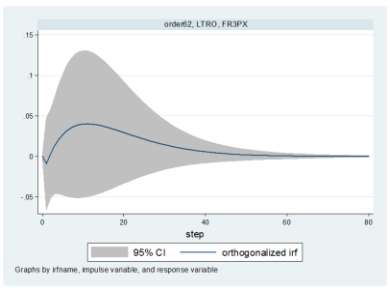
Graphs by irfname, impulse variable, and response variable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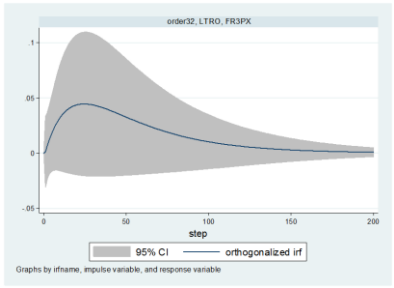
Graphs by irfname, impulse variable, and response variable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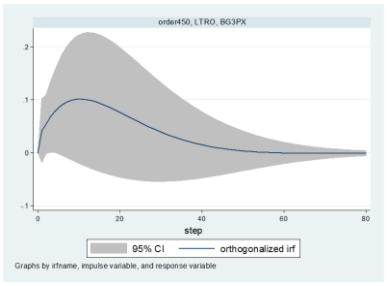
step
95% CI
orthogonalized irf
Graphs by irfname, impulse variable, and response variable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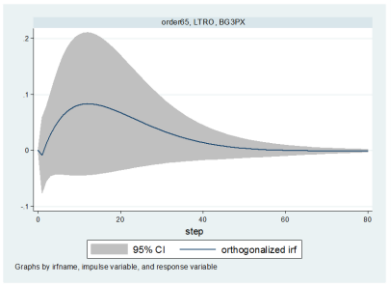
step
95% CI
orthogonalized irf
Graphs by irfname, impulse variable, and response variable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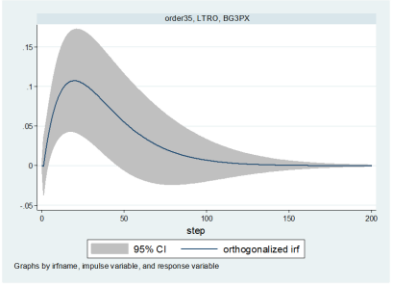
step
95% CI
orthogonalized irf
Graphs by irfname, impulse variable, and response variable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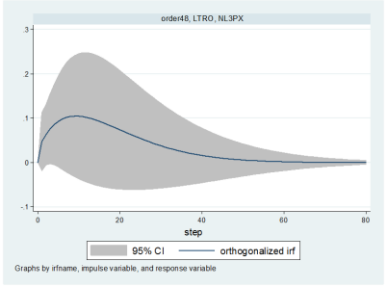
95% CI
orthogonalized irf
Graphs by irfname, impulse variable, and response variable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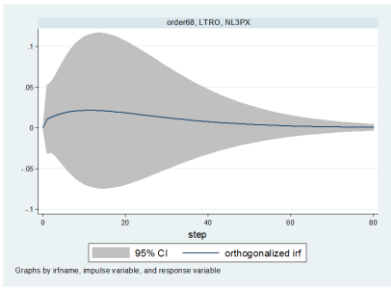
Graphs by irfname, impulse variable, and response variable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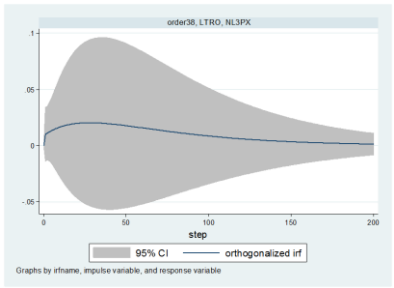
orthogonalized irf
Graphs by irfname, impulse variable, and response variable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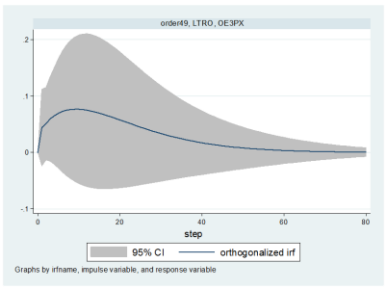
Graphs by irfname, impulse variable, and response variable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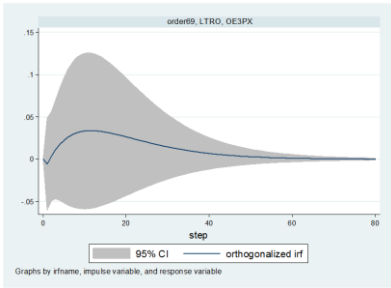
Graphs by irfname, impulse variable, and response variable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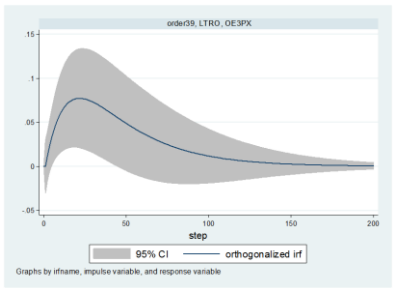
Graphs by irfname, impulse variable, and response variable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Graphs by irfname, impulse variable, and response variable

