National Bank of the Republic of Macedonia
Monetary Policy and Research Department

Research paper
2015

Transmission of external shocks in assessing debt sustainability, the case of Macedonia

Danica Unevska Andonova*
Dijana Janevska Stefanova*

Abstract

In the analysis of public and external debt sustainability the National Bank of the Republic of Macedonia is actively using the IMF's Debt Sustainability Analysis (DSA) framework. The aim of our analysis is to improve the analytical power of the IMF's DSA framework, in the case of Macedonia. This paper uses simple framework, based on methodology used in Adler and Sosa (2013), that integrates econometric estimates of the effect of global factors on key domestic variables that determine public and external debt dynamics, within the IMF's standard debt sustainability framework. VAR estimation is used in obtaining the forecasts of key domestic variables, conditional on a set of assumed global variables under different global shock scenarios. The results in general suggest that under all shock scenarios, there is negative effect to domestic GDP, however in the case of current account there is negative effect in the beginning of the period of applied shocks, but positive in the later period. Consequently, the expected effect to public debt sustainability is negative for the whole period due to lower real GDP growth. However, regarding external debt sustainability, negative effect is expected in the first year or two due to lower GDP growth and higher current account deficit, yet, in a medium run, external sustainability might not be jeopardized as the lower GDP growth might be neutralized by the lower current account deficit.

Key words: public debt, external debt, debt sustainability, Macedonia
JEL classification: C32, E60, F42, F47

*E-mails: UnevskaD@nbrm.mk, JanevskaD@nbrm.mk. The views expressed in this paper are those of the authors and do not necessarily represent those of NBRM.
The draft version was presented on 8th South-Eastern European Economic Research Workshop "Global Banks and International Shock Transmission", organized by Bank of Albania in Tirana and we would like to thank to the discussant Mustafa Kılınç for his valuable comments. The authors would also like to thank to NBRM staff: Ana Mitreska, Sultanija Bojceva Terzijan and Aneta Krstevska for their comments.

Introduction

Given the high global economic and financial uncertainty, assessing a country's external and fiscal sustainability is of great significance. The need for this type of assessment is all the more crucial, when it refers to a small and open economy, with a fixed exchange rate regime, such as Macedonia. A sustainable debt level does not solely depend on the debt in nominal terms, but on successful implementation of policies boosting economic growth and sound debt management, as well. In this broad context, the fiscal policies are of great importance, because sound debt management can only be achieved through prudent fiscal framework. At the same time, implementing more efficient macro-policies and structural reforms will result in improved investment climate and acceleration of growth that would be less dependent on official long term financing.

In the run up to the global financial crisis in 2008, Macedonia experienced strengthening of the key macroeconomic fundamentals. Favorable external conditions, as well as accelerating domestic demand translated into lower level of gross external and government debt, accumulation of foreign reserves and balanced fiscal policy. However, the effects of the global crisis in the Macedonian economy became stronger at the end of 2008 and continued during the first half of 2009, with strong negative impact on the external trade at the beginning and on financial inflows from abroad. Given the fall in trade and financial borrowing constraints to the domestic agents, domestic absorption also decreased significantly during 2009. In such conditions, the government fiscal stimulus created a significant support to the economy throughout crisis years, which however increased the total external debt as well as public debt.

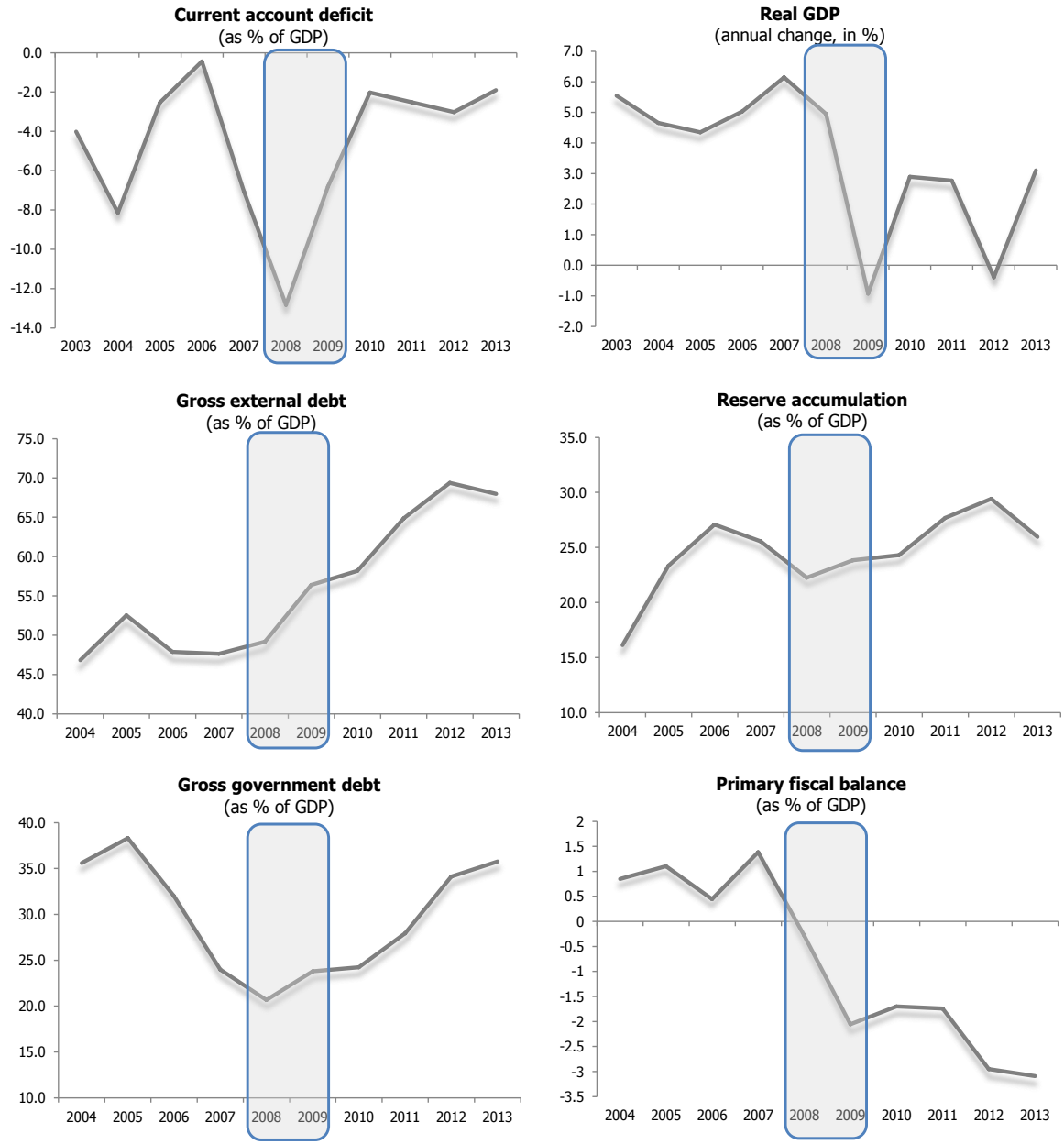
In the analysis of public and external debt sustainability the National Bank of the Republic of Macedonia is actively using the IMF's DSA framework. The framework for public debt sustainability analysis for advanced and emerging market economies was recently reformed by IMF and the new framework is more risk-based approach. However, the external debt framework was not changed. Albeit, there are stress test scenarios with individual shocks on key parameters, still the shocks are isolated and do not include feedback from other domestic variables. Additionally, the current framework does not analyze the effect of external shocks on debt dynamics. Taking into account the drawbacks of the current framework, the aim of our analysis is to improve the analytical power of the IMF's DSA framework, in the case of Macedonia.

The rest of this analysis is organized as follows: In the first part, stylized facts regarding the historical view at the dynamics and structure of public and external debt over the last decade are given. Additionally, analysis of the factors that drive the public and external debt dynamics, given the decomposition offered by the IMF's DSA framework is shown, including analysis in two sub-periods, before and after the global crisis. In the second part, a short literature review is elaborated, and the empirical methodology is explained. The data and the results of our findings are given in the third part, and the last part presents the conclusions.

I. Stylized facts

In this part historical view at the dynamics and structure of external and public debt over the last decade will be given, as well as the drivers of external and public debt dynamics, relying on the (accounting) decomposition offered by the IMF's DSA framework.

Figure 1
Key macroeconomic indicators



*Gross government debt refers to central government plus public funds debt.
Source: NBRM, MoF, SSO.

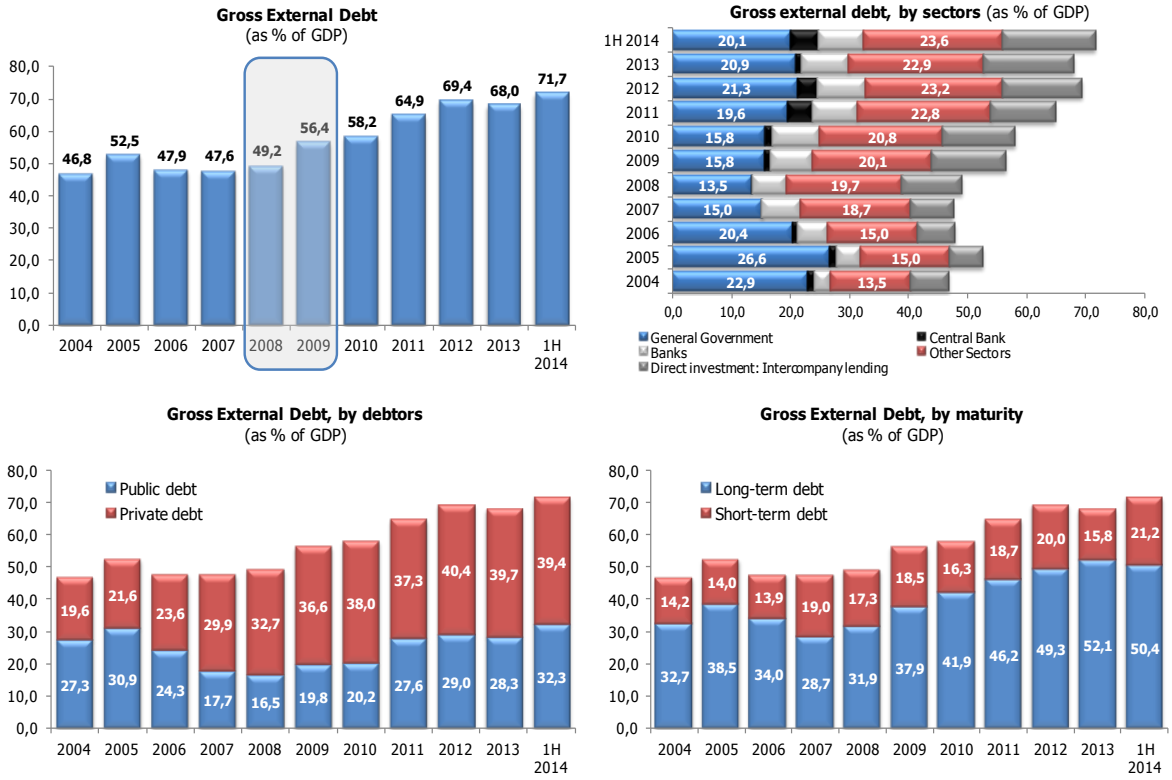
A. External Debt

A.1. External debt dynamics and structure

In the past decade, the gross external debt path[1], registered a general upward trend, reaching its historically highest level, of 71.7% of GDP, by the end of the first half of 2014. In the analyzed period, with the exception of the large government prepayments in 2006 and 2007, the external debt increased by around 3.7 p.p. on average, per year.

[1] The data on the overall gross external debt (including repo-transactions) used in the paper are as of 30.06.2014, compiled according to BPM5 methodology. The data on GDP refer to the NBRM April macroprojections for 2014.

Figure 2
Gross external debt, path and structure



Source: NBRM.

The current *debt structure* shows that ***private external debt*** (39.4% of GDP, as of 30.06.2014), represents approximately 55% share of the overall debt. Further liberalization of the capital and financial account, improvement in the credit rating of the country and higher availability of the capital on the foreign market for domestic agents contributed to an increase of the borrowings from abroad. Compared to 2004, the foreign private debt significantly expanded by around 20 p.p. of GDP. For the most part, debt growth was driven by inter-company debt linked to the FDI inflows stemming from the activity of new and existing foreign investors, which are generally considered less risky compared to financial loans. During the same period, large changes were also seen in the external debt of the non-banking corporate sector, with large part of the increase coming from long term loans and trade credits. The foreign indebtedness of the banking system also increased, although at a relatively slower pace, reflecting the financing structure of the credit activities, where domestic sources are dominant. On the other hand, the ***public external debt*** (32.3% of GDP, as of 30.06.2014), had a 45% share of the total debt structure. Foreign public debt also grew, albeit at a more moderate pace, by 5 p.p. of GDP, compared to 2004. The public debt dynamics varied throughout the period. After the major government prepayments in 2006 and 2007, in terms of favorable domestic and external conditions, the level of foreign public debt reduced to 16.5% of GDP, and then almost doubled by 2014. The major spikes in the following years represent the large borrowings of the government, with the sole purpose of supporting the economy through crisis years (second Eurobond issuance in 2009 and IMF Precautionary Credit Line in 2011)[2].

[2] Another major credit (Deutche Bank loan) was reported in 2013; however it did not impact the level of public debt, since it was used to pay off the second issued Eurobond.

As far as maturity is concerned, the long term debt (50.4% of GDP, as of 30.06.2014) represents around 70% share of the total debt. Dynamically, the long term debt enlarged by 17.8 p.p. of GDP, compared to 2004, or by approximately 2 p.p. on average. Largest part of the overall borrowing in the long run belongs to the government, the corporate sector and intercompany lending. The short term debt, which is considered more risky flows, imposing rollover risks, stands at 21.2% of GDP, which compared to 2004 is a moderate increase of 7.1 p.p. of GDP. Almost half of the debt in short run refers to the trade credits of the corporate sector, whereas other important parts are the short term intercompany lending and the central bank's repo transactions.

A.2. External sustainability

Given the high global economic and financial uncertainty, assessing a country's external sustainability is of great significance. The need for this type of assessment is all the more crucial, when it refers to a small and open economy, with a fixed exchange rate regime, such as Macedonia. The standard external indebtedness indicators demonstrate that gross external debt level of the Macedonian economy is generally considered to be in "safe" zone. An additional argument for this statement can be found in the gross debt structure which predominantly consists of intercompany debt and trade credits, generally considered less risky than financial loans. The solvency indicators show that, almost all of the indicators (interest payments, gross debt and debt servicing relative to export of goods and services, individually) put our country in the group of lower indebted countries, with the exception of the share of the gross debt to GDP, according to which Macedonia is a highly indebted country. The liquidity indicators point to a favorable external position, with near total coverage of the short term external debt with residual maturity with foreign reserves.

Table 1
Regular external indebtedness indicators

	Solvency				***Liquidity***		
	Interest payments/ Export of goods and services and other inflows	Gross debt/ Export of goods and services and other inflows	Gross debt/ GDP	Debt servicing/ Export of goods and services and other inflows	Foreign reserves/ Short-term debt	Foreign reserves/ Short-term debt, with residual maturity	Short-term debt/ Overall debt
	in %				ratio	ratio	in %
31.12.2004	2,41	129,3	49,3	12,4	1,14	0,89	30,3
31.12.2005	2,66	147,0	56,3	11,06	1,67	1,04	26,7
31.12.2006	3,44	131,3	51,8	21,7	1,95	1,34	29,0
31.12.2007	2,78	119,3	53,2	19,4	1,35	1,08	39,8
31.12.2008	2,66	116,9	55,3	10,2	1,29	0,95	35,2
31.12.2009	2,43	131,0	58,5	11,8	1,29	0,94	32,9
31.12.2010	3,22	140,4	60,1	13,9	1,49	0,99	27,9
31.12.2011	3,12	148,4	65,2	16,8	1,78	1,18	25,2
31.12.2012	2,92	141,9	68,4	13,1	1,64	1,03	26,7
31.12.2013	2,51	137,6	69,3	15,8	1,64	1,08	23,3
30.06.2014	3,39	137,6	70,5	19,2	1,34	0,91	25,7
Moderate indebtedness criterion	*12 - 20%*	*165 - 275%*	*30 - 50%*	*18 - 30%*		*1,00*	

*The moderate indebtedness criterion is according to the World Bank's methodology of calculating indebtedness indicators, which implies 3-year moving averages of GDP and exports of goods and services in the calculation of the indicators. In compliance with "External debt statistics: Guide for compilers and users," published by the IMF.
**According to the "Greenspan-Guidotti rule", a country should maintain full coverage of short-term debt at remaining maturity with gross foreign reserves.
Source: Quarterly Report, October 2014, NBRM.

