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Impact of Exchange Rate on Macroeconomic Indicators

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***Abstract*—**The exchange rate is a pivotal pricing instrument that simultaneously impacts various components of the economy. Depreciation of nominal exchange rate is export promoting, which might be a desired export-led growth policy, and particularly critical to closing-down the widening current account imbalance. However, negative effects resulting from high dollarization and high share of imported intermediate inputs can outweigh positive effect. The aim of this research is to quantify impact of change in nominal exchange rate and test contractionary depreciation hypothesis on Georgian economy using structural and Bayesian vector autoregression. According to the acquired results, appreciation of nominal exchange rate is expected to decrease inflation, monetary policy rate, interest rate on domestic currency loans and economic growth in the medium run; however, impact on economic growth in the short run is statistically not significant.

***Keywords*—**Bayesian vector autoregression, contractionary depreciation, dollarization, nominal exchange rate, structural vector autoregression.

I. Introduction

DURING the last 10 years, exchange rate volatility increased worldwide as a result of global financial crisis (2008), regional turbulences and the decline in commodity prices, including oil price (2014). In addition, several central banks, including Czech National Bank, People's Bank of China, ECB, started to use exchange rate as a monetary policy instrument to amplify economic growth and achieve their inflation target. Current episodes of exchange rate volatility confirmed that exchange rate is one of the important tools, which can affect country's economic situation, financial stability and social welfare. Taking into account recent events, in-depth analysis of exchange rate effect on macroeconomic environment is becoming significant, in order to inform policy makers and implement optimal economic policies.

The aim of this research is to analyze whether exchange rate depreciation is expansionary or contractionary in Georgia and quantify its impact on macroeconomic variables that are important to policy makers. Using structural and Bayesian autoregression models the paper evaluates effect of nominal exchange rate movement on real GDP growth, inflation, monetary policy rate and interest rate on domestic currency loans.

Georgia, as a high dollarized economy with high share of imported inputs, is an interesting case to analyze contractionary depreciation hypothesis and provides valuable insight for policy makers. In 2017 up to 65% of total loan portfolio and total deposits were in US dollars [1]. In addition, imports used as inputs of production in agricultural, manufacturing, transportation and communication and financial intermediation sectors are as high as 36% in Georgia, which are hence exposed to currency fluctuations [2]. So, the nominal exchange rate depreciation could directly lead to an increase in debt burden and a raise in production costs. Moreover, exchange rate risk is one of the main issues that financial sector in Georgia faces. Banking sector is quite vulnerable with respect to exchange rate depreciation, as it increases credit risk (most of the FX borrowers are not hedged) and rises financial stability concerns. Therefore, this research will give valuable information regarding contractionary depreciation hypothesis in Georgia.

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II. Literature Review

In standard small-open economy models [3], a nominal exchange rate depreciation has an expansionary effect on output through export promotion and import reduction. This impact is mostly valid in traditional Mundell-Fleming-Dornbusch (MFD) models and in the new open economy macro (NOEM) models. However, this impact can be reversed in an economy with high dollarization and high share of imported inputs. Various researchers [4]-[6] found out that exchange rate depreciation can have contractionary impact on output. When liabilities are denominated in foreign currency, while assets are in local currency, exchange rate depreciation deteriorates firms' balance sheet, which subsequently leads to a drop in investment. Therefore, exchange rate depreciation is contractionary if this negative impact outweighs positive impact on net export.

Literature about contractionary depreciation includes paper by Diaz-Alejandro [7], who examined Argentina's devaluation in 1959. He claims that contractionary depreciation happened due to income distribution in favor of people with low-propensity to consume. Another important paper in this subject is by Cooper [8], who evaluated 24 periods of devaluation and concluded that improvement in external position can potentially be outweighed by higher debt service and income redistribution. As Bahmani-Oskooee and Miteza [9] summarized, the main reasons behind contractionary depreciation is income redistribution towards people with low marginal propensity to consume, a drop in investment, increased debt service, decrease in real wealth, possible increase in interest rate, increase in imported input prices, wage indexation based on price levels and increase in cost of capital. However, there is also wide literature that could not

confirm contractionary depreciation hypothesis. For example, Kruegel [10] examined 22 major devaluations of different countries and could not find evidence of contractionary depreciation. Similar result was achieved by Gylfason [11], who examined 32 devaluation periods. Overall, evidence on the contractionary devaluation hypothesis is quite mixed and results depend on country characteristics and adopted methodologies of the different studies.