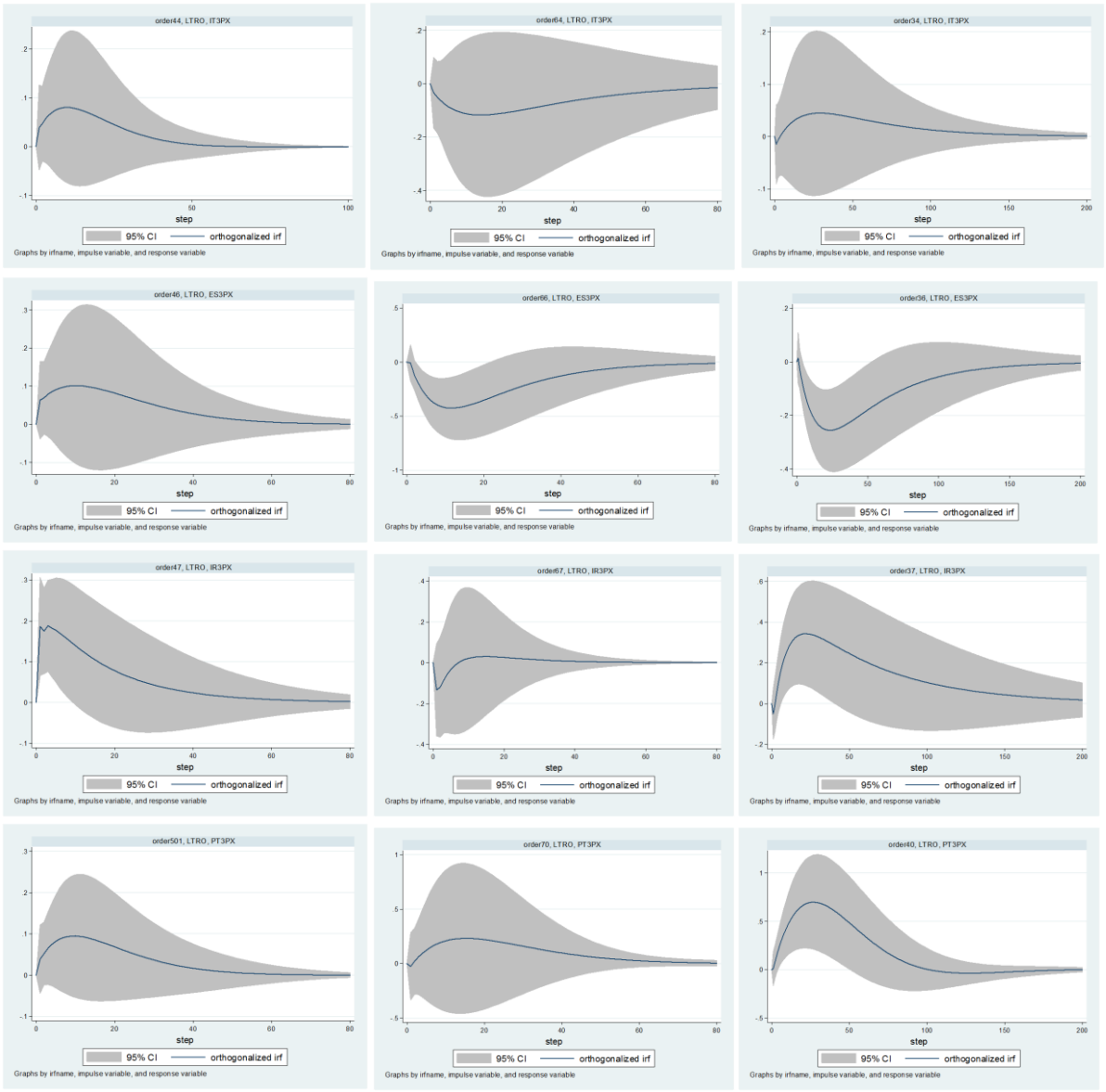
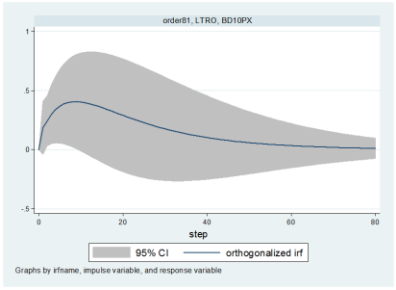


