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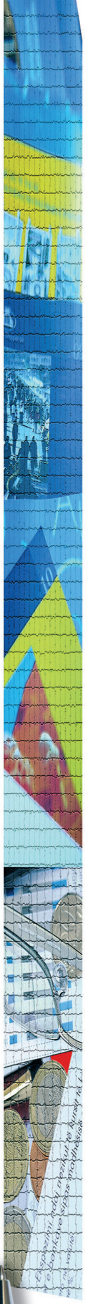

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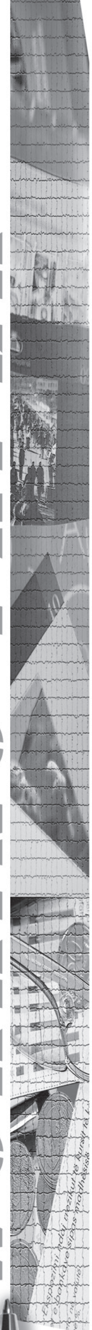

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1 – INTRODUCTION

The Bank of Albania introduced a small semi-structural Medium-Term Projection Model (MPM) in 2013, as part of its forecasting toolkit, to support the monetary policy decision making process. This initial version of the model was built in 2011 in joint cooperation between the IMF, through a Technical Assistance (TA) program, and the Bank of Albania, in a bid to modernize the latter's forecasting and policy analysis system (FPAS) and in conjunction with Bank of Albania's strategic goal to move to a fully-fledged inflation targeting regime. The initial version of the model was constructed around 4 key behavioral equations, namely an IS curve, a Philips Curve for core inflation, a monetary policy reaction function and a UIP condition, and the parameter matrix was a combination of estimated and calibrated coefficients (Dushku and Kota (2011))[1]. Within the FPAS framework, the MPM model constituted the core forecasting infrastructure in use for monetary policy decision making and a valuable auxiliary tool to interpret past economic developments and current initial conditions (Çeliku (2013)).

As sufficient practical experience was accumulated with using the model for medium-term forecasts, some design and parametrization limitations were identified. The IS curve equation lacked a detailed representation of the financial sector and some transmission channels could be extended. The Philips Curve could be developed further to model the noncore component of inflation. In addition, the uncovered interest rate parity (UIP) condition did not capture well the evolution of the exchange rate in time and a better specification was deemed necessary. The monetary policy reaction function could be strengthened further to make it more sensitive to economic fluctuations and to inflation deviation from target. Furthermore, expectations played a limited role in the model and the lack of a detailed financial sector did not allow to track fully the monetary policy transmission mechanism onto the real economy. Finally, with the Albanian economy evolving rapidly, the need emerged to upgrade the trend evolution in time of key variables as well as their equilibrium conditions.

[1] *The primary structural model equations of the previous version of the model and a general comparison highlighting improvements in dynamic behaviour are included in Appendix B.*

As such, the MPM model went through an upgrading and extension process starting from 2016, in the context of a newly initiated TA program from the IMF on "Monetary Policy Modelling and Forecasting". The latter focused on tackling the aforementioned model limitations as well as on bringing the model closer to economic data through full parameter calibration. This paper provides an overview about this improved model, its structure, parametrization, including calibration and its general dynamic properties. The MPM model is upgraded in line with generalized canonical versions of small semi-structural business cycle models of the same type, in use in other central banks, but at the same time it is flexible enough to incorporate idiosyncratic traits of the Albanian economy and financial market.

The model is constructed to reflect the general monetary policy paradigm in inflation targeting central banks and it is a consistent and a simplified instrument to describe key macroeconomic variables of interest and their underlying trends. In the upgraded MPM greater importance is given to the role of monetary policy as a nominal economic stabilization tool in the medium to long term. The monetary policy rule is endogenous and reflects the relative policy preferences and trade-offs of policy makers in responding to inflation deviations from target and output stabilization. In addition, modeling choices have ensured that monetary policy has nominal and real effects in the short run but it cannot influence the real side of the economy in the long run. The endogenous exchange rate, based on the (UIP) condition, is modelled through a fixed permanent risk premium combined with a cyclical and transitory component and with a stronger expectations channel. As in other small-open economies following a convergence path and price level equalization, the real exchange rate is on a trend appreciation path. The behavior of the core and noncore components of inflation is modelled through two standard Philips Curves. The expectation channel is strengthened to better capture the role of rational agents' in helping drive inflation to target in the medium-term.

The rationale behind the modelling and the inclusion of the financial sector is to reflect and track as closely as possible the policy impulse transmission mechanism through the financial sector onto the real economy. In the model, the loan interest rate setting behavior of the banking sector takes into account relevant risk premiums to model financial frictions that characterize the transmission mechanism. As Albania is a euroized economy (Della Valle (2018)), the interest rate channel in the IS curve is designed to capture both developments in the domestic currency and the euro loan interest rates, with the unhedged foreign currency borrowers' balance-sheet effect introduced directly onto the equation. The price-setting behavior of banks incorporated into the model embodies the importance of the exchange rate for the Albanian economy, in terms of the distinct effects it has on specific transmission channels.

The remainder of the paper is structured as follows. Section two presents some stylized facts of the Albanian economy and how the latter define modelling choices. The next section focuses on model specification and its theoretical and practical underpinnings. Section four describes the methodology and strategy behind the calibration of model parameters, by assessing their sensitivity and implications for replicating historical developments, and explores model dynamics, through a range of policy experiments. Section five concludes.

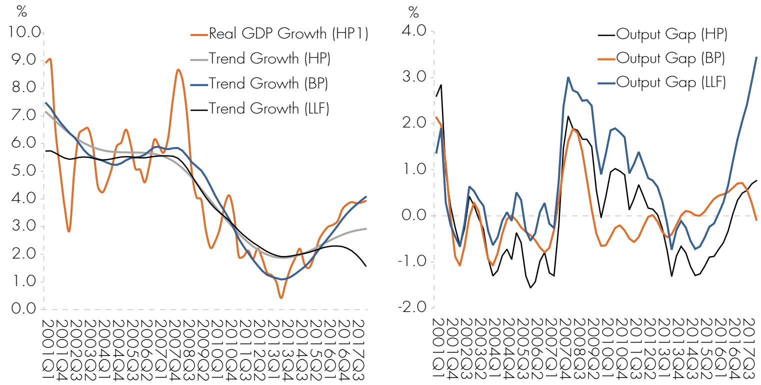
2 – STYLIZED FACTS

The Bank of Albania officially adopted a fully-fledged inflation targeting regime in 2015, complemented by a flexible exchange regime, in place since the fall of communist regime. Pursuant to the legal mandate to maintain and safeguard price stability, the objective of the Bank of Albania is to ensure an inflation rate close to the point target of 3% over the medium term. Monetary policy is formulated and implemented in an independent, transparent and forward-looking manner, so as to maximize the accountability and efficiency of the central bank in guiding the financial market and in anchoring inflation expectations around the target (Monetary Policy Document (2015)). As in other inflation targeting countries, the primary monetary policy instrument is the base interest rate, through which the Bank of Albania aims at steering money market interest rates in order to smooth cyclical fluctuations and affect prices in the economy. Although price stability has always been the principal policy objective, the adopted monetary policy framework guiding the decision-making process has varied over time.

