3. LIQUIDITY SHOCKS TRANSMISSION TO LENDING ACTIVITY IN THE ROMANIAN BANKING SYSTEM. A VAR APPROACH

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Abstract

The Romanian banking system has been dominated by foreign-owned banks since 2007, when the country joined the European Union. The implications for financial stability are twofold. First, the cross-border financial groups brought strong expertise in risk management and improved access to funding. Second, the vulnerability to external shocks increases, which off-set to some extent the aforementioned benefits. The global liquidity shock triggered by the Lehman Brothers failure in September 2008 and the following global turmoil had strong impact on the Romanian banking system. This study aims to determine the influence of the external liquidity shock to domestic lending activity using a VAR model. The empirical results underline the external funding as a transmission channel for external liquidity shock to credit activity in Romania.

Keywords: bank funding, lending, contagion, financial stability, risk management

JEL Classification:G21, G32, G01

1. Introduction

Liquidity risk in the banking sector, such as bank run or slump in assets liquidity, tends to be correlated with extreme events on financial markets. In normal times, variations in bank resources are low and financial market liquidity remain stable, therefore banks are stimulated to search for yield by lowering liquidity risk management. A weak liquidity position occurs when a liquidity shock emerges and put banks at risk of default in a short period of time, no matter how strong their capital base is.

In Romania, following the EU ascension and a strong expansion in European financial intermediation prior to 2008, banks entered a competition for market share. Consequently, lending increased at the cost of low investments in liquid assets, whereas the excess credit was financed through short-term liabilities. Moreover, the majority of Romanian banks were owned by European financial groups and the funding from parent

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banks was mostly denominated in foreign currency. When the global financial crisis hit in 2008, liquidity risk emerged as a major one for the Romanian banking system because the parent banks become reluctant to provide more funding to their foreign subsidiaries, while the holdings of liquid assets were insufficient to offset a funding withdraw. In addition, the Romanian banks external liabilities were denominated in foreign currency, making even more difficult for the banks to reimburse the funds with no severe consequences on their balance sheets.

This study offers a perspective on the external liquidity shock transmission to the Romanian banking sector, using a vector auto regression approach. The features of the funding structure of the Romanian banking system have strong implications for banks' response to liquidity shocks.

2. Literature Review

There is a broad literature on the banking system liquidity risk and the research accelerated since the global financial crisis inception in 2008. The systemic implications of banking liquidity are particularly highlighted by recent studies and emphasize the significant role of liquidity in preserving financial stability.

Cetorelli and Goldberg (2012), Aiyar (2011), Pokutta and Schmaltz (2011), Haas and Lelyveld (2010) and Dinger (2009) provide a cross-border approach to assessing liquidity risk within financial groups. Their studies focus on global financial groups as a source of cross border contagion and are related to the 2008-2009 global financial crisis and its negative implications that are still present in the financial system. Aiyar (2011) observed the impact of external liquidity shock on lending in the UK. The foreign banks had strong funding connections with other financial institutions located abroad, usually their parent banks, and reacted more severely when the external liquidity shock occurred, compare to the local banks. Even if the foreign banks in the UK owned external assets in 2008 that could be liquidated in order to accommodate the external funding withdrawals, foreign banks preferred to cut domestic lending. Consequently, the strong presence of foreign banks contributed to a significant decline in lending activity in the UK since 2008 following the global liquidity turmoil.

Adrian and Brunnermeier (2011) provide a systemic perspective on liquidity risk in the financial system. The authors determined the systemic importance of the financial institution using data from their balance-sheets and financial markets. They built a model where liquidity is highly important and has strong impact on the overall assessment regarding the systemic importance.

Other studies on the 2008-2009 global financial crisis were elaborated by Chudik and Fratzscher (2012), Ivashina and Scharfstein (2010) and Mannasoo and Mazes (2009). Ivashina and Scharfstein (2010) observed that non-financial companies opened the credit lines after the liquidity shock because the access to credit was restricted. Mannasoo and Mazes (2009) favor a comprehensive analysis of liquidity risk in the financial system that should take into account the macroeconomic environment and the structure of the financial system, besides the financial institution financial reports.

Hoggarth *et al*. (2005) applied a stress test methodology using a VAR model to determine the dynamics between the macroeconomic environment and bank assets

quality. They used data from the UK banking system and observed that an economic downturn does have a strong influence on bank assets quality.