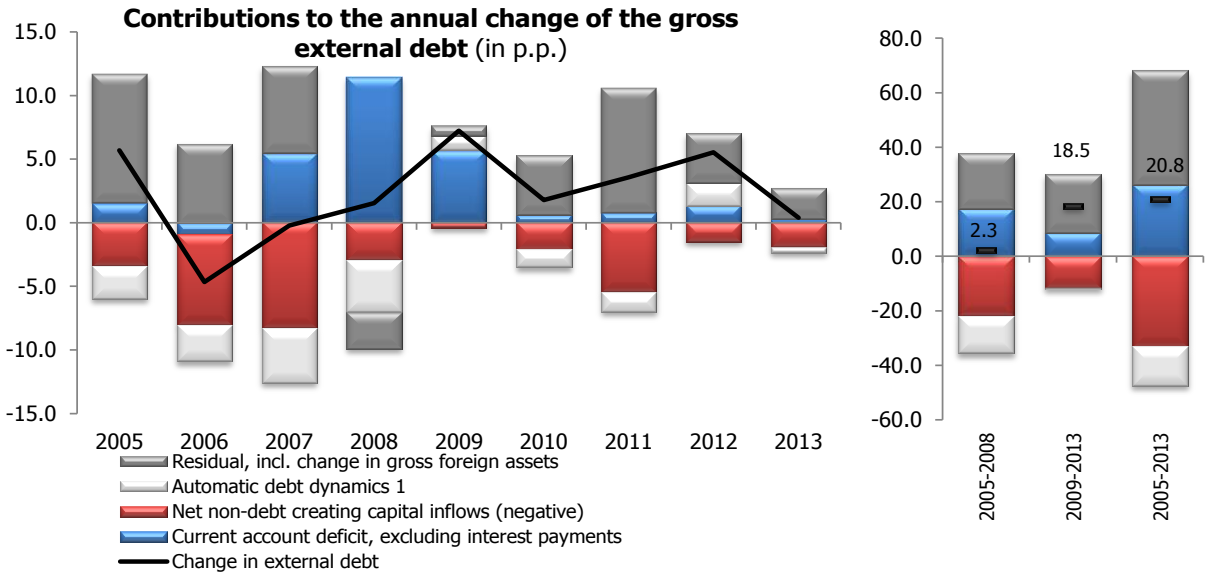
In order to enhance its analytical toolkit, NBRM introduced the IMF External sustainability framework, as well. The proposed framework for assessing external sustainability centers on the baseline medium-term projections for key balance of

payments variables, the stock of the gross external debt and main economic fundamentals (real GDP and interest rate). Beyond this baseline projection, the framework incorporates a standard set of sensitivity tests, examining the effects of alternative assumptions about the time paths of variables affecting the ability of debt servicing and the costs of financing. The external debt sustainability framework identifies three key sustainability factors: current external debt stock, external debt capacity repayment (closely linked to GDP growth) and the country's access to the international financial markets for additional external borrowing. Accordingly, a sustainable debt level does not solely depend on the debt in nominal terms, but on the successful implementation of policies boosting economic growth and sound debt management, as well. In this broad context, the fiscal policies are of great importance, because sound debt management can only be achieved through prudent fiscal framework. At the same time, implementing more efficient macro-policies and structural reforms will result in improved investment climate and acceleration of growth that would be less dependent on official long term financing.

The framework identifies the *following factors driving external debt dynamics*: 1) primary current account deficit (excluding interest payments); 2) non debt creating flows (FDI and portfolio investment, which could contribute for a lower external debt) 3) automatic debt dynamics. The automatic debt dynamics consists of: 1) contribution from nominal effective interest rate; 2) contribution from real GDP growth; 3) contribution from price and exchange rate changes.

In the run up to the global financial crisis, the 2005-2008 time frames, the external debt in Macedonia grew, by around 2.3 p.p. on cumulative basis. The higher debt level was determined by the primary current account deficit and the residual (including foreign reserves). This increase was largely neutralized by the soaring non-debt creating flows and the favorable international economic conditions and accelerating domestic growth (automatic debt dynamics). The post crisis period (2009-2013) recorded a much higher debt growth (18.5 p.p. on cumulative basis), from the usual growth determinants i.e. primary current account deficit and the residual, however this time round there were not nearly enough non-debt creating flows and the automatic debt dynamics to contribute to lower external debt.

Figure 3
Factors driving external debt, according to IMF's external sustainability framework



Source: NBRM.

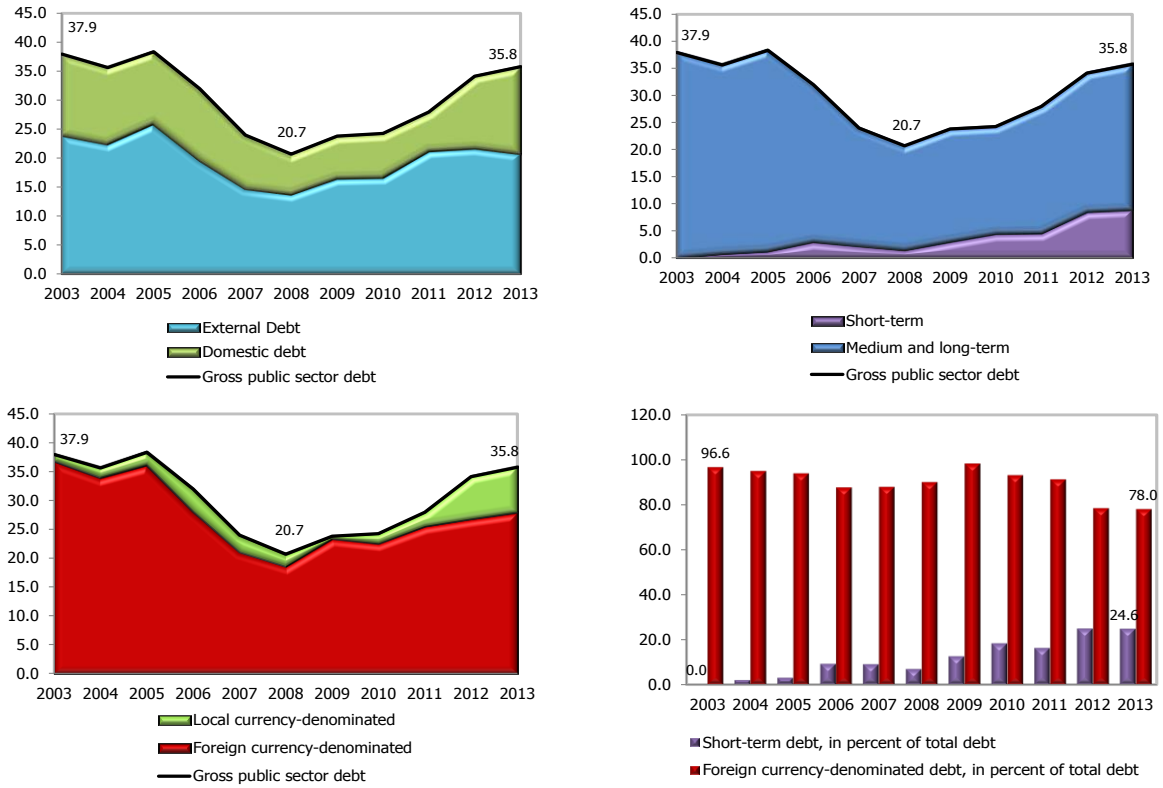
B. Public debt
B.1. Public debt dynamics and structure

The public debt in our analysis refers to consolidated debt of Central Government and Public Funds, on gross basis.

Public debt reached almost 36% of GDP in 2013 and it is the highest level in the last ten years. However, the dynamics of the debt is different before and after the crisis. Thus, in terms of favorable external and domestic economic conditions, the Government intention to improve the debt portfolio resulted in major government prepayments in 2006 and 2007[3]. Accordingly, the public debt recorded mostly decreasing path before the crisis and in 2008 it recorded the lowest level (20.7% of GDP). However, after the crisis an upward trend was noticed, mainly as a result of government borrowing from abroad in support of domestic economy during the crisis. Namely, considering the fall in external trade and financial borrowing constraints to the domestic agents, the external government borrowing (second Eurobond issuance in 2009 and IMF Precautionary Credit Line in 2011) helped in stabilization of the markets and in domestic absorption smoothing.

The debt structure reveals some of the vulnerabilities to the public debt sustainability: the increasing short term debt and high share of foreign currency denominated debt (Figure 4).

Figure 4
Public Debt structure
(% of GDP)



Source: Ministry of Finance and NBRM calculations.

[3] Early repayment of the total debt to the London Club of Creditors in 2006, and early repayment of a significant share of the foreign public debt in 2007 (full repayment of the debt to the World Bank - IBRD, the repayments of a share of the debt to the Paris Club of Creditors, full repayment of the debt to the International Monetary Fund and EIB).

The structure of public debt shows that external debt has a bigger share, 65% on average in the period 2004-2013. Domestically issued debt is smaller, but increases its share in the last two years and in 2013 it reached a share of over 42%. These developments in the domestic debt are result of the Government's intention to further develop the domestic securities market, and at the same time to meet the needs of the Pension funds for risk-free securities investments after the reforms in the pension system. However, the dynamics of domestic and external debts are very similar to those of total public debt, decreasing path before 2009 and increasing debt after crisis.

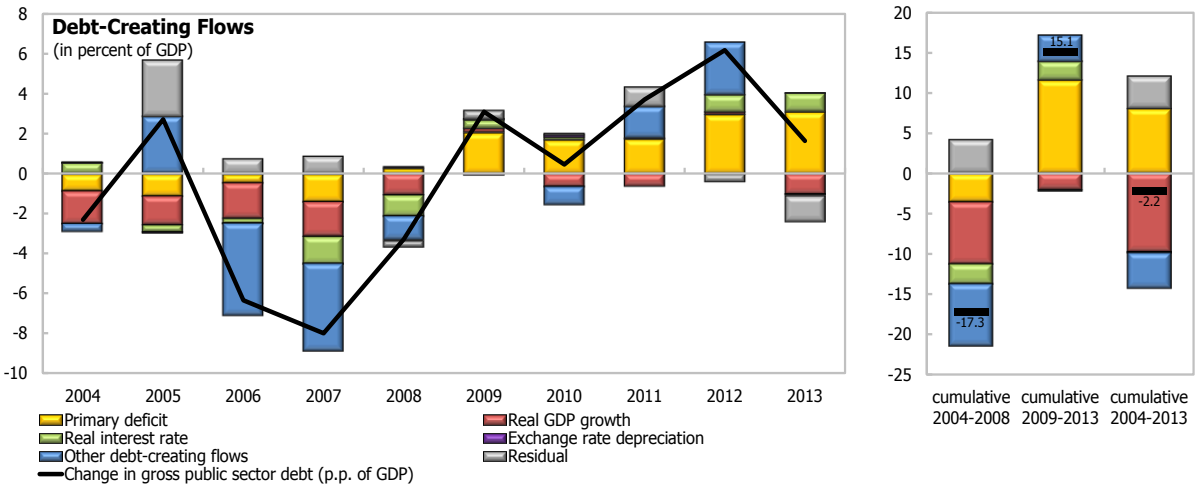
From maturity point of view, short term debt is small and its average share in the period 2004-2013 is 12% of the total debt and it is only domestically issued debt, which is on average 37% of the total domestic debt in the period 2004-2013. However, it is worryingly that the share of short term debt increases constantly during the analyzed period and at the end of 2013 it reached almost 25% of the total public debt (8.8% of GDP). The biggest rise in the short term debt occurred during and after the crisis, when the short-term securities were preferred, in terms of high uncertainty of domestic and external conditions and high risk aversion. The increasing share of short-term debt implies negative consequences to the gross financial needs and to the liquidity risk. The analysis of the dynamics shows that long-term debt decreases before the crisis (both domestic and external), but after the crisis it noticed a considerable rise in 2011 as a result of the increase in external debt, due to government borrowing from abroad in support of domestic economy during the crisis (second Eurobond issuance in 2009 and IMF Precautionary Credit Line in 2011).

The total public debt is mostly foreign denominated debt, and it is consisted of total external debt and more than 70% of domestic debt (on average in the period 2004-2013). In 2009, the Government decided to issue securities with forex clause in order to attract more investments in domestic securities due to high risk aversion, as additional sources for financing the budget deficits. The considerable demand for this type of securities, which is currency risk free, ensured the issuance of securities with FX clause to continue in the next years. Thus, the average share of foreign denominated debt in the period 2004-2013 is around 90% of total public debt, which has been reduced in the last two years when the smallest share was recorded (78%). However, the high share of foreign currency denominated debt rises the question about the exchange rate risks, which is very important for the country as Macedonia with *de facto* fix exchange rate. The shock in the exchange rate may increase the liabilities expressed in domestic currency and liquidity problems, which will have negative effect to risk premium of the country.

B.2 Fiscal sustainability

The IMF's Debt Sustainability Analysis (DSA) framework, as in case of external sustainability, provides analysis of the factors that drive the public debt dynamics. The template identifies the different channels that contribute to the evolution of the debt to GDP ratio: 1) Primary fiscal deficit (excluding interest payment); 2) Endogenous/automatic factors (related to interest rates, growth rates and exchange rate changes); and 3) Other debt-creating operations, such as recognition of contingent liabilities by the government, as well as debt-reducing operations, such as privatizations whose proceeds are used to pay down public debt.

Figure 5
Factors driving public debt dynamics, according to IMF's fiscal sustainability framework



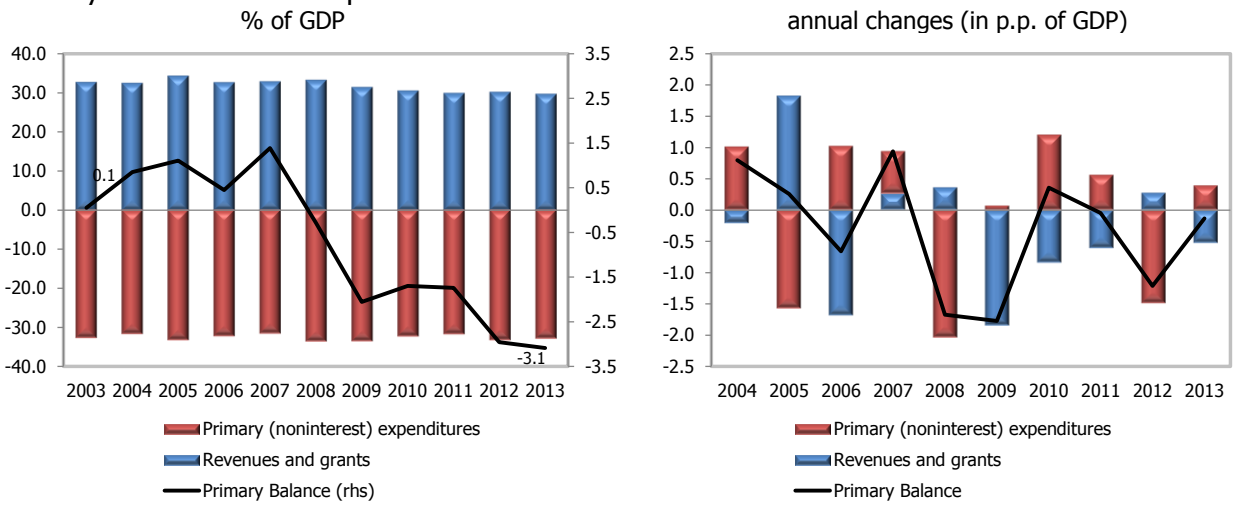
Source: SSO, Ministry of Finance, NBRM and NBRM calculations.

The analysis shows that the public debt decreased by 2.2 p.p. of GDP in 2013 compared to 2003. However, as was already mentioned, there is a clear cut in the dynamics before and after the crisis, decreasing debt before and increasing after the crisis. This implies that the behavior of the Government regarding fiscal policy and debt management was countercyclical in the analyzed period.

Before the crisis, strong domestic household consumption, supported by favorable condition for banks' lending contributed to acceleration of overall economic activity. With average real growth rate of 5% in the period 2004-2008, real GDP growth had a significant contribution to debt decreasing. At the same time, fiscal discipline was also present, and balanced primary balance (small surplus) was registered, which also contributed to debt fall. Real interest rates also had a small impact on debt decrease (negative real interest rate in terms of low nominal rates and relatively higher inflation). From other debt creating factors, the privatization receipts are one of the factors that contributed the most to the fall in debt, mainly as a result of the privatization of the Electricity Supply Company of Macedonia "ESM - Distribucija" (in the amount of Euro 225 million in March 2006).

After 2008, the debt was increasing constantly. Primary deficit was the main driving factor for debt increase (2.3% of GDP, on average in the period 2009-2013). In order to lessen the negative consequences of the crisis, the Government introduced fiscal measures (anti-crisis packages), which along with the effect of the automatic budget stabilizers had led to budget deficits. Small contribution to debt increase was noticed by real interest rate (small rise in nominal rates, but mostly due to lower inflation) and other debt creating flows (deposit savings). Only real GDP growth had negative contribution to the debt increase, but significantly lower compared to its contribution before the crisis (1.5% average growth rate).