In the first decade after the fall of communist regime, the Bank of Albania pursued monetary targeting, compatible with successive IMF stabilization programs and similar to other programs in the region used during the initial transition years (IMF (2015), Themeli (2012)). As financial markets were still underdeveloped and fiscal dominance prevailed, monetary policy relied on direct policy instruments, in the form of ceilings on credit expansion and of floors for interest rates for deposits in domestic currency. As the market became more sophisticated, the Bank of Albania was able to move to an operative framework relying on indirect policy instruments. The indirect framework focused on setting the policy rate - the one-week repo rate - that aimed at influencing interbank market rates to manage monetary expansion and ultimately inflation in Albania. The further expansion of the financial market via the entry and consolidation of foreign banking groups weakened the link between money supply and inflation (Muço at al. (2004), Luçi and Ibrahimi (2005)). Furthermore, heightened uncertainty during the first decade of transition, continuous high financial inflows in the form of remittances in foreign currency, high informality and high interest rate differentials, exacerbated the "euroization" of the Albanian economy (Luçi et al. (2006), Shijaku (2016)), and introduced additional challenges to monetary policy implementation (Manjani (2015)). Consequently, from 2004, the Bank of Albania adopted a hybrid inflation targeting regime with a target inflation band of 2%-4% (Bank of Albania (2003)). Initially, monetary programming complemented the overall analysis of monetary aggregates to evaluate inflationary pressures and guide the monetary policy decision-making process. Thereafter, the Bank of Albania shifted to short-term inflation forecasts to inform policy making while still retaining reference to monetary aggregates as an auxiliary set of analytical indicators. In 2015, when a fully-fledged IT regime was adopted reference to monetary indicators was dropped and medium term inflation forecasts moved to the forefront of the monetary policy decision making process. The endogenously derived medium term policy rate path, consistent with an overall macroeconomic forecast, became a new standard of monetary policymaking.

Throughout the post-communist transition period, Albania has experienced relatively fast economic growth rates, consistent with the economic convergence process to the most developed European economies. The country started from a comparatively low income per capita level and partly obsolete and/or inefficiently utilized capital stock. In order to upgrade and expand the capital stock necessary to keep the convergence process on track, macroeconomic policies enhanced faster capital accumulation rates and sustained rapid economic expansion (IMF (2006)). As such, Albania benefited from large efficiency gains in the production factors and from expanding total factor productivity reflected in high investment rates and steady consumption growth (WEF (2017)). The initially high potential GDP growth rates started to recede at a later stage, mirroring diminishing marginal returns on labor and capital, as well as a reduced scope for total factor productivity growth, as efficiency gains were decreasing over time (Çeliku et al. (2018)).

Figure 1 - Real GDP growth and statistical trend growth (left) and estimates of output gap (right)



Source: INSTAT, authors' calculations.

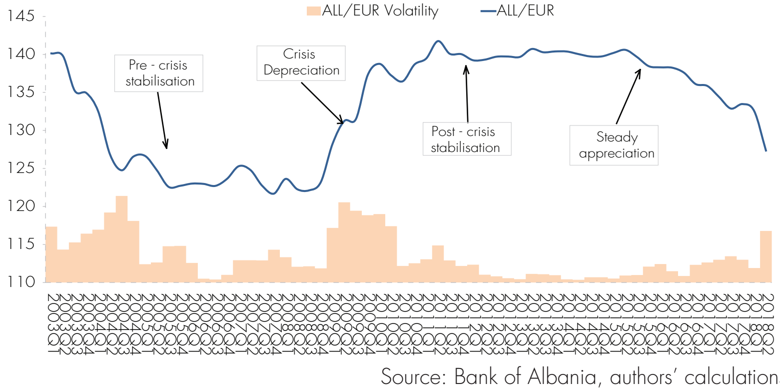
Naïve estimates of the cyclical behavior of the Albanian economy, obtained from standard statistical filters[2] and used here to extract a simple trend-cycle decomposition of Albanian GDP, indicate 2 major identifiable business cycles of different lengths. An important distinction can be drawn from the cyclical behavior of the economy prior to and after the global economic and financial crisis of 2008. The pre-crisis business cycle is rather shorter, at about 6 years measured peak to peak, with quick transitions around potential growth. The post-2008 business cycle has exhibited a longer peak-to-trough transition with smaller fluctuations around the trend and we cannot yet evaluate its full peak to peak time length. This change in the behavior of the Albanian economy is explained by not only the greater cyclical co-movement with the EU economy, but also by the business cycle interacting with the financial cycle (Kote and Saqe (2019)). Albania experienced a credit boom in the 2005-2008 period, embodied in fast rapid credit expansion and increasing credit to GDP levels. Nevertheless, credit growth started to decelerate steadily after 2008. Empirical estimates indicate that credit is a primary driver of the financial cycle, and that the latter's cyclical downturn post-2008 has had an important impact on the real economy's cyclical downturn (Kote and Saqe

[2] *Statistical filters used are Hodrick-Prescott Filter, Band-Pass Filter and Local Level Filter.*

(2019)). Statistical filters employed here do not allow for a structural interpretation of the cyclical behavior of the economy. Nonetheless, some insight can be drawn from the historical evolution of important economic variables that can partially explain the position of the output gap at specific points in time.

Cyclical fluctuations of public investment played an important role in the cyclical upturn during the pre-crisis period and its immediate aftermath (Gazidede (2013)). The 2008-2010 period was characterized by an expansionary fiscal policy due to large public infrastructure investments. Furthermore, the expansionary fiscal policy coincided with the credit boom in the financial market, whereby the combined effect of the two contributed to very high economic growth rates. In order to prevent an overheating of the economy, monetary policy was contractionary and consequently, interest rates in the financial markets were high. As public investment started to recede from 2010 onwards and as credit growth rates started to decelerate after the 2008 crisis, monetary policy initiated an expansive trajectory. As a result, risk premium and interest rates in the financial markets experienced a secular decrease and exports and private investments gained a larger prominence in explaining output gap fluctuations.

Figure 2 - ALL/EUR exchange rate and historical volatility[3]*.*



Source: Bank of Albania, authors' calculations.

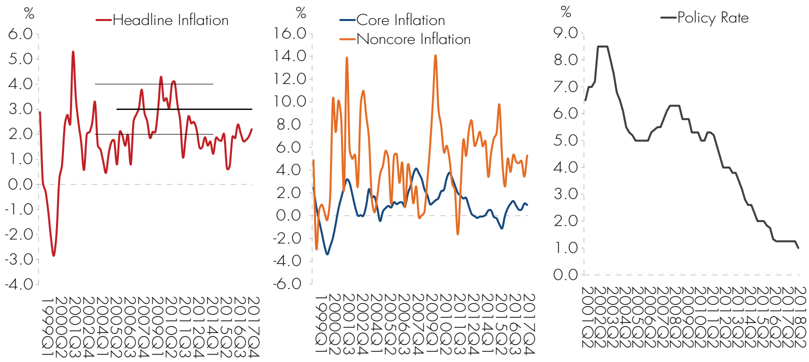
[3] *Here ALL/EUR exchange rate volatility is calculated as an expanding window standard deviation with a fixed initial point, whereby for each quarter the sample over which the standard deviation is calculated uses all the historical points up to that quarter.*

As in other small-open economies with fully liberalized capital accounts and sizeable "euroized" balance sheets, the exchange rate is an important macroeconomic factor with often opposite directional effects within the monetary policy transmission mechanism. Overall, the Albanian Lek (ALL) is a comparatively stable currency vis-à-vis the euro, though several specific episodes of heightened volatility can be highlighted throughout the recent history. The ALL experienced a short period of heightened volatility during the 2003-2004 period, whereby the domestic currency appreciated steadily as a result of large-scale privatizations (EBRD (2003); EBRD (2004)) and of high financial inflows in the form of remittances in foreign currency. Thereafter, the exchange rate was relatively stable and volatility low. This period ended with the advent of the global economic and financial crisis of 2008, during which the ALL sharply depreciated against the Euro. This shift in the nominal exchange rate constituted a new market equilibrium, which prevailed during the next 4 years, characterized by low volatility. As of the beginning of 2015, the ALL started a slow, uninterrupted, appreciation trend accompanied by subdued volatility of the FX market.