Figure 1.2. Impulse response to LTRO: 3yr Government Bond Price.

Note: from left to right: Financial Crisis group; Debt Crisis group; Overall Period group. Comparing with 1-3-year' government bond group, the response during financial crisis period more persistence but also more volatile. During sovereign debt crisis, the responses of southern countries are negative. This result is consistent with Krishnamurthy & Vissing-Jorgensen's finding (2014). For the overall periods, Belgium Austria, Ireland and Portugal show stronger positive responses.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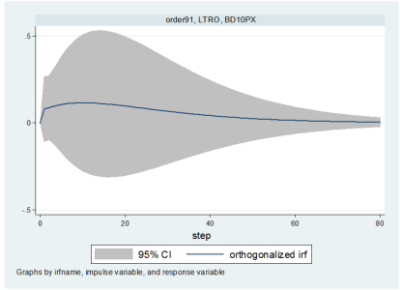
Graphs by irfname, impulse variable, and response variable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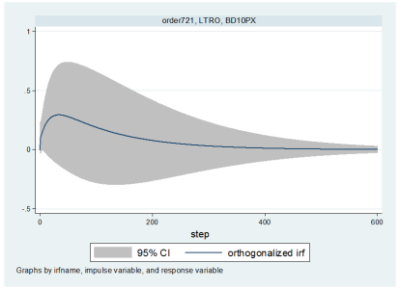
Graphs by irfname, impulse variable, and response variable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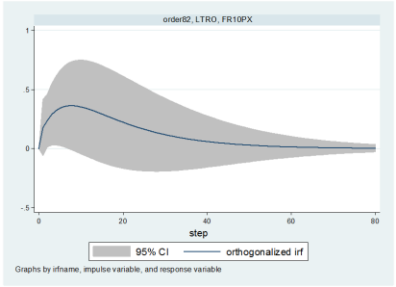