Figure 6
Primary deficit and its components



Source: Ministry of finance and NBRM calculations.

II. Literature overview and methodology

In the analysis of public and external debt dynamics the National Bank of the Republic of Macedonia is actively using the IMF's Debt Sustainability Analysis (DSA) framework. Regarding the period during and after the last global crisis, which revealed the fiscal unsustainability of some of developed countries, IMF gave an effort to improve the actual DSA framework, particularly for public debt, while for the external debt it was not changed. The framework for public debt sustainability analysis for advanced and emerging market economies has been revised in 2011 and the guidance for the implementation of the new framework was introduced in May 2013. The revision responded to shortcomings in identifying fiscal vulnerabilities and assessing risks to debt sustainability against the backdrop of increased concerns over fiscal policy and public debt sustainability in many advanced economies. This improved framework is more risk-based approach to DSA, and requires more analysis in countries facing greater risks; and commensurately less in countries facing lower risks. However, in the literature, some early work on improvement debt sustainability approach can be found. Most of them are trying to develop a probabilistic approach for debt sustainability analysis, focusing primarily on the joint stochastic properties of shocks, including also a fiscal reaction function to take into account the policy response to shocks and the feedback effects of fiscal policy on macroeconomic variables (Celasun et al, 2006; Cherif and Hasanov, 2012; Favero and Giavazzi, 2007; Kawakami and Romeu, 2011; and Tanner and Samake, 2006). They rely on methodology that combines VAR models with debt feedback to assess the impact of set of macroeconomic shocks on public debt dynamics. However, these approaches do not analyze the effect of external shocks on debt dynamics, and are focused on public debt and do not include the analysis on external debt sustainability. Similar approach, which also applies the combination of VAR models and estimated impact of specific external shocks on debt dynamics in DSA framework, is presented by Adler and Sosa (2013). However, their approach is based on analysis of the impact of specific external shocks on debt dynamics, particularly to external debt.

Taking into account the usage of the new improved framework for public debt sustainability, the aim of our analysis primarily is to improve the analytical power of the IMF's DSA framework for external debt, in the case of Macedonia, but also to upgrade the

fiscal sustainability framework with additional shock scenarios. The analysis is based on methodology used in Adler and Sosa 2013, who are trying to analyze how shocks in external conditions are transmitted to the key domestic variables included in IMF's regular DSA framework and to answer the question whether the Latin America region built enough buffers to guard itself from a weakening of the external environment. To address this issue, they study the link between global variables—such as commodity prices, world growth, and financial market conditions—and a set of domestic variables (GDP growth, trade balance, real exchange rate, and sovereign spreads) that explain most of the dynamics of public and external sustainability indicators. Actually, they tried to integrate the econometric estimates of the effect of exogenous external variables on key domestic variables within the IMF's standard framework for debt-sustainability analysis, which we found applicable for the analysis of Macedonian external debt sustainability.

Adler and Sosa (2013) use VAR methodology to obtain forecasts of key domestic variables, conditional on a set of assumed global variables under different global scenarios for 11 Latin American countries. Each country-specific VAR model is given as:

$$y_t = B(L)y_{t-1} + H(L)z_t + u_t \quad (1)$$

where $y_t = (g_t \; dTB_t \; dln(reer_t))'$ is a vector of endogenous variables and $z_t = (1 \; g_t^W \; vix_t \; P_t^A \; P_t^E \; P_t^M \; pb_{t-1} \; d_{t-1}^P)'$ is a vector of exogenous variables. The vector y_t includes real GDP growth (g_t), the change in the trade balance in percent of GDP (dTB_t), and the (log difference of) the real effective exchange rate ($dln(reer_t)$). The vector z_t, in turn, includes global real GDP growth (g_t^W), the S&P 500 Chicago Board Options Exchange Market Volatility Index - VIX (vix_t) as a proxy for international financial conditions, the (log differences of) agriculture, energy, and metals prices (P_t^A, P_t^E and P_t^M respectively), the primary balance, in percent of GDP (pb_t), and the public debt-to-GDP ratio (d_t^P). *B(L)* and *H(L)* are lag polynomial matrices.

With estimation of the VARs, the main purpose is to obtain the conditional forecasting performance of the model, and not to use standard VAR tools such as impulse response functions and variance decompositions, and according to that there is no need for identification restrictions to recover the structural parameters of the model. As the main interest of the authors was conditional forecasting during adverse external scenarios, the specifications are selected based on their out-of-sample forecast power during the Lehman Brothers event.

Another key feature of the methodology used by Adler and Sosa (2013) is that primary fiscal balance is included in the VAR in order to allow feedback effects from this variable to the other domestic variables that determine debt dynamics. However, this approach does not entail estimating a fiscal reaction function (i.e., there is no equation for the primary fiscal balance), as the objective is not to obtain alternative debt paths under the assumption that fiscal responses to the negative shocks mirror those of the past. This means that the primary fiscal balance is treated as exogenous for the purpose of estimation only, and for projections, the primary balance is constructed conditioning on alternative scenarios for primary fiscal balance. As our main purpose is transmission of global variables to key domestic variables, we are not interested in different fiscal policy scenarios and these scenarios will be not explained here.

After selection of best performing forecasting model during the Lehman event, the selected model is used for forecasting the key domestic variables under baseline projections of exogenous variables and under the alternative global scenarios, each

defined by exogenously determined paths for the exogenous variables. There are two scenarios of temporary shocks and two other in which shocks have more permanent effects:

i) **Temporary Financial Shock** which includes shock on VIX in the first year of projections of similar magnitude as the one observed after the Lehman event, with the VIX returning to baseline levels in next years. Real variables, such as global growth and commodity prices, are assumed to remain unchanged at baseline levels;

ii) **Temporary Real Shock** which assumes a temporary global recession, with lower growth and commodity prices during the first two years of projections, returning to the baseline path afterwards. This scenario can be characterized as a backdrop where global uncertainties remain somewhat elevated for some time—leading to a global economic slowdown, but no crisis—and are eventually resolved;

iii) **A Protracted Global Slowdown** which is consisted of relatively high level of uncertainty, lower growth and commodity prices during the whole period of projections (all relative to the baseline). The scenario does not assume abrupt changes, but rather protracted weakness in real global variables;

iv) **A Tail event** which is an extreme case of crisis and includes shocks of magnitude similar to those observed after the Lehman event, for the whole period of projections. This scenario assumes that a new Lehman-like event would have more protracted effects on the global economy, as fiscal and monetary space in advanced economies is today much more limited than in 2008.

For the purposes of DSA, Adler and Sosa (2013) first examine the projected trajectories of public and external debt under the baseline, with the path of global variables as in IMF's World Economic Outlook (WEO). Assessing the debt sustainability under the alternative scenarios is conducted by adding the estimated impact of changes in external conditions to the WEO baseline (Eq.2). The marginal impact is computed as the difference between the debt projection under each VAR scenario forecast and the projection under the VAR baseline forecast (Eq.3):

$$d_t|Scenario_i = d_t|WEOBaseline + d_t|marginal\ impact_t \quad (2)$$

$$d_t|marginal\ impact_t = (d_t|VAR\ Forecast_i - d_t|VAR\ Forecast\ Baseline) \quad (3)$$

III. Data and results

In order to estimate the marginal impact of shocks in external variables on the key domestic variables, we are following the methodology as in Adler and Sosa 2013, with some slight changes in some of the variables, the period of forecasting necessary for selection of the best performing forecasting model, the magnitude of the shocks in each of the alternative scenarios, as reflection of the Macedonian country specifics.

Regarding endogenous variables in the VARs, we include: the real GDP growth rate (g_t), and the (log difference of) the real effective exchange rate index ($dln(reer_t)$), and the change in the current account in percent of GDP (dCA_t) instead of the change in the trade balance in percent of GDP (dTB_t), as in Alder and Sosa. Although the trade balance is the most important item in the Macedonian current account, however, Macedonia is one of the countries that receive a large amount of private transfers from abroad[4], which also

[4] Private transfers include workers' remittances, net purchase of foreign cash in the exchange market and other transfers. Net inflow of foreign currency in the banking sector from the exchange operations is used as approximation for the cash transfers.

determine Macedonian current account. For the vector of the exogenous variables, we include the same variables as in Adler and Sosa (2013), with the difference for the global real GDP growth, for which we use the real GDP growth of the Euro Area (EA). We considered that EA is a relevant variable as a proxy for global GDP, as almost 43% of the Macedonian external trade is made with EA, and over 50% of the export is directed to EA in the last three years (see Appendix 1, Figure 1).

The data sources for the domestic variables are: State Statistical Office of Republic of Macedonia (GDP data, millions of Denars, constant prices, referent year 2005), National Bank of the Republic of Macedonia (GDP in millions of Denars, seasonally adjusted data; current account in millions of Euros, seasonally adjusted data and REER, 2010=100) and the Ministry of Finance of Republic of Macedonia (primary budget balance and public debt), and for the external variables are: Eurostat (Euro Area GDP- volumes, seasonally adjusted and adjusted data by working days), IMF Primary Commodities Prices database (Food Price Index, Energy Price Index and Metal Price Index, 2005=100), CBOE Futures Exchange (CBOE S&P 500 Market Volatility Index (VIX) Futures Price). For the forecast, we use IMF Commodity price forecast (last update 02.06.2014), Consensus Forecast April 2014, VIX Futures Daily Settlement Prices. Given that the forecasts for exogenous variables are annual, the method of interpolation is used for quarterly forecast.

The VAR models are estimated with quarterly data for the period 1998q1-2013q4. The *B(L)* and *H(L)* are lag polynomial matrices, where *B(L)* and *H(L)* includes up to 3 lags of the endogenous and exogenous variables, accordingly, as we have short data span and we do not want to lose a lot of degrees of freedom.

The selection of the best forecasting model is based on the in-sample forecast for the period 2008q4-2010q1, instead of Lehman event (2008q3-2011q2) as in Adler and Sosa. The reason behind this is that strongest effect of the global crisis on the Macedonian economy was in the period mentioned above and it was not so long as it is in Adler and Sosa. Actually, the Macedonian economy started to recover from the end of 2009, when the first positive annual growth rate was noticed, and experienced a modest recovery of 2.9% on average in the period 2010-2011. The analysis from q-o-q changes confirms almost the same, as the negative growth rates were noticed only in three quarters (2008q4, 2009q1 and 2010q1) (see Appendix 1, Figure 2). Another reason is that the first and the biggest deterioration of the current account due to the global crisis was noticed in q4 2008, when the current account deteriorated by almost 7 p.p. of GDP compared to previous quarter[5]. Additionally, in 2012 Macedonian economy experienced another downturn, which compared with 2008 was significantly smaller and it was not taken into account in selection of crisis period.

The forecast power was based on calculated Root Mean Square Error (RMSE), which is the average of the RMSE's of the equations for *g*, *dCA* and *dln(REER)* in each VAR. According to this criteria, the best forecast model in crisis is VAR (1,1,1)(2,3,3,2,0,3) and the forecast power of the selected model is given in the Appendix 1 (Figure 3). The estimated coefficients are given in Appendix 1 (Table 4). The coefficients show some surprising results regarding the effect of EA GDP growth and commodity prices, as one of the most important variables, to domestic growth and current account. Although EA GDP q-o-q growth in the current period has a positive effect on domestic quarterly growth and current account, still taking into account all EA growth's coefficients, on cumulative basis there is a negative effect. The reason behind this can be found in different movement

[5] The calculations of current account in percent of GDP are done by dividing the current account, seasonally adjusted data in each quarter with the GDP, seasonally adjusted data realized in the same quarter.

during the crisis period and the time discrepancy in getting into recession and in the recovery between EA and Macedonian economy, which was explained above. Thus, Macedonian current account, after the initial negative shock, shows improvement while EA growth is still in the negative zone. Regarding the commodity prices, they all have positive effect, on cumulative basis, on domestic GDP and current account, as their movement during the crisis is very similar, after the initial shock in Q4 2008 there is recovery in one or two quarters later. For metal prices it was expected as Macedonia is a country that has positive trade balance for metal products, however for food and energy prices the opposite effect was expected as we are import dependent country for food and particularly for energy. Financial uncertainty has small effect and it is negative to domestic GDP but positive to current account.

The results in the chosen model are very similar with the VARs which also have small RMSE on average for all three equations in the VAR, but bigger than of the chosen VAR. The similar situation is with the VARs that have the smallest RMSE only for current account equation or GDP growth equation, in which most of the variables in all three equations keep the coefficient's signs, with some deviations in the size of the coefficients, but the forecast power for the other two variables, is significantly lower. Additionally to this, we made some additional robustness check, by changing the period for selection of the best forecasting model. In the first robustness check, the period was shorter and the decision for best fitting model was based on the period 2008q4-2009q3, when the effects of the crisis were the strongest. The results are the same as in original estimation, as the same model appeared to have the smallest RMSE in average of all three equations in each VAR. The second robustness check refers to find the best forecasting model for the whole period of estimation, not only for the period during the crisis. This robustness check, unlike previous one, showed different VAR models with the smallest RMSE in average for all three equations in the VAR than those with period of selection during global crisis. However, the coefficient's signs in front of all variables are almost the same as the chosen VAR, although the magnitude of the coefficients differs. The results of robustness check are given in the Appendix 2. As the robustness check shows that the best forecasting models, regardless the selection period, have almost the same relationships among the variables in each equation, we are proceeding with our selected model, according to the suggested methodology.

Later, the selected model is used for projections for the next five years period (2014-2018), including Baseline scenario (baseline projections for exogenous variables) and 4 different alternative scenarios. We are applying the same scenarios with same shocks as in Adler and Sosa, with the exception of the Tail event scenario, where the initial shocks are calculated according to the data during the crisis, taking into account the difference in the data from peak to through. The sizes of the shocks are given in Table 2, and Figure 8.

Table 2
Key Global Assumptions under Alternative Scenarios

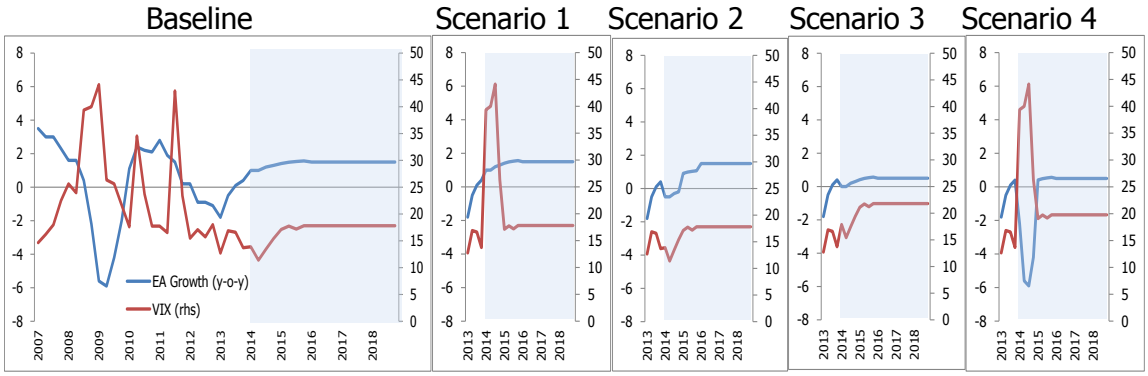
Global Assumptions	Scenarios				
	Baseline (BL) *2014-18 avg.*	1 Finacial Shock /1	2 Global Recession /2	3 Protracted Global Slowdown /3	4 Tail event /4
EA GDP annual growth	1.4	BL	2014: BL-1.5 p.p. 2015: BL-0.5 p.p. 2016-2018: BL	BL-1 p.p.	2014: Global crisis-like 2015-18: BL-1 p.p.
VIX	16.9	2014: Lehman-like 2015-18: BL	BL	BL+4 pts	2014: Global crisis-like 2015-18: BL+2 pts
Food prices	-6.7 /5	BL	2014: BL-10% /6 2015-18: BL	BL-7%	2014: BL-30% /7 2015-18: BL-5%
Metals prices	-8.0 /5	BL	2014: BL-20% /6 2015-18: BL	BL-15%	2014: BL-45% /7 2015-18: BL-10%
Energy Prices	-7.4 /5	BL	2014: BL-25% /6 2015-18: BL	BL-15%	2014: BL-60% /7 2015-18: BL-10%

1/ Temporary financial shock affecting the first year of projections only. Financial variables return to projected path under the baseline in 2015.
2/ Temporary real shock (commodity prices and world growth) in 2014-15. Variables return to projected path under the baseline in 2016.
3/ Global slowdown over the whole forecast horizon.
4/ Global crisis (from peak to through) like event in 2014-2015, with protracted impact on global growth, commodity prices and the VIX.
5/ Change relative to 2013 level.
6/ Reported gap vis-à-vis baseline is reached by the end-2014. Prices recover gradually afterward to reach baseline by end-2015.
7/ Reported gap vis-à-vis baseline is reached by the 2014-Q1. Prices recover gradually afterward to reach new path by end-2015.

