# A small scale forecasting and simulation model for Azerbaijan (FORSAZ)

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# A Small Scale Forecasting and Simulation Model for Azerbaijan (FORSAZ)[1]

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**ABSTRACT**

In our study, we model both steady state and short-run dynamics of the important aspects of the national economy using quarterly data for the period 1999Q1-2016Q2. We explicitly model government, money market and external sector, but omit household sector, labor market, wage dynamics and volume of the physical capital specifications due to serious data quality issues. Using Fully Modified OLS (FMOLS) co-integration methodology we explore co-integration relations among the variables. Coefficient estimates of short-run dynamics are in compliance with our ex-ante expectations. Stability tests indicate that the system seems to exhibit stability around its steady state values and model variables converges to their steady state values approximately within 140 periods (2016Q3-2050Q4). Impulse-response analysis also show stable convergence of the model and predict economically consistent results. The results of in-sample and out-of-sample simulation exercises for the inflation, the government consumption and the imports are satisfactory. However, it seems that the model cannot adequately capture ex-post dynamics of NFA and reserve money. In general the results indicate that model can be used for the specific policy analysis and forecasting of main macroeconomic variables of Azerbaijan.

*JEL classification:* C32, C51, C52, E17
*Keywords:* general equilibrium; co-integration analysis; forecast evaluation

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*To those who always inspire, encourage and challenge us*

## 1. Introduction

Modeling emerging market economies is a relatively harder task, especially when a country is a transition economy. In general, one can claim that the starting point for existing economic theories is advanced economies. Nevertheless, testing those theories against data even taken from advanced economies do not always produce expected results. Pagan (2003) claims that there is an inherent tradeoff between theoretical and empirical coherence of economic models. To Hendry and Mizon (2011), there is no such tradeoff if one carefully takes into account general modeling methodology. In particular, a researcher should carefully deal with structural shifts, outliers, external events such as wars and policy shifts, data issues, etc., while developing her models. In short, even "correct" theories will be rejected if one bluntly ignores time series characteristics of data.

A researcher frequently faces theoretically weird empirical findings while working with data from transition economies, especially from CIS countries. Of course, one problem is related to recurrent structural shifts, political instabilities, institutional arrangements, etc. Nonetheless, there are also widespread problems related to the overall quality of data, lax application of international methodological standards by national statistical offices in data collection, processing and reporting, available length of time series, etc. These problems make it indispensible to carefully handle time series properties of economic variables while taking economic models to the data. Researchers also possess fewer clues from economic theories on how to tackle certain peculiarities of transition economies. Though we believe that transition economies are under-researched, in the recent years there are ever increasing trend in the studies devoted to the transition countries. We hope that our recent study on general equilibrium modeling will contribute to the research literature on transition economies as well.

Over the years, a lot of methodological advances took place in the general equilibrium and computationally intensive modeling venue. Since Tinbergen (1937, 1939), Frisch (1938) and Klein's (1950) pioneering works, a lot of invaluable general modeling studies such as Klein-Goldberger model (1952), Christ (1956), Adelman and Adelman (1959), de Leeuw and Gramlich (1968), Andersen and Carlson (1970), Fair (1971), Kmenta and Smith (1972), etc were followed. With rational expectations revolution taking place, researchers tried to come up with model consistent expectations explicitly embedded into their models. Interest in estimating models with forward looking variables surged in parallel to the incredible reductions in computational time requirements. Smets and Wouters (2003) estimate a DSGE model for Euro area using Bayesian techniques, which might be considered a highly computationally demanding exercise before. Nowadays, such DSGE models are main workhorses of the central bankers around the world and one of the core models of their working model suite.

Huseynov and Ahmadov (2013, 2014) develop and estimate a DSGE model for Azerbaijan, which is also a main modeling apparatus for the Central Bank. In their estimation, they first de-trend data and then conduct Bayesian estimation of parameters. However, experience shows that trends are important factors in modeling and forecasting transition economies. When one removes trend from data little information remains for carrying out modeling and forecasting exercise. This fact is in general true for emerging market economies if one remembers *"the cycle is the trend"* catchphrase from Aguiar and Gopinath (2007). Hence, one needs a model which thoroughly treats trends and short-run dynamics of the data simultaneously in the same framework (see, for instance, Fukac and Pagan (2006), Andrle (2008), Ferroni (2011)). The second issue is related to the inadequate dynamics produced by DSGE models relative to what is observed in the data. As Hendry and Mizon (2011) aptly put forward though economic theory is explicit about which variables are relevant in modeling, in general it is reticent about dynamics.

In this study, we use a classical co-integration modeling approach which deals with steady state and short-run dynamics of the economy in a more data consistent way. There are several useful studies on general equilibrium modeling for emerging and transition economies. Khan and Knight's (1980) study on general equilibrium modeling for developing countries is one such important works. There are also several studies on transition CIS economies, such as on Russia (Ayvazyan and Brodskiy (2009), Benedictow, *et al.* (2010), Krepcev and Seleznev (2016), etc), on Belarus (Kruk and Chubrik (2008)) as well as on Kazakhstan (Dufrenot and Sand-Zantman (2010)).

Numerous important studies have been undertaken to model Azerbaijani economy as well. There are various macroeconometric models developed by Hasanli and Ismayilov (1998), Hasanli and Imanov (2001), Hasanli (2007), Hasanov and Joutz (2013), Huseynov and Ahmadov (2013, 2014) for the national economy. Besides, with the technical support of the IMF, Ministry of Finance (MF), Ministry of Economic Developments (MED) and CBAR developed several working Financial Programming (FP) models for policy simulations and econometric forecasting of the national economy.

Our recent work differs from the previous studies of the national economy on several dimensions. First, in contrary to FP models, the incumbent model successfully deals with simultaneity issues. Second, we also carefully develop steady state properties of the model so that it behaves in a theoretically consistent way in the long-run. Third, in contrary to theoretically coherent DSGE models developed by Huseynov and Ahmadov (2013, 2014) for Azerbaijan, we simultaneously handle steady state and short-run dynamics of the model in the same framework. Besides, we also estimate a model with relatively richer short-run dynamics. Fourth, by using longer time series on national economy and making benefit of the recent important economic developments of the last couple of years, our estimates turn out to be more policy relevant.

In our study, we model both steady state and short-run dynamics of the important aspects of the national economy using quarterly data for the period 1999Q1-2016Q2. The model consists of 1 identity, 6 long-run and 6 short-run behavioral equations, and 7 endogenous and 11 exogenous variables. Applying Fully Modified OLS (FMOLS) co-integration methodology we find co-integration relations among the model variables. Coefficient estimates of short-run dynamics are in compliance with our ex-ante expectations, as well. Stability tests indicate that the system demonstrates stability around its steady state values and model variables converges to their steady state values approximately within 140 periods (2016Q3-2050Q4). Impulse-response analysis also emphasizes the stable convergence of the model and predicts economically consistent results. The results of in-sample and out-of-sample simulation exercises for the inflation, the government consumption and the imports are satisfactory. However, it seems that the model cannot adequately capture ex-post dynamics of NFA and reserve money. In general the results indicate that model can be used for the specific policy analysis and forecasting of main macroeconomic variables of Azerbaijan.

The paper is organized as follows: the second section develops theoretical framework for both steady state and short-run dynamics. The third section discusses data issues (more in Appendix) and presents empirical findings. The fourth section checks model validity from various perspectives. The last section concludes.

**Table 1.** Variable notations

| | |
|---|---|
| $y_t$ | real GDP at 2005 constant prices |
| $yn_t$ | real n/o GDP at 2005 constant prices |
| $yo_t$ | physical oil production in thousands tonnage |
| $yn_t^*$ | potential n/o output |
| $b_t$ | total budget expenditures at current prices |
| $g_t$ | government consumption expenditures at current prices (in manat) |
| $i_t^G$ | government investment expenditures at current prices (in manat) |
| $ex_t$ | exports of goods and services at current prices (in USD) |
| $im_t$ | imports of goods and services at current prices (in USD) |
| $t_t$ | total taxes at constant 2005 prices |
| $t_t^{no}$ | n/o taxes at current prices |
| $t_t^o$ | oil taxes at current prices |
| $p_t$ | CPI (December, 2000 = 100) |
| $p_t^o$ | current oil price per barrel in USD |
| $p_t^*$ | trade partners' CPI (December, 2000 = 100) |
| $p_t^{us}$ | US CPI (December, 2000 = 100) |
| $m_t$ | reserve money (in manat) at current prices |
| $e_t$ | nominal AZN/USD exchange rate |
| $neer_t$ | nominal effective exchange rate (December, 2000 = 100) |
| $neer_t^*$ | nominal effective exchange rate excluding AZN/USD rate |
| $nfa_t$ | net foreign assets (in manat) |
| $nda_t$ | net domestic assets |

*Note: We use upper-case letters to denote variables in levels and lower-case to denote natural logarithm of them.*

## 2. Theoretical Model

In this study, we model both steady state and short-run dynamics of the important aspects of the national economy. Since it is intended to be a small scale but operational model we deliberately omit some sectors. In particular, we do not explicitly model the household sector, which we think that, given our modeling experience of the national economy, the cost of omission does not overwhelm the benefit of its inclusion. Labor market, wage dynamics and firms' capital accumulation specifications are also eliminated from the model. This decision in part related to the quality of statistics on the labor market, the wage dynamics and the volume of the physical capital.

Despite omissions of some sectors, our specifications of the government and monetary sectors are relatively richer. In addition, we treat the oil and non-oil sectors as well as tax collections from those sectors separately. Government budget expenditures are classified into two categories: government consumption expenditures and government investment expenditures. Because during most of the sample period the Central Bank pegged national currency (manat) to the US dollar, we treat AZN/USD exchange rate as a policy instrument. Besides, we also make net domestic assets of the Central Bank exogenous, which can be effectively utilized for cyclical adjustment purposes. In addition, we also explicitly model the external sector.

But before we present our specifications for the steady state and short-run dynamics of the model, it is better to define four variables that will simplify our notations in writing equations.

$$Y_t = Yn_t + Yo_t \tag{1}$$

$$T_t = T_t^{no} / P_t + T_t^{o} /(P_t^{o} E_t) \tag{2}$$

$$B_t = G_t + I_t^{G} \tag{3}$$

$$neer_t = 0.94 \cdot neer_t^{*} - 0.06 \cdot e_t \tag{4}$$

The first equation defines total real GDP as the sum of real n/o GDP and real oil production.[4] The second equation defines real total taxes as the sum of real n/o tax payments and oil sector

[4] For the sake of lucid and elegant exposition, we do not express constant multiplications, normalizations and base year adjustments in the above equations. For example, to find total real GDP, it appears as if we solely add real n/o GDP and oil GDP ( $Yn_t + Yo_t$ ) in the above equations without any adjustments. However, in the estimations we carry out all required adjustments. That is, because oil production is expressed in thousands tonnage, but real n/o GDP in mln AZN (2005 constant average prices), to add them we multiply oil production by 7.33 to convert it to thousands barrel, then divide it by 1000 and multiply it to the average oil price ($54.4) and AZN/USD exchange rate (0.95) in 2005. We check whether such calculations are much different from the official total real GDP data. It turn

real tax receipts. The third equation defines nominal budget expenditures as the sum of nominal government consumption expenditures and nominal government investment expenditures. Note that because price deflators are the same both for government consumption and investment expenditures in the last equation real budget expenditures can also be written in the similar way. The fourth equation defines how we link natural logarithm values of the NEER* (excluding AZN/USD bilateral exchange rate) and the AZN/USD exchange rate.[5]

*2.1. Steady State*

There are five steady state economic relations among different variables that we define in our model. The first relation specifies a classical money demand equation, the second and the third the grand ratios of taxes and government expenditures, the fourth defines import demand and the fifth depicts the equilibrium level of the real exchange rate. The equations are listed below (note that we intentionally suppress constants in the equations to make them more readable):

$$m_t - p_t = \gamma_{11} y_t - 4 \cdot \gamma_{12} \Delta p_t + \mu_{m,t} \tag{5}$$

$$b_t - p_t = \gamma_{13} y_t + \mu_{G,t} \tag{6}$$

$$t_t = \gamma_{14} y_t + \mu_{T,t} \tag{7}$$

$$im_t - p_t^* = \gamma_{15} y_t + \gamma_{16}(p_t + neer_t - p_t^*) + \mu_{im,t} \tag{8}$$

$$p_t + neer_t - p_t^* = \mu_{p,t} \tag{9}$$

The first equation is a classical money demand equation with one exception – the opportunity cost of holding money is the rate of inflation instead of an interest rate. Our choice of the rate of (annualized) inflation is mostly related to the empirical findings for Azerbaijan (see, for instance, Mammadov, Ahmadov and Dreger (2016)). Most previous works show that the interest rate has a weaker, if any, impact on the decision making process of the economic agents in the national economy. This is in part related to the underdevelopment of the financial system, weak financial deepening, shallow money and capital markets, etc. Because there is a currency substitution (see Huseynov and Ahmadov (2012)) in the economy people's decisions of holding money is also forged under depreciation expectations of the national currency. However, in the presence of

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outs that there are only minor differences in the levels of the official and the computed total real GDP. Most probably this is due to oil price variable that we employ (price of dated Brent oil) instead of price of Azeri Light.