orthogonalized irf
Graphs by irfname, impulse variable, and response variable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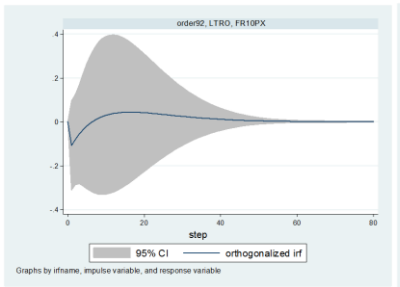
Graphs by irfname, impulse variable, and response variable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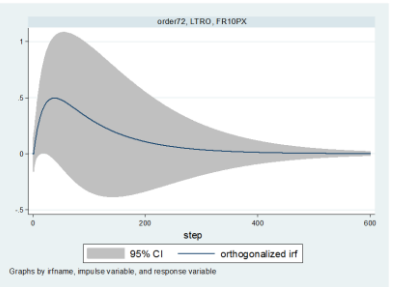
Graphs by irfname, impulse variable, and response variable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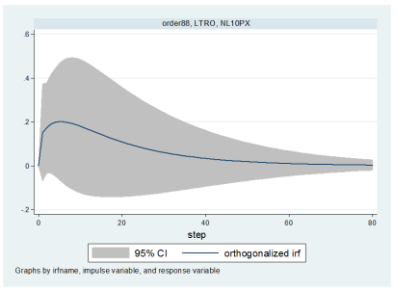
95% CI
orthogonalized irf
Graphs by irfname, impulse variable, and response variable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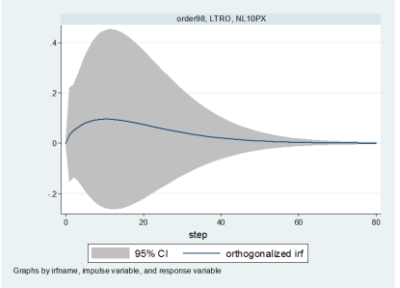
95% CI
orthogonalized irf
Graphs by irfname, impulse variable, and response variable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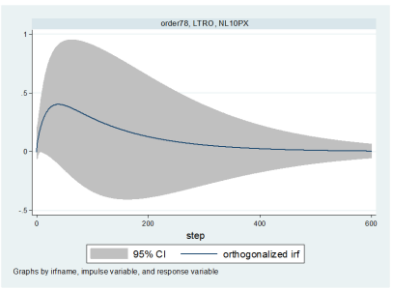
Graphs by irfname, impulse variable, and response variable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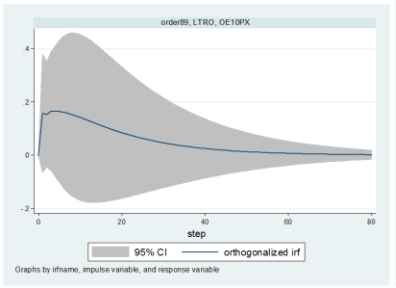