Figure 7
Shocks in the exogenous variables under different alternative scenarios

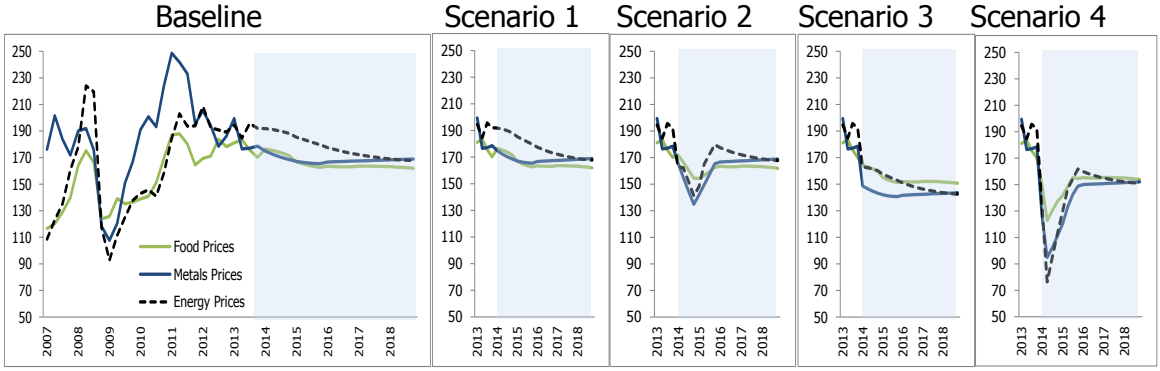
EA growth and VIX

(Percent and points)



Commodity prices

(Index, 2005=100)



We want to point out again, the goal of these VAR forecasts is not obtaining the projected level of the key domestic variables relevant for sustainability framework in case of baseline and in case of external shocks and as such to be included in DSA framework, instead, projected levels are used only to estimate the marginal effect to the level of each domestic variable between baseline and assumed external shock scenario (Eq. 3). The estimated marginal effect latter will be added to the baseline projected path of the domestic variables forecasts given in DSA framework[6].

The results of the alternative scenarios:

1) Financial Shock Scenario

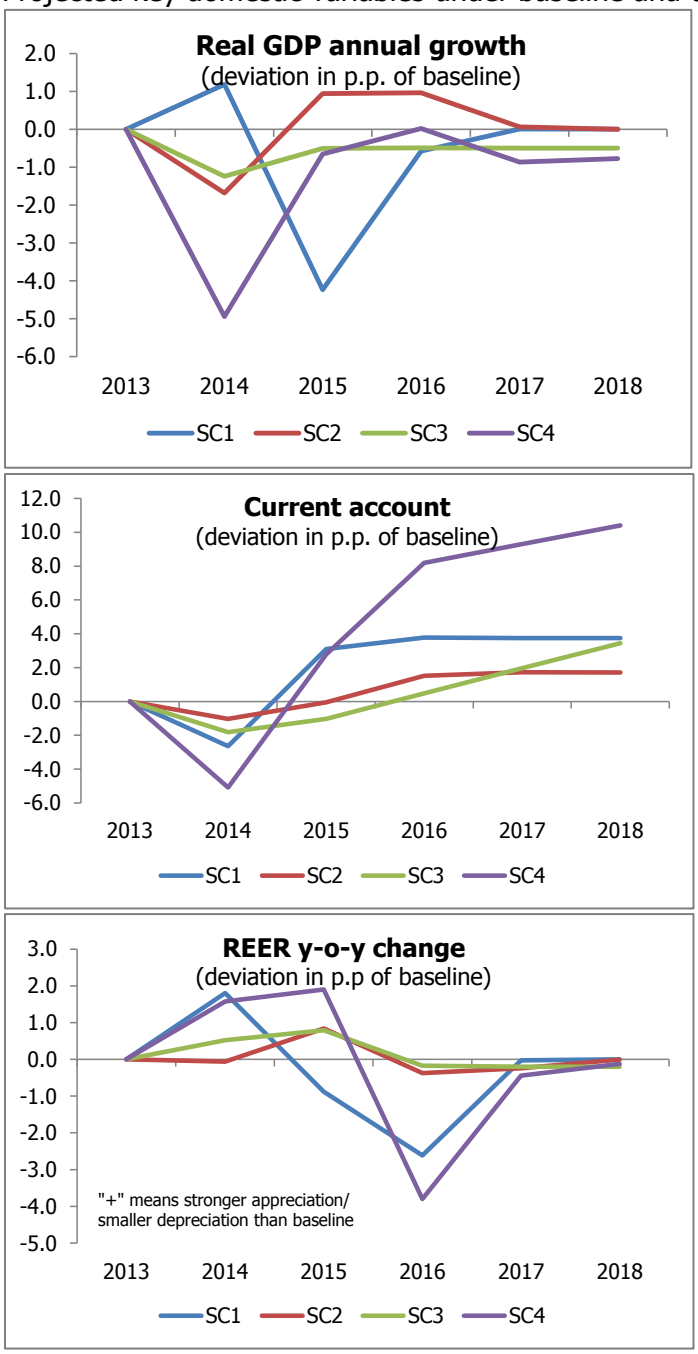
Under this scenario, the effect of the increased volatility on GDP growth is not immediate, but it is noticed in the years after the shock. Thus, GDP growth is lower comparing to baseline projections, and it is followed by lower deficit in current account than in baseline and depreciation of REER on cumulative basis. The improvement in current account, after the initial worsening, can be explained by increased precautions due to higher global uncertainty which may lead to higher savings and higher risk aversion. Later, in the last two years of the projections, the current account deficit is still lower than the baseline, which is the effect of the lower base previously, but in the dynamics, there is no change as there is no change in exogenous factors as well as in endogenous (GDP growth rate is the same as in baseline). Regarding sustainability, overall, this shock is expected to have positive effect on external debt sustainability, mainly due to current account improvement which will surpass the negative effect of GDP, but it is expected to have negative effect on public debt sustainability as lower GDP growth, ceteris paribus, will cause higher budget deficit as percent of GDP and larger debt-to GDP-ratio.

2) Temporary Real shock Scenario

Slower EA growth and lower world prices of food, metals and energy than projected will have immediate negative effect on GDP growth and on the current account due to lower global demand for Macedonian export and unfavorable terms of trade. However, the gradual improvement in prices and global demand during 2015, have a positive effect on domestic GDP, which shows higher growth in the next two years of projections, and lower deficit in the current account particularly in the third year of projection and continuous after, in terms of smaller appreciation of REER. This shock is expected to increase the debt level in the year of the shock, but in a medium run, as the shock disappears, no negative effects to the public and external sustainability are expected.

[6] The baseline projections of domestic variables included in DSA framework are not the same with those obtained with VAR baseline forecast, because VAR estimation does not include all specific factors for the domestic variables estimation.

Figure 8
Projected key domestic variables under baseline and different shock scenarios



3) A Protracted Global Slowdown Scenario

Protracted global recession will have negative effect on domestic GDP for the whole period as a result of higher global uncertainty and lower world commodity prices. Lower domestic demand and world prices, along with stronger appreciation than in baseline have a negative effect on the current account in the first two years of projections, which shows higher deficit than in the baseline. In the following years, current account is in better condition compared with the baseline projection, which can be explained by increased global financial instability which is reflected in lower world demand, but at the same time smaller import due to increased risk aversion for new investments, accompanied by REER development, which shows lower appreciation than in baseline. Lower than expected GDP growth will have negative effect on public debt sustainability, but in case of external

sustainability the effect is unclear as the debt is expected to increase in the first two years, but later lower GDP growth can be neutralized by better current account which probably will contribute to decreasing path of the debt and to maintain the external sustainability.

4) A Tail event Scenario

The extreme case scenario results are very similar to the previous ones, except the intensity of movements in the key domestic variables is stronger. Thus, it shows strong negative effect in the first year of the projection, when the applied shock is the biggest. Namely, there will be disruptive fall in GDP growth and doubling the deficit in the current account comparing with the baseline. GDP will continue to register lower growth than in baseline, while current account is expected to have strong improvement and lower deficit than in baseline due to lower foreign demand and increased uncertainty. Regarding the sustainability, the expected effects are the same with the previous scenario, but both debts (public and external), will increase strongly in the first year of the shock.

On cumulative basis for the five year period of projections, GDP is expected to be lower in case of exogenous shocks, except for the second scenario and to have negative effect on sustainability, particularly in extreme case scenario. Current account deficit will be lower than in baseline in case of all shocks, due to higher uncertainty and lower global and domestic demand. This is expected to have positive effect to external sustainability, as there will be lower financial needs from abroad.

However, taking into account that scenarios explained above could be implemented into the DSA framework as additional shock scenarios with simultaneous responses of the key domestic variables on external shocks, the results should be taken with caution, as the developments of domestic economy and world developments were somewhat different during the global crisis in 2008-09, as well as during the crisis in 2012. The crises in Macedonia were shorter and the domestic economy recovered faster than the European economy, and the main reasons can be found in domestic factors. In order to reduce the negative effects from global economy, infrastructural projects were launched and significant amount of FDI in the tradable sector were attracted which contributed to export diversification and expansion that is not related with traditional export destinations and products such as metal products, which are highly dependent on world demand and prices.

IV. Conclusion

In order to improve the sensitivity analysis of IMF's debt sustainability framework which NBRM uses, we are implementing the Adler and Sosa (2013) approach. This methodology allows for examining the simultaneous effects to key domestic variables in case of external shocks. The methodology combines the results of VAR econometric modeling with DSA framework. The methodology suggests first estimating VAR models, with key domestic variables in DSA framework as endogenous variables (GDP growth, current account and REER) and several exogenous variables (world GDP, world prices of food, metals and energy, VIX, and primary budget balance), followed by selection of the VAR model which fits the best the period of crisis (Q4.2008-Q1.2010). Later, the selected model is used to project simultaneously the key domestic variables, given medium term projections of exogenous variables under four different shock scenarios, according to Adler and Sosa (2013).

The results show in general that all shocks have negative effect to domestic GDP, for shorter or longer period. However, in the case of current account there is negative effect in the beginning of projection period, but positive in the later period, which can be explained by the lower external demand in terms of higher global uncertainty which will contribute to higher risk aversion and lower investments and import, as well as more favorable developments in REER than in baseline. Regarding sustainability, in the case of external debt, the debt is expected to increase in the first year or two of projection period as there will be lower GDP growth and higher current account deficit which will require more foreign financing. However, in a medium run, protracted lower GDP might be neutralized by improvement in the current account without jeopardizing the sustainability. In the case of public debt sustainability, lower GDP growth will have negative effect as it will cause higher budget deficit as percent of GDP and larger debt-to GDP-ratio.

The implementation of the estimated dynamic joint responses of the key domestic variables that determine debt dynamics to specific external shocks as additional shock scenarios will bridge over some of the disadvantages and will improve significantly the sensitivity analysis of the current DSA framework. Furthermore, this methodology can be used not only for analysis of debt dynamics under alternative negative external scenarios, but also in case of positive external shocks.

REFERENCES

Adler, G. and Sosa, S., (2013), "External Conditions and debt sustainability in Latin America", IMF working paper WP/13/27.

Celasun, O., Debrun X., and Ostry J.D., (2006), "Primary Surplus Behavior and Risks to Fiscal Sustainability in Emerging Market Countries: A 'Fan-Chart' Approach", IMF Working Paper WP/06/67.

Favero, C., and Giavazzi F., (2007), "Debt and the Effects of Fiscal Policy", NBER Working Paper No. 12822.

International Monetary Fund, 2002, "Assessing Sustainability", IMF Policy Paper.

International Monetary Fund, 2011, "Modernizing the Framework for Fiscal Policy and Public Debt Sustainability Analysis", IMF Policy Paper.

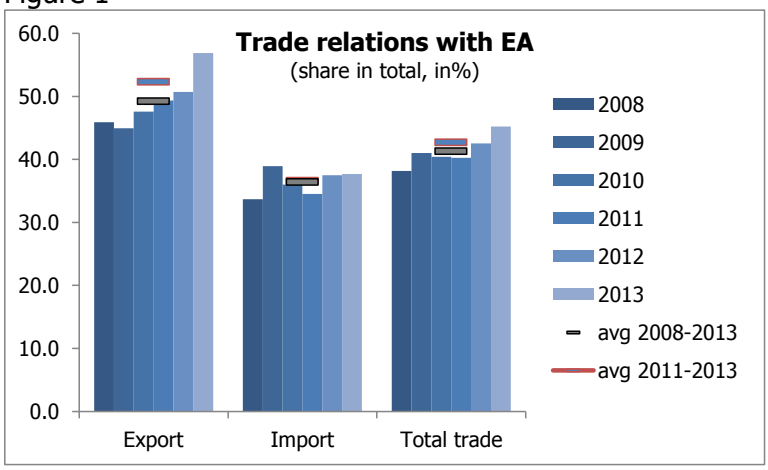
International Monetary Fund, 2013, "Staff Guidance Note for Public Debt Sustainability Analysis in Market Access Countries".

Kawakami, K., and Romeu R., (2011), "Identifying Fiscal Policy Transmission in Stochastic Debt Forecasts", IMF Working Paper WP/11/107.

Tanner, E., and Samake I., (2006), "Probabilistic Sustainability of Public Debt: A Vector Autoregression Approach for Brazil, Mexico, and Turkey", IMF Working Paper WP/06/295.

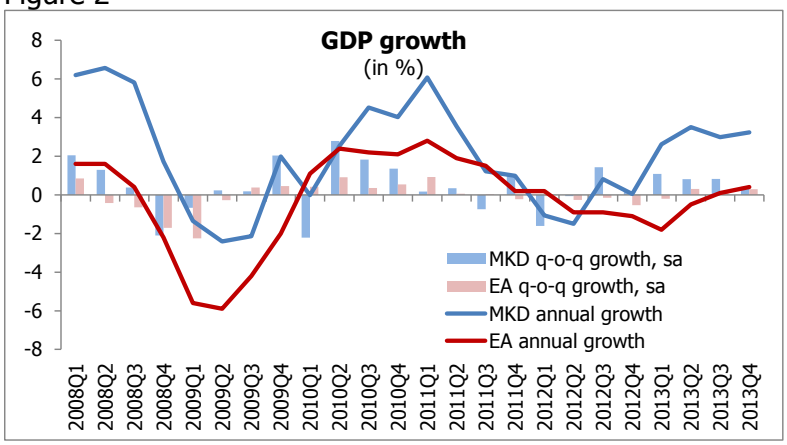
APPENDIX 1

Figure 1



Source: State statistical office and author's calculations.

Figure 2



Source: State statistical office, EUROSTAT and author's calculations.

Table 1
Data explanation

variable	explanation	Data source
g_t	MKD GDP sa, q-o-q growth	SSO and NBRM calculation
dCA_t	MKD Current account, sa, % of GDP, first difference	NBRM and author's calculations
$dln(reer_t)$	REER Index (CPI) 2010=100, log difference	NBRM
g_t^{EA}	EA GDP sa, q-o-q growth	EUROSTAT
vix_t	CBOE S&P 500 Market Volatility Index, in points	CBOE Futures Exchange
P_t^F	Food Price Index, 2005=100	IMF Primary Commodities Prices database
P_t^E	Energy price Index, 2005=100	IMF Primary Commodities Prices database
P_t^M	Metal price Index, 2005=100	IMF Primary Commodities Prices database
pb_{t-1}	Primary budget balance, % of GDP, first difference	Ministry of Finance and author's calcualtions

Table 2
Unit root test

Variable	level	
	ADF statistics	*p*-value
endogenous variables		
MK GDP growth (q-o-q change)	-12.14	0.0000
CA balance, %GDP (q-o-q difference)	-9.45	0.0000
REER_CPI Index (difference in log)	-6.42	0.0000
exogenous variables		
EA GDP growth (q-o-q change)	-4.32	0.0010
VIX (points)	-4.26	0.0012
Food prices index (difference in log)	-6.33	0.0000
Metal prices index (difference in log)	-5.40	0.0000
Energy prices index (diff. in log)	-6.28	0.0000
PB balance, %GDP (q-o-q difference)	-10.09	0.0000

Tests are done in levels with Intercept and Schwarz Info Criterion, using E-Views software.