Headline inflation in Albania has been generally low and relatively stable. Inflation volatility has tended to decrease in line with the gradual transition to a fully-fledged IT regime. Core inflation[4] is the primary component of total inflation, consequently the key driver of medium to long term inflation dynamics. The noncore component of inflation is substantially more volatile reflecting largely international commodity price fluctuations. Headline inflation moved below target in 2012 and has fluctuated at around 2% since. This development mirrors primarily subdued core inflation, largely explained by the cyclical downturn of the Albanian economy as well as recurrent supply-side shocks hitting the economy. The Bank of Albania started to reduce the key policy rate in mid-2011 with the aim of keeping expected inflation close to the target in an environment of falling inflationary pressures.

[4] *Core inflation is not a variable directly measured and published by INSTAT. It is calculated within the Monetary Policy Department of the Bank of Albania and published at regular frequency here: https://www.bankofalbania.org/Monetary_Policy/Objective_and_strategy/Core_inflation_23085_1.html*

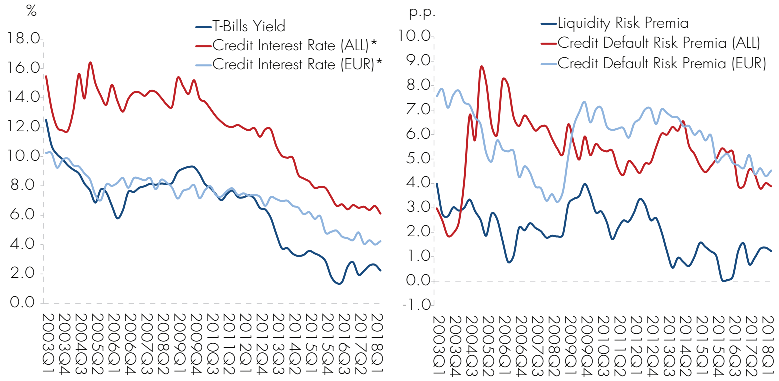
Figure 3 - Headline inflation (1), core and noncore inflation (2) and the base policy rate (3).



Source: Bank of Albania.

Although the financial market in Albania is relatively underdeveloped, it has nevertheless progressed significantly in the last two decades (Note (2007), Suljoti and Vika (2016)). The well-functioning of the financial market is key for transmitting monetary policy signals to the real economy. Changes in the base interest rate are first transmitted into the money market interest rates and thereafter passed onto government paper yields. The 12 month Treasury bills (T-bills) yield is the prevalent benchmark of credit prices for domestic currency. Therefore, any fluctuation in the T-bills yield is transmitted onto loan interest rates in domestic currency. On the other hand, the 3 month EURIBOR is a prevalent benchmark for loan interest rates in euros. Interest rates in financial markets have followed a downward trend since mid-2011 as a result of accommodative monetary policy by the Bank of Albania, declining foreign interest rates and receding risk premiums in the market. Both the liquidity risk premium and credit default risk premium in ALL display secular declining trends over the past 4 years. The former is underpinned by the fiscal consolidation path undertaken during this period, coupled with an increased reliance on external financing. The latter reflects the decline in NPLs, as a result of the implementation of a comprehensive NPL resolution strategy[5], improving cyclical conditions and increased 'within-sector' competition.

Figure 4 - Interest rates (left) and market risk premia (right).



Source: Bank of Albania, authors' calculations.
* Average interest rate for credit with maturity over 1 year.

5 The Bank of Albania and the Albanian Government introduced targeted macroprudential policy packages and legal changes as part of a comprehensive NPL resolution strategy. These included the adoption of a new Bankruptcy Law, amendment of the Law on the Registration of Immovable Properties and of the Private Bailiffs Law, mandatory write offs and/or the encouragement of the write-offs through the use of out-of-court debt restructuring settlements. The quality of the loan portfolio improved markedly and NPLs declined from a peak of 24% in 2014 to about 11% in 2018.

3 – MODEL SPECIFICATION AND EQUATIONS

The main foundations of the MPM model are based on variables in gap form (deviation from trends) and real variables are decomposed into a trend-cycle component. Therefore, observed values are the results of the sum of the gap (_gap) and trend (_tnd) variables. The cyclical (gap) variables enter the behavioral equations of the model, while trend variables are used to recover the implied levels and growth rates of the model variables. The core model consists of five main equation blocks, mainly:

- Aggregate Demand
- Philips Curve
- Taylor Rule
- Uncovered Interest Rate Parity
- Financial Block

All variables are log transformed (l_ notation). Gap variables are assumed to be multiplicative and measured in percentage point deviation from their trends. Kalman filtration technique is used to derive the shocks and unobserved model variables. Moreover, the model is specified in quarterly frequencies, where a d_ and d4_ notation in front of variables measures respectively the annualized quarter on quarter and year on year seasonally adjusted rate of change. Variables related to foreign economic partners are referred with (_eur) notation.

3.1 Aggregate Demand

The behavioral relationship of the output gap is modeled on its autoregressive component, capturing real rigidities in the economy, the monetary conditions index (real loans interest rate gap in ALL and EUR currency and real exchange rate gap), foreign output gap and an IID exogenous shock[6].

[6] *As a general notation, a notation of res_ variable represents an exogenous IID shock to the variable.*

$$l\_y\_gap = a1\_1*l\_y\_gap\{-1\} + a1\_2*l\_y\_gap\{+1\} - a1\_3*(a1\_4*rr\_lo\_gap\{-1\} + (1-a1\_4)*(rr\_lo\_eur\_gap\{-1\} + a1\_5*l\_z\_gap\{-1\})) + a1\_6*l\_z\_gap\{-1\} + a1\_7*l\_y\_gap\_eur + res\_l\_y\_gap \quad (1)$$

Theoretically, the monetary conditions index measures the effect of two of the most important monetary policy transmission channels, the interest rate channel and exchange rate channel. The former helps in addressing the intertemporal substitution effect of consumption and investment, whereas the latter deals with the substitution effect between domestic and foreign goods. In order to better capture the impact of interest rates in a highly euroized financial system, coupled with a large presence of unhedged loans, a dissection between loan rates in ALL and EUR currency is made.

Historically, Albania has been faced with a high degree of financial euroization, where around 60% of loans are denominated in EUR currency. This makes the Albanian economy somewhat more exposed to EUR/ALL exchange rate movements, besides the direct effect coming from the export competitiveness channel (a1_6*l_z_gap{-1}). To capture these effects, the aggregate demand equation includes ALL (rr_lo_gap) and the EUR (rr_lo_eur_gap) loan's real interest rates gaps. In addition, an implicit assumption is made so that fluctuations in the exchange rate affect differently hedged and unhedged borrowers[7]. Hedged borrowers modify their consumption and investment behavior conditional only on the fluctuation of the FX loans interest rate cycle. Unhedged borrowers experience an additional direct effect coming from exchange rate fluctuations which alter their spending behavior, known as the balance sheet effect.

Under these circumstances, the transmission channels of the exchange rate into the real sector, whether monetary policy induced or otherwise, are the following:

- First, the competitiveness channel. This channel stipulates that any depreciation (appreciation) of the real exchange rate increases (decreases) net exports. In turn, it tends to

[7] *FX credit to unhedged borrowers in Albania constitutes around 44% of the total foreign currency credit stock as of mid-2018, down from a peak of about 55% in 2011.*

move aggregate demand and inflation up (down). This is a straightforward channel, applicable to big and small open economies, regardless of their euroization levels.

- Second, the risk-taking channel in foreign currency lending amongst commercial banks. This represents an additional channel, valid only to euroized financial systems. In essence, it means that any depreciation (appreciation) of the real exchange rate tends to increase (reduce) the perceived likelihood of a default for foreign currency loans. In turn, this drives up (down) the interest rates for foreign currency loans, which makes financial conditions in the country tighter (looser). It is interesting to note this channel works in the opposite direction compared with the previous, conventional, one.
- Third, the balance sheet channel. This channel works its way through the impact of movements of the exchange rate in the balance sheets of un-hedged borrowers. In practice, any real depreciation (appreciation) of the exchange rate will deteriorate (improve) the net cash-flow for un-hedged borrowers and thus induce a reduction (increase) in their consumption and investment path. Similarly to the second channel, this one also works in the opposite direction compared with the first.