[5] As in the case of real GDP calculations, the formula for nominal effective exchange rate (NEER) above may appear weird. This expression hides one fact that NEER* is an index (December, 2000 = 100), but exchange rate is the price per US dollar. Recall that every exchange rate in the NEER calculations is expressed in the reverse rate (per manat). Thus, we need to convert exchange rate to an index and then raise power 0.06. That is, the exact formula will be $(neer_t^*)^{0.94}(0.9130/er_t * 100)^{0.06}$ where 0.9130 is the December, 2000 price of US dollar. But when we express it above, we throw away constants and ignore further complications.

inflation as an opportunity cost variable in the money demand equation adding the exchange rate depreciation does not produce plausible economic results. It seems that the inflation variable in the equation captures currency substitution effect as well besides acting as a proxy variable for the opportunity cost of the domestic transaction demand.

The second and the third equations are the standard grand ratio estimations which ensure that in the steady state the government expenditures and the taxes will grow in line with the potential GDP. We think that imposing grand ratio implications on our model can be defended by economic theory and empirical findings of the literature.

The fourth equation expresses import demand as a function of real GDP and real effective exchange rate (REER). As we will discuss in the next paragraph, the real exchange rate is a stationary variable in our model. If we assume that in the steady state REER will be at its mean value, then it is obvious that the long-run behavior of the import will be determined by the potential GDP as in the other grand ratio equations above.

The fifth equation defines one of the important relations of our model. It implies that the real exchange rate is a mean-reverting process and a stationary variable. In fact, a visual inspection of the series as well as various unit root tests undertaken allows us to characterize it as a stationary process.

Long-run behavior of the real exchange rate is crucial in obtaining theoretically consistent and plausible results from the estimated model dynamics. Under the assumption that the exchange rate is pegged by the Central Bank in the model, the real exchange rate will be a stationary process if the law of one price holds.[6] In that case, long-run domestic inflation will be determined by the long-run foreign inflation dynamics abroad, rather than internal forces.

Besides, we also impose this relation on the short-run dynamics of the domestic inflation. This ensures that under the maintained pegged regime inflation is not a domestic phenomenon in the long-run rather it is imported from abroad. However, if we eliminate this relation from the short-run dynamics of the inflation equation, the real exchange rate and the import as well as the reserve money will demonstrate implausible long-run behavior. In particular, the real exchange rate appreciates indefinitely which makes the import grow at a positive rate in the long-run. Therefore, to ensure theoretical coherence, we impose this relation on the short-run dynamics of the inflation model.

There is also a sixth equation which is indispensable in describing long-run relations of the model, but it is not listed under the five equations above. This equation defines the long run behavior of the n/o real output.

We assume that in the long-run n/o real output is only determined by two real shocks, namely productivity (technology) and labor supply shocks (see Shapiro and Watson (1987)). This result can be derived explicitly with minimum number of assumptions.

[6] This is called a weaker version of PPP. International price arbitrage works effectively under fixed regime than flexible ones. See, for instance, Lothian and Taylor (1996), Hayashi (2000, pp. 603-605)

Let's assume that the evolution dynamics of labor supply and technology are defined according to

$$h_t^* = \delta_h + h_{t-1}^* + \Theta_l(L)\nu_t \tag{10}$$

$$a_t^* = \delta_a + a_{t-1}^* + \Theta_a(L)\varepsilon_t \tag{11}$$

where $a_t^*$ and $h_t^*$ are log levels of technology and labor supply whereas $\nu_t$ and $\varepsilon_t$ are mutually orthogonal labor supply and technology shocks. The lag polynomials $\Theta_l(L)$ and $\Theta_a(L)$ are assumed to be absolutely summable. Note that in the long-run labor supply is influenced only by the labor supply shock.

The long-run production function is assumed to be a Cobb-Douglas type with homogenous degree of one:

$$yn_t^* = \alpha h_t^* + (1-\alpha)k_t^* + a_t^* \tag{12}$$

where $k_t^*$ is the long-run level of capital.

Further, suppose that capital-output ratio is constant in the long-run:

$$k_t^* = yn_t^* + \eta \tag{13}$$

where $\eta$ is the constant capital-output ratio in the long-run. If we substitute (13) into (12) and carry out some manipulations yield:

$$yn_t^* = h_t^* + (1/\alpha)a_t^* \tag{14}$$

where the constant $\eta(1-\alpha)/\alpha$ is suppressed. Surely, we can re-write (14) to express the long-run growth rate of output explicitly related to two orthogonal structural shocks above:

$$\Delta yn_t^* = \Theta_h(L)\nu_t + (1/\alpha)\Theta_a(L)\varepsilon_t \tag{15}$$

where we suppress the constant term $\delta_h + \delta_a/\alpha$. To elaborate, as it is obvious from (15) the growth rate of the potential output ($\Delta yn_t^*$) is influenced by both technology (productivity) and labor supply shocks. However, in the short-run output can deviate from its long-run level due to other shocks, for instance, aggregate demand shocks, money supply shocks, or government expenditures shocks, etc.

In our model, potential level of n/o output is exogenous and determined outside of the model. To estimate the potential n/o output, we utilize the Hodrick-Prescott filter ($\lambda = 100$) and feed the trend into the model. The estimated trend dynamics reflects the interaction of the two real shocks – the labor supply and the technology shock. In fact, we could apply the HP filter to productivity ( $yn_t - h_t$ ) variable rather n/o output itself which would provide us with the level of n/o output produced by the technology shock alone. Since the quality of data on labor statistics is not satisfactory we have intentionally avoided this option and preferred applying the filter to n/o output instead.

With an exogenous potential output, our model is closed and can be solved for the steady state values. For instance, using the steady state relation (5) for money demand one can solve for growth rate of nominal money stock in the long-run. Because inflation is a stationary process and will be at its mean value in the long-run the growth rate of nominal money stock can be found using the relation:

$$\Delta m_t^* - \Delta p_t^* = \gamma_{11} \Delta y_t^* \tag{16}$$

The long-run growth rates for other endogenous variables can be worked out similarly using the steady-state relations above.

Equation (16) states that one can easily pin down the long-run growth rate of nominal money stock given exogenous real growth rate of output and long-run domestic inflation (which is determined by the exogenous foreign inflation in the long-run). That is, in our model, three structural shocks – two real (labor supply and technology) and one nominal shock (foreign inflation) explain the long-run dynamics of all model variables.

*2.2. Short-run dynamics*

There are six behavioral equations that describe short-run evolution of the six endogenous variables and one analytical balance identity.

*Reserve money and net foreign assets (NFA)*

We assume that the Central Bank utilizes the bilateral AZN/USD exchange rate as a main policy instrument and pegs it. Mundel's famous *"Impossible Trinity"* hypothesis dictates that a country cannot simultaneously pursue an independent monetary policy with a peg regime under free capital mobility. In our case, this means that because the Central Bank is fixing the exchange rate, it loses control over the money supply. In practice, a perfect capital mobility assumption may not be applicable to Azerbaijan. Though most of the commercial banks enjoyed an easy access to the international capital markets, as a result of the underdeveloped domestic money and capital markets one can hardly characterize capital mobility to the country as perfect. Nevertheless, due to the maintained pegged regime and fiscal dominance the Central Bank exercised only minor control over the money supply. In most of the sample period, at most 10% of the variations in the money supply can be attributed to the Bank interventions (Huseynov and Ahmadov (2014), Rahimov, Adigozalov and Mammadov (2016)).

The only identity of the model links reserve money (in manats) to net foreign assets (NFA) and net domestic assets (NDA) holdings of the Central Bank:

$$M_t = NFA_t + NDA_t \tag{17}$$

NDA is treated as an exogenous variable in the model. In the previous versions of the model, we also decomposed it into two parts – net claims to the central government and net claims on banks. The Central Bank carries out several market operations to control the money supply which are reflected in the net claims on banks. These operations run from REPO and reverse-REPO operations to the direct extension of credits to the commercial banks. Though these operations reflected only the Bank's relatively precarious control over the money supply, we thought it would be worthwhile to explicitly describe it with some modified model specifications (see, for instance, Huseynov and Ahmadov (2013, 2014)). In contrary to our expectations, these modifications did not work well. In fact, as we will see in the upcoming sections, in general it is hard to model money market block of the economy. Therefore, in the current specification, we treat NDA as an exogenous variable. It partly reflects the Bank's ability to curb the money supply, but largely fiscal authorities' firm command of it.

The change in NFA is specified as a function of change in the trade balance (of goods and services), excess money supply, deviations of the real exchange rate from its long-run mean and its own lagged terms:

$$\Delta nfa_t - \Delta er_t = \beta_{11}(L)(\Delta nfa_t - \Delta er_t) + \beta_{12}(L)(\Delta ex_t - \Delta im_t) + \beta_{13}(L)\mu_{m,t} + \beta_{14}(L)\mu_{p,t} \tag{18}$$

where $\beta_{ij}(L)$ are lag polynomials, $\mu_{m,t}$ excess money supply and $\mu_{p,t}$ deviations of the real exchange rate from its long-run mean. The lag polynomials for the current account balance starts from the current period and goes up to the lag order *p*. The remaining lag polynomials begin from the first lag and continue up to the order *p*.

Balance of Payment (BOP) accounting states that change in current account balance (CAB) plus change in capital accounting balance should equal to change in central bank reserves. In the case of Azerbaijan, the changes in these two components should add up to the changes in the Central Bank and SOFAZ reserves taken together. The substantial dollarization occurring in the recent years is recognized as a capital account transaction in the BOP. In the above specification, we abstract ourselves from modeling the primary and the secondary income balances, the capital account transactions as well as the changes in the SOFAZ reserves. We expect that the excess money supply and correcting movements in the real exchange will capture those transactions. Note that we also take into account reserve changes due to an exchange rate movement by modeling the Bank reserves in USD.

*Non-oil output gap*

Though in the long-run n/o real output is affected only by productivity and permanent supply shocks, in the short-run it may temporarily deviate from its potential level due to other shocks. As in Blanchard and Perotti (2002), we assume that n/o output is affected by real government spending and real taxes. Besides, we assume that excess money supply exerts a positive pressure on output gap and boosts it:

$$\begin{aligned}(yn_t - yn_t^*) &= \beta_{21}(L)(yn_t - yn_t^*) + \beta_{22}(L)\Delta(b_t - p_t) \\ &+ \beta_{23}(L)\Delta(t_t^{no} - p_t) + \beta_{24}(L)\mu_{m,t} + \beta_{25}(L)\mu_{p,t}\end{aligned} \quad (19)$$

where as usual where $\beta_{ij}(L)$ are lag polynomials, $\mu_{p,t}$ and $\mu_{m,t}$ represent deviations of the real exchange rate from its long-run level and excess money supply, respectively. The lag polynomials for the real government expenditures and taxes start from the current period and go up to the lag order of *p*. The remaining lag polynomials begin from the first lag and continue up to the order *p*.

One may claim that there exist other channels through which output gap may be influenced. One such channel might be direct effects of oil sector/oil production or oil prices on n/o output. However, there are certain issues that should be considered. First of all, less than 1% of the labor force is employed in the oil sector which produces nearly half of the total GDP. Thus, through spending of the employed people in the oil sector there would be little pressure on the output gap. Second, the State Oil Fund of Azerbaijan (SOFAZ) is established to act as a stabilization fund. Each year the annual oil export revenues are distributed among the AIOC shareholders. The export revenues of Azerbaijan from these operations accrue to the SOFAZ. Each year the SOFAZ undertakes a unilateral transfer from its reserves to the state budget to finance n/o budget deficit. The transfer amount for the next year's budget is determined during a budget planning and preparation period which as usual starts in October of each year and concludes in December. The government prepares next year's budget based on an oil price assumption for the next year. It also enjoys a leverage of giving corrections to the state budget expenditures in May of the current year if deemed necessary. Though there is an official fiscal rule in force (so-called Permanent Income Hypothesis (PIH)), in practice there do not exist any enforcement mechanism and government do not observe the fiscal rule. So, the main channel of the oil sector affecting the economy operates through the fiscal spending which is taken into account in our above specification.

To summarize, because oil sector employment is negligible and oil revenue feeds mainly into the economy through government spending we hope that ignoring channels such as SOCAR spending and other oil processing industry is not pernicious.

*Government expenditure*

In our model, we treat budget investment expenditures as an exogenous variable and only specify a behavioral equation for the government consumption. In general, the budget investment expenditures reflect a discretionary nature of the spending decisions by the government and it is very hard to model. Instead, the government consumption expenditures are relatively well-behaved.

We assume that real government consumption expenditure is a function of its own lagged values, real GDP, real taxes and the deviation its long-run level:

$$\begin{aligned}\Delta(g_t - p_t) &= \beta_{31}(L)\Delta(g_t - p_t) + \beta_{32}(L)\Delta y_t \\ &+ \beta_{33}(L)\Delta t_t + \beta_{34}(L)\mu_{G,t}\end{aligned} \qquad (20)$$

where as usual where $\beta_{ij}(L)$ are lag polynomials and $\mu_{G,t}$ represents deviation of the government expenditures from its long-run level. The lag polynomials for the real GDP and the taxes start from the current period and go up to the lag order of *p*. The remaining lag polynomials begin from the first lag and continue up to the order *p*.