Table 3
Correlation matrix

	G_Q	**DCA**	**DLREER**
G_Q	1	-0.092	-0.134
DCA	-0.092	1	-0.046
DLREER	-0.134	-0.046	1
EA_G_Q	0.162	-0.014	-0.073
VIX	-0.097	0.034	0.062
DLFOOD	-0.020	-0.082	0.000
DLENERGY	0.271	-0.018	-0.088
DLMETAL	0.219	0.087	-0.083
DPB (-1)	0.235	0.017	-0.025

Table 4
Estimation results

variables	Vector Autoregression Estimates		
	G_Q	DCA	DLREER
G_Q(-1)	-0.71***	0.22	0.002**
	(0.1327)	(0.23555)	(0.00097)
DCA(-1)	-0.11	-0.23	-0.001
	(0.08187)	(0.14532)	(0.0006)
DLREER(-1)	11.06	48.09	0.37**
	(20.4269)	(36.2586)	(0.14903)
EA_G_Q	1.69**	1.90	0.004
	(0.72388)	(1.28492)	(0.00528)
EA_G_Q(-1)	-0.11	-3.15**	-0.001
	(0.71847)	(1.27532)	(0.00524)
EA_G_Q(-2)	-1.89**	0.25	-0.004
	(0.71346)	(1.26642)	(0.00521)
VIX	0.05	-0.11	0.000
	(0.05769)	(0.10241)	(0.00042)
VIX(-1)	-0.01	0.20*	0.000
	(0.06483)	(0.11507)	(0.00047)
VIX(-2)	-0.02	-0.36***	0.000
	(0.06724)	(0.11935)	(0.00049)
VIX(-3)	-0.07	0.33***	0.00
	(0.05716)	(0.10146)	(0.00042)
DLFOOD	4.19	-15.86	-0.06
	(8.52755)	(15.1368)	(0.06222)
DLFOOD(-1)	-18.21**	8.05	0.01
	(6.92215)	(12.2871)	(0.0505)
DLFOOD(-2)	14.36*	-5.14	0.04
	(7.3824)	(13.1041)	(0.05386)
DLFOOD(-3)	10.47	22.05*	-0.05
	(6.88926)	(12.2287)	(0.05026)
DLMETAL	1.93	21.75**	0.01
	(5.19077)	(9.21385)	(0.03787)
DLMETAL(-1)	7.32	-15.40*	-0.03
	(4.88295)	(8.66744)	(0.03562)
DLMETAL(-2)	-4.67	6.34	0.01
	(4.71569)	(8.37055)	(0.0344)
DLENERGY	5.12	0.10	-0.002
	(3.89191)	(6.90832)	(0.02839)
DPB_L	0.30**	-0.09	0.000
	(0.11843)	(0.21021)	(0.00086)
DPB_L(-1)	0.10	-0.19	0.000
	(0.11491)	(0.20397)	(0.00084)
DPB_L(-2)	-0.03	-0.48**	0.001
	(0.12035)	(0.21363)	(0.00088)
DPB_L(-3)	0.06	-0.16	-0.001
	(0.11105)	(0.19712)	(0.00081)
C	2.36	-1.70	-0.001
	(1.47042)	(2.61005)	(0.01073)
R-squared	0.612	0.565	0.388
Adj. R-squared	0.375	0.299	0.014
Sum sq. resids	196.876	620.313	0.010
S.E. equation	2.339	4.151	0.017
F-statistic	2.584	2.126	1.037
Akaike AIC	4.823	5.970	-5.018
Schwarz SC	5.632	6.780	-4.208
Sample (adjusted): 1999Q2 2013Q4			
Included observations: 59 after adjustments			

Standard errors in ( ). Significance: *** p<0.01, ** p<0.05, * p<0.1.

Table 5
Test for residuals autocorrelation

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h

Sample: 1998Q1 2013Q4
Included observations: 59

Lags	LM-Stat	Prob
1	12.47135	0.1880
2	10.69761	0.2970
3	9.178648	0.4209

Probs from chi-square with 9 df.

Table 6
Normality test of the residuals

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal

Sample: 1998Q1 2013Q4
Included observations: 59

Component	Skewness	Chi-sq	df	Prob.
1	0.233955	0.53823	1	0.4632
2	0.405322	1.61548	1	0.2037
3	-0.1704	0.28553	1	0.5931
Joint		2.43923	3	0.4864

Component	Kurtosis	Chi-sq	df	Prob.
1	2.863953	0.0455	1	0.8311
2	3.343779	0.29054	1	0.5899
3	6.753915	34.6425	1	0
Joint		34.9786	3	0

Component	Jarque-Bera	df	Prob.
1	0.583729	2	0.7469
2	1.906012	2	0.3856
3	34.92806	2	0
Joint	37.4178	6	0

Table 7
Test for VAR stability

Roots of Characteristic Polynomial Endogenous variables: G_Q DCA DLREER Exogenous variables: EA_G_Q(0 TO -2) VIX(0 TO -3) DLFOOD(0 TO -3) DLMETAL(0 TO -2) DLENERGY(0 TO -0) DPB_L(0 TO -3) C Lag specification: 1 1	
Root	Modulus
-0.707107	0.707107
0.246717	0.246717
-0.110906	0.110906
No root lies outside the unit circle. VAR satisfies the stability condition.	

Figure 3
Forecasting Power of VAR Model during the crisis period (Q4.2008-Q1.2010)

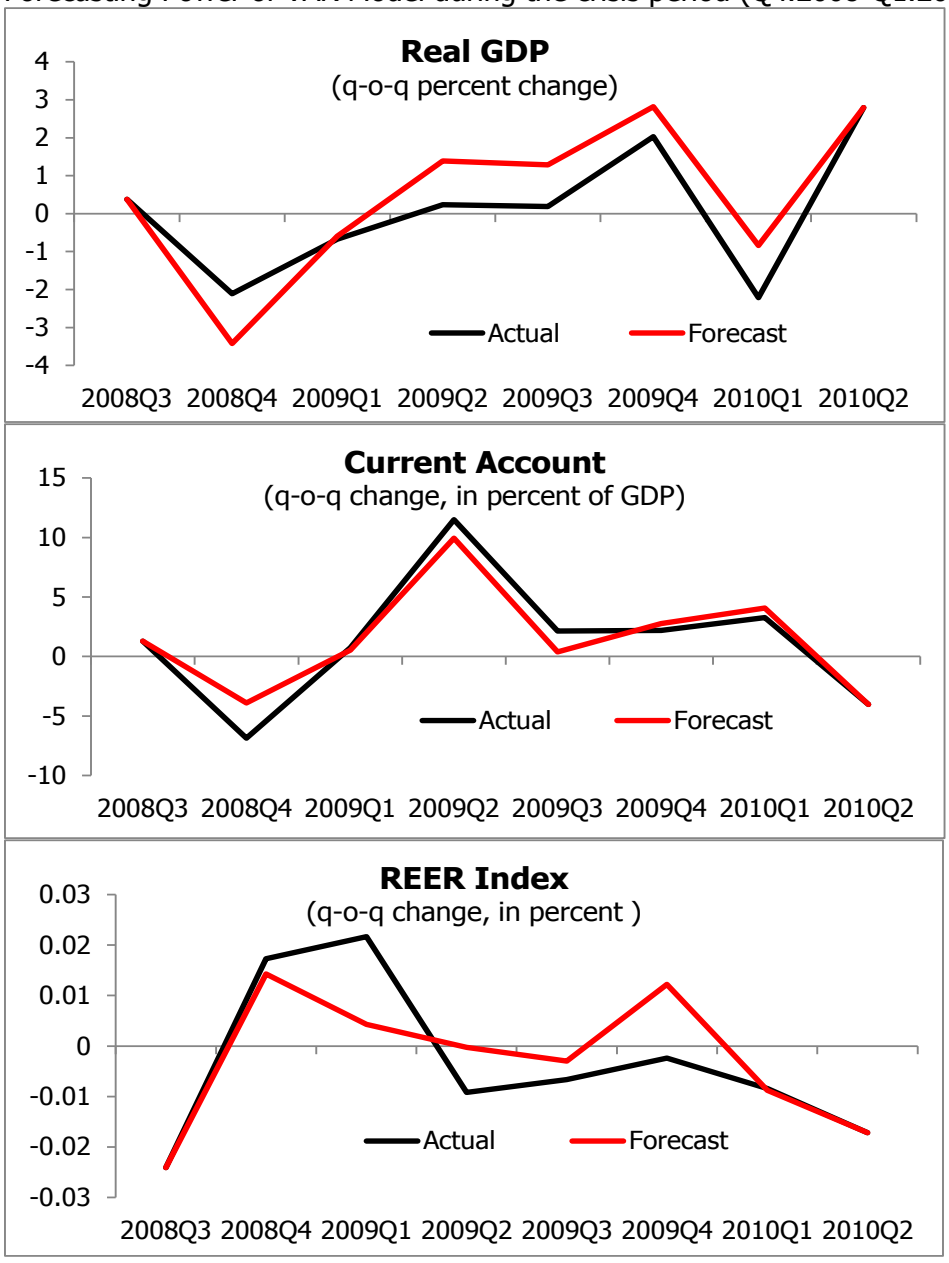
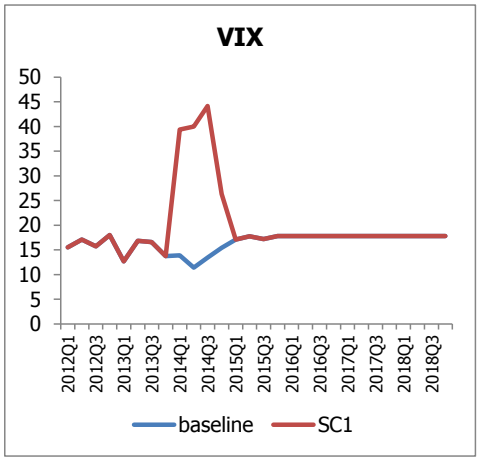
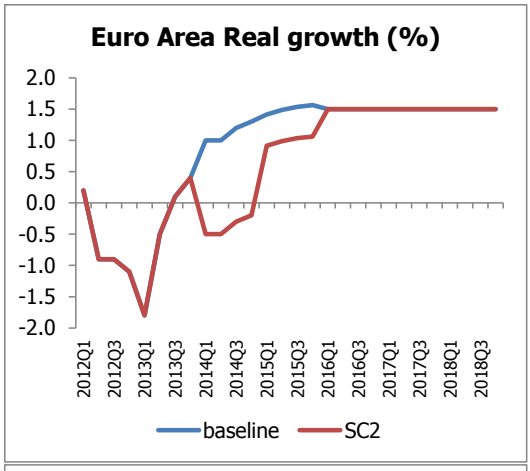


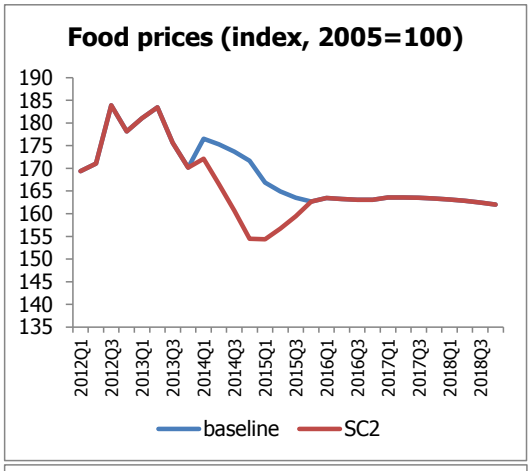
Figure 4
Shocks in the external variables under different alternative scenarios

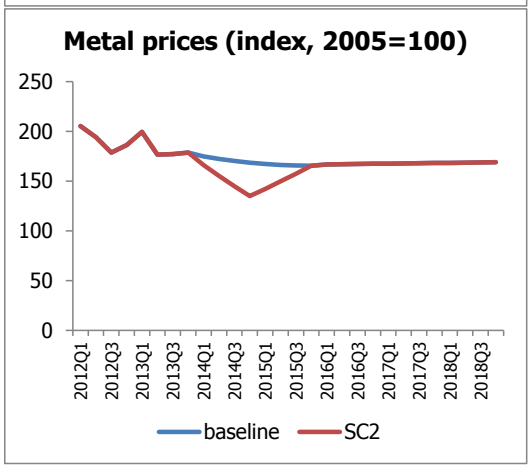
Scenario 1

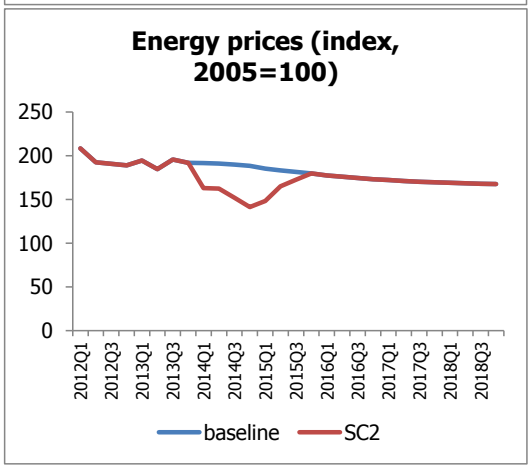


Scenario 2

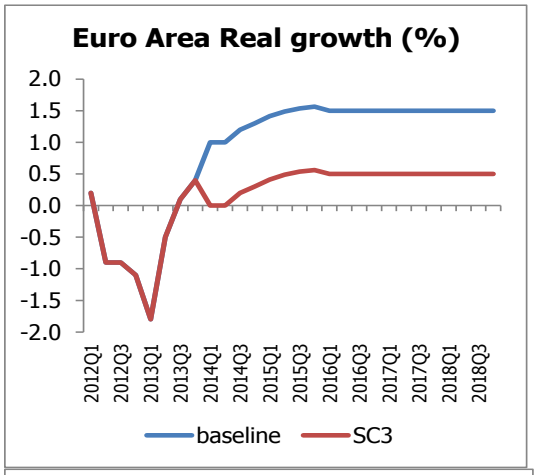


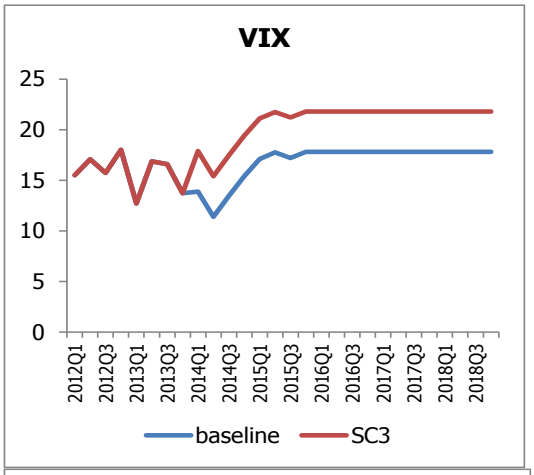


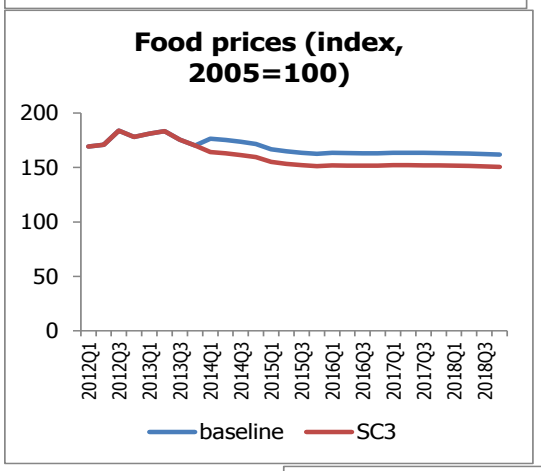


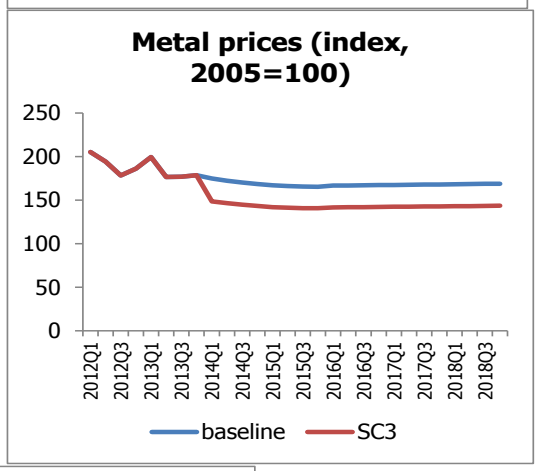


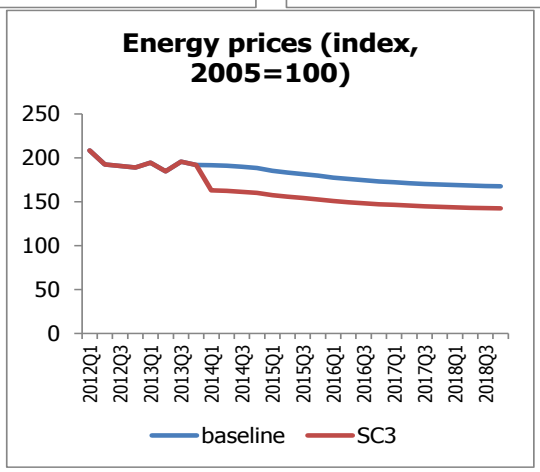
Scenario 3


Euro Area Real growth (%)
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
2012Q1
2012Q3
2013Q1
2013Q3
2014Q1
2014Q3
2015Q1
2015Q3
2016Q1
2016Q3
2017Q1
2017Q3
2018Q1
2018Q3
baseline
SC3