3.2 Philips Curve

In terms of prices, the Bank of Albania defines price stability as keeping the headline inflation rate at 3% in the medium term. The inflation target in measured as the annual rate of change in the Consumer Price Index, which is calculated and published by INSTAT. The price formation in the MPM model includes two Philips Curve specifications to quantify the dynamics of core and noncore inflations, with the headline inflation being a weighted average value of the abovementioned two components.

$$dl\_cpi = a2\_1*dl\_cpi\_core + (1- a2\_1)*dl\_cpi\_ncore \qquad (2)$$

Fluctuations of core and non-core inflation rates depend on (model-consistent) inflation expectations; at the same time they are limited by inflation inertia. Fundamentally, they are driven by the cyclical conditions of the economy, defined by the output gap, and by the relative price cycles, defined by the real exchange rate gap[8], which together form the Real Marginal Costs (RMC) component[9]. In more details:

- An increase (decrease) in domestic demand drives firms to increase (decrease) capacity utilization rates. In turn, further increases (decreases) in labor demand beyond its potential level would bring higher (lower) production costs per unit which would make firms increase (decrease) prices in order to accommodate costs.
- A depreciation (appreciation) of the exchange rate opens a positive (negative) REER gap and increases (decrease) the relative costs of importers. In turn, prices would go up (down) in order for firms to restore profit margins.

Philips Curve – Core Inflation

dl_cpi_core ***= a3_1*dl_cpi_core {+1} + (1- a3_1)*dl_cpi_core {-1} + a3_2*(a3_3*l_y_gap + (1- a3_3)*l_z_core_gap) + res_dl_cpi_core (3)***

Philips Curve – Noncore Inflation

dl_cpi_ncore = a4_1*dl_cpi_ncore {+1} + (1- a4_1)*dl_cpi_ncore {-1} + a4_2*(a4_3*l_y_gap + (1- a4_3)*l_z_ncore_gap) + res_dl_cpi_ncore (4)

In order to better capture the effect that imported inflation has on different baskets of goods traded, the REER is decomposed into a core and a noncore component. These two components, transformed in gap form, are then used to model the core and noncore PC equations. In other words, the domestic core and noncore prices are driven by the de-trended relative foreign and domestic (core and noncore respectively) prices adjusted for the overall movement in exchange rate. These variation also gives way

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[8] *The Real Effective Exchange Rate is decomposed into a core and noncore REER component in order to better capture the effect that imported inflation has on different baskets of goods traded.*

[9] *Output gap as a proxy for real marginal costs of domestic producers and real exchange rate gap as a proxy for the real marginal costs of importers.*

for the identification of representative steady-state values for these inflation subcategories.

3.3 Taylor Rule – Reaction Function

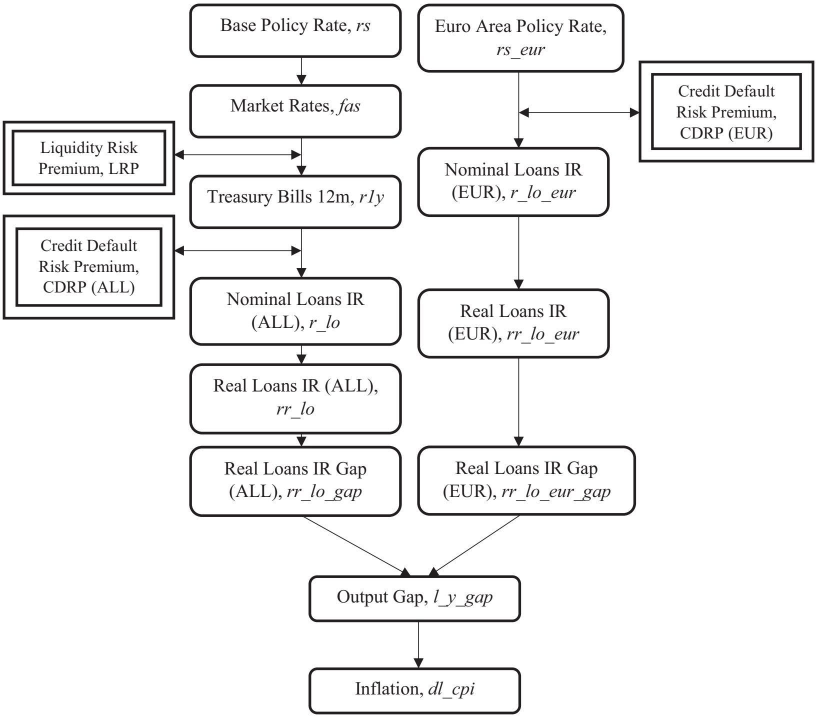
The monetary policy reaction function is based on an inflation forecast targeting rule that ensures the central bank sets the interest rate in response to the deviation of one-year-ahead model consistent inflation expectations from target and the domestic output gap. The lagged short term interest rate is included to obtain a smoothed policy reaction to changes in fundamental inflation pressures or any exogenous shocks (res_rs).

The policy rule includes the nominal "policy neutral" rate that is defined as a sum of the natural rate of real interest (rr_tnd) and inflation expectations[10]. The real interest rate trend (rr_tnd) is an unobserved variable determined through Kalman filtration, defined as an autoregressive process converging to its equilibrium value. The one-year feedback horizon set in the policy rule assures that monetary policy does not react to short-term, transitory inflationary shocks hitting the economy, only to shocks feeding into inflation expectations in the longer time horizon. That is one of the reasons why forward looking inflation targeting rules have frequently better stabilization properties than myopic Taylor type rules. In addition, the inclusion of the output gap into the policy rule helps to stabilize real economic activity.

*rs = a5_1*rs{-1} +(1- a5_1)*(rr_tnd + a5_2*d4l_cpi+(1- a5_2)*d4l_cpi{+4}+a5_3*(d4l_cpi{+4}-dl_cpi_tar_ss)+a5_4*l_y_gap)+res_rs (5)*

[10] *It is defined as a weighted average of current and one-year ahead annual inflation rates.*

Figure 5 - Interest Rate channel



3.4 Uncovered Interest Parity (UIP)

The UIP equation is an arbitrage condition. It states that it is impossible to make an ex-ante profit by investing into either domestic or foreign currency, regardless of the interest rate differential, since nominal exchange rate movements will always diminish the difference between foreign and domestic investment yields. More technically, the level of the nominal exchange rate depends on exchange rate expectations[11], the short term interest rate differential between Albania and the Eurozone (rs_eur corrected for the permanent risk premium, a cyclical component (measured by the inflation deviation from target and foreign output gap) and the temporary risk premium, prem_t. The 2/4*(dl_z_tnd_ss-dl_cpi_eu_

[11] *Specified as a weighted average of forward-looking model-consistent exchange rate expectations and the lagged exchange rate.*

ss+dl_cpi_tar_ss) term assures that the model steady-state is well defined for any model calibration, regardless of the value of a6_1.

$$l\_s = a6\_1*l\_s\{+1\}+(1- a6\_1)*(l\_s\{-1\}+ 2/4*(dl\_z\_tnd\_ss-dl\_cpi\_eur\_ss+dl\_cpi\_tar\_ss))-(rs-rs\_eur-prem\_p)/ 4 + a6\_2*(a6\_3*(d4l\_cpi-d4l\_cpi\_tar\_ss)+ a6\_4*l\_y\_gap\_eur)+prem\_t \quad (6)$$