3. Data

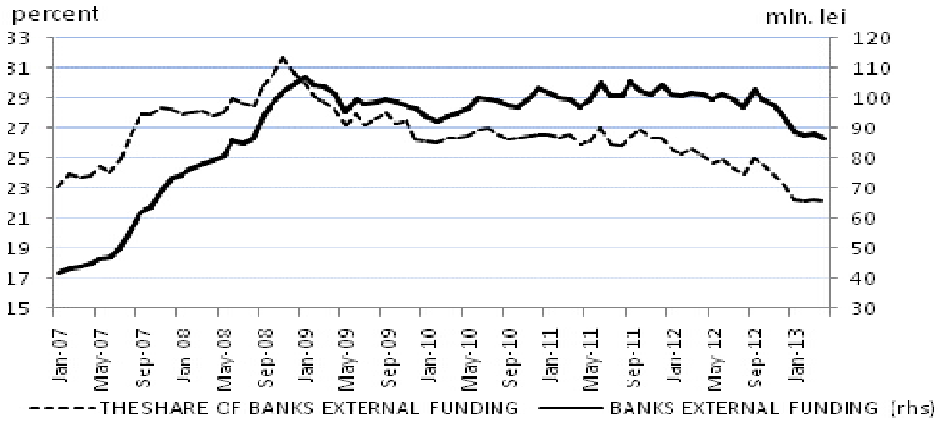
The dataset covers the period between January 2007 and April 2013. We choose January 2007 as the starting point because of several factors. First, Romania joined the European Union in 2007 and the statistical methodologies were harmonized to European standards; therefore, going before 2007 will affect data homogeneity. Second, the Romanian banking system has experienced structural changes in the late years, a massive privatization process and a global financial crisis that caused significant losses. In this respect, a time series which starts before 2007 is subject to consistency problems.

We collected data on banks' external liabilities, banks' total assets and liabilities, lending activity (including breakdown by type of debtor), exchange rate developments, key interest rates on money market, interbank market activity and bank holdings of liquid assets, mainly government bonds. Data frequency is monthly for balance-sheet items and daily for data concerning financial markets. All the data refer to the Romanian banking sector (aggregated) and Romanian financial markets. The data source is the website database of National Bank of Romania.

The external funding of the Romanian banking sector suffered a sudden stop and even a reversal after the 2008 – 2009 global financial crisis, as depicted in Figure 1.

Figure 1

External Funding of the Romanian Banking System



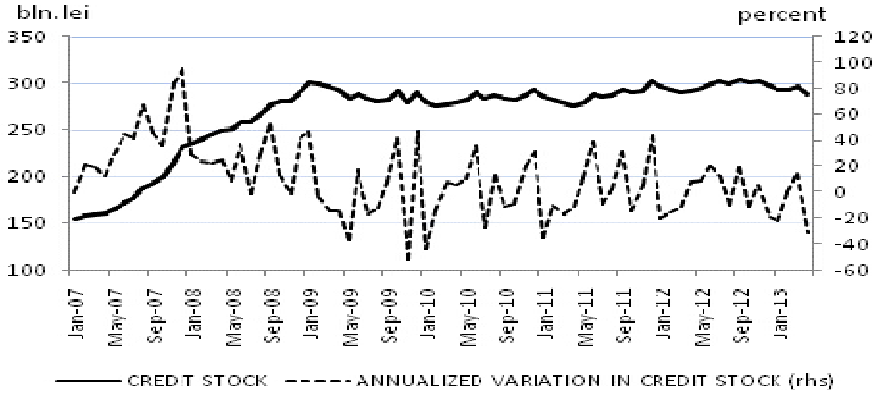
Source: The National Bank of Romania (NBR).

In relative terms, banks' funding through parent banks declined even more, but the overall banking system assets did not decrease. The explanation stands in increasing the domestic funding to offset the freeze in external inflows.

As a consequence of external funding constraints, banks cut lending to non-financial companies and households, starting in 2009 (Figure 2). Further, we want to assess the liquidity component of lending activity, besides credit risk, and to model external liquidity shock transmission to bank lending.

Figure 2

Developments in Credit Stock in the Romanian Banking Sector



Source: NBR.