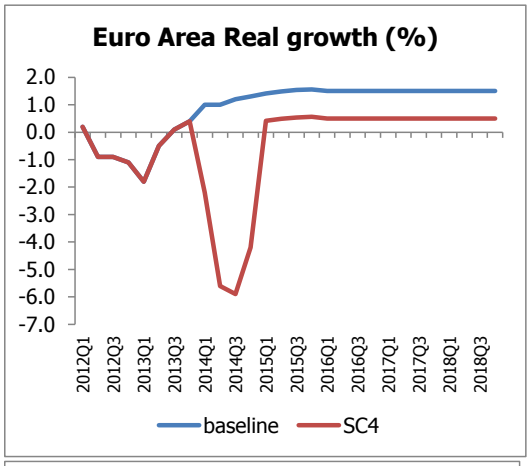

VIX
25
20
15
10
5
0
2012Q1
2012Q3
2013Q1
2013Q3
2014Q1
2014Q3
2015Q1
2015Q3
2016Q1
2016Q3
2017Q1
2017Q3
2018Q1
2018Q3
baseline
SC3

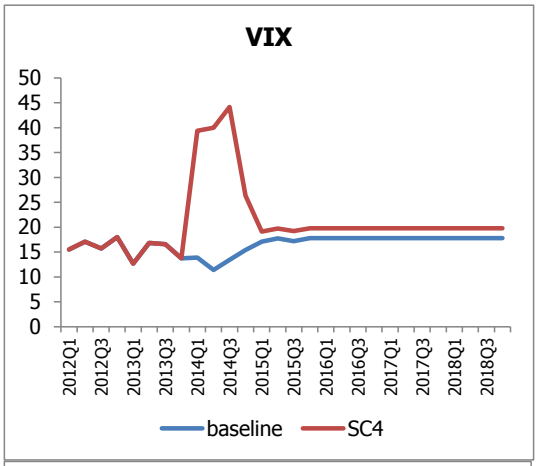

Food prices (index, 2005=100)
200
150
100
50
0
2012Q1
2012Q3
2013Q1
2013Q3
2014Q1
2014Q3
2015Q1
2015Q3
2016Q1
2016Q3
2017Q1
2017Q3
2018Q1
2018Q3
baseline
SC3

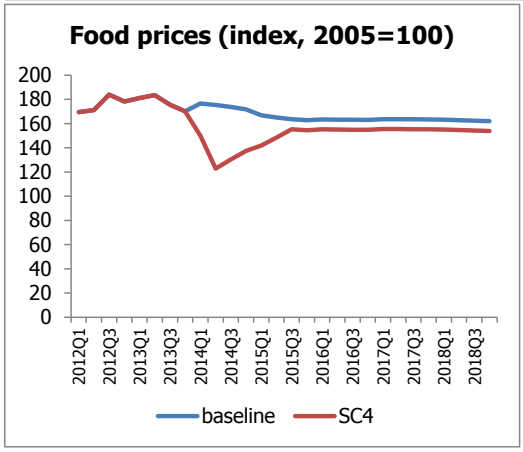

Metal prices (index, 2005=100)
250
200
150
100
50
0
2012Q1
2012Q3
2013Q1
2013Q3
2014Q1
2014Q3
2015Q1
2015Q3
2016Q1
2016Q3
2017Q1
2017Q3
2018Q1
2018Q3
baseline
SC3

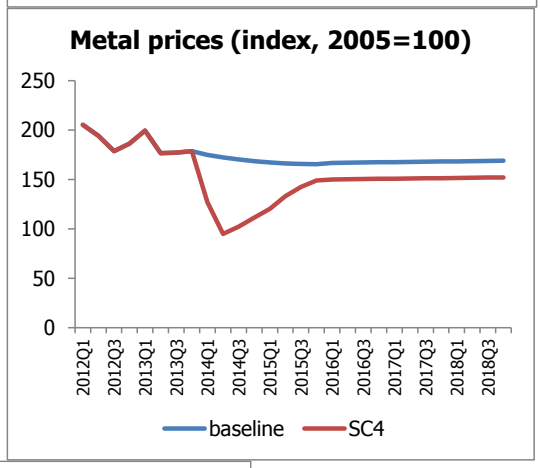

Energy prices (index, 2005=100)
250
200
150
100
50
0
2012Q1
2012Q3
2013Q1
2013Q3
2014Q1
2014Q3
2015Q1
2015Q3
2016Q1
2016Q3
2017Q1
2017Q3
2018Q1
2018Q3
baseline
SC3

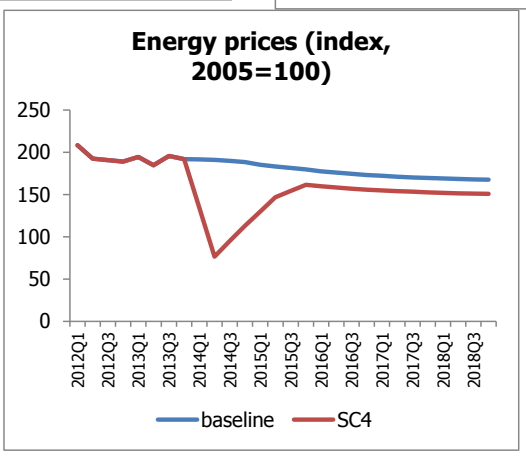
Scenario 4


Euro Area Real growth (%)
2.0
1.0
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
-7.0
2012Q1
2012Q3
2013Q1
2013Q3
2014Q1
2014Q3
2015Q1
2015Q3
2016Q1
2016Q3
2017Q1
2017Q3
2018Q1
2018Q3
baseline
SC4


VIX
50
45
40
35
30
25
20
15
10
5
0
2012Q1
2012Q3
2013Q1
2013Q3
2014Q1
2014Q3
2015Q1
2015Q3
2016Q1
2016Q3
2017Q1
2017Q3
2018Q1
2018Q3
baseline
SC4


Food prices (index, 2005=100)
200
180
160
140
120
100
80
60
40
20
0
2012Q1
2012Q3
2013Q1
2013Q3
2014Q1
2014Q3
2015Q1
2015Q3
2016Q1
2016Q3
2017Q1
2017Q3
2018Q1
2018Q3
baseline
SC4


Metal prices (index, 2005=100)
250
200
150
100
50
0
2012Q1
2012Q3
2013Q1
2013Q3
2014Q1
2014Q3
2015Q1
2015Q3
2016Q1
2016Q3
2017Q1
2017Q3
2018Q1
2018Q3
baseline
SC4


Energy prices (index, 2005=100)
250
200
150
100
50
0
2012Q1
2012Q3
2013Q1
2013Q3
2014Q1
2014Q3
2015Q1
2015Q3
2016Q1
2016Q3
2017Q1
2017Q3
2018Q1
2018Q3
baseline
SC4

APPENDIX 2

Tables 1-3 Estimation results of VARs with next smallest RMSE (average RMSE of all 3 equations), period of selection 2008Q4-2010Q1

Vector Autoregression Estimates
Sample (adjusted): 1999Q2 2013Q4
Included observations: 59 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	G_Q	DCA	DLREER
G_Q(-1)	-0.70413	0.250021	0.001932
	(0.13705)	(0.24233)	(0.001)
	[-5.13766]	[1.03175]	[1.93850]
DCA(-1)	-0.10741	-0.21835	-0.00123
	(0.08353)	(0.14769)	(0.00061)
	[-1.28597]	[-1.47842]	[-2.01887]
DLREER(-1)	10.58086	46.0327	0.375014
	(20.7996)	(36.7768)	(0.15127)
	[0.50871]	[1.25168]	[2.47905]
EA_G_Q	1.674005	1.845714	0.004604
	(0.73584)	(1.30107)	(0.00535)
	[2.27497]	[1.41861]	[0.86030]
EA_G_Q(-1)	-0.13072	-3.24157	-0.00101
	(0.7332)	(1.29641)	(0.00533)
	[-0.17828]	[-2.50043]	[-0.18977]
EA_G_Q(-2)	-1.93159	0.084852	-0.00368
	(0.74183)	(1.31167)	(0.0054)
	[-2.60381]	[0.06469]	[-0.68192]
VIX	0.046653	-0.11319	-2.78E-05
	(0.0586)	(0.10361)	(0.00043)
	[0.79617]	[-1.09249]	[-0.06527]
VIX(-1)	-0.01502	0.20017	0.000204
	(0.06575)	(0.11625)	(0.00048)
	[-0.22845]	[1.72191]	[0.42747]
VIX(-2)	-0.02115	-0.3475	0.000385
	(0.0689)	(0.12183)	(0.0005)
	[-0.30689]	[-2.85227]	[0.76819]
VIX(-3)	-0.06511	0.337242	-0.0006
	(0.05848)	(0.1034)	(0.00043)
	[-1.11331]	[3.26153]	[-1.39800]
DLFOOD	4.031408	-16.5419	-0.05251
	(8.66754)	(15.3255)	(0.06304)
	[0.46512]	[-1.07937]	[-0.83304]

DLFOOD(-1)	-17.9662	9.089036	0.001335
	(7.08874)	(12.534)	(0.05156)
	[-2.53448]	[0.72515]	[0.02589]
DLFOOD(-2)	14.41566	-4.91781	0.036462
	(7.4845)	(13.2338)	(0.05443)
	[1.92607]	[-0.37161]	[0.66983]
DLFOOD(-3)	9.804886	19.1812	-0.04139
	(7.5316)	(13.317)	(0.05478)
	[1.30183]	[1.44035]	[-0.75567]
DLMETAL	1.661284	20.60557	0.017666
	(5.37876)	(9.51048)	(0.03912)
	[0.30886]	[2.16662]	[0.45159]
DLMETAL(-1)	7.355713	-15.2658	-0.03281
	(4.95012)	(8.75257)	(0.036)
	[1.48597]	[-1.74415]	[-0.91121]
DLMETAL(-2)	-4.65991	6.388573	0.006635
	(4.779)	(8.45001)	(0.03476)
	[-0.97508]	[0.75604]	[0.19091]
DLMETAL(-3)	1.163382	5.000861	-0.01885
	(4.92751)	(8.7126)	(0.03584)
	[0.23610]	[0.57398]	[-0.52593]
DLENERGY	5.385519	1.236318	-0.00587
	(4.09931)	(7.2482)	(0.02981)
	[1.31376]	[0.17057]	[-0.19676]
DPB_L	0.291498	-0.12995	-0.00017
	(0.12622)	(0.22318)	(0.00092)
	[2.30944]	[-0.58227]	[-0.18534]
DPB_L(-1)	0.097756	-0.21311	0.000323
	(0.11829)	(0.20915)	(0.00086)
	[0.82642]	[-1.01891]	[0.37556]
DPB_L(-2)	-0.03104	-0.49598	0.001206
	(0.1231)	(0.21766)	(0.0009)
	[-0.25216]	[-2.27866]	[1.34732]
DPB_L(-3)	0.0508	-0.18262	-0.00053
	(0.11437)	(0.20222)	(0.00083)
	[0.44418]	[-0.90309]	[-0.63251]
C	2.296878	-1.98678	0.000111
	(1.51593)	(2.68039)	(0.01103)
	[1.51517]	[-0.74123]	[0.01008]
R-squared	0.61293	0.569087	0.392653
Adj. R-squared	0.35857	0.285916	-0.00646

Sum sq. resids	196.5631	614.5287	0.010397
S.E. equation	2.369829	4.190222	0.017236
F-statistic	2.409697	2.009691	0.983812
Akaike AIC	4.854883	5.994755	-4.99232
Schwarz SC	5.699983	6.839855	-4.14722

Vector Autoregression Estimates
Sample (adjusted): 1999Q2 2013Q4
Included observations: 59 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	G_Q	DCA	DLREER
G_Q(-1)	-0.75547	0.168896	0.001605
	(0.14264)	(0.2546)	(0.00103)
	[-5.29649]	[0.66338]	[1.55755]
DCA(-1)	-0.11006	-0.2216	-0.0012
	(0.0837)	(0.1494)	(0.0006)
	[-1.31493]	[-1.48330]	[-1.97582]
DLREER(-1)	4.303415	44.82584	0.301638
	(22.7956)	(40.6891)	(0.16471)
	[0.18878]	[1.10167]	[1.83131]
EA_G_Q	1.472786	1.6569	0.00234
	(0.76789)	(1.37064)	(0.00555)
	[1.91798]	[1.20885]	[0.42173]
EA_G_Q(-1)	-0.0534	-2.95881	-0.00084
	(0.75435)	(1.34648)	(0.00545)
	[-0.07079]	[-2.19745]	[-0.15418]
EA_G_Q(-2)	-2.0468	0.035455	-0.00577
	(0.74396)	(1.32793)	(0.00538)
	[-2.75123]	[0.02670]	[-1.07350]
VIX	0.040172	-0.12387	-0.00011
	(0.05971)	(0.10657)	(0.00043)
	[0.67283]	[-1.16234]	[-0.25822]
VIX(-1)	-0.02198	0.201209	0.00012
	(0.06703)	(0.11965)	(0.00048)
	[-0.32794]	[1.68165]	[0.24792]
VIX(-2)	-0.02137	-0.34713	0.000443
	(0.06928)	(0.12367)	(0.0005)
	[-0.30844]	[-2.80694]	[0.88402]
VIX(-3)	-0.06056	0.32671	-0.0005
	(0.06002)	(0.10714)	(0.00043)

	[-1.00893]	[3.04947]	[-1.15178]
DLFOOD	8.494117	-12.0065	-0.01381
	(9.86185)	(17.603)	(0.07126)
	[0.86131]	[-0.68207]	[-0.19384]
DLFOOD(-1)	-21.6345	2.422993	-0.02684
	(8.22732)	(14.6854)	(0.05945)
	[-2.62959]	[0.16499]	[-0.45146]
DLFOOD(-2)	11.49801	-6.17482	0.009394
	(8.67427)	(15.4832)	(0.06268)
	[1.32553]	[-0.39881]	[0.14988]
DLFOOD(-3)	12.03719	24.102	-0.0374
	(7.1885)	(12.8312)	(0.05194)
	[1.67451]	[1.87839]	[-0.71995]
DLMETAL	2.442553	21.86795	0.01842
	(5.33841)	(9.52885)	(0.03857)
	[0.45754]	[2.29492]	[0.47753]
DLMETAL(-1)	5.995721	-17.5476	-0.04473
	(5.21812)	(9.31414)	(0.0377)
	[1.14902]	[-1.88397]	[-1.18639]
DLMETAL(-2)	-5.18966	7.104593	0.001469
	(5.18669)	(9.25803)	(0.03748)
	[-1.00057]	[0.76740]	[0.03919]
DLENERGY	4.410543	-0.86479	-0.00831
	(4.0247)	(7.18392)	(0.02908)
	[1.09587]	[-0.12038]	[-0.28567]
DLENERGY(-1)	3.532896	5.913068	0.033038
	(4.49907)	(8.03065)	(0.03251)
	[0.78525]	[0.73631]	[1.01628]
DLENERGY(-2)	2.299409	-0.3872	0.022777
	(4.90448)	(8.75429)	(0.03544)
	[0.46884]	[-0.04423]	[0.64274]
DPB_L	0.302554	-0.10929	-0.0003
	(0.12389)	(0.22114)	(0.0009)
	[2.44206]	[-0.49422]	[-0.33063]
DPB_L(-1)	0.0597	-0.25304	-0.00016
	(0.12594)	(0.2248)	(0.00091)
	[0.47402]	[-1.12562]	[-0.17748]
DPB_L(-2)	-0.08808	-0.5228	0.000555
	(0.14253)	(0.25441)	(0.00103)
	[-0.61799]	[-2.05496]	[0.53848]

DPB_L(-3)	0.038184	-0.1688	-0.00077
	(0.11569)	(0.2065)	(0.00084)
	[0.33006]	[-0.81745]	[-0.92562]
C	2.471755	-1.54113	7.12E-05
	(1.49796)	(2.67379)	(0.01082)
	[1.65008]	[-0.57638]	[0.00657]
R-squared	0.622643	0.571876	0.415573
Adj. R-squared	0.356273	0.269671	0.003036
Sum sq. resids	191.6308	610.5508	0.010005
S.E. equation	2.374068	4.237615	0.017154
F-statistic	2.337516	1.892346	1.00736
Akaike AIC	4.863368	6.022159	-4.99689
Schwarz SC	5.74368	6.902471	-4.11657