One can argue that in addition to taxes unilateral transfers from the Fund is one of the main financial sources of expanding government expenditures and actively used to close n/o budget deficit. In fact, we tried to introduce the Fund transfers as an exogenous variable to the model and use it in different specifications. It turned out that the Fund transfers do not enjoy a sufficient explanatory power for the variables in the model. Because we introduce oil production as an explanatory variable in the above specification, we think that it effectively captures the Fund transfer effects on government expenditures.

*Taxes*

With the oil boom years of the mid 2000s, the importance of taxes as the main source of government financing declined significantly. In some past years, its share in government financing fell to around 40%. Note that in the national economy tax payments represent n/o tax receipts collected by the Ministry of Taxes, import VAT collections and other customs duties received by the Customs Committee and oil sector tax payments by the SOCAR and AIOC.

Since the tax collection practice and the quality of the tax data are not satisfactory modeling tax revenues is a challenging task. Because oil production is considered as an exogenous process in the model, we treat tax collected from the oil sector as an exogenous variable as well. We model tax collections from both sectors together, so that n/o tax payments are determined as a residual from the total tax collections given the tax payments from the oil sector. We specify real total taxes as a function of its own lagged values, real GDP, real budget expenditures, real imports and deviations from its long-run level:

$$\Delta t_t = \beta_{41}(L)\Delta t_t + \beta_{42}(L)\Delta y_t +$$
$$\beta_{43}(L)\Delta(b_t - p_t) + \beta_{44}(L)\Delta(im_t + er_t - p_t^*) + \beta_{45}(L)\mu_{T,t} \quad (21)$$

where as usual where $\beta_{ij}(L)$ are lag polynomials and $\mu_{T,t}$ represents deviation of the taxes from its long-run level. The lag polynomials for the real GDP, the real budget expenditures and the real imports start from the current period and go up to the lag order of *p*. The remaining lag polynomials begin from the first lag and continue up to the order *p*.

*Inflation*

Several previous studies (Huseynov, *et al* (2014), Ahmadov, *et al* (2016), Rahimov, *et al* (2016)) reveal some essential facts for the inflation determinants and inflation forecasting in the domestic economy. First of all, despite widespread belief that the government budget expenditures play an important role in determining inflation dynamics, the data is not very supportive of that view. Though, we think that the effect of budget expenditures on the domestic inflation works through mainly over the money supply. Second, since 2003 the influence of foreign prices in shaping domestic inflation has been bolstered significantly. Third, in the post-oil boom years, the inflation became difficult to forecast.

In this study, the domestic inflation is defined as a function of its own lagged values, nominal effective exchange rate, foreign inflation, real budget capital expenditures, output gap, money supply and deviation of the real exchange rate from its long-run level:

$$\Delta p_t = \beta_{51}(L)\Delta p_t + \beta_{52}\Delta neer_t + \beta_{53}(L)\Delta p_t^* +$$
$$\beta_{54}(L)\Delta(i_t^G - p_t) + \beta_{55}(L)\Delta(yn_t - yn_t^*) + \beta_{56}(L)\Delta m_t + \beta_{57}(L)\mu_{p,t} \quad (22)$$

where as usual where $\beta_{ij}(L)$ are lag polynomials and $\mu_{p,t}$ represents deviation of the real exchange rate from its long-run level. The lag polynomials for the nominal exchange rate, the foreign inflation, the real budget capital expenditures, the output gap and the money supply start from the current period and go up to the lag order of *p*. The remaining lag polynomials begin from the first lag and continue up to the order *p*.

As we discussed in the previous section, in the long-run inflation is assumed to be determined by the foreign inflation in the trade partners. However, in the short-run the domestic factors expressed in the above equation can be influential on the inflation in the national economy.

**Table 2.** Steady State Estimates

***Money demand***

$$m_t - p_t = -10.7 + 2.1 \cdot y_t - 4 \cdot 1.9 \cdot \Delta p_t$$
$$(0.8) \quad (0.09) \quad (0.6)$$

*Fully Modified OLS*, T = 1999(3) - 2016(2) = 68

*Long-run variance estimate: Bartlett, NW bandwidth = 4.00, long-run* $\hat{\sigma}^2 = 0.15$

***Budget expenditures***

$$b_t - p_t = -7.4 + 1.6 \cdot y_t$$
$$(0.5) \quad (0.06)$$

*Fully Modified OLS*, T = 1999(2) - 2016(2) = 69

*Long-run variance estimate: Bartlett, NW bandwidth = 4.00, long-run* $\hat{\sigma}^2 = 0.05$

***Taxes***

$$t_t = -5.1 + 1.4 \cdot y_t$$
$$(0.5) \quad (0.06)$$

*Fully Modified OLS*, T = 1999(2) - 2016(2) = 69

*Long-run variance estimate: Bartlett, NW bandwidth = 4.00, long-run* $\hat{\sigma}^2 = 0.05$

***Imports***

$$im_t - p_t^* = 0.4 \cdot y_t + 0.9 \cdot (p_t + neer_t - p_t^*)$$
$$(0.15) \quad (0.29)$$

*Fully Modified OLS*, T = 2003(1) - 2016(2) = 54

*Long-run variance estimate: Bartlett, NW bandwidth = 4.00, long-run* $\hat{\sigma}^2 = 0.08$

*Note: Standard deviations are reported in the parenthesis.*

**Table 3.** Short-run Estimates

***Net Foreign Assets (NFA)***

$$\Delta nfa_t - \Delta er_t = \underset{(0.04)}{0.24} \cdot (\Delta ex_{t-3} - \Delta im_{t-3}) - \underset{(0.05)}{0.16} \cdot \mu_{m,t-3} - \underset{(0.08)}{0.24} \cdot \mu_{p,t-1}$$

$OLS$, T = 2000(1) - 2016(2) = 66, $\hat{\sigma} = 0.09$

$F_{AR(1-4)}(4, 54) = 1.49 \quad F_{ARCH(1-4)}(4, 57) = 0.76$

$\chi^2_{normality}(2) = 0.54 \quad F_{Het}(7, 58) = 0.57$

***Output gap***

$$(yn_t - yn_t^*) = \underset{(0.02)}{0.1} \cdot \Delta(b_t - p_t) + \underset{(0.024)}{0.041} \cdot \Delta(b_{t-2} - p_{t-2})$$

$$- \underset{(0.022)}{0.075} \cdot \Delta(t_t^{no} - p_t) - \underset{(0.025)}{0.044} \cdot \Delta(t_{t-1}^{no} - p_{t-1}) + \underset{(0.01)}{0.04} \mu_{m,t-1}$$

$2SLS$, T = 1999(4) - 2016(2) = 67, $\hat{\sigma} = 0.02$

$\chi^2_{BP}(4) = 3.2 \quad F_{ARCH(1-4)}(4, 58) = 2.25^*$

$\chi^2_{normality}(2) = 2.97 \quad F_{Het}(5, 61) = 1.91 \quad J - stat = 0.32$

***Government consumption***

$$\Delta(g_t - p_t) = \underset{(0.11)}{0.23} \cdot \Delta(g_{t-1} - p_{t-1}) + \underset{(0.14)}{0.65} \cdot \Delta y_t - \underset{(0.17)}{0.5} \cdot \Delta y_{t-1}$$

$$+ \underset{(0.08)}{0.15} \cdot \Delta t_{t-3} - \underset{(0.04)}{0.1} \mu_{G,t-1}$$

$2SLS$, T = 2000(2) - 2016(2) = 65, $\hat{\sigma} = 0.04$

$\chi^2_{BP}(4) = 6.93 \quad F_{ARCH(1-4)}(4, 56) = 0.71$

$\chi^2_{normality}(2) = 0.85 \quad F_{Het}(6, 58) = 1.61 \quad J - stat = 17.5$

*Note: $^{***}$ denotes 1%, $^{**}$ 5%, $^{*}$ 10% significance level only for the diagnostics tests. Standard deviations for the regression coefficient estimates are reported in the parenthesis.*

***Taxes***

$$\Delta t_t = \underset{(0.11)}{0.42} \cdot \Delta t_{t-3} + \underset{(0.11)}{0.19} \cdot \Delta t_{t-4} + \underset{(0.32)}{0.61} \cdot \Delta y_{t-1} + \underset{(0.32)}{0.73} \cdot \Delta y_{t-2} + \underset{(0.37)}{0.81} \cdot \Delta y_{t-3}$$

$$-\underset{(0.62)}{1.26} \cdot \Delta y_{t-4} - \underset{(0.1)}{0.25} \cdot \Delta(b_t - p_t) + \underset{(0.24)}{0.59} \cdot \Delta(b_{t-4} - p_{t-4}) - \underset{(0.09)}{0.42}\mu_{T,t-1}$$

$$2SLS,\ \mathrm{T} = 2000(2)\text{ - }2016(2) = 65,\ \hat{\sigma} = 0.09$$

$$\chi^2_{BP}(4) = 4.2 \qquad F_{ARCH(1-4)}(4, 56) = 0.74$$

$$\chi^2_{normality}(2) = 0.3 \qquad F_{Het}(9, 55) = 0.91 \quad J - stat = 5.7$$

***Inflation***

$$\Delta p_t = \underset{(0.10)}{0.23} \cdot \Delta p_{t-1} + \underset{(0.008)}{0.017} \cdot \Delta(i_t^G - p_t) + \underset{(0.3)}{0.86}\Delta p^*_{t-2} - \underset{(0.28)}{0.59}\Delta p^*_{t-4}$$

$$-\underset{(0.04)}{0.24} \cdot \Delta neer_t + 0.09 \cdot \Delta m_{t-1} - \underset{(0.04)}{0.025}\mu_{p,t-3}$$

$$2SLS,\ \mathrm{T} = 2000(2)\text{ - }2016(2) = 65,\ \hat{\sigma} = 0.02$$

$$\chi^2_{BP}(4) = 3.0 \qquad F_{ARCH(1-4)}(4, 56) = 0.26$$

$$\chi^2_{normality}(2) = 2.33 \qquad F_{Het}(18, 46) = 1.31 \quad J - stat = 8.15$$

***Imports***

$$\Delta(im_t - p_t^*) = \underset{(0.1)}{0.18} \cdot \Delta(im_{t-4} - p^*_{t-4}) + \underset{(0.33)}{0.98} \cdot \Delta(p_{t-3} + neer_{t-3} - p^*_{t-3})$$

$$-\underset{(0.35)}{0.96} \cdot \Delta(p_{t-4} + neer_{t-4} - p^*_{t-4}) + \underset{(0.04)}{0.07} \cdot \Delta(b_{t-2} - p_{t-2}) + \underset{(0.04)}{0.11} \cdot \Delta(b_{t-3} - p_{t-3})$$

$$+\underset{(0.08)}{0.39} \cdot \Delta(p^o_{t-1} - p^{us}_{t-1}) - \underset{(0.07)}{0.19} \cdot \mu_{IM,t-1}$$

$$OLS,\ \mathrm{T} = 2003(1)\text{ - }2016(2) = 54,\ \hat{\sigma} = 0.09$$

$$\chi^2_{BP}(4) = 3.8 \qquad F_{ARCH(1-4)}(4, 45) = 0.62$$

$$\chi^2_{normality}(2) = 0.39 \qquad F_{Het}(7, 46) = 1.29$$

*Imports*

In the model, export of goods and services are treated as an exogenous variable. Instead, import of goods and services is explicitly modeled. Imports is defined as a function of its own lagged values, real exchange rate, real output, real budget capital expenditures, real oil price and deviations of real exchange rate from its long-run value:

$$\Delta(im_t - p_t^*) = \beta_{61}(L)\Delta(im_t - p_t^*) + \beta_{62}(L)\Delta(p_t + neer_t - p_t^*) +$$
$$\beta_{63}(L)\Delta y_t + \beta_{64}(L)\Delta(i_t^G - p_t) + \tag{23}$$
$$\beta_{65}(L)\Delta(p_t^o - p_t^{us}) + \beta_{66}(L)\mu_{im,t} + \beta_{67}(L)\mu_{p,t}$$

where as usual where $\beta_{ij}(L)$ are lag polynomials, $\mu_{im,t}$ and $\mu_{p,t}$ represents deviation of the imports and real exchange rate from their long-run levels, respectively. The lag polynomials for the real exchange rate, real output, the real budget capital expenditures and the real oil price start from the current period and go up to the lag order of *p*. The remaining lag polynomials begin from the first lag and continue up to the order *p*.

In addition to real output and real effective exchange rate, we also introduce real budget capital expenditures and real oil price separately to the short-run import equation to account for probable independent effects of both variables.

## 3. Data and Empirical Results

In this section, we describe the data and its sources briefly as well as discuss our empirical findings. Detailed information on the data definitions and its sources can be found in the Appendix.

### *3.1. Data*

In our study, we use quarterly data covering the period 1999Q1-2016Q2. We draw on the data for n/o real GDP, oil production (physical volume), taxes, government consumption and investment expenditures, exports and imports of goods and services, reserve money (in manats), Net Domestic Assets (NDA) and Net Foreign Assets (NFA) of the CBAR, nominal effective exchange rate (NEER) and AZN/USD exchange rate, trade partners' CPI, domestic CPI and Brent oil price.