III. Methodology and Data

Effect of exchange rate differs from country to country, according to the structure of the economy; therefore it is crucial to take into consideration country's characteristics for implementation of correct exchange rate policy. To analyze impact of exchange rate on macroeconomic variables, research is conducted using structural vector autoregression (SVAR) and Bayesian vector autoregression (BVAR). SVAR (proposed by Sims [12]) is an extension of traditional vector autoregression (VAR) analysis. It combines economic theory with time series data to quantify impact and response of variables on different shocks or economic policies. Main advantage of SVAR analysis is that it needs relatively low number of identifying assumptions. Reduced form model can be estimated using restrictions that are based on economic theory. To identify structural shocks from reduced SVAR model, Cholesky decomposition is applied, which is one of commonly used approaches for this analysis. After recovering structural shocks, they can be used to perform impulse response and variance decomposition. Finally, it is possible to evaluate impact of shocks to different variables. A reduced form VAR can be expressed using:

$$Y_t = C_0 + \sum_{i=1}^{n} A_i Y_{t-i} + BX_t + e_t$$

where, Y_t denotes vector of endogenous variables, C_0 – interception coefficients, A_i – coefficient matrix of lags of endogenous variables, B - coefficient matrix of exogenous variables and e_t – vector of structural shocks.

Each equation of the model is measured by minimizing sum of squared residuals. It is important that the model is covariance stationary, so that the impact of shocks in the long run disappears and impulse response functions are correctly estimated. If model is covariance stationary, then its all components are stationary as well.

Additionally, paper uses BVAR to check the robustness of results attained in the structural model. Bayesian estimation used in this study is based on Litterman [13], which partially solves problems of many parameter estimation. According to this methodology, if the database has a short series or is inaccurate, it is better to give more weight to prior probability distribution. By taking into account both database and the prior distribution, model can estimate more parameters and have a better forecasting power than the SVAR model. When the predefined distribution is correctly chosen some researchers conclude that the Bayesian autoregression gives more accurate results than the structural autoregression [14], [15]). According to Litterman approach, the expected value of all lags except the first one is zero, coefficient variation is inversely proportional to the lag sequence and the lag of the variable contains more information about the current state of that variable than the present data of other variables.

VAR analysis is conducted using quarterly data from the first quarter of 2004 to the fourth quarter of 2016. The model consists of 5 endogenous, 1 exogenous and 1 structural change variables. Endogenous variables are: annual growth rate of real GDP, annual inflation rate, monetary policy rate, interest rate on loans issued in national currency and annual growth rate of nominal effective exchange rate. The exogenous variable is change in the net international investment position that reflects the difference between foreign assets and liabilities of the country. Increase in foreign liabilities is expected to have a positive impact on the economic growth in the short term. The structural change dummy variable reflects decrease in potential growth of the economy after the financial crisis [16].

It should be noted that until 2009, the National Bank of Georgia did not use monetary policy rate, because it was targeting monetary base. Therefore, in order to depict monetary policy stance in 2004-2009, similar to the research of Bakradze and Billmeier [17], the paper uses the growth rate of reserve money and short run interbank interest rate. Using these variables, monetary policy rate index is created, whose change corresponds to a change in the monetary policy rate by respective percentage points.

In Cholesky decomposition, order of variables is important to reflect which variables react to other variables' exogenous shock in the same period. Growth rate of gross domestic product is located on the first place, because it does not adjust to the change of other variables in the same quarter. Respectively, inflation is on the following position, which is also quite rigid in the short run. Monetary policy rate is on the third place, because it can adjust to changes in GDP growth and inflation in the same quarter. On the next place follows interest rate on domestic currency loans, which can adjust to changes in above-mentioned variables in the same period. And on the last position is exchange rate, because it reacts to changes to all other variables in the same period.

Based on LR test and Akaike information criterion two lags of endogenous variables have been chosen. The model is covariance stationary, because all roots lie within the unit circle. Therefore, all components of the model are stationary and impulse response functions will be correctly estimated.