Graphs by irfname, impulse variable, and response variable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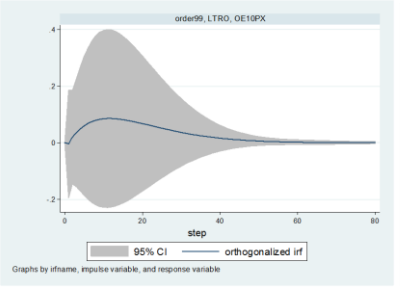
Graphs by irfname, impulse variable, and response variable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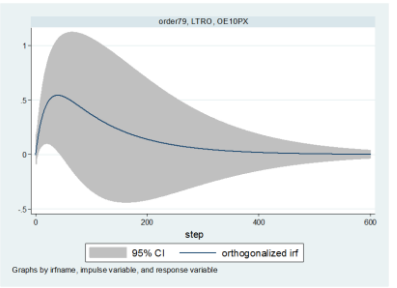
Graphs by irfname, impulse variable, and response variable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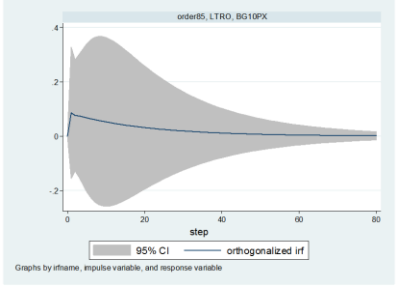
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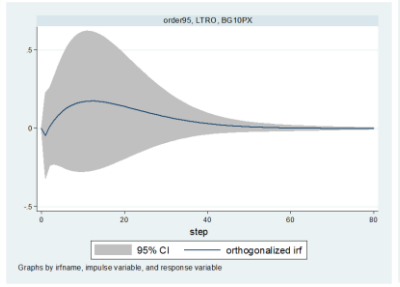
Graphs by irfname, impulse variable, and response variable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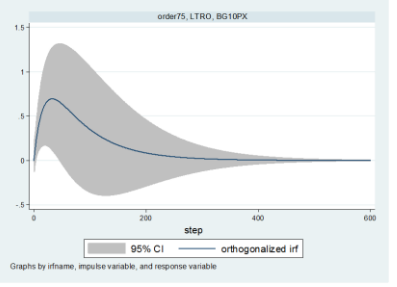
step
95% CI
orthogonalized irf
Graphs by irfname, impulse variable, and response variable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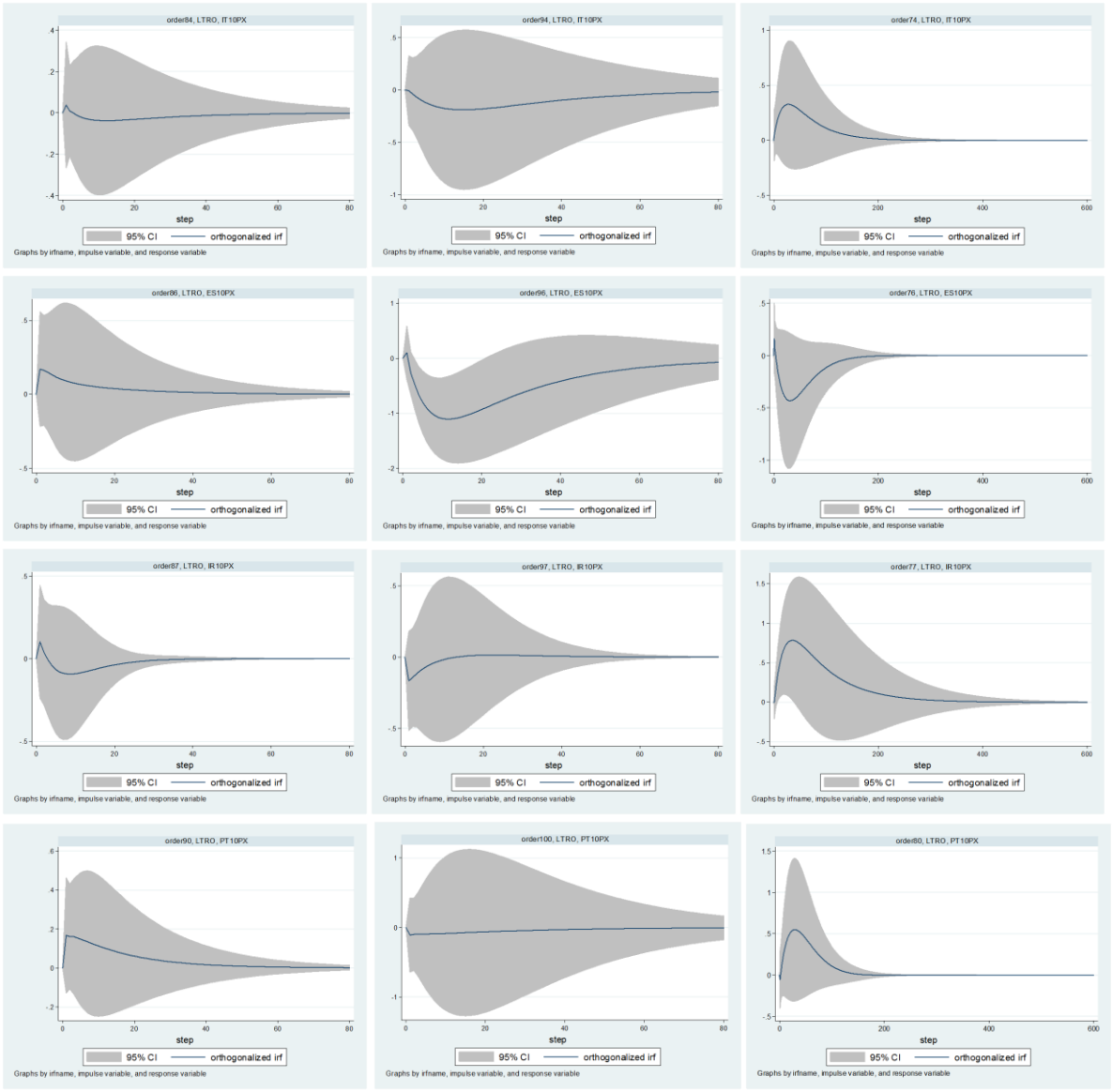