We compile the data mainly from two sources – the CBAR's and State Statistical Committee's (SSC) statistical bulletins. In general, the data on taxes are collected from SSC bulletins, though the decomposition of the tax data into the oil and the n/o sector is based on the sources from the Ministry of Taxes. Admittedly, it is difficult to find the decomposition of the data on the non-oil and oil sector tax receipts even on annual basis. We interpolate annual data on the tax payments in both sectors to obtain the required decomposition on quarterly basis.

Though government consumption expenditures are readily available from SSC statistical publications on quarterly basis, we prefer to interpolate annual data on government consumption expenditures to produce quarterly figures. Government investment expenditures are also interpolated from the annual data though they are collected from the different source.

We employ three sources to collect the data on imports of goods – *TradeMap*, SSC and Customs Committee. The data on exports of goods and services are from SSC database. Brent oil price is taken from the IMF's monthly commodity price database. Except CPI (from SSC database) all other data series are obtained from the CBAR database (see Appendix).

### *3.2. Empirical results*

In the theoretical part of the previous section, we have discussed our specifications for the steady state relationships and the short-run dynamics. Here, we present our results from both empirical estimations (see Table 2 and Table 3).

#### *3.2.1. Steady-State*

We run co-integration estimations for the 4 long-run relationships and the other two are trivially determined from the statistical/accounting properties of the data. Our co-integration approach is based on Fully Modified OLS (FMOLS) with Bartlett kernel. The sample years for all equations except the import specification covers the period of 1999Q1-2016Q2. We estimate the import equation for the period 2003Q1-2016Q2 instead of the period 1999Q1-2016Q2 which is due to higher sensitivity of the estimates for different sub-sample choices. This shows prevalence of the instability of the import equation estimates over the period under the study. Thus, we prefer to discard the data for the years 1999-2002 and confine our regression estimations for a more recent period of 2003-2016.

We also carry out four co-integration tests (*Hansen instability test*, *Park added variables test*, *Engle-Granger* and *Phillips-Ouliaris tests*) for each estimated long-run relation. Because it is theoretically reasonable to expect the existence of such co-integration relations expressed in our specifications, we are more inclined to accept a co-integration relation if at least two tests do not reject the existence of the co-integration in the estimated equations. The tests confirm that there are co-integration relations among the variables as specified in the above equations. Table 2 shows that the estimates from the equations can be considered satisfactory.

#### *3.2.2. Short-run dynamics*

We report our findings from empirical estimations of the short-run dynamics for six equations in the Table 3 above. We start from a general specification with 4 lags (in addition to current terms) for each variable. We repeat our regression estimations for several iterations. At each iteration of the regression estimation we eliminate the statistically insignificant largest lagged terms. We continue this procedure until only the significant terms (at least at 10% level) remain in the equation. As Pagan (1987) correctly points out the outcome of this modeling procedure may depend on the simplification path chosen. So, if in our simplification procedure results more than one competing models we make a choice among them, which is generally carried out on two criteria: (i) overall plausibility of the model and (ii) its success in satisfying diagnostic checks. We discuss the estimation methodologies, diagnostic tests and some equation specific issues in details below.

*Net Foreign Assets (NFA)*

Drawing on OLS, we run regression estimation for the short-run dynamics of the NFA (in USD) for the period 1999Q1-2016Q2. Because all explanatory variables can be considered exogenous in this equation, our OLS estimates are not contaminated (i.e., biased or inconsistent). Since we employ seasonally adjusted data we do not introduce seasonal dummies explicitly into the equation.

We run our regression estimations with constant term included in all specifications. Though not reported the constant term is statistically significant and retained in our further analysis. When we closely inspect the regression fit as well as the residuals and run diagnostic tests, it seems that there are some problems in the estimation. Some residuals are more than three standard deviations apart from the mean. In some periods, such deviations can be traced back to the specific events happening at that time. For instance, before 2015 the SOFAZ was not smoothing out the supply of foreign currencies to the exchange market. At that time the CBAR was maintaining a hard peg and in one day in December, the CBAR forced to buy a large amount of foreign currency sales of the SOFAZ (approximately 25% of the CBAR current reserves and also far beyond the daily exchange market absorption) from the market to ensure the stability of the exchange rate. So, we introduce dummy for that period to take into account this transaction. The second and the third dummies are introduced to capture two devaluation events and the following melt down in CBAR reserves taking place at that time. The introduction of the other four dummies is related to the quality of the data issues and diagnostic performance of this specification.

The empirical findings from this equation seem to in line with our ex-ante expectations. In particular, the excess money supply appears to exert downward pressure on the Bank reserves which in our opinion captures dollarization effect. In addition, empirical results confirm that the higher domestic prices or overvalued real exchange rate in the long-run stimulate a reduction in CBAR reserves, for instance, due to a rising demand for the imports. The model successfully passes through diagnostic tests – normality (Jarque-Bera test), serial correlation (Breusch-Godfrey test), ARCH and heteroscedasticity (Breusch-Pagan-Godfrey) tests.

*Output gap*

Output gap estimation is carried out based on the 2SLS methodology for the period 1999Q1-2016Q2. The instrument set for the estimation includes the four lagged values of the output gap, the budget capital expenditures, the cyclically adjusted non-oil taxes, in addition to the current values of the explanatory variables, a period lagged of the excess money and the real exchange rate. Because we employ the cyclically adjusted non-oil taxes[7] as instruments in the equation, we expect that it will be uncorrelated with the error term of the equation (see, Blanchard and Perotti (2002)).

Since in the final specification the number of instruments is more than the included variables in the equation, we also report the result of the overidentifying restriction test (*J-stat*). Specific to that equation, though we started with four lags in the instrument set, in the final specification we only include two lags of all variables. Though we restrict the number of lags in this equation to the two lags, in the final equation the most variables have only one lag and no single variable has a lag order higher than two.

The coefficient estimates are in compliance with our ex-ante expectations. An increase in real budget expenditures and excess money supply lead to an expansion of the output gap whereas a rise in the tax burden has a reverse effect. The final specification passes successfully through all tests except the presence of ARCH effect in residuals which is barely significant at 10% significance level. If we investigate output gap estimates over the sample period, it seems that they are not very precise which in general complicates further analysis. The experience shows that when one removes trends from the economic variables in countries like Azerbaijan, little information remains in the data.

*Government consumption*

We run regression estimation for the government consumption using 2SLS approach over the period 1999Q1-2001Q2. In the instrument set, we include four lagged values of the government consumption, the n/o potential output, the oil production, the tax collections from the oil sector, the one lagged value of the error correction term in addition to the current values of the explanatory variables. We introduce one dummy variable for the period 2015Q4 to account for the fiscal austerity measure taken at that time, which caused a large slump in the government investment expenditures.

The coefficient estimates of the specification seem to take economically plausible values. The output growth positively contributes to the growth in government consumption in two subsequent periods. There is also a three period lagged positive feedback from a rise in tax receipts. Only 10% of the deviations from the long-run level are corrected in one quarter or it takes approximately 2.5 years to fully restore equilibrium after a shock. The estimated equation displays satisfactory performance in the diagnostic checks.

[7] For cyclically adjusted fiscal balances, see, for instance, Girouard and Andre (2005), Fedelino, Ivanova, and Horton (2009) and Villafuerte and Loperz-Murphy (2010). We set the revenue elasticity equal to one.

*Taxes*

The tax equation[8] is also estimated based on the 2SLS approach for the period 1999Q1-2016Q2. We use the four lagged values of the taxes, the budget capital expenditures, the n/o potential output, the oil production and one lag of the error correction term in the instrument set.

As Table 3 shows, the regression estimates appear fairly plausible and satisfactory. No constant term and dummies are statistically significant in the final specification. The real output has significant effects for all lags except the current term. Though the budget capital expenditures have negative effect on impact, the overall effect of the budget expenditures on the tax receipts is positive. Error correction term is also significant, i.e., it takes approximately less than a year to restore the equilibrium. The final specification satisfies all diagnostic checks.

*Inflation*

2SLS coefficient estimates for the inflation equation are reported in the Table 3. In the instrument set the four lagged values of the inflation, the foreign inflation in trade partners, the change in nominal effective exchange rate, the output gap, the change in oil price, the change in oil production and one lag of the deviation of the real exchange rate from its long-run level in addition to the current values of the explanatory values are included. Though most variables in the estimation can be considered exogenous, there would be endogeneity issues due to the presence of the reserve money in the equation if we rather employed OLS approach. Moreover, since we deflate the budget capital expenditures with the CPI, we prefer not to include the real budget capital expenditures in the instrument set.

Eliminating insignificant terms when moving from our general specification to a more specific one, we obtain different competing models. In some of them, the deviation of the real exchange rate from its long-run level is found to be statistically significant. Even in specifications in which it is insignificant, the significance level is around 15%-20%. As we discussed in the previous sections, for a theoretically consistent long-run behavior of the model as a whole, the domestic inflation should be imported from the abroad at the steady state. Though in the short-run domestic or other factors may have influences on the inflation dynamics, these effects should be transitory. Therefore, to ensure theoretical consistency of the model, we calibrate the error correction coefficient around 2.5% and impose this relation on the inflation equation while carrying out the regression estimation. The choice of this magnitude for the coefficient is due to the fact that it is within 95% confidence band of the estimates of the specifications where it is found to be statistically significant.

[8] In this block we obtain two competing equation estimates both of which retain almost the same explanatory power. In the first one, real import explicitly enters the final specification whereas in the second it is absent. The RHS variables in the two final specifications are almost the same (one lag from the real budget expenditures and two lags from the real output are missing in the first specification). The coefficient estimates in the two equations are very similar except for the real output. However, we prefer to continue with the second specification mainly due to two reasons: (i) import coefficients add up to zero in the first specification (ii) the coefficient estimates of the second specification are economically more reasonable.

In the final specification, no constant term or dummies are statistically significant. In the short-run the most important factors determining the domestic inflation behavior can be considered the nominal exchange rate and the imported inflation. Though relatively small, a rise in the real budget capital expenditures or the money supply exerts a positive pressure on the inflation. The final model successfully passes through all diagnostic checks.

*Imports*

Using 2SLS approach, we run regression estimation for the period 2003Q1-2016Q2. In the instrument set, the four lagged values of the imports, the real exchange rate, the real budget investment expenditures, the n/o potential output, the oil production, the real oil price and one lag of the error correction term, in addition to the current values of the explanatory values are included. Because in the final specification only exogenous variables appear to be statistically significant 2SLS coefficients are similar to the OLS estimates. Thus, in our final estimation we prefer to base our results on the OLS approach. No constant term or dummies do appear statistically significant in the final equation.

Though the real output growth rates are found to be statistically insignificant, the real budget capital expenditures and the real oil price have significant effects on the imports in the short-run. The real exchange rate influences the imports over the two lags, but the overall effect is close to zero. The model satisfies all diagnostic checks.

## 4. Model Validation

In the previous section, we discussed the empirical estimation of the model equations using the limited information techniques. Overall, the individual blocks have plausible coefficient estimates and perform satisfactorily in the diagnostic checks. Nevertheless, one needs to conduct a performance evaluation of the model as a whole rather than assessing its individual blocks separately. For that, we will carry out the stability test of our non-linear model, implement the impulse-response analysis, run the static and dynamic simulations, as well as check for the ex-post forecasting performance of our model.

### *4.1. Stability of the steady state*

Since the estimated model incorporates non-linear relations, we run numerical simulations to check for the stability of the steady state. We simulate the model for 2,000 periods (quarters) but it seems that the model variables converges to their steady state values approximately within 140 periods (2016Q3-2050Q4), hence we report our results for the latter case.