4. The Model

We build the vector auto regression model based on Luetkepohl (2011) methodology. The author presents in detail the vector autoregressive models, including the types of VAR processes and estimation of VAR models. In addition, we consider some applied facts from the study elaborated by Hoggarth *et al*. (2005).

$$x_t = c + A_1 x_{t-1} + A_2 x_{t-2} + \cdots + A_p x_{t-p} + u_t \; x_t \; c \;\; A_i \; u_t \; A(L)$$

$$A(L) = I_k - A_1 L - A_2 L^2 - \square - A_p L^p \; A(L) x_t = u_t$$

$$\det[\![A(z) = \det(I_k - A_1 z - A_2 z^2 - \cdots -]\!] \; A_p z^p) \neq 0 \text{ for } z \in \mathbf{C}, |z| \leq 1 \; .$$

Following the theoretical background developed by Luetkepohl (2011), we consider a VAR (p) process with 5 endogenous variables:

{CREDIT, SECURITIES, ROBOR3M, EXCHANGE_RATE, EXT_FUNDING}

where: CREDIT refers to the total credit stock in banks' balance-sheet, but also contains other four credit sub-components: COMP_CREDIT, HH_CREDIT, RON_CREDIT and FX_CREDIT. COMP_CREDIT refers to credit granted to non-financial companies, HH_CREDIT is credit granted to households, whilst RON_CREDIT is the credit denominated in lei and FX_CREDIT is the credit denominated in foreign currency. Therefore, there are four VAR (p) processes, depending on which credit variable is considered. EXT_FUNDING refers to external funding of banking system, EXCHANGE_RATE is the EUR/RON exchange rate, ROBOR3M is the 3 month interest

rate on money market and SECURITIES counts for the banks holdings of liquid securities (mainly government bonds). See Appendix 1 for detailed information about the variables.

The variables' order was based on the pattern determined by the external liquidity shock, meaning that the variables are sorted in ascending order according to how fast they respond to external liquidity shocks. First, the information is transmitted through parent banks funding (EXT_FUNDING) and afterwards it transferred to financial markets (EXCAHNGE_RATE AND ROBOR3M) because the banks and other investors react to accommodate the new information. Second, the shock propagates from bank liabilities to bank assets side (SECURITIES and CREDIT) following the developments in financial markets. On the other hand, the variables that react to external liquidity shocks with lags (the first variables in row) immediately impact the next ones (the last variables in row). CREDIT is the first variable in row, while EXT_FUNDING is the last variable in row.

$$\Delta y_t = c + \alpha t + \beta y_{t-1} + \gamma_1 \Delta y_{t-1} + \gamma_2 \Delta y_{t-2} - \square - \gamma_p \Delta y_{t-p} + \varepsilon_t \quad (4)$$

$$y_t = c + \alpha t + k \sum_{i=1}^{t} \theta_i + \varepsilon_t \quad (5)$$

$$\theta_i \ \sigma_n^2 \ \varepsilon_t \sigma_i \varepsilon_t$$

In order to estimate the VAR(p) model, it is necessary to determine the optimal number of lags, i.e., the value of *p*. Braun and Mittnik (1993) demonstrated that estimated VAR models are inconsistent if the selected lag length is not the "true" one. In that case, the impulse response functions and the variance decompositions provide biased results. Moreover, Lutkepohl (1993) showed that VAR over-fitting (the lag length is higher than the optimal one) causes an increase in terms of forecast error, while under-fitting (the lag length is lower than the optimal one) leads to autocorrelation in terms of error. Detailed estimation techniques for lag length of VAR models are developed by Ozcicek (1997).

Several criteria are applied to determine the appropriate lag length for the VAR model. They are LR (sequential modified likelihood ratio), FPE (final prediction error), AIC (Akaike information criterion), SC (Schwarz information criterion) and HQ (Hannan – Quinn information criterion). The optimal lag is the one that minimizes the information criteria.

All the information criteria suggest that p=1 is the optimal lag length (see Appendix 4 for details). Therefore, the estimated model is going to be VAR(1) for all credit variables considered in the analysis. The absolute values of the roots for the characteristics AR polynomial are smaller than one (are inside the unit circle (see Appendix 5)), hence the VAR model is stationary.

5. The Estimation Results

The unrestricted VAR (1) model is estimated using the standard OLS (Ordinary Least Square) regression for the period January 2007 – April 2013. Following the estimation results, the VAR(1) model can be rewritten as in Table 1.

The exchange rate and liquid asset investments have the strongest influence on credit activity. When banks increase their holding of government bonds, credit lowers by one lag. This result is intuitive, taking into account that credit portfolio and government security holdings are the main bank asset classes. The exchange rate depreciation has a strong impact on lending as well, causing a decrease in credit with one lag. The result points out that there is a large share of FX loans in total credit portfolio. Impulse response functions are available in Appendix 6.