IV. Results

According to the obtained results, appreciation of the nominal exchange rate by 1% leads to a gradual reduction in inflation. Inflation in the third-fourth quarter decreases by 0.3 percentage points and then the impact gradually diminishes. As a result of reduction in expected inflation, the monetary policy rate is reduced by 0.15 percentage points in the short term, which in turn decreases interest rates of domestic currency loans by 0.1 percentage points. The impact of exchange rate appreciation on economic growth is negative in the medium term (0.1 pp), but in the short term it is

statistically insignificant. It should be noted that results obtained from alternative models, where variables are sorted in a different order, are not statistically different compared to the results obtained from the baseline model, which confirms the robustness of attained results.

VAR Lag Order Selection Criteria
Endogenous variables: GDP CPI MPI I_GEL_TOT NEER
Exogenous variables: C CRISIS_DUMMY N_F_POS_USD
Date: 03/22/17 Time: 20:55
Sample: 3/01/2004 12/01/2016
Included observations: 49

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-586.9833	NA	32277.56	24.57075	25.14987	24.79047
1	-393.5688	323.6732	33.85354	17.69669	19.24103*	18.28261*
2	-362.7235	45.32371*	28.04283*	17.45810*	19.96766	18.41023
3	-341.9865	26.23869	37.44127	17.63210	21.10687	18.95042

* indicates lag order selected by the 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

Fig. 1 Selection of number of lags

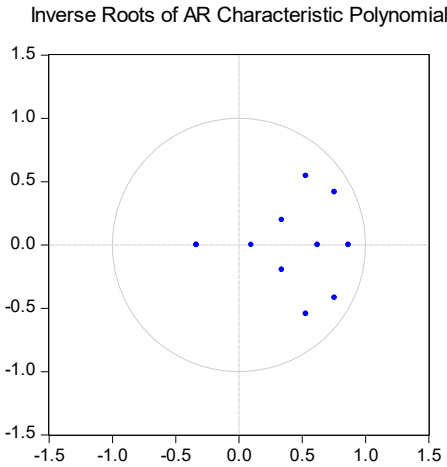

Fig. 2 Covariance stationarity test

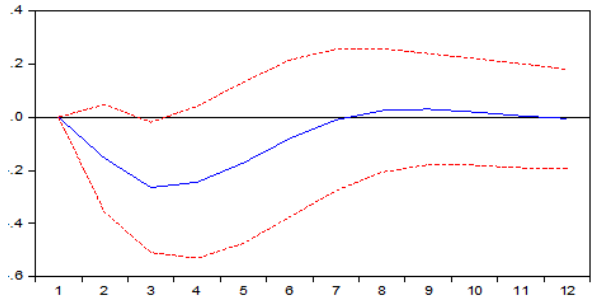

Fig. 3 Impact of nominal exchange rate appreciation by 1% on inflation

The results obtained from BVAR confirm significant effect of exchange rate on macroeconomic variables, although the impact is smaller compared to the effect acquired from SVAR model. According to the results attained from this model, appreciation of exchange rate by 10% is expected to impact inflation in 2-3 quarters and reduces it by 1 percentage points. As a result, monetary policy rate is expected to decrease by 0.7 percentage points, while the interest rate on domestic currency loans declines by 0.5 percentage points. Appreciation of nominal exchange rate has a slight impact on economic growth. Real GDP growth is expected to increase by 0.1 percentage points in the second and third quarter, which might reflect reduction in debt burden. However, in the medium run GDP growth declines and the impact of exchange rate appreciation becomes negative, which reflects undervalued competitiveness.

V. Conclusion

There is vast literature that evaluates impact of nominal exchange rate movement on macroeconomic environment and tests contractionary devaluation hypothesis. However, the evidence on contractionary effect of exchange rate depreciation is quite mixed. So, the question, whether nominal depreciation is expansionary or contractionary remains still open not only in Georgia but also worldwide. This is a very interesting issue in Georgia given its high level of dollarization and high share of imported inputs. This study aims to contribute to expand empirical evidence on this significant topic and using SVAR and BVAR models quantify impact of exchange rate on macroeconomic variables in Georgia.

According to the obtained results, nominal exchange rate appreciation leads to decline in inflation rate, monetary policy rate and interest rate of domestic currency loans, while impact on economic growth is negative in the medium run (1-2 years), but statistically insignificant in the short run. Therefore, it is possible to reject the hypothesis of contractionary impact of exchange rate depreciation in Georgia in the medium term, but in the short run, there is not enough evidence to reject this.

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