To simulate the model we need to define a trajectory for each exogenous variable. For most of *I(1)* variables, we assign a constant growth path for their levels. In particular, we assume that at the steady state, the total real output grows at a 2% annual rate. The other domestic exogenous variables grow at the same rate with the output, so that their shares to the output stay constant in the long-run. Exports grow at a rate which will be consistent with a balanced trade account in the

# Stability Analysis

**Figure 1.** Inflation

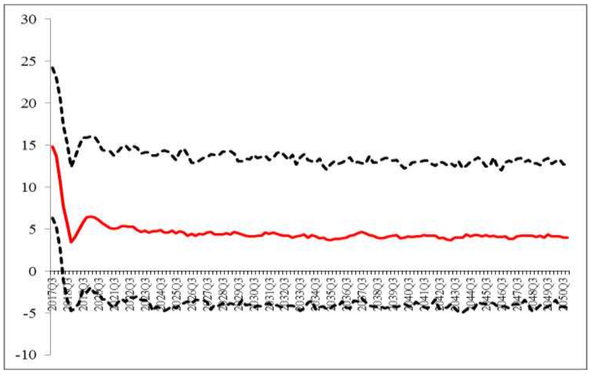



**Figure 2.** n/o Growth

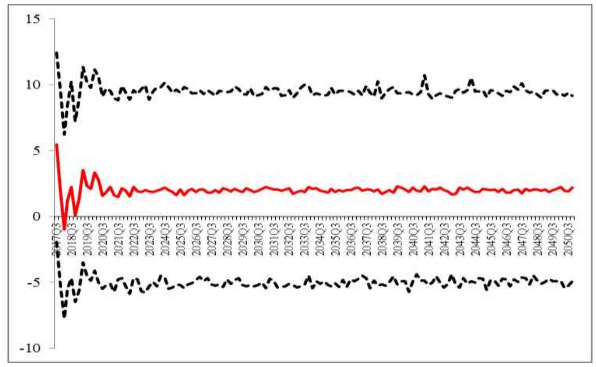



**Figure 3.** Government consumption

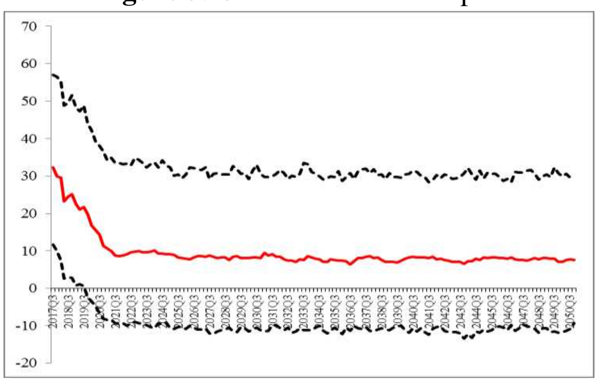



**Figure 4.** n/o Tax

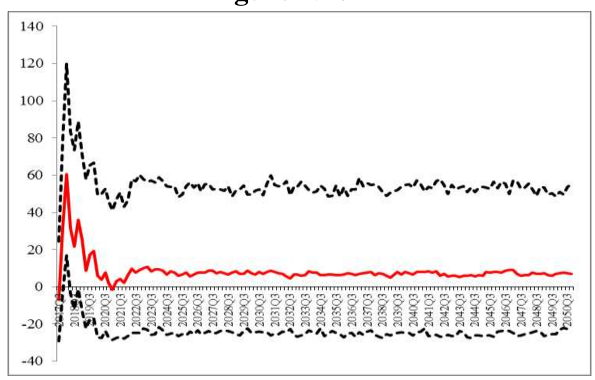



**Figure 5.** Reserve money

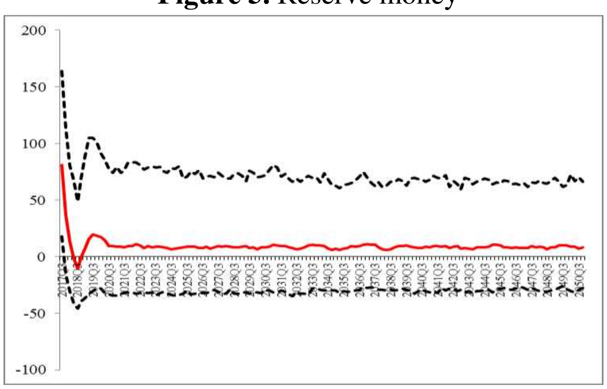
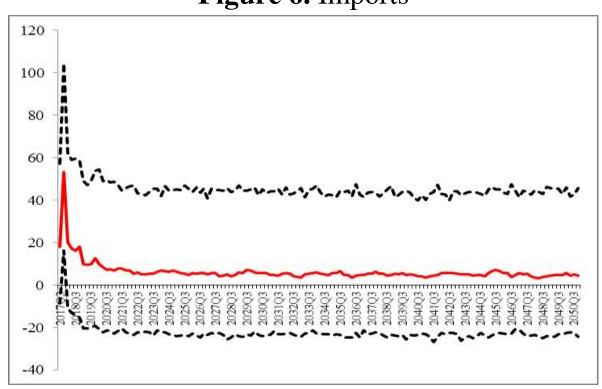



**Figure 6.** Imports



long-run. We assume that oil prices will stay at $50 per barrel in the long-run. We also fix the bilateral USD/AZN exchange rate and NEER (excluding USD/AZN rate) at the current levels. We assign a 4% annual path for the foreign inflation rate (*I(0)* variable).

We report the medians of the endogenous variables along with their respective 95% confidence bands from the stochastic simulation exercise in the Figures 1-6.[9] We present the results of all variables expressed at annual growth rate terms. As it can be deduced from the graphs all variables settle down to their respective long-run values. The system seems to demonstrate stability around its steady state values.

In the long-run, the domestic inflation converges to the foreign inflation rate in trade partners. The real GDP grows at 2% annual rate in the long-run. All other variables' steady state values can be derived from the long-run inflation and real GDP growth rates.

### *4.2. Impulse-response analysis*

A reliable way of checking the plausibility of the model dynamics is conducting impulse-response analysis. In our impulse-response analysis, we shock the system with different shocks, namely, AZN/USD exchange rate shock, NEER shock, budget capital expenditure shock and oil production shock. The impulse-response functions are calculated as percentage deviations from their respective values in the baseline scenario which is the same scenario for the stability analysis.

The impulse-response results of inflation, n/o output growth and import growth to a 10% depreciation shock of AZN/USD exchange rate are presented in the Figures 7-9. The responses of inflation and n/o output growth to the shock are in line with our expectations though the response magnitudes are smaller, especially for n/o output growth. It seems that 10% depreciation of the national currency against the USD (other exchange rates being constant) on average only contribute 0.4% points to the n/o output growth on cumulative basis during a year. In the case of the imports, though in the fourth quarter after the shock the import growth jumps to a large positive value, in the other subsequent quarters the responses are as expected.

In the above exercise we only shock the AZN/USD exchange rate, but hold other exchange rates vis-à-vis the national currency (AZN) constant. This might mean that they also depreciate at the same rate with the AZN. In contrary, in the exercise with the NEER shock, we let the weighted average exchange rates with the trade partners (except US) to depreciate at the same rate with the AZN/USD exchange rate. The results of this impulse-response exercise are given in the Figures 10-12. From the graphs it seems that the response dynamics of the respective variables are similar to the previous case with one exception – the response magnitudes are relatively larger. For instance, a 10% NEER depreciation shock leads to a 2.5% rise in inflation on impact. The cumulative increase in inflation during a year is a little more than 5.2%.

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[9] All stochastic simulations are taken with 1,000 replications for nearly 140 periods (2016Q3-2050Q4) using Broyden solution algorithm. The result for the NFA is not reported to save space, but its dynamics is similar to that of the reserve money.

## Impulse-response analysis

*(% deviations from the baseline)*

**Figure 7.** Inflation (*10% AZN/USD shock*)

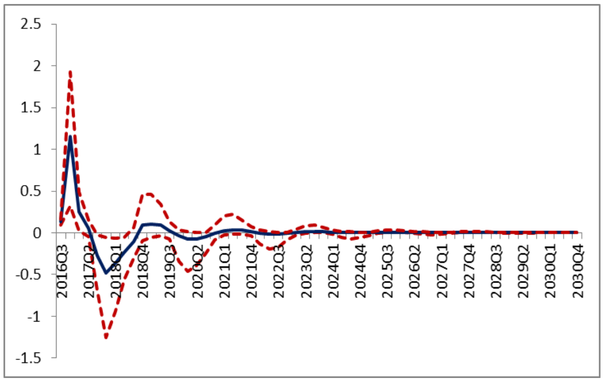


**Figure 8.** n/o Growth (*10% AZN/USD shock*)

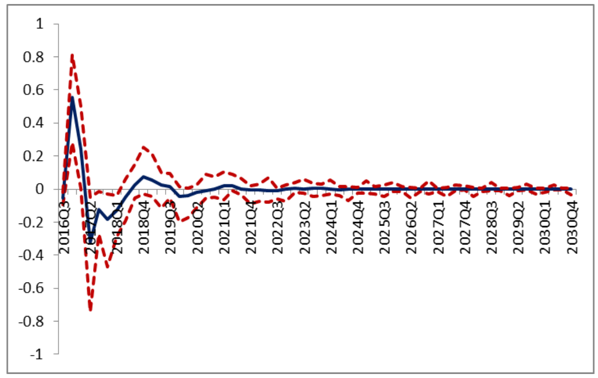


**Figure 9.** Imports (*10% AZN/USD shock*)

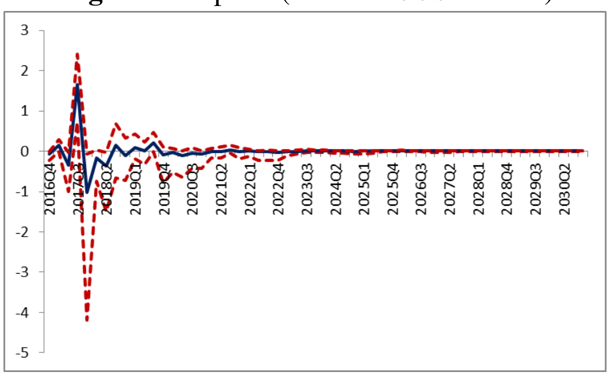


**Figure 10.** Inflation (*10% NEER shock*)

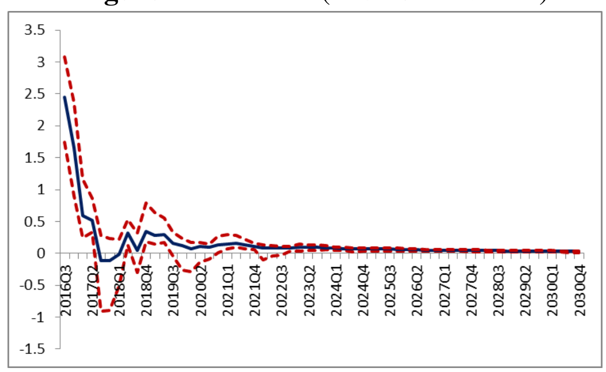


**Figure 11.** n/o Growth (*10% NEER shock*)

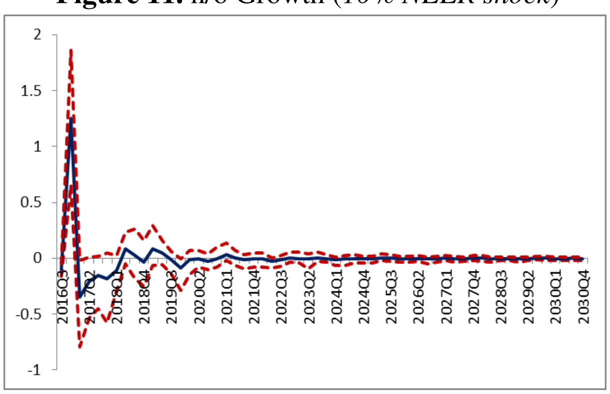
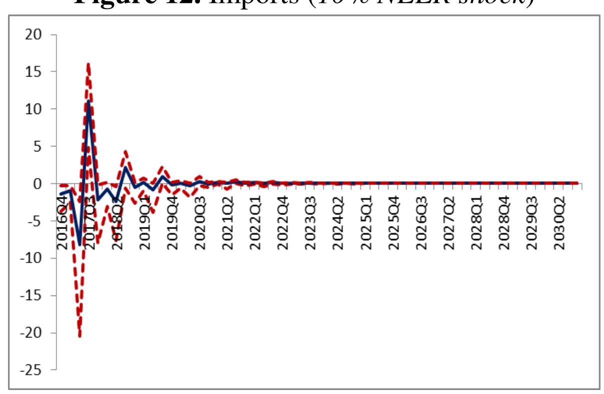