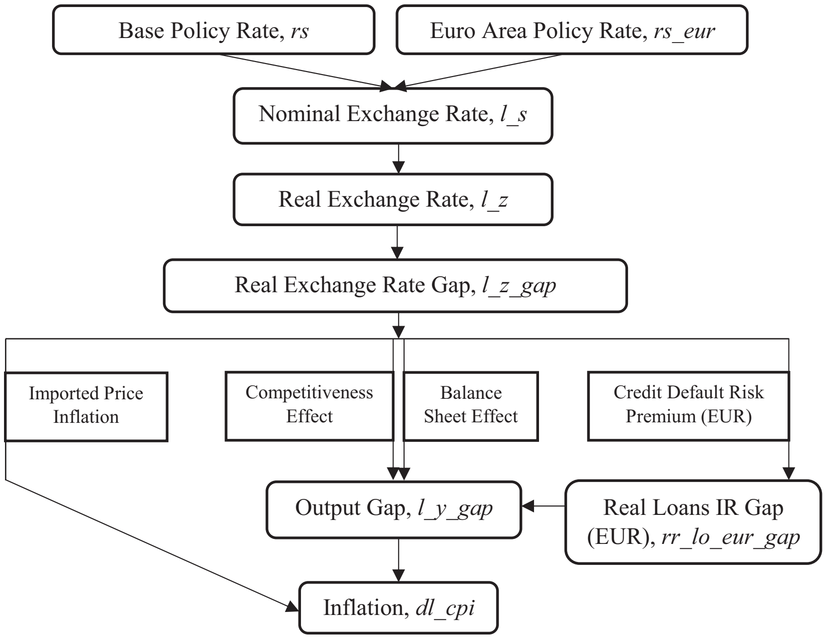
where:

$$prem\_p= -dl\_z\_tnd\_ss+rr\_tnd\_ss-rr\_eu\_tnd\_ss \quad (7)$$

$$prem\_t= a6\_5*prem\_t\{-1\}+res\_dl\_s \quad (8)$$

The UIP equation describes the level of the nominal exchange rate under inflation targeting regime with a free floating currency and full capital mobility. Changes in the domestic and/or foreign interest rates move the spot exchange rate as capital moves in and/or out of the domestic market. The permanent component of the risk premium is composed of the steady state values of the real exchange rate trend, domestic real interest rate trend and foreign real interest rate trend. The cyclical part of the risk premium consist of (i) the inflation deviation from target, measuring increased/reduced trust in the domestic currency and the attendant depreciation/appreciation pressures on the exchange rate stemming from the direction and magnitude of inflation deviation from target and (ii) foreign output gap, capturing exchange rate movements influenced by overall economic performance of foreign trading partner economies (foreign capital flows). The temporary component is measured via an autoregressive AR(1) equation, making it possible to adjust gradually for fluctuations in the exogenous shocks to the nominal exchange rate (res_dl_s).

Figure 6 - Real Exchange Rate channel



3.5 Financial Block

3.5.1 12 months Tbills

The short term policy rate (rs) passes to the 12-month treasury bills interest rates (r1y) through a pricing process that contains an arbitrage condition, where interest rates are a function of the expected path of the short-term monetary policy rate, the current monetary policy rate and a price shock (res_fas). The one-year ahead expected monetary policy rate included into the model specification is based on the financial agents' expectations for the one-year ahead base policy rate (fas). The weights of the components are set so that that the expectations of financial agents are based mainly on the current quarter short-term interest rate.

$$fas=a7\_1*(rs+rs\{+1\}+rs\{+2\}+rs\{+3\})/4+(1-a7\_1)*rs+disc\_fas \quad (9)$$

$$disc\_fas=a7\_2*disc\_fas\{-1\}+res\_fas \quad (10)$$

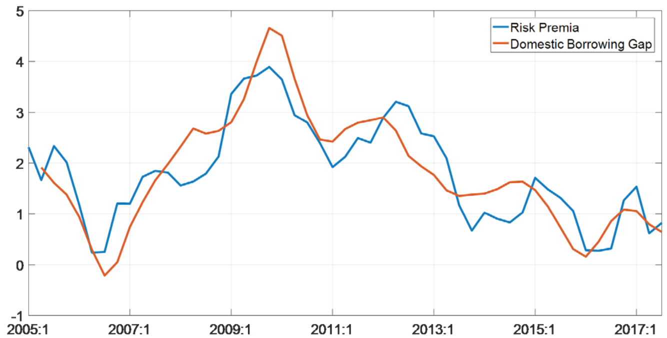
The 12-month Treasury bill interest rate is modeled as the 1 year ahead financial agents' expectation on the policy rate, a liquidity risk premium (prem_r1y) and a shock component.

$$r1y=fas+prem\_r1y + res\_r1y \quad (11)$$

The liquidity risk premium (prem_r1y) is linked to its constant equilibrium value (prem_r1y_ss), the trend (prem_r1y_tnd) capturing ongoing structural changes on the Albanian financial market, a fiscal indicator (db12_gap) and an exogenous shock (res_prem_r1y). The fiscal indicator, which represents the new domestic government borrowing funded by 12-month treasury bills as a percentage of GDP, after being transformed in gap form, has been used as a proxy for the government's demand for liquidity. Any increase (decrease) in this indicator generates increases (decreases) pressure on the liquidity risk premium.

$$prem\_r1y=prem\_r1y\_ss + prem\_r1y\_tnd + a7\_3*(a7\_4*db12\_gap + (1-a7\_4)*db12\_gap\{-1\}) + res\_prem\_r1y \quad (12)$$

Figure 7 - Liquidity risk premium (less trend and equilibrium) and new domestic borrowing (funded by 12month T-bills) as a percentage of GDP (in gap form)



Source: MPD, authors' calculations.

3.5.2 Interest rate on loans, domestic currency

The nominal interest rate of loans (of over 1 year) (r_lo) is captured as a simple sum of the interest rate of 12-month treasury bills and the credit default risk premium (ALL).

$$r\_lo = r1y + prem\_r\_lo \qquad (13)$$

The credit default risk premium (ALL) is estimated as a function of its equilibrium value (prem_r_lo_ss), the trend (prem_r_lo_tnd), the domestic output gap (l_y_gap), and the shock (res_prem_r_lo). The weighted average of the current and previous quarter's output gap is used as a cyclical economic determinant of the credit default risk premium, signaling its fall when the economy is overheated and its rise during recessions. The inclusion of the credit risk premium trend picks up improvements in financial intermediation, increased competition in the banking system, and higher efficiency in the financial market.

$$prem\_r\_lo=prem\_r\_lo\_ss + prem\_r\_lo\_tnd + a8\_1*(a8\_2*l\_y\_gap + (1-a8\_2)*l\_y\_gap\{-1\}) + res\_prem\_r\_lo \qquad (14)$$

The real interest rate on loans maturing over one year is estimated as a function of its nominal rate by subtracting a weighted average of the model consistent inflation expectation one-quarter-ahead and lagged annual inflation.

$$rr\_lo = r\_lo - (a8\_3*d4l\_cpi\{+1\}+(1- a8\_3))*d4l\_cpi\{-1\} \qquad (15)$$

The real loan interest rate (ALL) gap (rr_lo_gap) is calculated as the difference between the real interest rates of loans in ALL with the short term interest rate trend (rr_tnd), the liquidity risk premium and the credit default risk premium (ALL).

$$rr\_lo\_gap = rr\_lo - rr\_lo\_tnd \qquad (16)$$

$$rr\_lo\_tnd = rr\_tnd+prem\_r1y\_ss+prem\_r\_lo\_ss \qquad (17)$$

3.5.3 Interest rate on loans, EUR

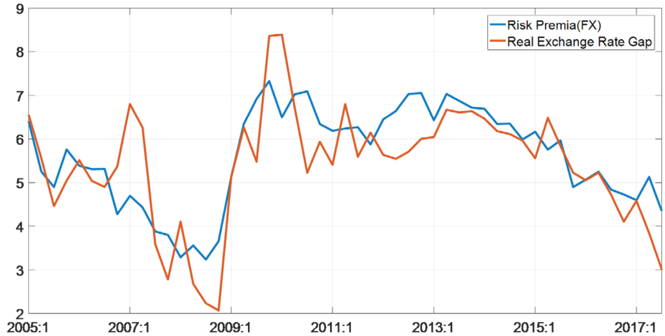
The nominal interest rate of loans denominated in EUR (r_lo_eur) is modeled on the 3-months EURIBOR rate plus the credit default risk premium (EUR).

$$r\_lo\_eur = prem\_r\_lo\_eur - rs\_eu \qquad (18)$$

The behavioral equation is modeled through the value of the credit default risk premium (EUR) in equilibrium (prem_r_lo_eur_ss), the real exchange rate gap (l_z_gap) and a shock (res_prem_r_lo_eur). The real exchange rate gap represents the main indicator used to approximate the credit default risk premium component in EUR.

$$prem\_r\_lo\_eur=prem\_r\_lo\_eur\_ss+ a9\_1*l\_z\_gap+res\_prem\_r\_lo\_eur \qquad (19)$$

Figure 8 - Credit Default Risk Premium (EUR) less equilibrium and trend and Real Exchange Rate Gap.