Table 1

The Estimated Coefficients of the VAR (1) Model

Variables	Constant	Matrix A				
		CREDIT	SECURI-TIES	ROBOR3M	EXCHAN-GE_RATE	EXT_FUN-DING
CREDIT	0.432	0.813	-0.010	0.001	-0.065	-0.021
	[2.568]	[10.204]	[-1.562]	[0.197]	[-2.319]	[-0.992]
SECURITIES	0.506	-0.394	0.948	0.134	0.435	-0.059
	[0.285]	[-0.468]	[13.769]	[2.018]	[1.453]	[-0.255]
ROBOR3M	-1.002	0.352	-0.167	0.710	0.710	0.217
	[-0.579]	[0.430]	[-2.501]	[10.971]	[2.436]	[0.964]
EXCHANGE_RATE	0.435	-0.282	-0.010	-0.001	0.875	0.132
	[1.204]	[-1.648]	[-0.750]	[-0.058]	[14.350]	[2.802]
EXT_FUNDING	1.042	-0.440	-0.028	0.009	-0.185	0.946
	[2.834]	[-2.523]	[-2.002]	[0.688]	[-2.988]	[19.658]

Source: Author's calculations

Even if both banks external funding and credit portfolio decreased in relative terms after the Lehman Brothers' failure, the VAR (1) model detects a negative relation between the two variables. A decrease in external funding causes an increase in credit portfolio by one lag. This can be explained by the fact that around half of the credit granted by banks is denominated in local currency, while the external funding is almost entirely denominated in foreign currency. Another explanation can be that, following the external funding shock, banks accommodated the lower foreign resources and increased funding from domestic sources. To test this hypothesis, the VAR model is re-estimated for different time periods and credit subcomponents.

The sample period consists of 3 parts: (i) 2007 – 2008, a period with high growth rates for external funding and lending activity, (ii) 2009 – 2010, a crisis period on global and domestic financial markets, when external funding trend reversed, while lending activity froze, and (iii) 2011 – 2013 (April), when the banks adapted to adverse external funding conditions and oriented to domestic financial resources to sustain the credit growth.

The VAR estimation results for all the three periods, for the total credit and its sub-components as well, reveal a strong influence of external funding on lending activity. An

increase in external funding in the pre-crisis period (2007-2008) determined a larger credit portfolio by one lag, while an external funding reversal in the crisis period (2009-2010) caused an abrupt decrease in lending activity by one lag. After the crisis (2011-2013, April), banks partially accommodated the scarcity of foreign resources with internal funding. These findings emphasize the significant implication of external liquidity shocks during financial crisis. The impact is stronger during crisis if compared to the lending boom period.

Credit granted to households is more sensitive to external funding conditions, compared to credit to non-financial companies. The latter is more stable and highly correlated with the economic cycle, whereas credit to households increases significantly at the end of the upward trend of the economic cycle and decreases abruptly when economy slows down or enter recession. Credit denominated in lei is clearly undermined by the strong external inflows. This developments are posing medium and long-term risk to financial stability because credit risk rises more for FX loans than loans denominated in lei when the economic activity decreases and exchange rate depreciates.

6. Robustness Check

The VAR (1) estimation provide results in line with the model hypothesis. A shock to external liquidity influences lending in Romania due to the strong linkages between the domestic banking system and the European one. By splitting the sample period into three sub-periods, the model proves stable, while pointing out the banking system response to strong external inflows, sudden stop and funds reversal, as well as banks adjustment process in liquidity management following the shock.

An additional variable is inserted into the VAR model in order to enhance the robustness testing. INTERBANK_DEP measures the transactions on interbank market, i.e., the volume of new interbank deposits (see Appendix 1 for details). INTERBANK_DEP is considered in the model between short-term interest rate and bank holdings of liquid securities (government bonds). An increase (decrease) in short-term interest rate signals lower (higher) liquidity in the banking system. Consequently, banks will decrease (expand) their activity on interbank deposits market and will raise (lower) holdings of liquid assets.