**Figure 12.** Imports (*10% NEER shock*)



## Impulse-response analysis

*(% deviations from the baseline)*

**Figure 13.** Inflation (*10% b/expenditure shock*)

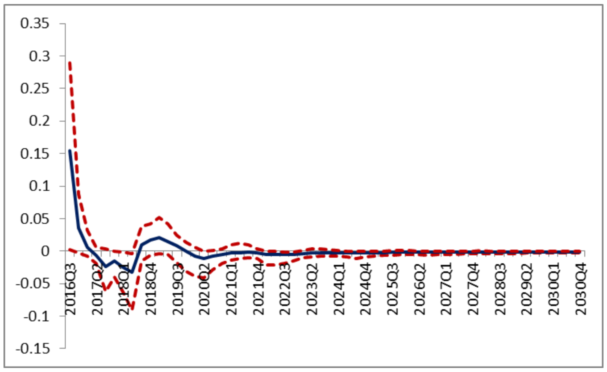



**Figure 14.** n/o Growth (*10% b/expenditure shock*)

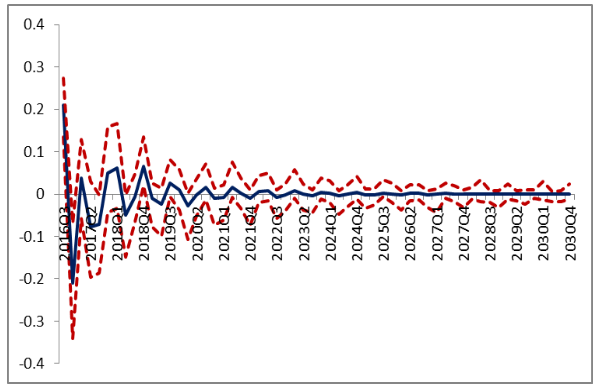



**Figure 15.** Imports (*10% b/expenditure shock*)

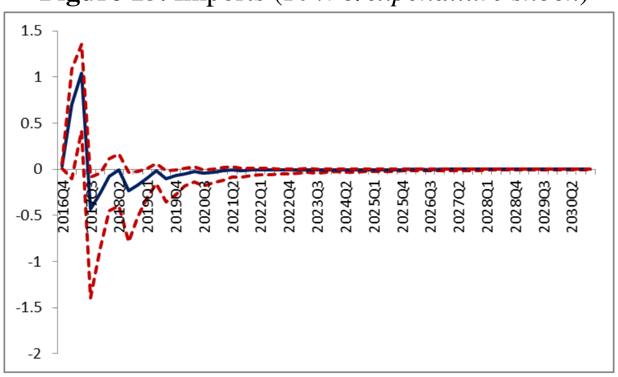



**Figure 16.** Inflation (*10% o/prod shock*)

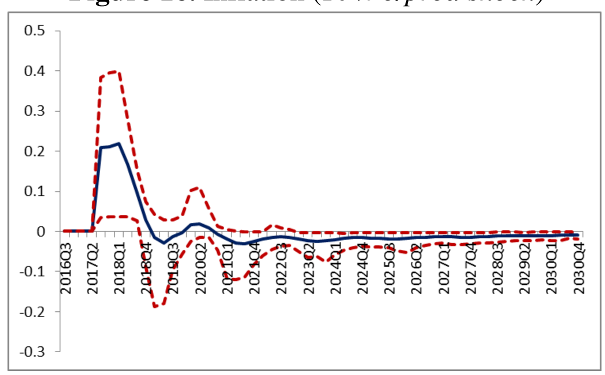



**Figure 17.** n/o Growth (*10% o/prod shock*)

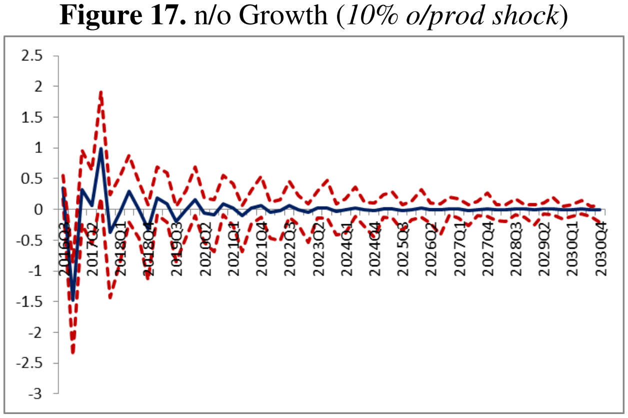
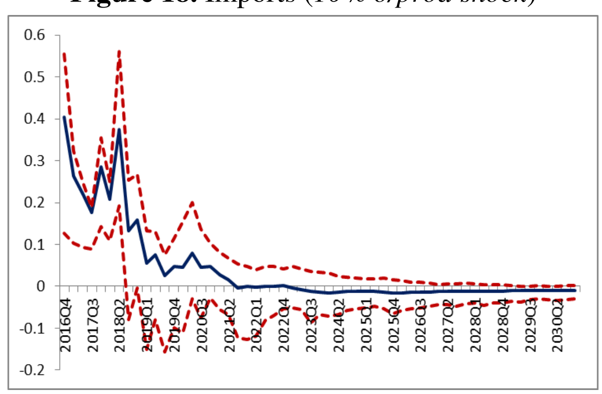



**Figure 18.** Imports (*10% o/prod shock*)



However, as in the previous case, depreciation of the NEER does not notably improve n/o output growth. The cumulative decline in imports in the two subsequent years after this shock is about -4.6%.

The Figures 13-15 depict a 10% increase in the nominal budget capital expenditure. It has very small effects on inflation as well as on n/o output growth rate. The impact multiplier effect is around 0.18 (i.e., 1 AZN increase in real budget capital expenditures induces 0.18 AZN rise in real n/o GDP) and the long-run multiplier is around zero. However, a 10% rise in the budget capital expenditures stimulates a cumulative 1.4% increase in the imports within a year.

The responses of the respective variables to a 10% increase in the oil production are reported in the Figures 16-18. As seen from the graphs, it has small effects on inflation and n/o output growth, i.e., it leads to a 0.8% and 0.11% rise in inflation and n/o output growth in two years. However, in the eight subsequent quarters a 10% increase in the oil production result in a cumulative 2.1% rise in imports.

### *4.3. Static and dynamic simulations*

The static simulation results for all endogenous variables (except NFA) over the period 2006Q1-2016Q2[10] are depicted in the Figures 19-24. We do not report the confidence bands for this exercise since the predicted values are very close to the actual values.

As can be seen from the graphs, the model demonstrates a sufficiently good prediction performance for the inflation, the government consumption, the imports and the reserve money. However, the forecast performance relatively deteriorates for the n/o output growth rate and the taxes over the period. This deterioration is especially visible over the period 2007-2008 both for the n/o output growth and the taxes. For this period, it seems that the forecasted turning points are lagging behind the actual turning points. Starting from the year 2010, the forecast performance improves for both variables.

The dynamic simulation results for the six endogenous variables are given in the Figures 25-30. We also report 95% confidence bands obtained from the stochastic simulation exercise with 1,000 replications including both shock and coefficient uncertainties.

The dynamic simulation results for the inflation, the government consumption and the imports are satisfactory. However, it seems that the model cannot sufficiently capture higher inflation and government consumption growth period of the 2007-2008. During that period the model is underpredicting the inflation and the government consumption growth. Even in the case of the government consumption the actual annual growth values do not even fall into the 95% forecast interval for the two quarters (2007Q2 and 2007Q3). Except for some short span, the forecasts for those variables are notably good at capturing turning points. Excluding the years of 2007-2008, the n/o tax forecasts display a reasonable performance in capturing turning points as

[10] Because some of the model equations are estimated for the period 2003Q1-2016Q2, we simulate the model for the period 2005Q1-2016Q2. We calculate predicted values for the annual growth rates of each endogenous variable, so the forecast period for the growth rates covers 2006Q1-2016Q2. As usual, to save space, we do not report the results for the NFA, but the fit of NFA is better than that of the reserve money.

## Historical static simulation

**Figure 19.** Inflation

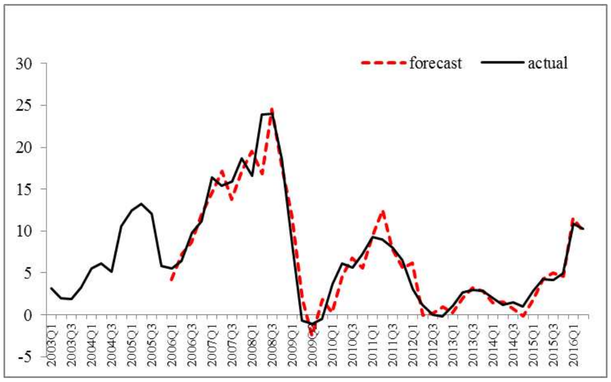



**Figure 20.** n/o Growth

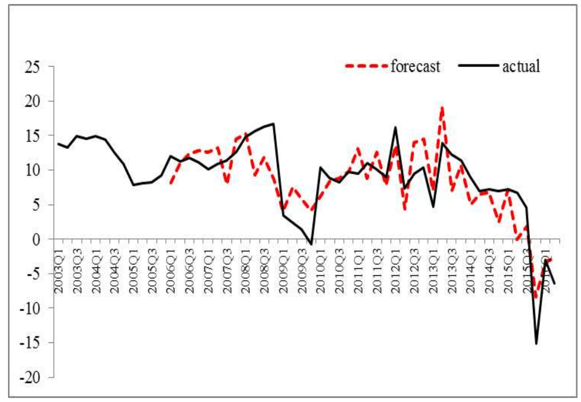



**Figure 21.** Government consumption

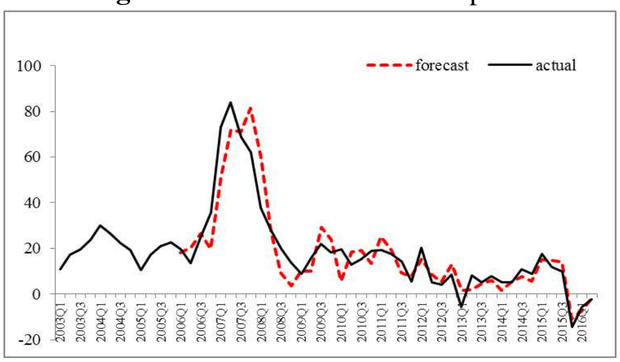



**Figure 22.** n/o Tax

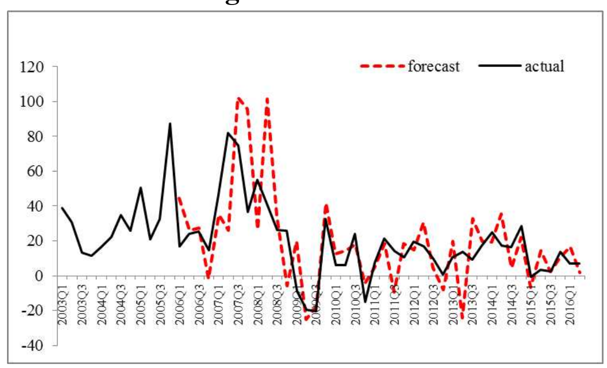



**Figure 23.** Reserve money

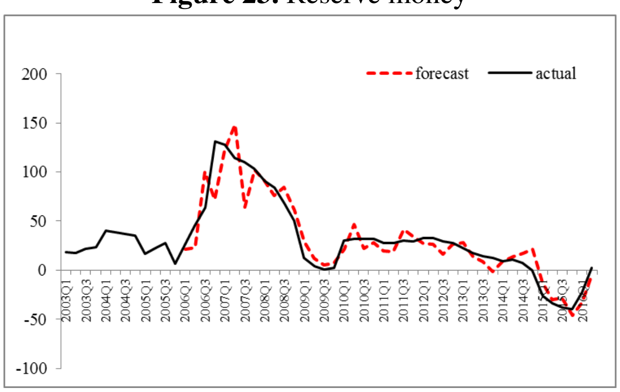
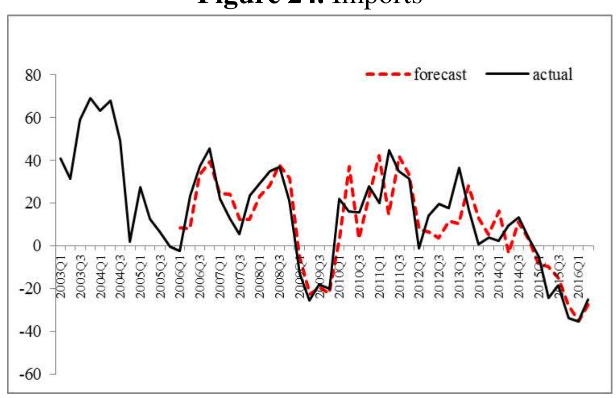