Source: MPD, Author's Calculation.

The real interest rate on loans in EUR is estimated as a function of its nominal rate by subtracting a weighted average of model consistent one-year ahead foreign inflation expectations and current annual foreign inflation).

$$rr\_lo\_eur=r\_lo\_eur - (a9\_2*d4l\_cpi\_eu + (1-a9\_2)*d4l\_cpi\_eu\{+4\}) \qquad (20)$$

The real loan interest rate (EUR) gap (rr_lo_eur_gap) is calculated as the difference between the real interest rates of loans in EUR with the 3-months EURIBOR trend (rr_eu_tnd) and the credit default risk premium (EUR).

$$rr\_lo\_eur\_gap=rr\_lo\_eur-rr\_lo\_eur\_tnd \quad (21)$$

$$rr\_lo\_eur\_tnd=rr\_eu\_tnd+prem\_r\_lo\_eur\_ss \quad (22)$$

4 – MODEL PARAMETRIZATION AND DIAGNOSTICS

4.1 Calibration

The model's parameter matrix is fully calibrated. In the initial stage of the calibration process, parameter values close to those in the literature were used as the starting points (see for instance Berg et al. (2006) or Benes et al. (2003)). The parameters were subsequently amended in an iterative process aimed at obtaining plausible dynamic impulse responses as well as unbiased model-based forecasts, measured in terms of in-sample simulations. In addition, the goal was to identify economically intuitive shocks supported by observed domestic policy actions or external developments.

There are three broad parameter sets to be described separately: the calibration of the steady-state part of model, its cyclical block and stochastic properties captured by the standard errors of the shocks used by the Kalman filter, the technical tool that brings the model to data.

4.1.1 Steady-State Calibration of the Model

The steady-state parameters of the model are based on historical means and judgment about the medium-term growth rates of the non-stationary real variables of the model. For stationary variables, expected medium-term averages were used. The medium-term denotes a 3–5 years ahead horizon.

The calibration of the steady-state parameters is shown in Table 1 below. The domestic inflation target is set to 3%, consistently with the BoA's target. The slopes of these trend lines are in line with trends of observed historic data. The steady-state annual trend appreciation of relative prices in the non-core segment of CPI is calibrated to 3.8 % compared to the core segment value of 1%. These values, jointly with the calibration of steady-state growth rates of foreign price levels, imply that the prices of non-core and core segments of CPI steady-state inflation rates remain close to observed historic averages. The 3.5% potential GDP growth rate of the Albanian economy reflects closely the results from Çeliku et al. (2018) that aggregate estimates ranging from statistical approaches to Cobb-Douglas technique, and the authors' judgment about medium-term equilibrium growth a rate. This value is lower than the estimated potential growth rate of the Albanian economy in the period before the start of the economic and financial crisis in 2008.

Table 1 - Steady-state parameters

Variable	Coefficient, notation	Values
Inflation target of the BoA	dl_cpi_tar_ss	3.0
Relative prices, non-core segment of CPI	dl_z_ncore_tnd_ss	-3.8
Relative prices, core segment of CPI	dl_z_core_tnd_ss	-1.0
Relative prices, CPI	dl_z_tnd_ss	-1.8
Domestic real GDP	dl_y_tnd_ss	3.5
Domestic real interest rate	rr_tnd_ss	2.0
Risk premium, domestic money market	prem_r1y_ss	1.0
Risk premium, domestic loans	prem_r_lo_ss	6.0
Credit default risk premium (EUR)	prem_r_lo_eur_ss	5.5
Foreign real interest rates	rr_eur_tnd_ss	0.0
Foreign inflation rate	dl_cpi_eur_ss	2.0
UIP risk premium	prem_p_ss	3.8

Source: MPD, authors' calculations.

The Albanian real exchange rate, measured in terms of relative consumer prices, results in a trend appreciation, reflecting an expected long-term a convergence path and price level equalization with the EU countries. The calibration of the foreign variables is based on a mix of historical averages and expert judgment. For the Eurozone, inflation is set to the inflation target of 2 percent and the short-term steady-state real interest rate to 0 percent, reflecting the assumption of very low level of the natural rate of interest in the Eurozone[12].

[12] *For more detailed analyses and estimates on the declining natural rate of interest in the Eurozone see Garnier and Willhelmsen (2005) and Holston et al (2016).*

4.1.2 Calibration of the Parameters determining the Cyclical Properties of the Model

The calibration of the parameters determining the dynamic properties of the model follows an iterative process aimed at obtaining economically plausible impulse response functions and unbiased model-based forecasts – so called in-sample simulations. The parameters are reported in Tables 2-8 and grouped according to the main equations (1)–(8).

Table 2 - Cyclical parameters, IS curve

Equation coefficient	Coefficient, notation	Values
Lagged output gap	a1_1	0.75
Expected output gap, one quarter ahead	a1_2	0.00
Elasticity w.r.t. real interest rates on total domestic loans	a1_3	0.20
Share of ALL denominated loans in total domestic loans	a1_4	0.40
Share of EUR denominated loans in total domestic loans	1- a1_4	0.60
Share of unhedged borrowers in total EUR denominated loans	a1_5	0.50
Elasticity w.r.t. real exchange rate	a1_6	0.20
Elasticity w.r.t. foreign demand	a1_7	0.25

Source: MPD, authors' calculations.

The calibration of the IS curve is consistent with a relatively high inertia in the output gap (the lagged output gap parameter a1_1 is set to 0.75); the weight of the forward-looking term a1_2 is set to zero. This calibration choice has several advantages. On the one hand, the high weight on lagged output results in good in-sample simulation results and impulse response functions, on the other hand, the absence of expected output term in it makes it easier to decompose the IS curve into the contribution of its main lagged determinants[13]. The output elasticity with respect to (w.r.t) real interest rate on domestic loans (a1_3) is calibrated to 0.2. This calibration means that real interest rates already play an important role in determining domestic demand, at the same time, the further development of the Albanian financial market should lead to even higher values of this parameter in the future. The share of ALL denominated loans in total domestic loans, a1_4, is set

[13] *By iteratively substituting out the lagged output gap from the IS curve equation.*

to 0.4; the share of EUR denominated loans to 0.6 to reflect the share of the two in the total credit stock. The share of unhedged EUR denominated loans, a1_5, is set to 0.5. These values are consistent with observed data and statistical information on the share of unhedged borrowers in foreign currency. The elasticity of output w.r.t. real exchange rate, a1_6 is set to 0.2, the elasticity of the output gap to foreign demand, a1_7, to 0.25. These values reflect some role of the export channel through the real exchange rate and foreign demand to the real economy in the transmission mechanism. However, compared with more open and export oriented economies these values are still relatively moderate.