Vector Autoregression Estimates
Sample (adjusted): 1999Q2 2013Q4
Included observations: 59 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	G_Q	DCA	DLREER
G_Q(-1)	-0.74621	0.167335	0.001697
	(0.13968)	(0.24852)	(0.00101)
	[-5.34237]	[0.67332]	[1.67679]
DCA(-1)	-0.10593	-0.22229	-0.00115
	(0.0823)	(0.14643)	(0.0006)
	[-1.28710]	[-1.51806]	[-1.93514]
DLREER(-1)	8.508483	44.11774	0.343292
	(20.722)	(36.87)	(0.15015)
	[0.41060]	[1.19657]	[2.28631]
EA_G_Q	1.523366	1.648383	0.002841
	(0.75175)	(1.33756)	(0.00545)
	[2.02643]	[1.23238]	[0.52155]
EA_G_Q(-1)	0.008207	-2.96919	-0.00023
	(0.73449)	(1.30685)	(0.00532)
	[0.01117]	[-2.27202]	[-0.04323]
EA_G_Q(-2)	-2.03367	0.033245	-0.00564
	(0.7351)	(1.30794)	(0.00533)
	[-2.76654]	[0.02542]	[-1.05898]
VIX	0.038366	-0.12357	-0.00013
	(0.05891)	(0.10482)	(0.00043)
	[0.65122]	[-1.17884]	[-0.30288]

VIX(-1)	-0.01608	0.200216	0.000179
	(0.0651)	(0.11584)	(0.00047)
	[-0.24705]	[1.72845]	[0.37842]
VIX(-2)	-0.01712	-0.34785	0.000485
	(0.06792)	(0.12084)	(0.00049)
	[-0.25199]	[-2.87852]	[0.98493]
VIX(-3)	-0.06774	0.32792	-0.00057
	(0.05738)	(0.1021)	(0.00042)
	[-1.18059]	[3.21184]	[-1.37259]
DLFOOD	6.842573	-11.7284	-0.03017
	(9.10801)	(16.2056)	(0.066)
	[0.75127]	[-0.72373]	[-0.45719]
DLFOOD(-1)	-21.8021	2.451218	-0.0285
	(8.12742)	(14.4609)	(0.05889)
	[-2.68254]	[0.16951]	[-0.48391]
DLFOOD(-2)	13.48686	-6.50973	0.029095
	(7.48142)	(13.3115)	(0.05421)
	[1.80271]	[-0.48903]	[0.53671]
DLFOOD(-3)	11.81377	24.13962	-0.03961
	(7.0923)	(12.6191)	(0.05139)
	[1.66572]	[1.91294]	[-0.77072]
DLMETAL	2.047797	21.93442	0.01451
	(5.21251)	(9.27445)	(0.03777)
	[0.39286]	[2.36504]	[0.38416]
DLMETAL(-1)	5.952084	-17.5403	-0.04516
	(5.15882)	(9.17892)	(0.03738)
	[1.15377]	[-1.91093]	[-1.20822]
DLMETAL(-2)	-4.27959	6.951344	0.010484
	(4.75585)	(8.46194)	(0.03446)
	[-0.89986]	[0.82148]	[0.30422]
DLENERGY	4.492351	-0.87856	-0.0075
	(3.97585)	(7.0741)	(0.02881)
	[1.12991]	[-0.12419]	[-0.26024]
DLENERGY(-1)	3.769333	5.873254	0.03538
	(4.4206)	(7.86544)	(0.03203)
	[0.85267]	[0.74672]	[1.10453]
DPB_L	0.289889	-0.10716	-0.00042
	(0.11956)	(0.21272)	(0.00087)
	[2.42470]	[-0.50375]	[-0.48648]
DPB_L(-1)	0.063123	-0.25362	-0.00013

	(0.12432)	(0.2212)	(0.0009)
	[0.50774]	[-1.14655]	[-0.14165]
DPB_L(-2)	-0.0584	-0.5278	0.000849
	(0.12627)	(0.22466)	(0.00091)
	[-0.46251]	[-2.34932]	[0.92749]
DPB_L(-3)	0.049938	-0.17078	-0.00066
	(0.11167)	(0.1987)	(0.00081)
	[0.44718]	[-0.85951]	[-0.81231]
C	2.467609	-1.54044	3.01E-05
	(1.48114)	(2.63535)	(0.01073)
	[1.66602]	[-0.58453]	[0.00280]
R-squared	0.620203	0.571852	0.408472
Adj. R-squared	0.370623	0.290497	0.019753
Sum sq. resids	192.8697	610.586	0.010126
S.E. equation	2.347459	4.176759	0.01701
F-statistic	2.484983	2.032495	1.050817
Akaike AIC	4.835914	5.988318	-5.01871
Schwarz SC	5.681014	6.833418	-4.17361

Table 4 Estimation results of VAR with smallest RMSE of CA equation, period of selection 2008Q4-2010Q1

Vector Autoregression Estimates
Sample (adjusted): 1999Q2 2013Q4
Included observations: 59 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	G_Q	DCA	DLREER
G_Q(-1)	-0.61575	0.210501	0.002249
	(0.13784)	(0.22391)	(0.00093)
	[-4.46701]	[0.94010]	[2.42222]
DCA(-1)	-0.04515	-0.23681	-0.00104
	(0.0843)	(0.13694)	(0.00057)
	[-0.53552]	[-1.72934]	[-1.83531]
DLREER(-1)	9.624347	48.28638	0.363971
	(22.0222)	(35.7726)	(0.14835)
	[0.43703]	[1.34982]	[2.45352]
EA_G_Q	1.263805	1.96112	0.003417
	(0.76143)	(1.23685)	(0.00513)
	[1.65978]	[1.58557]	[0.66613]
EA_G_Q(-1)	-1.01402	-3.03284	-3.40E-03
	(0.68219)	(1.10814)	(0.0046)
	[-1.48642]	[-2.73687]	[-0.74050]

VIX	0.018066	-0.10526	-0.00011
	(0.06105)	(0.09917)	(0.00041)
	[0.29591]	[-1.06137]	[-0.26771]
VIX(-1)	0.021565	0.198026	0.000276
	(0.06837)	(0.11105)	(0.00046)
	[0.31543]	[1.78315]	[0.60001]
VIX(-2)	-0.04435	-0.35512	0.000377
	(0.07202)	(0.11699)	(0.00049)
	[-0.61573]	[-3.03545]	[0.77664]
VIX(-3)	-0.03789	0.32517	-0.0005
	(0.0605)	(0.09827)	(0.00041)
	[-0.62635]	[3.30903]	[-1.22059]
DLFOOD	-0.00583	-15.3005	-0.06464
	(9.03719)	(14.6799)	(0.06088)
	[-0.00064]	[-1.04228]	[-1.06182]
DLFOOD(-1)	-15.8601	7.73801	0.010594
	(7.40413)	(12.0272)	(0.04988)
	[-2.14206]	[0.64338]	[0.21241]
DLFOOD(-2)	13.04464	-4.96824	0.034312
	(7.94369)	(12.9036)	(0.05351)
	[1.64214]	[-0.38503]	[0.64122]
DLFOOD(-3)	4.252161	22.88187	-0.06638
	(6.98626)	(11.3484)	(0.04706)
	[0.60865]	[2.01631]	[-1.41056]
DLMETAL	3.862001	21.48612	0.017783
	(5.54254)	(9.00323)	(0.03734)
	[0.69679]	[2.38649]	[0.47631]
DLMETAL(-1)	7.046076	-15.3657	-0.03292
	(5.26494)	(8.5523)	(0.03547)
	[1.33830]	[-1.79667]	[-0.92827]
DLMETAL(-2)	-5.15913	6.407173	0.005698
	(5.08189)	(8.25496)	(0.03423)
	[-1.01520]	[0.77616]	[0.16646]
DLENERGY	4.885208	0.133609	-0.00213
	(4.19624)	(6.81632)	(0.02827)
	[1.16419]	[0.01960]	[-0.07535]
DPB_L	0.315898	-0.0923	-0.00029
	(0.12757)	(0.20723)	(0.00086)
	[2.47623]	[-0.44541]	[-0.33177]
DPB_L(-1)	0.114743	-0.19362	0.000271

	(0.12383)	(0.20115)	(0.00083)
	[0.92662]	[-0.96258]	[0.32499]
DPB_L(-2)	0.034996	-0.48734	0.001284
	(0.12732)	(0.20681)	(0.00086)
	[0.27487]	[-2.35642]	[1.49706]
DPB_L(-3)	0.116717	-0.17012	-0.00047
	(0.11716)	(0.19031)	(0.00079)
	[0.99621]	[-0.89391]	[-0.58886]
C	1.836871	-1.63353	-0.00215
	(1.57133)	(2.55245)	(0.01058)
	[1.16899]	[-0.63998]	[-0.20346]
R-squared	0.536551	0.564547	0.376171
Adj. R-squared	0.273512	0.317398	0.022106
Sum sq. resids	235.3505	621.0031	0.010679
S.E. equation	2.522068	4.096812	0.016989
F-statistic	2.039816	2.284239	1.062435
Log likelihood	-124.532	-153.154	170.4834
Akaike AIC	4.967178	5.937438	-5.03334
Schwarz SC	5.741853	6.712113	-4.25866

Table 5 Estimation results of VAR with smallest RMSE of GDP growth equation, period of selection 2008Q4-2010Q1

Vector Autoregression Estimates Sample (adjusted): 1999Q1 2013Q4 Included observations: 60 after adjustments Standard errors in ( ) & t-statistics in [ ]			
	G_Q	DCA	DLREER
G_Q(-1)	-0.58475	-0.00589	0.003091
	(0.12746)	(0.26765)	(0.00101)
	[-4.58753]	[-0.02199]	[3.06139]
G_Q(-2)	-0.20246	-0.36978	0.003
	(0.1513)	(0.3177)	(0.0012)
	[-1.33814]	[-1.16392]	[2.50272]
G_Q(-3)	-0.25683	0.104475	0.000757
	(0.14983)	(0.31462)	(0.00119)
	[-1.71412]	[0.33207]	[0.63806]
DCA(-1)	-0.07892	-0.48109	-0.0014
	(0.08886)	(0.1866)	(0.0007)
	[-0.88806]	[-2.57821]	[-1.98405]
DCA(-2)	-0.02064	-0.32264	-0.00094
	(0.09852)	(0.20688)	(0.00078)

	[-0.20945]	[-1.55955]	[-1.20811]
DCA(-3)	0.051023	-0.12076	0.000459
	(0.08209)	(0.17237)	(0.00065)
	[0.62155]	[-0.70058]	[0.70507]
DLREER(-1)	25.73266	47.73235	0.136373
	(19.0476)	(39.9968)	(0.1509)
	[1.35097]	[1.19341]	[0.90373]
DLREER(-2)	-17.8795	35.81563	-0.09167
	(17.973)	(37.7402)	(0.14239)
	[-0.99480]	[0.94900]	[-0.64380]
DLREER(-3)	38.75446	10.88228	0.052775
	(16.367)	(34.3678)	(0.12966)
	[2.36785]	[0.31664]	[0.40702]
EA_G_Q	0.525991	2.682033	0.001237
	(0.66615)	(1.39881)	(0.00528)
	[0.78959]	[1.91736]	[0.23441]
EA_G_Q(-1)	-0.20423	-2.69944	-0.00079
	(0.71045)	(1.49183)	(0.00563)
	[-0.28746]	[-1.80948]	[-0.14029]
EA_G_Q(-2)	-2.15624	-0.11605	-0.00372
	(0.70727)	(1.48515)	(0.0056)
	[-3.04866]	[-0.07814]	[-0.66333]
EA_G_Q(-3)	1.184946	-0.69927	0.00109
	(0.67393)	(1.41513)	(0.00534)
	[1.75827]	[-0.49414]	[0.20408]
VIX	0.032398	-0.08269	-0.0002
	(0.05294)	(0.11116)	(0.00042)
	[0.61198]	[-0.74381]	[-0.46512]
VIX(-1)	-0.02761	0.110018	0.000354
	(0.05829)	(0.1224)	(0.00046)
	[-0.47368]	[0.89883]	[0.76717]
VIX(-2)	-0.01126	-0.15423	3.27E-05
	(0.05587)	(0.11731)	(0.00044)
	[-0.20157]	[-1.31472]	[0.07384]
VIX(-3)	-0.06037	0.18035	1.26E-05
	(0.05031)	(0.10564)	(0.0004)
	[-1.19996]	[1.70722]	[0.03169]
DLFOOD	6.904295	-32.2387	-0.03342
	(7.251)	(15.2259)	(0.05744)
	[0.95218]	[-2.11736]	[-0.58177]

DLFOOD(-1)	-18.2978	3.108144	-0.06933
	(7.28574)	(15.2988)	(0.05772)
	[-2.51146]	[0.20316]	[-1.20110]
DLFOOD(-2)	16.80795	-11.4746	0.054994
	(7.12484)	(14.961)	(0.05644)
	[2.35906]	[-0.76697]	[0.97430]
DLFOOD(-3)	0.63853	20.04355	-0.00883
	(6.83306)	(14.3483)	(0.05413)
	[0.09345]	[1.39693]	[-0.16315]
DLMETAL	0.916909	22.89975	0.027637
	(4.9454)	(10.3845)	(0.03918)
	[0.18541]	[2.20519]	[0.70542]
DLMETAL(-1)	10.05057	-6.00233	-0.00838
	(5.11608)	(10.7429)	(0.04053)
	[1.96451]	[-0.55873]	[-0.20673]
DLMETAL(-2)	-2.46202	7.231095	-0.02191
	(4.52145)	(9.49428)	(0.03582)
	[-0.54452]	[0.76163]	[-0.61170]
DLMETAL(-3)	4.820312	-1.91397	-0.02507
	(4.57601)	(9.60885)	(0.03625)
	[1.05339]	[-0.19919]	[-0.69159]
DLENERGY	8.168641	0.239934	0.001532
	(3.73185)	(7.83625)	(0.02956)
	[2.18890]	[0.03062]	[0.05181]
DPB_L	0.156807	-0.04914	0.000285
	(0.07932)	(0.16656)	(0.00063)
	[1.97692]	[-0.29506]	[0.45419]
C	2.674854	-0.66448	-0.00912
	(1.42442)	(2.99105)	(0.01128)
	[1.87785]	[-0.22216]	[-0.80781]
R-squared	0.723716	0.58462	0.48737
Adj. R-squared	0.490602	0.234142	0.054839
Sum sq. resids	140.3361	618.7829	0.008808
S.E. equation	2.09416	4.397382	0.01659
F-statistic	3.104553	1.668067	1.126787
Log likelihood	-110.627	-155.139	179.6577
Akaike AIC	4.620906	6.10462	-5.05526
Schwarz SC	5.598267	7.081981	-4.0779

Tables 6-8 Estimation results of VARs with smallest RMSE (average RMSE of all 3 equations), period of selection: 1999Q2-2013Q4

Vector Autoregression Estimates
Sample (adjusted): 1999Q2 2013Q4
Included observations: 59 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	G_Q	DCA	DLREER
G_Q(-1)	-0.72988	-0.03959	0.003361
	(0.1834)	(0.35461)	(0.00148)
	[-3.97980]	[-0.11164]	[2.26672]
G_Q(-2)	-0.46038	0.254806	0.002868
	(0.24192)	(0.46776)	(0.00196)
	[-1.90303]	[0.54473]	[1.46634]
G_Q(-3)	-0.41911	0.629621	0.000637
	(0.20839)	(0.40294)	(0.00168)
	[-2.01115]	[1.56258]	[0.37829]
DCA(-1)	-0.10133	-0.4173	-0.00129
	(0.10154)	(0.19634)	(0.00082)
	[-0.99789]	[-2.12544]	[-1.57284]
DCA(-2)	-0.09117	-0.28641	-0.00061
	(0.11955)	(0.23116)	(0.00097)
	[-0.76256]	[-1.23897]	[-0.62676]
DCA(-3)	-0.00229	-0.04305	0.000518
	(0.09694)	(0.18743)	(0.00078)
	[-0.02364]	[-0.22966]	[0.66069]
DLREER(-1)	37.91898	-39.555	0.158945
	(29.0904)	(56.2478)	(0.2352)
	[1.30349]	[-0.70323]	[0.67578]
DLREER(-2)	-27.346	56.26675	-0.0747
	(20.6016)	(39.8343)	(0.16657)
	[-1.32737]	[1.41252]	[-0.44848]
DLREER(-3)	33.15188	11.04691	0.062146
	(17.9854)	(34.7758)	(0.14542)
	[1.84326]	[0.31766]	[0.42737]
EA_G_Q	0.610485	1.577285	0.000232
	(0.81952)	(1.58458)	(0.00663)
	[0.74493]	[0.99540]	[0.03500]
EA_G_Q(-1)	-0.00874	-2.1808	-0.00174
	(0.79151)	(1.53042)	(0.0064)
	[-0.01104]	[-1.42497]	[-0.27126]
EA_G_Q(-2)	-2.26763	-1.42334	-0.00448