**Figure 24.** Imports



## Historical dynamic simulation

**Figure 25.** Inflation

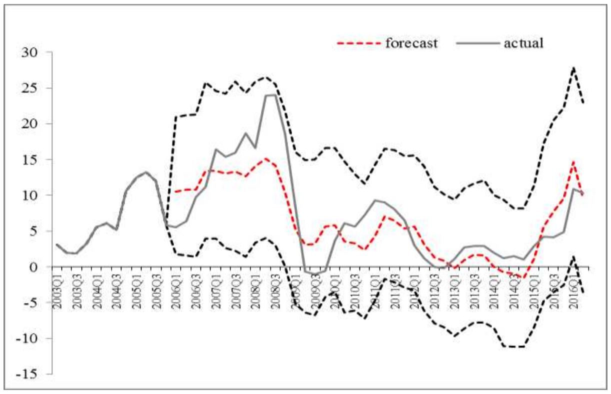



**Figure 26.** n/o Growth

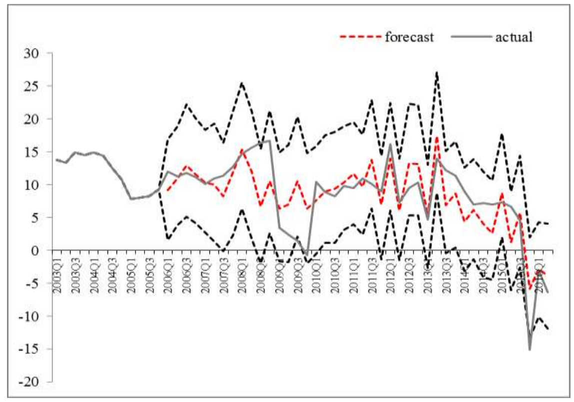



**Figure 27.** Government consumption

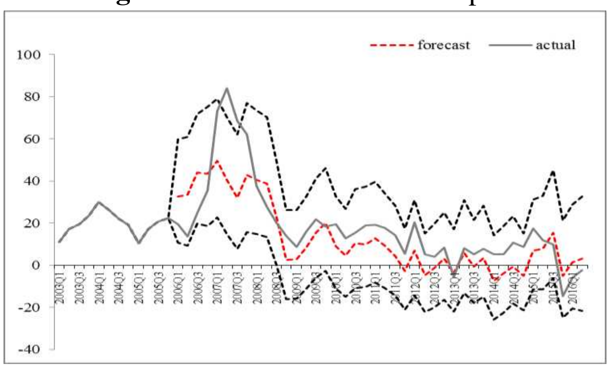



**Figure 28.** n/o Tax

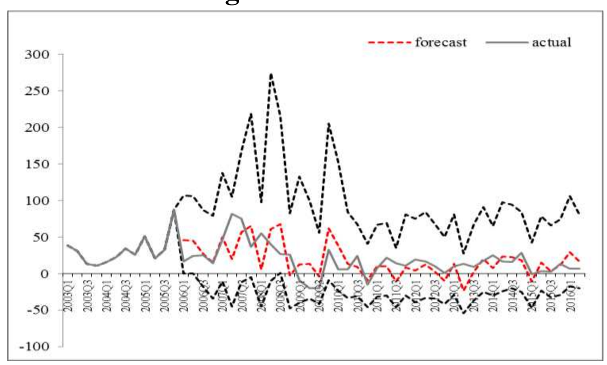



**Figure 29.** Reserve money

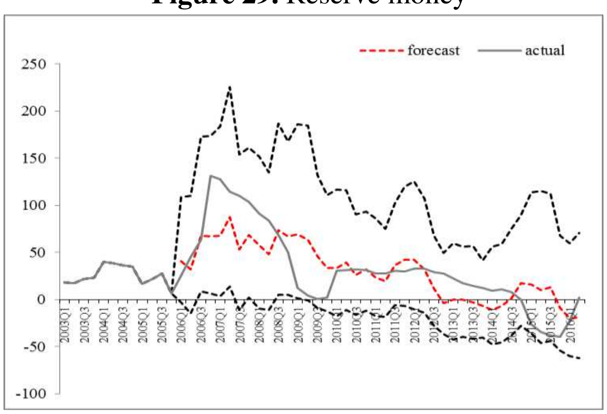
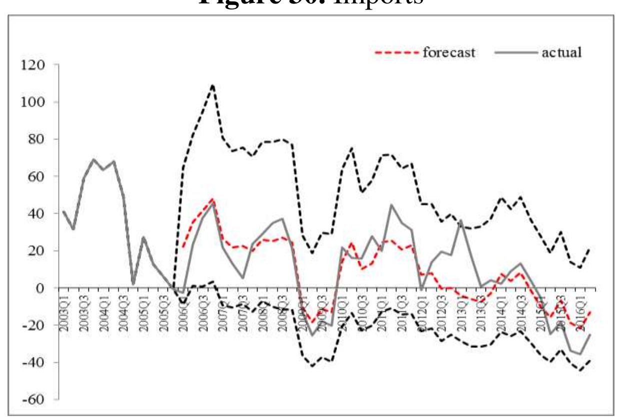



**Figure 30.** Imports



well. The forecast ability of the model relatively deteriorates for predicting the n/o output growth, though the post-2008 period forecasts can be considered fairly acceptable. However, despite the worsening of the forecast performance for the reserve money, the model's 95% forecast intervals include actual values. In fact, Huseynov and Ahmadov (2014) also point out the difficulty of forecasting the reserve money for the national economy.

*4.4. Ex-post forecasting*

To evaluate ex-post forecasting performance of the model we carried out expanding window (deterministic) forecasting exercises for the short-run equations over the period 2013Q1-2016Q2. Then, we compared forecasts of the model with forecasts of the best chosen specification among the autoregressive models. The results of dynamic ex-post simulations for all short terms dynamics are summarized in Table 4.

**Table 4.** Relative RMSFE (baseline AR)

| | **1Q** | **4Q** | **6Q** |
|---|---|---|---|
| *Reserve money* | 2.07 | 3.16 | 4.86 |
| *n/o Growth* | 0.35 | 0.32 | 0.35 |
| *n/o Tax* | 0.59 | 0.65 | 0.70 |
| *Government consumption* | 0.67 | 0.72 | 0.89 |
| *Inflation* | 0.95 | 1.77 | 3.83 |
| *Imports* | 0.15 | 0.22 | 0.25 |

The table displays the relative root mean squared forecast errors (RMSFE) for endogenous variables (except NFA) over the 1, 4 and 6 quarter forecast horizons. A value lower than one indicates that the model performs better than the baseline model (autoregressive model) or vice versa for a higher than one value. Table indicates that the model outperforms the baseline model for the n/o growth, n/o tax, government consumption and imports in all forecast horizons. The model has a marginally better relative forecast performance for the inflation in the 1$^{st}$ quarter and then deteriorates substantially for the higher forecast horizons. This fact is in line with the findings of Huseynov, *et al* (2014) and Ahmadov, *et al* (2016) who demonstrate that regardless of how sophisticated the model one uses it is difficult to forecast the domestic inflation during the post-oil boom years. Particularly, their analysis reveals that inflation started to behave like a white-noise process during the post-oil boom years. Although, decreasing volatility and ability of the monetary authority to control inflation could be possible reasons for such behavior as they mention, this remains an open question to further investigations.

Furthermore, the model experiences hard times in explaining or forecasting the reserve money. Indeed, the model cannot beat the autoregressive model in all forecast horizons. Interestingly, Huseynov and Ahmadov (2014) also point out the difficulty of forecasting the reserve money for the national economy.

## 5. Conclusion

In our study, we model both steady state and short-run dynamics of the important aspects of the national economy using quarterly data for the period 1999Q1-2016Q2. There are several peculiarities of our model. We explicitly model government, money market and external sector, but omit household sector, labor market, wage dynamics and volume of the physical capital specifications due to serious data quality issues. In addition, we treat the oil and non-oil sectors as well as tax collections from those sectors separately. Government budget expenditures are classified into two categories: government consumption expenditures and government investment expenditures. Moreover, since during most of the sample period the Central Bank pegged national currency (manat) to the US dollar we treat AZN/USD exchange rate as a policy instrument.

Using Fully Modified OLS (FMOLS) co-integration methodology we find co-integration relations among the variables. We also carry out four co-integration tests (*Hansen instability test*, *Park added variables test*, *Engle-Granger* and *Phillips-Ouliaris tests*) for each estimated long-run relation and found the same results. Most of short-run dynamics are estimated by 2SLS approach. Coefficient estimates are in compliance with our ex-ante expectations. Moreover, the estimated model behaves well and successfully passes through diagnostic tests – normality, serial correlation, ARCH and heteroscedasticity tests.

To conduct a performance evaluation of the model as a whole we carried out the stability test of our non-linear model, implemented the impulse-response analysis, run the static and dynamic simulations, as well as checked for the ex-post forecasting performance.

Stability tests by numerical simulations indicate that the system demonstrates stability around its steady state values and model variables converges to their steady state values approximately within 140 periods (2016Q3-2050Q4). Impulse-response analysis also emphasizes stable convergence of the model and predicts economically consistent results.

In order to check in-sample forecasting performance we employed dynamic and static simulation exercises. The dynamic simulation results for the inflation, the government consumption and the imports are satisfactory. However, it seems that the model cannot sufficiently capture higher inflation and government consumption growth period of the 2007-2008. During that period the model is underpredicting the inflation and the government consumption growth. The forecast ability of the model relatively deteriorates for predicting the n/o output growth, though the post-2008 period forecasts can be considered fairly acceptable. We also found difficulties in forecasting reserve money, which is in line with Huseynov and Ahmadov (2014).

Furthermore, to evaluate out-of-sample (ex-post) forecasting performance of the model we carried out expanding window forecasting exercises for the short-run equations over the period of 2013Q1- 2016Q2. According to our analysis the model outperform the baseline model for the n/o growth, the n/o tax, the government consumption and the imports in all forecast horizons.

However, it seems that the baseline model does better job in forecasting inflation and reserve money relative to the model.

The results indicate that model can be used for the specific policy analysis and forecasting of main macroeconomic variables of Azerbaijan.

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# *Appendix: Data Definitions and Sources*

This section provides the detailed description of the data employed in this study and its sources.

*Real GDP*

The State Statistical Committee of Azerbaijan (SSCA) calculates GDP figures using two different methodologies. The first is based on the value-added (production) approach and provides period-to-period monthly real growth rates. In this approach, the base period for each month is the previous year's corresponding period and it is moving within the year. For instance, the base period for January is the previous year's corresponding month. However, the base period for the January-February is the previous year's January-February. Obviously, in this approach it is difficult to calculate cumulative figures such as GDP deflator. IMF (2016) considers this approach outdated and incompatible with international practices.

To meet IMF requirements SSCA also calculates real GDP figures using fixed base year of 2005. In that case, the real GDP growth figures are obtained based on the average annual prices of 2005. In this approach as well, SSCA provides real figures across different sectors based on value-added methodology. Besides, based on expenditure approach, SSCA publishes *nominal* consumption, investment, government consumption and net export figures. However, only annual *nominal* data are available for GDP components based on income approach.

*Real non-oil GDP*

To calculate real non-oil GDP figures, we draw on GDP sectorial figures provided by SSCA treating 2005 as the fixed base year. We define real n/o GDP by excluding the value-added of the extraction (mining) sector and net taxes from the overall GDP. Note that net taxes also include some component from the n/o sector but it is hard to distribute it among oil and n/o sector due to lack of required information.

Quarterly real GDP figures with 2005 constant prices cover the period 2001-2016. To extend these figures beyond 2001, we employ the period-to-period real growth figures based on the first approach of SSCA. Real n/o GDP figures are obtained using overall GDP and extraction (mining) sector real growth rates. We employ TRAMO-SEATS seasonal adjustment package to obtain seasonally adjusted series.

*Oil production*

Oil production figures are collected from SSCA's monthly Statistical Bulletin "*On the Socio-Economic Situation of the Country*". It involves oil as well as condensed gas and measured in thousands tonnages. SSCA do not provide oil production figures on consistent basis, so we employ this indicator in our estimations. However, the volume of the condensed gas in this figure is negligible. As before, TRAMO-SEATS package is used to obtain seasonally adjusted series.

*Tax*

Tax statistics is also collected from the same monthly bulletin of the SSCA. To obtain tax data, we add up figures on *Income tax, VAT, Profit tax, Property tax, Land tax, Excise tax, Mining tax* as well as *Tax from international economic activities.* Data on these subcomponents of the overall tax payments are available on monthly basis and we sum up monthly figures to obtain quarterly ones. Here as well, TRAMO-SEATS package is applied to get seasonally adjusted series.

*Oil profit (corporate) tax and non-oil tax*

SSCA do not provide data on taxes from oil and non-oil sector separately, even on annual basis. To determine n/o taxes, we need to exclude *corporate profit taxes* of the oil sector from overall tax payments. However, there is no single source for this data. We were compelled to collect data on non-oil tax payments from three different sources: (i) special issue "*Tax System of Azerbaijan*" in 2015 – this issue of the Ministry of Taxes provides annual figures on profit taxes collected from the oil as well as the n/o sector. However, this data covers the period 2005-2014. (ii) Zermeno (2008) provide annual data on n/o tax revenues for the period 2003-2007 (iii) data on oil profit taxes for the years 2015-2016 is taken equivalent to the profit tax payments of the Azerbaijan International Operating Company (AIOC), an international consortium acting on the behalf of the shareholders of the international agreements to exploit oil in the Caspian Sea.

The annual data for the oil profit tax figures for the years 1999-2002 is approximated as 46% (2003-2004 yearly average) of the overall corporate profit tax payments to the budget. The annual data on oil profit tax payments is then linearly interpolated to get quarterly figures. The n/o tax figures are obtained by deducting oil profit tax payments from the overall taxes. As usual, TRAMO-SEATS package is used to get seasonally adjusted figures.

*Budget investment (capital) expenditures*

In its Statistical Bulletin, the SSCA publishes monthly data on government investment (capital) expenditures. In most of its issues until 2012, investment expenses of the state budget are outlined under the heading of *Expenses on Economy*, which covers *(i) Housing expenses, (ii) Agriculture, forestry, and fishery expenses, (iii) Industry and construction expenses,* and *(iv) Transportation and logistics expenses.* However, in general, expenses on *(i) Housing, (ii) Agriculture, forestry and fishery* and (iii) *Transportation and logistics* are considered *current* expenditures, not *capital* expenditures. In fact, starting from the year 2013, SSCA's budget investment expenses data is in line with expenses on *Industry and construction.*

Discussion with experts from the Ministry of Finance assured us that instead of using *quarterly* data for these expenses, it would be preferable to interpolate annual data to find quarterly series. Rather than collecting annual budget investment expenditure figures from the Statistical Bulletin, we opt to compile our data from the National Assembly's *The Law of Azerbaijan Republic on the Execution of the State Budget* for the sample years. In those laws, the state budget expenditures are expressed in satisfactory details for the aim of our study. In those laws, the required annual figure for the budget investment expenditures is recorded under the subcomponent of *State Investments.*

Annual budget investment figures are then interpolated employing Chow and Lin (1971) methodology. As explanatory variables, we use oil prices, seasonally adjusted oil production, as well as current and one period leaded real non-oil GDP figures. Applying this methodology we tap annual correlations between explanatory variables while interpolating quarterly budget investment series.

*Government consumption*

SSCA publishes quarterly data on government consumption at current prices covering the period 2001-2016. However, as previous studies (see, for instance, Mehdiyev, *et al* (2015)) on Azerbaijan show, the data on the components of the budget expenditures do not possess good quality. In general, regression analysis using lower frequency data provide better and theoretically more consistent estimates for Azerbaijan. Therefore, as in the case of the budget investment expenditures, we prefer to interpolate annual figures to produce quarterly series. We have obtained all annual data for government consumption expenditures for the whole sample period 1999-2016 from the SSCA.

For interpolation, we apply Chow and Lin (1971) methodology to annual government consumption data. As explanatory variables, we employ data on oil prices, seasonally adjusted oil production and current non-oil real GDP figures.