Table 3 - Cyclical parameters, CPI identity, Phillips curves, (core and non-core inflation rates)

Equation coefficient	Coefficient, notation	Values
CPI identity		
Share of core inflation	a2_1	0.72
Share of non-core inflation	1- a2_1	0.28
Phillips curve, core inflation		
Expected core inflation at time t+1	a3_1	0.55
Lagged core inflation	1- a3_1	0.45
RMC elasticity	a3_2	0.25
Output gap	a3_3	0.75
Relative prices, core segment	1- a3_3	0.25
Phillips curve, non-core inflation		
Expected non-core inflation at time t+1	a4_1	0.6
Lagged non-core inflation	1- a4_1	0.4
RMC elasticity	a4_2	0.2
Output gap	a4_3	0.5
Relative prices, non-core segment	1- a4_3	0.5

Source: MPD, authors' calculations.

The calibration of the shares of the individual sub-indices in the total CPI is based on their respective average historical weight in total CPI (see Table 3 above). The share of core inflation, a2_1, is 0.72; the share of non-core inflation is 0.28. The parameters for core and non-core Phillips curves (see Table 3) share some similarities. Namely, the coefficients on the expected inflation rates (and the lagged inflation coefficients) are set close to 0.6 in both Phillips curves. These values are in line with micro-based Phillips curve calibrations for models with Calvo pricing, when almost full backward indexation is assumed[14]. The weights on the output gap and the relative price gaps reflect the perceived domestic and import price content of goods and services in the core and non-core sub-indices. The import price (approximated by relative price gaps) content within the CPI, a3_3, is set to 0.25 for core inflation, and to 0.5 for non-core inflation. Obviously, the share of output gap, 1- a3_3, is considerably higher for core inflation (0.75) and it is lower for the non-core segment of the basket (0.5). The elasticities w.r.t. the real marginal costs (RMC), approximated by the weighted average of the relative price and output gaps, are set to 0.25 for the Phillips curve capturing core inflation and 0.2 for the non-core block of the model. These values were set to obtain plausible dynamic impulse responses of the model to various shocks and they were iteratively verified further during testing of the model's in-sample simulation results.

Table 4 - Policy rule

Equation coefficient	Coefficient, notation	Values
Lagged policy rate	a5_1	0.8
Inflation expectations, coefficient on current inflation	a5_2	0.50
Inflation expectations, coefficient on expected inflation	1- a5_2	0.50
Deviation of four-quarters-ahead of inflation expectations from target	a5_3	2.50
Output gap	a5_4	0.20

Source: MPD, authors' calculations.

The policy rule parameters are similar to other models with an endogenous monetary policy function in use in other inflation targeting central banks. Their values are included in Table 4. The coefficient on the lagged policy rate is set to 0.8, reflecting high inertia in setting the policy rate. The high value of a5_1 assures that the reaction function, tested through impulse response functions and in-sample simulations, generates economically intuitive and realistic reactions and does not allow for jumps and unnecessary high volatility in the policy rate. The coefficients of inflation expectations on current inflation and expected inflation are set to 0.5 (a5_2). The

[14] *Full indexation will be consistent with coefficient set to 0.5.*

coefficient on inflation stabilization, a5_3, is set to 2.5, ensuring that the policy reaction is adequate to bring inflation to target within the medium-term. The relatively small weight on the output gap, 0.2, reflects the fact that direct output smoothing is moderate in the BoA's current decision-making process (see Monetary Policy Document (2015)). Nevertheless, implicit output gap stabilization is present through stabilizing inflation expectations via real marginal costs.

Table 5 - Uncovered interest rate parity

Equation coefficient	Coefficient, notation	Values
Weight on the expected nominal exchange rate, one quarter lead	a6_1	0.50
Weight on the lagged nominal exchange rate, one quarter lag	1- a6_1	0.50
Elasticity of the endogenous risk premium	a6_2	0.40
Deviation of y-o-y inflation from target in endogenous risk premium	a6_3	0.27
Output gap in endogenous risk premium	a6_4	-0.24
Autoregressive term for temporary risk premium	a6_5	0.50

Source: MPD, authors' calculations.

The UIP condition included into the BoA's model differs from the standard UIP equation in that it captures exchange rate expectations as a weighted average of forward- and backward-looking terms, compared with the standard specification featuring fully model consistent expectations. This modification of the textbook-type UIP results in more realistic impulse responses and intuitive shock decompositions. The parameters of the UIP equations are included into Table 5. The share between forward-looking exchange rate expectations and lagged exchange rate[15] (a6_1, 1- a6_1) is set to 0.5. The 2/4 adjustment coefficient assures that for any calibration consistent with a non-stationary nominal exchange rate in the steady state the assumption that exchange rate expectations are partially backward looking, will not violate the model's steady state. The elasticity of the endogenous risk premium, a6_2, is set to 0.4. This parameter, together with coefficients entering into the endogenous

[15] *This parameter controls how "jumpy" the nominal exchange rate is. When a6_1=1, the exchange rate expectations are model consistent, therefore the exchange rate reacts to any shock fully, without putting additional weight on the lagged exchange rate. When 0<a6_1<1, model consistent expectations still play a role in quantifying the exchange rate reaction to shocks, but the reaction is less pronounced, smoothed.*

risk premium a6_3 (= 0.27) and a6_4 (= -0.24) was calibrated to limit the autocorrelation observed in error term prem_t. Parameter a6_5 was estimated by OLS.

Table 6 - Financial block, 12-months T-bills

Equation coefficient	Coefficient, notation	Values
Weight on 1Y interest rates based on the expected path of the policy rate	a7_1	0.20
Weight on the current policy rate	1- a7_1	0.80
AR(1) coefficient capturing inertia in error term disc_fas	a7_2	0.70
Elasticity w.r.t the endogenous risk premium of the 12-months T-bill rate	a7_3	0.70
Share of current and lagged 12-months T-bill government financing gap	a7_4	0.50

Source: MPD, authors' calculations.

The 12-months T-bills rate is modeled as a weighted average of the one-year interest rate (based on the expected future path of the policy rate) and the current policy rate. Parameter a7_1 is the weight on the expected 1Y rate. Its calibrated value, 0.2, is consistent with the perceived weak expectation channel in determining the 1-year T-bill rate, the weight of the current policy rate is therefore its main determinant. As the Albanian financial markets develops further, supported by the BoA's forward guidance, the role of the expectation channel (and therefore the weight of a7_1) is expected to rise. The AR(1) coefficient capturing inertia in error term, a7_2, the elasticity w.r.t the endogenous risk premium of the rate, a7_3, and the share of current and lagged 12-month T-bills government financing gap in the endogenous risk premium, a7_4, were estimated by simple OLS.

Table 7 - Interest rates on domestic loans

Equation coefficient	Coefficient, notation	Values
Elasticity w.r.t the risk premium, interest rates on domestic loans	a8_1	-0.35
Share of current and lagged output gap in the endogenous risk premium	a8_2	0.50
Inflation expectations, real interest rates, coefficient on expected inflation	a8_3	0.50
Inflation expectations, real interest rates, coefficient on lagged inflation	1-a8_3	0.50

Source: MPD, authors' calculations.

The elasticity w.r.t the endogenous risk premium of the interest rates on loans, a8_1, is set to -0.35. This parameter, together with coefficients entering into the endogenous risk premium a8_2 (= 0.50) and a8_3 (= 0.50) was estimated by using OLS. Inflation expectations defining the real interest rates on loans are defined as a weighted average of expected and lagged inflation. Both coefficients are calibrated with an equal weight of 0.50.

Table 8 - Interest rates on EUR denominated loans

Equation coefficient	Coefficient, notation	Values
Elasticity w.r.t the risk premium, EUR denominated loans	a9_1	1.00
Inflation expectations, real interest rates (EUR), expected inflation	a9_2	0.50
Inflation expectations, real interest rates (EUR), lagged inflation	1-a9_2	0.50

Source: MPD, authors' calculations.