Table 2

The Estimated Coefficients of the Extended VAR (1) Model

Variables	Constant	Matrix A					
		CREDIT	SECURI-TIES	INTERBANK_DEP	ROBOR3M	EXCHANGE_RATE	EXT_FUNDING
CREDIT	0.454	0.796	-0.009	0.008	0.003	-0.078	-0.030
	[2.722]	[10.008]	[-1.424]	[1.604]	[0.560]	[-2.694]	[-1.374]
SECURITIES	0.145	-0.114	0.932	-0.140	0.096	0.642	0.087
	[0.084]	[-0.140]	[14.004]	[-2.535]	[1.461]	[2.144]	[0.380]
INTER-BANK_DEP	-2.913	1.724	0.009	0.372	-0.238	0.505	1.111
	[-0.867]	[1.076]	[0.073]	[3.445]	[-1.848]	[0.861]	[2.456]
ROBOR3M	-0.743	0.152	-0.156	0.100	0.737	0.562	0.112
	[-0.435]	[0.187]	[-2.363]	[1.827]	[11.278]	[1.884]	[0.489]
	0.401	-0.256	-0.012	-0.013	-0.004	0.895	0.146

Variables	Constant	Matrix A					
		CREDIT	SECURI-TIES	INTERBANK_DEP	ROBOR3M	EXCHANGE_RATE	EXT_FUNDING
EXCHANGE_RATE	[1.108]	[-1.484]	[-0.853]	[-1.128]	[-0.315]	[14.141]	[3.001]
EXT_FUN-DING	1.020	-0.423	-0.029	-0.008	0.007	-0.172	0.955
	[2.755]	[-2.395]	[-2.052]	[-0.712]	[0.504]	[-2.670]	[19.136]

Source: Author's calculations

Following the extended VAR (1) estimation, the model can be rewritten as in Table 2. The VAR model is robust, as the influence of external funding on lending is not affected by the interbank deposits. There is a direct relationship between the interbank deposits and external funding, while the interbank deposits have low influence on credit activity. The estimation results of the extended VAR for all the three periods confirm the model robustness.

7. Variance Decomposition

The variance decomposition allows for innovations in endogenous variables that can be decomposed into the component shocks of the VAR. Thus, we can detect how much of the random innovations (forecast error variance) in credit developments can be explained by exogenous shocks to external funding and other endogenous variables. The forecast horizons for variance decomposition of credit granted by banks are 5, 10 and 20 periods (months) ahead.

Table 3

Variance Decomposition for Total Credit (Percents)

Time period	Months ahead	CREDIT	SECURITIES	ROBOR3M	EXCHANGE_RATE	EXT_FUNDING
2007 – 2013, April	5	83.488	5.933	0.110	8.416	2.050
	10	63.490	8.925	0.121	16.312	11.150
	20	48.780	4.897	0.220	12.257	33.843
2007 – 2008	5	72.446	7.810	10.296	9.041	0.404
	10	55.422	6.644	20.841	12.274	4.816
	20	48.714	17.030	16.973	12.049	5.232
2009 – 2010	5	54.246	1.113	1.015	18.743	24.880
	10	50.983	1.135	1.079	18.295	28.507
	20	50.414	1.159	1.065	18.326	29.034
2011 – 2013, April	5	39.032	2.336	16.843	32.321	9.466
	10	32.160	2.820	15.911	30.258	18.848
	20	27.361	8.558	15.611	30.302	18.166

Source: Author's calculations

External funding explains many of the changes in lending activity (about 25 percent) during the global financial crisis of 2009-2010). In pre-crisis and post-crisis the results

are not that strong. Exchange rate seems to explain also a significant share of credit variation and the stronger influence in crisis and post-crisis periods. In conclusion, external funding is a leading indicator for domestic lending activity during liquidity crisis, whereas it still has low to moderate influence in no crisis periods. The results for 10 or 20 months ahead for the three sub-period estimations should be interpreted cautiously because of the limited sample size.

External resources explain the variance of credit sub-components as well. External funding has high relative importance mainly for innovations in credit granted to non-financial companies and credit denominated in lei, when the entire sample period is considered. During liquidity crisis, credit denominated in both lei and foreign currencies are explained to a large extent by external funding.

8. Conclusions

The VAR model used detected a strong influence of developments in external liquidity on lending activity in Romania. The fact that global financial groups own a large share of the Romanian banking system, over 80% of total assets, implicitly raises questions regarding the banking system ability to absorb external shocks. The boom and bust credit cycle experienced by the Romanian banking system between 2007 and 2010 is directly related to the strong banks' reliance on external resources to fund their activities. Moreover, the external funding has implication for financial markets as well, like foreign exchange market or money market.