*Exports of goods and services*

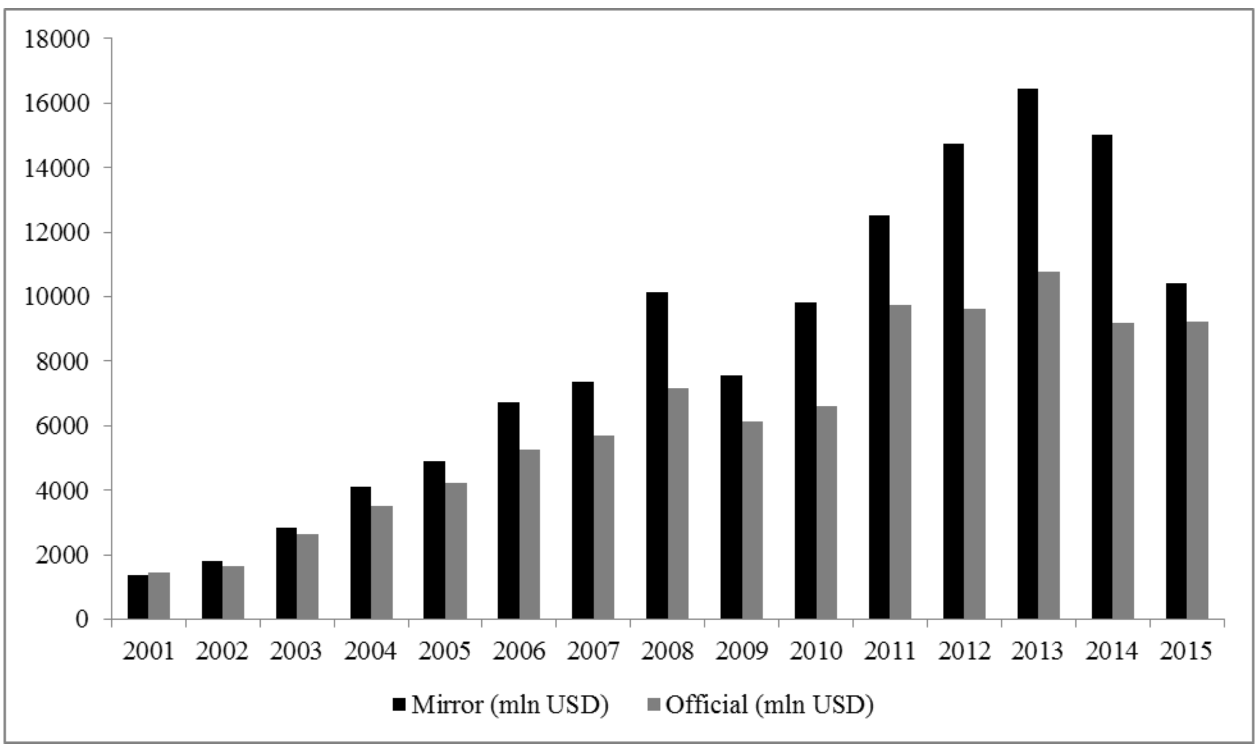
The data on *Exports of goods and services* is taken from three sources, CBAR, SSCA and State Customs Committee (SCC). In practice, the data on exports of goods is provided by SCC to the SSCA and the CBAR. The data on export of services is generally provided by the CBAR to the SSCA. In general, export of goods figures of SSCA and SCC differ substantially from one another, especially during and after oil boom years. Most part of this inconsistency is due to the two different time conventions of registering the exported goods leaving the country. There were also inconsistences in export figures with trading partners (i.e., importers). In 2008, to correct inconsistences, SCC calculated the discrepancy errors in the past years and added to the export figure of that year. As a result, the export figure of the year 2008 inflated artificially.

We use SSCA's quarterly data on *Exports of goods and services* which covers 2001-2016. It is published as a subcomponent of the GDP by expenditure approach. Because it is provided in national currency, we use official exchange rate to convert it into figures denominated in USD. For the years 1999 and 2000, we do not have data on exports of services. We use growth figures of exports of goods (in USD) collected from SSCA's monthly Statistical Bulletin to find *Exports of goods and services* in USD. This quarterly data is seasonally adjusted using TRAMO-SEATS package.

*Imports of goods and services*

In contrary to the volume of the exported goods case above, the SSCA and SSC figures for imported goods do not differ. As in the previous case, the CBAR publishes data on imported services on quarterly basis. However, we cannot find data on services going back to the years 1999 and 2000. As in the case of exported goods and services, the growth figures of imported goods (which even goes beyond to the year 1999 on monthly basis) is borrowed to compute respective figures in 1999 and 2000. In other words, we assume that the import of services grows at the same nominal rate with the import of goods. We hope that this assumption is innocuous as the share of services at that time was not significantly larger.

**Figure 31.** Imported goods (in millions USD)




*Source: TradeMap and SSCA, SSC*

In our study, we will not use official data on imported goods, but draw on official data on imported services. Our reluctance to use official data is due to two reasons. First, some anecdotal evidence and unofficial discussion with some experts from the SCC, as well as, *"mirror"* data from different international sources confirm the prevalence of significant underreporting in official imports of goods. In Figure 31, the official and *"mirror"* data on imported volume of goods are depicted. As it is clear from the figure, in most of the years there is an ample evidence of sizable underreporting. However, it is also clear that the year-to-year dynamics do not differ between the two series.

Second, since 2015 the SCC started to totally eliminate the unofficial import of goods to the country. As it is easily seen from the figure, beginning from 2015, the official and *"mirror"* data statistics do not differ significantly. However, if we explore available monthly figures of 2016 for both series, we discern two important facts. The first is the contradiction in the magnitude of the decline between the years 2015 and 2016 according to these two sources. According to the official statistics, in the first eight months of 2016 the volume of imported goods (in USD) declined by -6% when compared to the same period of 2015. In contrast, according to the *"mirror"* statistics this decline was far large in magnitude, around -45%. The second fact is related to the reversed tendency between "mirror" and official import statistics. According to the "mirror" statistics during the first eight months of 2016 the volume of imports to the country was 3.8 billion USD. In contrast, according to the official statistics this figure was registered around 5.5 billion USD. Talking to some experts in the field, the predominant view is that this discrepancy is due to SCC's reluctance to rely on invoices provided by importers. SCC's allegation is that importers prevalently use undervoicing practices and underreport their prices of imports. SCC runs an internal evaluation process and determines "true" customs value of each imported good.

These two facts coupled with two recent sharp devaluations of the national currency are important in deciding which statistics to employ in our analysis. As known, in 2015, the country went through two large devaluations in its national currency, which amounted to a cumulative twofold decline in the external value of manat against US dollar. In order to measure a true elasticity of imports to exchange rate movements, we need to rely on a rather consistent statistics which is immune to the recent legalization efforts in import statistics, undertaken at the outset of the year 2015. If we consider the fact that the bilateral AZN/USD exchange rate was pegged and not volatile during the most of the sample period, these two larger devaluations and its repercussions on imports is of considerable value in determining the true elasticity.

Therefore, we prefer to draw on "*mirror*" data on imported goods (in USD) from *TradeMap*. Quarterly *"mirror"* data on imported goods for Azerbaijan starts from the last quarter of 2011. Besides, adding quarterly "*mirror*" figures within a year do not produce "*mirror*" annual volumes. Nevertheless, the discrepancy is minor and it seems that few trading partners of Azerbaijan do not provide data on quarterly basis. We use annual "mirror" figures between the years 2001-2015 to interpolate quarterly series during that period. For the years 1999 and 2000 quarterly official statistics data is used. Because official statistics data differ from "mirror" data on average +/-4% during the years 2001-2003, we consider using official statistics for the years 1999 and 2000 unproblematic.

Therefore, we apply Chow and Lin (1971) methodology to interpolate annual *"mirror"* statistics to get quarterly series during the period 2001-2015. As we have seen above, because annual dynamics of official and *"mirror"* statistics are similar during these years, we use the official import series as the only explanatory variable in the regression approach of Chow and Lin (1971). However, because quarterly *"mirror"* series is available since Q1, 2011, we prefer to use growth rates of *"mirror"* statistics to adjust quarterly interpolated series after this period. Before that we correct seasonality in the quarterly *"mirror"* statistics relying on seasonal factors obtained from quarterly official statistics (applying TRAMO-SEATS package). The growth figures for the first two quarters of 2016 used to obtain quarterly import data for 2016. We add official statistics on imported services to interpolated imported goods series to produce data on *Imports of goods and services*.

*Reserve money (in manat)*

The data on reserve money for the sample period is obtained from the Central Bank of Azerbaijan's (CBAR) monthly *Statistical Bulletin* and its daily *Analytical Balance* circulated inside the Bank. The CBAR publishes two figures for the reserve money – the first is *Reserve money in manat (national currency)* and the other is *Broad reserve money* which beside *Reserve money in manat*, also incorporates the commercial bank reserves in foreign currencies.

In our study, we employ data on *Reserve money in manat.* Since 2003, daily Analytical Balance is readily available internally. When reporting, the Bank publishes the *end of period* figures for certain components of Analytical Balance (as well as reserve money) on monthly basis. We acquired monthly figures for the reserve money which goes beyond 2003 and extend to the December, 1995. We obtain quarterly figures for the sample years from the monthly data on the basis of last month of the corresponding quarter (*end of period*). Our preference to use *end of period* rather than average monthly figures in our study is related to the availability of the data on NFA or NDA on monthly basis before 2003. As usual, we apply TRAMO-SEATS package to seasonally adjust reserve money series.

*NDA* and *NFA (excluding commercial bank foreign reserves at the CBAR)*

From an accounting identity, we know that adding *net domestic assets (NDA)* and *net foreign assets (NFA)* together will produce *reserve money.* However, if we add up *NFA* and *NDA* in the Analytical Balance of the CBAR, it will be equal to *Broad reserve money,* not to *Reserve money* *in manat.* As explained above, this is the result of the fact that the commercial banks hold reserves in foreign currency at the CBAR. Thus, we need to exclude those commercial bank reserves from *NFA*. To do that, we calculate the required *NFA* data by subtracting *NDA* from *Reserve money in manat*.

Here, we obtain quarterly figures from monthly data on the basis of the *end of period* figures for the period 2003-2016. Quarterly (*end of period*) data for the period 1999-2002 is almost available for NDA/NFA. However, the first three quarters of the year 1999 are not available for *NDA* (and hence NFA adjusted). Hence, we linearly interpolate the first three quarters of the year 1999 for NDA data. As usual, the adjusted NFA series for this period is obtained by subtracting NDA from the reserve money. Since tests do not show any seasonal pattern in NDA and adjusted NFA series, we do not seasonally adjust them.

*NEER, NEER (excluding AZN/USD rate)* and *AZN/USD rate*

The CBAR publishes nominal effective exchange rate for national currency on monthly basis. During the sample years of this study, the Bank added new countries to the *NEER* basket and changed weights for the trade partners several times. In practice, the CBAR calculates *NEER* based on import shares, export shares and trade turnover, which is the average of imports and exports. Besides, it also calculates *NEER* with *"High Inflation"* and *"Low Inflation"* countries as well as *NEER* using *oil* and *non-oil* sector weights. However, in practice, the Bank only reports *NEER* for the overall economy based on weights derived from the trade turnovers. We will also draw on this *NEER* series in our calculations.

In our study, we need *NEER* (*December, 2000 = 100*) series excluding *AZN/USD* exchange rate. Because we *NEER* and *AZN/USD* series are available, it is not difficult to adjusted *NEER* series. During the sample period, the *AZN/USD* weights were changed several times, but remained between 3.6-12.1%. The average weight for this series during the sample period was 6.0%. So, we use the average weight for *AZN/USD* series, *NEER* and *AZN/USD* series to find adjusted *NEER* series. That is, we divide *NEER* to the inverted *AZN/USD* index raised to power 0.06. Note that, the adjusted *NEER* series is not re-normalized to make weights add up to 1. Monthly data within the quarter are averaged to obtain quarterly series. Because quarterly data do not demonstrate any seasonal pattern we left them seasonally unadjusted.

*Trade partner's CPI*

We obtain data on *Trade partner's CPI (December, 2000 = 100)* from CBAR's database. This data is collected on monthly basis, but not published. However, since CBAR publishes *NEER* and *REER* data on monthly basis, it is not difficult to calculate *Trade partner's CPI.* In the database, this series goes back to the December, 2000. To extend this series to the first month of 1999, we use *NEER* and *REER* data to calculate the required series. Specifically, after equalizing base period for *NEER, REER* and domestic *CPI,* we divide *NEER* to *REER* series, then multiply it to the domestic *CPI* to get *Trade partner's CPI.* Quarterly data are computed as an average of the monthly figures of the respective quarter. This series is seasonally adjusted using TRAMO-SEATS package.

*CPI*

Data on domestic *CPI (December, 2000 = 100)* is compiled from SSCA's monthly Statistical Bulletin. Monthly data are averaged to determine quarterly figures. The TRAMO-SEATS package is applied to obtain seasonally adjusted series.

*Oil price*

Data on *Oil price* is taken from IMF's monthly updated publication on primary commodity prices. This data is per barrel USD price of crude oil - dated Brent, light blend. Monthly data are averaged to obtain quarterly series. Quarterly figures do not exhibit any seasonality, hence left seasonally unadjusted.