	(0.82192)	(1.58922)	(0.00665)
	[-2.75895]	[-0.89562]	[-0.67376]
EA_G_Q(-3)	0.741565	0.205825	0.00205
	(0.76716)	(1.48334)	(0.0062)
	[0.96664]	[0.13876]	[0.33051]
VIX	0.056302	-0.08466	-0.0003
	(0.06049)	(0.11696)	(0.00049)
	[0.93078]	[-0.72389]	[-0.61164]
VIX(-1)	-0.02157	0.140528	0.000185
	(0.06416)	(0.12406)	(0.00052)
	[-0.33613]	[1.13276]	[0.35722]
VIX(-2)	-0.02479	-0.2879	0.000376
	(0.06793)	(0.13134)	(0.00055)
	[-0.36494]	[-2.19193]	[0.68456]
VIX(-3)	-0.08476	0.311819	-0.00015
	(0.06445)	(0.12462)	(0.00052)
	[-1.31518]	[2.50218]	[-0.28308]
DLFOOD	1.946545	1.963754	-0.02865
	(10.4968)	(20.2961)	(0.08487)
	[0.18544]	[0.09676]	[-0.33761]
DLFOOD(-1)	(13.842)	(10.0088)	(0.07928)
	(9.81841)	(18.9844)	(0.07938)
	[-1.40980]	[-0.52721]	[-0.99872]
DLFOOD(-2)	14.96496	-27.2872	0.054132
	(9.73981)	(18.8324)	(0.07875)
	[1.53647]	[-1.44895]	[0.68741]
DLFOOD(-3)	-6.98177	42.0026	-0.02047
	(9.83051)	(19.0078)	(0.07948)
	[-0.71021]	[2.20975]	[-0.25755]
DLMETAL	-1.04524	30.53387	0.0287
	(5.52128)	(10.6757)	(0.04464)
	[-0.18931]	[2.86013]	[0.64291]
DLMETAL(-1)	12.36435	-9.95127	-0.02702
	(5.99602)	(11.5936)	(0.04848)
	[2.06209]	[-0.85834]	[-0.55739]
DLMETAL(-2)	0.094082	5.413969	-0.0258
	(5.58251)	(10.7941)	(0.04514)
	[0.01685]	[0.50157]	[-0.57150]
DLMETAL(-3)	1.417824	-2.19333	-0.00781
	(5.37816)	(10.3989)	(0.04348)
	[0.26363]	[-0.21092]	[-0.17955]

DLENERGY	8.208548	-2.62753	0.005209
	(4.23606)	(8.19064)	(0.03425)
	[1.93778]	[-0.32080]	[0.15210]
DLENERGY(-1)	1.324378	3.997812	0.019982
	(4.64595)	(8.98319)	(0.03756)
	[0.28506]	[0.44503]	[0.53196]
DLENERGY(-2)	-2.94743	8.558686	0.021791
	(5.13488)	(9.92856)	(0.04152)
	[-0.57400]	[0.86203]	[0.52488]
DLENERGY(-3)	7.237186	-1.98704	-0.01102
	(4.78462)	(9.25132)	(0.03868)
	[1.51259]	[-0.21478]	[-0.28479]
DPB_L	0.217844	-0.04119	-0.00043
	(0.13145)	(0.25417)	(0.00106)
	[1.65722]	[-0.16205]	[-0.40641]
DPB_L(-1)	0.209855	-0.19935	-0.00105
	(0.16861)	(0.32602)	(0.00136)
	[1.24462]	[-0.61147]	[-0.76873]
DPB_L(-2)	0.199239	-0.81981	-0.00021
	(0.19898)	(0.38473)	(0.00161)
	[1.00132]	[-2.13086]	[-0.12998]
DPB_L(-3)	0.070866	-0.39925	-0.00056
	(0.13489)	(0.26081)	(0.00109)
	[0.52538]	[-1.53081]	[-0.51205]
C	3.414592	-2.79191	-0.00753
	(1.59606)	(3.08607)	(0.0129)
	[2.13939]	[-0.90468]	[-0.58348]
R-squared	0.7614	0.682354	0.537315
Adj. R-squared	0.446447	0.263062	-0.07343
Sum sq. resids	121.1668	452.9975	0.007921
S.E. equation	2.201516	4.256748	0.0178
F-statistic	2.417507	1.627394	0.87977
Log likelihood	-104.947	-143.849	179.2989
Akaike AIC	4.71005	6.028769	-4.92539
Schwarz SC	5.907275	7.225994	-3.72816

Vector Autoregression Estimates
Sample (adjusted): 1999Q2 2013Q4
Included observations: 59 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	G_Q	DCA	DLREER
G_Q(-1)	-0.73826	-0.02663	0.003407
	(0.17736)	(0.34277)	(0.00143)
	[-4.16246]	[-0.07769]	[2.37779]
G_Q(-2)	-0.46317	0.259122	0.002883
	(0.23732)	(0.45865)	(0.00192)
	[-1.95164]	[0.56497]	[1.50386]
G_Q(-3)	-0.40819	0.612738	0.000577
	(0.20055)	(0.38758)	(0.00162)
	[-2.03537]	[1.58093]	[0.35628]
DCA(-1)	-0.10459	-0.41225	-0.00127
	(0.09896)	(0.19126)	(0.0008)
	[-1.05686]	[-2.15549]	[-1.59252]
DCA(-2)	-0.09841	-0.27521	-0.00057
	(0.11426)	(0.22081)	(0.00092)
	[-0.86127]	[-1.24634]	[-0.61312]
DCA(-3)	-0.00359	-0.04103	0.000525
	(0.09506)	(0.18372)	(0.00077)
	[-0.03780]	[-0.22334]	[0.68355]
DLREER(-1)	37.65098	-39.1404	0.160421
	(28.5477)	(55.1709)	(0.23064)
	[1.31888]	[-0.70944]	[0.69554]
DLREER(-2)	-27.9493	57.19993	-0.07138
	(20.1044)	(38.8536)	(0.16243)
	[-1.39020]	[1.47219]	[-0.43946]
DLREER(-3)	33.29296	10.82867	0.061369
	(17.6528)	(34.1157)	(0.14262)
	[1.88598]	[0.31741]	[0.43029]
EA_G_Q	0.644325	1.524935	4.56E-05
	(0.79479)	(1.53599)	(0.00642)
	[0.81069]	[0.99280]	[0.00710]
EA_G_Q(-1)	0.012993	-2.21442	-0.00186
	(0.77299)	(1.49387)	(0.00625)
	[0.01681]	[-1.48234]	[-0.29713]
EA_G_Q(-2)	-2.24448	-1.45915	-0.00461
	(0.80246)	(1.55082)	(0.00648)
	[-2.79701]	[-0.94089]	[-0.71028]

EA_G_Q(-3)	0.721648	0.236636	0.00216
	(0.74964)	(1.44875)	(0.00606)
	[0.96266]	[0.16334]	[0.35659]
VIX	0.059446	-0.08953	-0.00032
	(0.05823)	(0.11253)	(0.00047)
	[1.02088]	[-0.79557]	[-0.67265]
VIX(-1)	-0.0216	0.140582	0.000186
	(0.063)	(0.12176)	(0.00051)
	[-0.34286]	[1.15462]	[0.36444]
VIX(-2)	-0.0282	-0.28261	0.000395
	(0.06548)	(0.12654)	(0.00053)
	[-0.43072]	[-2.23333]	[0.74622]
VIX(-3)	-0.08655	0.314576	-0.00014
	(0.06294)	(0.12163)	(0.00051)
	[-1.37511]	[2.58627]	[-0.27080]
DLFOOD	1.812035	2.171838	-0.02791
	(10.2951)	(19.8961)	(0.08318)
	[0.17601]	[0.10916]	[-0.33557]
DLFOOD(-1)	-13.6797	-10.2598	-0.08018
	(9.62216)	(18.5957)	(0.07774)
	[-1.42169]	[-0.55173]	[-1.03134]
DLFOOD(-2)	14.62381	-26.7595	0.056011
	(9.47914)	(18.3193)	(0.07658)
	[1.54274]	[-1.46073]	[0.73136]
DLFOOD(-3)	-6.48702	41.23723	-0.0232
	(9.47546)	(18.3122)	(0.07655)
	[-0.68461]	[2.25190]	[-0.30299]
DLMETAL	-0.73048	30.04694	0.026967
	(5.29329)	(10.2297)	(0.04277)
	[-0.13800]	[2.93721]	[0.63057]
DLMETAL(-1)	12.55797	-10.2508	-0.02809
	(5.84342)	(11.2929)	(0.04721)
	[2.14908]	[-0.90772]	[-0.59495]
DLMETAL(-2)	0.181058	5.27942	-0.02627
	(5.47213)	(10.5754)	(0.04421)
	[0.03309]	[0.49922]	[-0.59430]
DLENERGY	8.048405	-2.3798	0.006091
	(4.11657)	(7.95564)	(0.03326)
	[1.95512]	[-0.29913]	[0.18314]
DLENERGY(-1)	1.058916	4.408472	0.021444

	(4.45362)	(8.60701)	(0.03598)
	[0.23777]	[0.51220]	[0.59597]
DLENERGY(-2)	-2.98005	8.609138	0.021971
	(5.0407)	(9.74159)	(0.04072)
	[-0.59120]	[0.88375]	[0.53949]
DLENERGY(-3)	7.663557	-2.64662	-0.01337
	(4.42167)	(8.54527)	(0.03572)
	[1.73318]	[-0.30972]	[-0.37412]
DPB_L	0.22713	-0.05555	-0.00048
	(0.12436)	(0.24033)	(0.001)
	[1.82642]	[-0.23115]	[-0.48080]
DPB_L(-1)	0.222281	-0.21857	-0.00112
	(0.15896)	(0.30721)	(0.00128)
	[1.39831]	[-0.71146]	[-0.86926]
DPB_L(-2)	0.203871	-0.82697	-0.00024
	(0.19462)	(0.37612)	(0.00157)
	[1.04753]	[-2.19869]	[-0.14921]
DPB_L(-3)	0.069883	-0.39773	-0.00055
	(0.1324)	(0.25588)	(0.00107)
	[0.52782]	[-1.55440]	[-0.51699]
C	3.460507	-2.86294	-0.00778
	(1.55788)	(3.01074)	(0.01259)
	[2.22129]	[-0.95091]	[-0.61831]
R-squared	0.760736	0.681789	0.536718
Adj. R-squared	0.466258	0.290145	-0.03348
Sum sq. resids	121.5037	453.8036	0.007931
S.E. equation	2.161763	4.177797	0.017465
F-statistic	2.583336	1.740837	0.941291
Log likelihood	-105.028	-143.901	179.2609
Akaike AIC	4.678928	5.996648	-4.958
Schwarz SC	5.840941	7.158661	-3.79598

Vector Autoregression Estimates
Sample (adjusted): 1999Q2 2013Q4
Included observations: 59 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	G_Q	DCA	DLREER
G_Q(-1)	-0.78873	-0.05592	0.003198
	(0.17278)	(0.32813)	(0.00137)
	[-4.56492]	[-0.17042]	[2.32686]
G_Q(-2)	-0.54494	0.231337	0.002634
	(0.22527)	(0.42781)	(0.00179)

	[-2.41910]	[0.54075]	[1.46997]
G_Q(-3)	-0.43522	0.62515	0.000593
	(0.20746)	(0.394)	(0.00165)
	[-2.09781]	[1.58669]	[0.35920]
DCA(-1)	-0.12567	-0.42406	-0.00136
	(0.09824)	(0.18658)	(0.00078)
	[-1.27918]	[-2.27280]	[-1.73823]
DCA(-2)	-0.14712	-0.30194	-0.00076
	(0.10447)	(0.19841)	(0.00083)
	[-1.40821]	[-1.52177]	[-0.91503]
DCA(-3)	-0.03492	-0.0521	0.000428
	(0.09076)	(0.17236)	(0.00072)
	[-0.38470]	[-0.30227]	[0.59227]
DLREER(-1)	38.23066	-39.4684	0.159807
	(29.0519)	(55.1734)	(0.23112)
	[1.31594]	[-0.71535]	[0.69143]
DLREER(-2)	-28.4668	55.95567	-0.0778
	(20.543)	(39.0139)	(0.16343)
	[-1.38572]	[1.43425]	[-0.47605]
DLREER(-3)	33.09239	11.0304	0.061981
	(17.9626)	(34.1134)	(0.1429)
	[1.84229]	[0.32335]	[0.43373]
EA_G_Q	0.856202	1.645485	0.000911
	(7.78E-01)	(1.48E+00)	(6.19E-03)
	[1.10036]	[1.11351]	[0.14720]
EA_G_Q(-1)	0.138886	-2.13983	-0.00133
	(0.77566)	(1.47307)	(0.00617)
	[0.17906]	[-1.45263]	[-0.21518]
EA_G_Q(-2)	-2.03541	-1.35888	-0.00384
	(0.78503)	(1.49088)	(0.00625)
	[-2.59277]	[-0.91146]	[-0.61412]
	-0.07974	0.078424	0.000101
VIX	0.065201	-0.08219	-0.00028
	(0.05971)	(0.11339)	(0.00048)
	[1.09199]	[-0.72486]	[-0.57794]
VIX(-1)	-0.02131	0.140598	0.000186
	(0.06408)	(0.12169)	(0.00051)
	[-0.33261]	[1.15534]	[0.36488]
VIX(-2)	-0.02964	-0.28924	0.000363
	(0.06766)	(0.12849)	(0.00054)
	[-0.43802]	[-2.25105]	[0.67361]

VIX(-3)	-0.09399	0.309259	-0.00017
	(0.06366)	(0.1209)	(0.00051)
	[-1.47644]	[2.55801]	[-0.34163]
DLFOOD	-0.60266	1.256209	-0.0357
	(10.1473)	(19.271)	(0.08073)
	[-0.05939]	[0.06519]	[-0.44222]
DLFOOD(-1)	-11.983	-9.49286	-0.07414
	(9.61607)	(18.2622)	(0.0765)
	[-1.24614]	[-0.51981]	[-0.96917]
DLFOOD(-2)	12.54988	-27.9576	0.047456
	(9.40203)	(17.8557)	(0.0748)
	[1.33481]	[-1.56575]	[0.63445]
DLFOOD(-3)	-6.59752	42.10925	-0.01941
	(9.81007)	(18.6306)	(0.07804)
	[-0.67253]	[2.26022]	[-0.24868]
DLMETAL	-2.00408	30.26774	0.026049
	(5.42459)	(10.302)	(0.04316)
	[-0.36944]	[2.93804]	[0.60361]
DLMETAL(-1)	13.00903	-9.77234	-0.02524
	(5.9513)	(11.3023)	(0.04735)
	[2.18592]	[-0.86463]	[-0.53309]
DLMETAL(-2)	0.247996	5.456688	-0.02537
	(5.5732)	(10.5842)	(0.04434)
	[0.04450]	[0.51555]	[-0.57219]
DLMETAL(-3)	0.905863	-2.33543	-0.00922
	(5.34526)	(10.1514)	(0.04252)
	[0.16947]	[-0.23006]	[-0.21689]
DLENERGY	8.174609	-2.63695	0.005115
	(4.23056)	(8.0344)	(0.03366)
	[1.93227]	[-0.32821]	[0.15199]
DLENERGY(-1)	0.800046	3.85228	0.018533
	(4.60835)	(8.75187)	(0.03666)
	[0.17361]	[0.44017]	[0.50550]
DLENERGY(-2)	-3.18705	8.492178	0.021129
	(5.12242)	(9.72815)	(0.04075)
	[-0.62218]	[0.87295]	[0.51847]
DLENERGY(-3)	8.016041	-1.77087	-0.00886
	(4.71034)	(8.94555)	(0.03747)
	[1.70180]	[-0.19796]	[-0.23653]
DPB_L	0.241405	-0.03465	-0.00037

	(0.12901)	(0.24501)	(0.00103)
	[1.87123]	[-0.14142]	[-0.35739]
DPB_L(-1)	0.265583	-0.18388	-0.00089
	(0.15825)	(0.30053)	(0.00126)
	[1.67828]	[-0.61185]	[-0.71005]
DPB_L(-2)	0.256731	-0.80385	-5.02E-05
	(0.18964)	(0.36015)	(0.00151)
	[1.35378]	[-2.23198]	[-0.03326]
DPB_L(-3)	0.095567	-0.3924	-0.00049
	(0.13228)	(0.25121)	(0.00105)
	[0.72247]	[-1.56202]	[-0.46578]
C	3.769656	-2.69336	-0.00655
	(1.55126)	(2.94604)	(0.01234)
	[2.43006]	[-0.91423]	[-0.53058]
R-squared	0.752482	0.68211	0.535293
Adj. R-squared	0.447844	0.29086	-0.03665
Sum sq. resids	125.6955	453.3464	0.007955
S.E. equation	2.198737	4.175691	0.017492
F-statistic	2.470087	1.743412	0.935913
Log likelihood	-106.029	-143.871	179.1703
Akaike AIC	4.712846	5.99564	-4.95492
Schwarz SC	5.874859	7.157653	-3.79291