External funding of the Romanian banking system was volatile and accelerated close to the economic cycle peak, whereas it suffered a sudden stop and even trend reversal when the economy entered recession. Comparing the response to external liquidity shocks of credit to households and credit to non-financial companies, the model detected a higher sensitivity in case of credit to households. This finding can be explained by the fact that the credit to households usually lags behind the economic activity when the economy is expanding, while credit to non-financial companies is more stable along the economic cycle.

The results underline the high sensitivity of the Romanian banking system to external liquidity shocks. Before the crisis, external funding acted as a stabilizing mechanism for the Romanian banking system because usually developed financial markets are much more stable if compared to emerging ones. But the global financial crisis highlights the necessity for banks to properly assess the external liquidity risks and take measures to mitigate that risk.

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Appendices

Appendix 1. The variables used in the VAR model

Table 4

The Variables Descriptions

ID	Name	Frequency	Source
CREDIT	The log share of total credit in bank assets	Monthly	National Bank of Romania (NBR) website
COMP_CREDIT	The log share of credit to non-financial companies in bank assets	Monthly	NBR website
HH_CREDIT	The log share of credit to households in bank assets	Monthly	NBR website
RON_CREDIT	The log share of credit denominated in lei in bank assets	Monthly	NBR website
FX_CREDIT	The log share of credit denominated in foreign currency in bank assets	Monthly	NBR website
SECURITIES	The log share bank holdings of liquid securities in total assets	Monthly	NBR website
INTERBANK_DEP	The log new interbank deposits (transactions)	Monthly	NBR website
ROBOR3M	The log short term interest rate (ROBOR3M)	Daily	NBR website
EXCHANGE_RATE	The log EUR/RON exchange rate	Daily	NBR website
EXT_FUNDING	The log banks external funding in total assets	Monthly	NBR website

Source: Author's calculations

Appendix 2.ADF Results for the Variables (t-Statistic)

Variable	None	Intercept	Trend and intercept
CREDIT	-1.698	-0.482	-1.878
COMP_CREDIT	0.591	-2.134	-2.124
HH_CREDIT	1.117	-3.832	-4.841
SECURITIES	0.271	-0.838	-2.820
ROBOR3M	-0.737	-0.860	-1.968
EXCHANGE_RATE	1.212	-1.512	-1.411
EXT_FUNDING	-0.233	-0.851	-2.493

Source: Author's calculations

Appendix 3. KPSS Results for the Variables (KPSS Test Statistic)

Variable	Intercept	Trend and intercept
CREDIT	1.083	0.163
COMP_CREDIT	0.266	0.232
HH_CREDIT	0.243	0.189
SECURITIES	0.976	0.121
ROBOR3M	0.705	0.152
EXCHANGE_RATE	0.959	0.222
EXT_FUNDING	0.488	0.199

Source: Author's calculations

Appendix 4. VAR Lag Order Selection Criteria

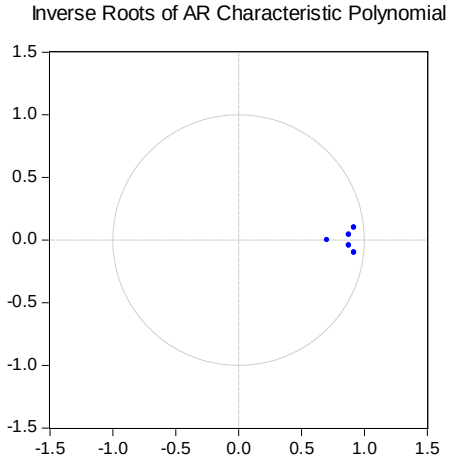
Lag	LR	FPE	AIC	SC	HQ
0	NA	5.37E-15	-18.669	-18.511	-18.606
1	748.001*	1.29e-19*	-29.308*	-28.359*	-28.930*
2	28.784	1.63E-19	-29.085	-27.346	-28.393
3	23.180	2.21E-19	-28.805	-26.275	-27.798
4	21.906	3.02E-19	-28.540	-25.220	-27.218

Source: Author's calculations
Note: "*" indicates the selected lag for each criterion

LR: sequential modified LR test statistic (each test at 5% level), FPE: Final prediction

error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan- Quinn information criterion

Appendix 5. Impulse Response Functions



Appendix 6. Impulse Response Functions