Figure 1.3. Impulse response to LTRO: 10yr Government Bond Price.

Note: from left to right: Financial Crisis group; Debt Crisis group; Overall Period group. The result of 10-year' government bond is more volatile, but stronger comparing with 1 to 3-yearand 3-year government bond group, which is consistent with panel data's finding. During sovereign debt crisis period, all southern countries show a negative response. In general, responses of western countries are more persistent than responses of southern countries, however responses of southern countries are more persistent.

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Appendix

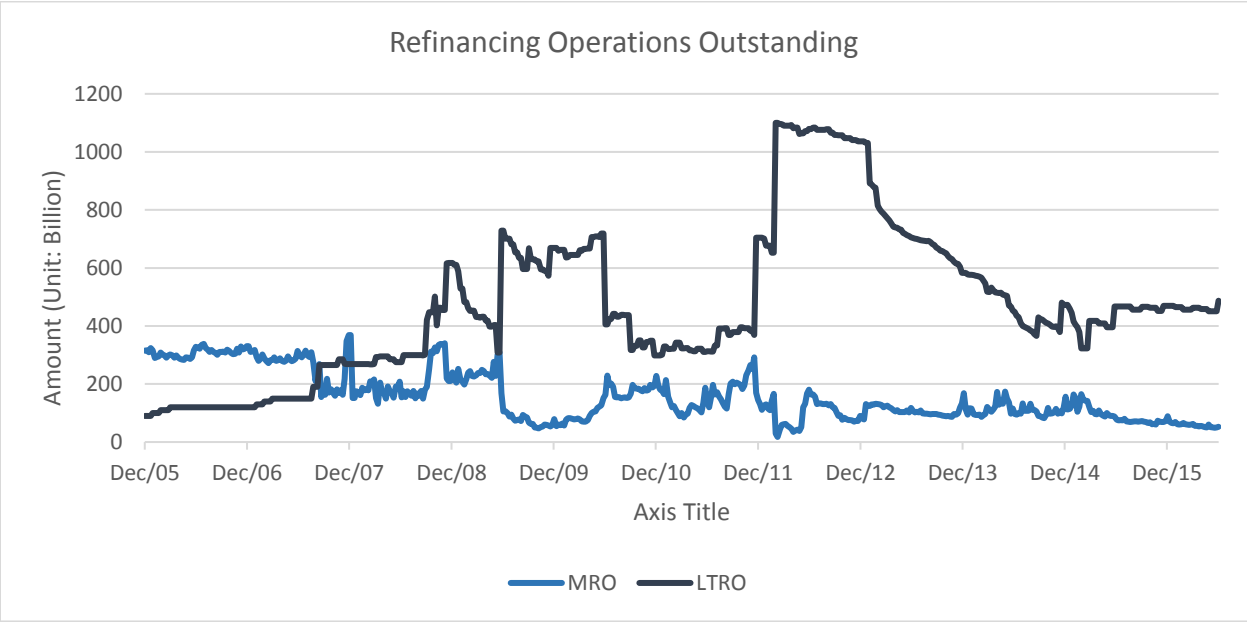

Figure A. The weekly outstanding change of MRO and LTRO between 2006 and 2016

		LTRO(EUR, Bn)	Inflation (Percantage)	Government Deficit(percentage)	Unemployment
Overall Period	Mean	471.43	1.57	-0.031	9948579
	St.dev	471.43	1.16	0.018	1538173
	Min	90.02	-0.7	-0.066	7240000
	Max	1100.08	4.1	0	1.21E+07
Sovereign debt Crisis Period	Mean	474.08	1.64	0	9809480
	St.dev	142.17	1.11	-0.14	726360.2
	Min	298.22	-0.7	-0.066	7650000
	Max	728.6	3.6	-0.015	1.07E+07
Financial Crisis Period	Mean	342.96	2.66	-0.01	7813297
	St.dev	116.89	1.09	0.013	683263.5
	Min	150	0.6	-0.042	7240000
	Max	616.92	4.1	0	9470000

Table A. Statistics summary of LTRO outstanding, Inflation rate, Government Deficit ratio, and unemployment rate.

		General					Debt Crisis				
AIC	LTRO (GB)	VAR(1)	VAR(2)	VAR(3)	VAR(4)	VAR(5)	VAR(1)	VAR(2)	VAR(3)	VAR(4)	VAR(5)
	Austria	-4.471	-23.719	-23.747*	-23.742	-23.737	-8.586	-25.5474	-25.484	-25.448	-25.557*
	Belgium	-4.563	-23.171	-23.193*	-23.162	-23.175	-8.715	-24.813*	-24.771	-24.715	-24.795
	France	-5.170	-23.982	-24.001*	-23.993	-23.969	-9.214	-26.021*	-25.955	-25.914	-25.942
	Germany	-5.278	-24.236	-24.261*	-24.258	-24.240	-9.4248	-26.563*	-26.498	-26.436	-26.400
	Netherlands	-5.560	-24.168	-24.195*	-24.181	-24.144	-9.311	-26.380*	-26.312	-26.253	-26.215
	Italy	-6.381	-22.639	-22.663*	-22.631	-22.591	-7.891	-24.160*	-24.119	-24.058	-24.023
	Spain	-6.141	-22.362	-22.397*	-22.384	-22.338	-7.792	-23.837*	-23.807	-23.769	-23.723
	Portugal	-3.620	-20.37	-20.374*	-20.369	-20.336	-5.307	-21.792*	-21.754	-21.731	-21.698
HQIC	Austria	-4.459	-23.658*	-23.636	-23.581	-23.527	-8.569	-25.460*	-25.327	-25.221	-25.26
	Belgium	-4.551	-23.109*	-23.082	-23.001	-22.965	-8.698	-24.726*	-24.614	-24.489	-24.498
	France	-5.158	-23.92*	-23.894	-23.833	-23.759	-9.197	-25.934*	-25.798	-25.687	-25.645
	Germany	-5.265	-24.174*	-24.150	-24.097	-24.03	-9.407	-26.476*	-26.340	-26.209	-26.103
	Netherlands	-5.548	-24.106*	-24.084	-24.020	-23.934	-9.294	-26.292*	-26.155	-26.025	-25.918
	Italy	-6.369	-22.578*	-22.552	-22.471	-22.381	-7.8731	-24.073*	-23.962	-23.831	-23.726
	Spain	-6.129	-22.299*	-22.286	-22.223	-22.128	-7.774	-23.750*	-23.650	-23.542	-23.426
	Portugal	-3.608	-20.308*	-20.263	-20.209	-20.126	-5.289	-21.704*	-21.596	-21.503	-21.401
SBIC	Austria	-4.439	-23.562*	-23.463	-23.331	-23.200	-8.542	-25.328*	-25.089	-24.877	-24.811
	Belgium	-4.532	-23.013*	-22.909	-22.751	-22.638	-8.671	-24.594*	-24.376	-24.145	-24.049
	France	-5.139	-23.824*	-23.721	-23.583	-23.432	-9.170	-25.802*	-25.560	-25.343	-25.196
	Germany	-5.246	-24.078*	-23.977	-23.847	-23.703	-9.381	-26.343*	-26.103	-25.866	-25.654
	Netherlands	-5.528	-24.010*	-23.911	-23.770	-23.607	-9.267	-26.160*	-25.917	-25.682	-25.469
	Italy	-6.349	-22.481*	-22.379	-22.221	-22.054	-7.847	-23.941*	-23.723	-23.488	-23.277
	Spain	-6.110	-22.204*	-22.113	-21.973	-21.801	-7.748	-23.618*	-23.412	-23.199	-22.977
	Portugal	-3.589	-20.212*	-20.090	-19.959	-19.799	-5.263	-21.572*	-21.359	-21.160	-20.951
	EMU	-5.122	-23.553*	-23.468	-23.319	-23.155	-9.155	-25.261*	-25.042	-24.813	-24.621

Table B. Lag-Length Test result

		1 to 3-year government bonds			3-year government bonds			10-year government bonds		
		Financial Crisis	Sovereign Crisis	Overall Period	Financial Crisis	Sovereign Crisis	Overall Period	Financial Crisis	Sovereign Crisis	Overall Period
Germany	L1.	1.867	0.143	0.319	3.496	0.294	0.423	7.145	1.650	2.759
	L2.	-0.877	-0.165	-0.273	-1.570	-0.331	-0.428	-2.592	-1.219	-2.071
Belgium	L1.	1.090	-0.116	0.139	1.560	-0.172	-0.024	3.323	-0.930	1.409
	L2.	-0.520	0.421	-0.022	-0.726	0.561	0.429	-2.633	1.837	0.277
France	L1.	1.689	-0.002	0.229	2.857	-0.185	0.034	6.949	-2.231	-0.134
	L2.	-0.858	0.103	-0.154	-1.217	0.401	0.103	-2.677	2.393	1.181
Netherlands	L1.	1.614	0.091	0.258	1.754	0.215	0.274	5.885	0.704	1.990
	L2.	-0.834	-0.097	-0.209	-0.956	-0.134	-0.232	-3.501	-0.266	-1.169
Austria	L1.	1.185	0.006	0.150	1.652	-0.118	-0.001	6.151	-0.089	1.297
	L2.	-0.676	0.158	-0.093	-1.042	0.288	0.273	-4.311	0.564	-0.117
Italy	L1.	1.383	-0.287	0.061	1.489	-0.721	-0.401	1.446	-0.153	1.278
	L2.	-0.723	0.087	0.069	-0.789	0.275	0.532	-1.924	-0.560	-0.440
Spain	L1.	1.812	0.000	0.181	2.330	-0.147	0.371	6.555	2.034	4.346
	L2.	-1.149	-0.777	-0.252	-1.614	-2.264	-1.370	-5.570	-8.798	-5.654
Ireland	L1.	1.852	-0.839	0.192	6.857	-2.735	-1.348	4.011	-3.469	-0.060
	L2.	1.949	1.020	0.271	-4.190	2.792	2.514	-5.264	3.376	1.688
Portugal	L1.	1.316	-0.849	0.112	1.439	-0.523	0.330	6.455	-2.314	-1.493
	L2.	-0.680	1.329	0.442	-0.602	1.432	1.395	-4.630	2.008	2.866

Table C. Coefficient estimation of the shock to government bond price

Note: LTRO rescales to EUR Trillion