The elasticity w.r.t the endogenous risk premium of the interest rates on EUR denominated loans, a9_1, is set to one. This calibration, as it is indicated by Table 8, results in a good fit of equation capturing the credit default risk premium component for loans extended in EUR (prem_r_lo_eur).

Inflation expectations defining the real interest rates on loans denominated in EUR are modelled as a weighted average of expected and lagged inflation; both coefficients (a9_2 and 1-a9_2) are calibrated, having an equal weight of 0.50.

4.1.3 Calibration of Stochastic Properties

The stochastic properties of the model, as well as the identification of unobserved variables, are driven by the standard deviations of the shocks. The standard deviations are calibrated to get reasonable dynamics of unobserved variables (trends smoother than gaps) and contributions of shocks in line with economic intuition. In the software that is used (IRIS) for filtering, only the relative size, not the absolute value, of the standard deviations determines the outcomes.

Table 9 - Behavioral Equations

Variable	Shock term	Standard Deviation
IS curve	res_l_y_gap	0.85
Phillips curve – Core Inflation	res_dl_cpi_core	0.90
Phillips curve – Non-Core Inflation	res_dl_cpi_ncore	3.00
Policy rule	res_rs	1.50
Uncovered Interest Rate Parity	res_dl_s	1.50
1Y-ahead expected monetary policy rate, financial market survey	res_fas	2.00
12-months T-bill	res_r1y	4.00
Risk premium on 12-months T-bill	res_prem_r1y	4.00
Nominal interest rates on loans, maturity over one year	res_prem_r_lo	5.00
Nominal interest rate on loans, denominated in EUR	res_prem_r_lo_eur	5.00

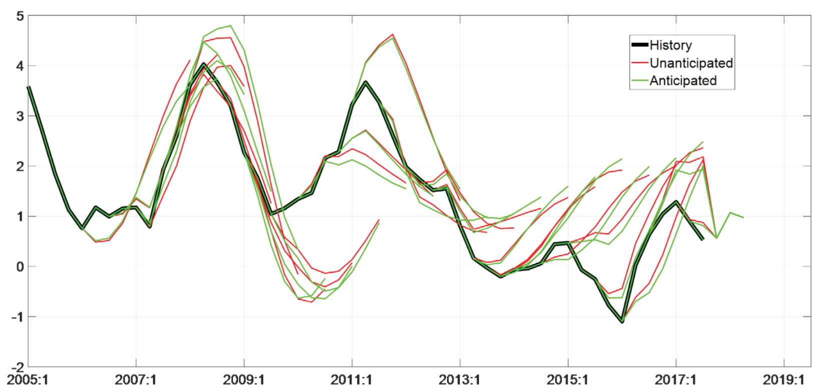
Source: MPD, authors' calculations.

Inflationary pressures identified by the model and its main behavioral equations are one of the key verifications of the quality of the model calibration. Logically, the Phillips curve(s) plays a crucial role in identifying underlying inflationary pressures. At the same time, the equations determining the unobserved values for potential output and trends in relative prices are important as well, as they determine the contribution of the domestic economic cycle on top of import prices to inflationary pressures. Therefore, the standard deviation of the shocks entering into the Phillips curve driving core inflation is set relatively low to ensure that there is a link between inflation and the pressures approximated by the output gap. At the same time, the standard deviation of the supply shocks in the core inflation Phillips curve is smaller than the standard deviation of the shocks for non-core Phillips curve. This is due to higher volatility of the non-core prices compared with that of core inflation. The high standard deviations of risk premiums of various market interest rates reflect the observed high volatility in these mark-ups. The calibrated standard deviations are reported in Table 9 above.

4.2 Historical Exercise

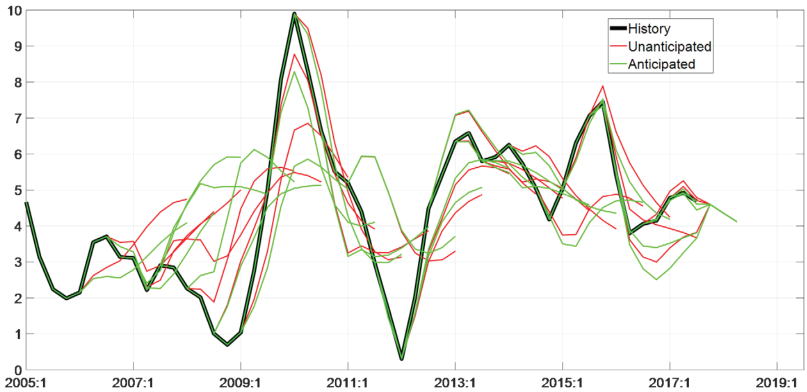
To verify the calibration in terms of its dynamic properties, model-based projections, so-called in-sample simulations, were carried out. Only simulation results of annual core and non-core inflation are reported here. When doing the simulations, model-based simulation is produced iteratively. First, the Kalman filter is run to identify the initial conditions at each point in time in the past. After that, the model is used to generate a forecast, using the filtration results obtained for unobserved variables for the whole sample and external (exogenous) variables as inputs. No other judgments are imposed. The exogenous variables are treated both as unanticipated and anticipated. In case of unanticipated simulation, the future path of exogenous variables or resulting shocks is not known. When the simulation is anticipated the full path of exogenous variables or resulting shocks is known and the economy adjusts accordingly to future expected developments. The model-based forecasts are subsequently compared with the actual data (see Figures 9 and 10). The model's dynamic simulations, relying on knowledge of the exogenous variables, are relatively close to the observed data, implying a reasonable calibration of the model.

Figure 9 - In-sample simulations, core inflation (%, y-o-y)



Source: MPD, authors' calculations.

Figure 10 - In-sample simulations, non-core inflation (%, y-o-y)



Source: MPD, authors' calculations.

4.3 Impulse Response Functions (IRFs)

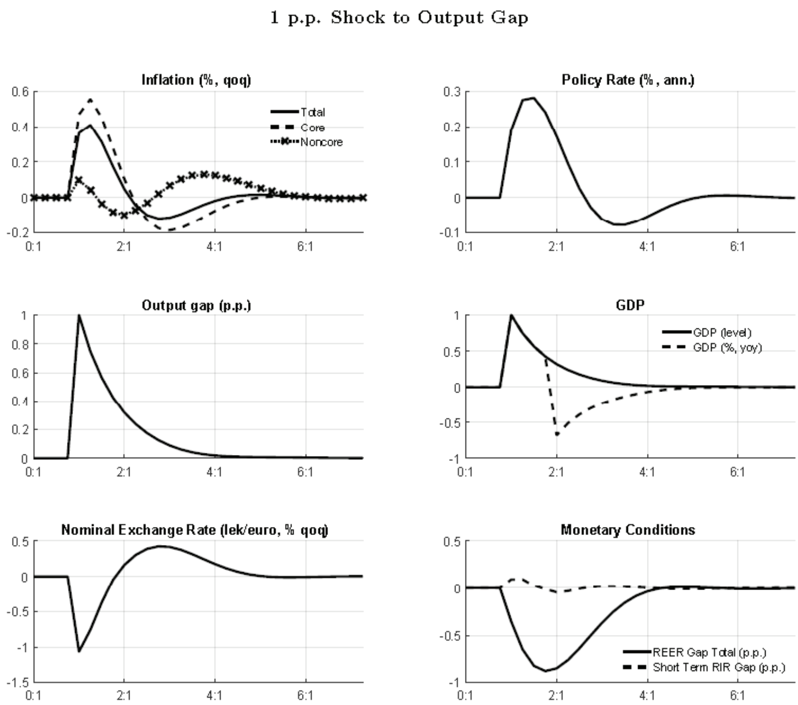
The complete model structure in its reduced-form complemented with a single parameter matrix allows for a unique and stable model solution around a steady-state. The latter can be used to conduct tests on model dynamic properties and investigate resultant economic implications. We conduct this exercise by initially constructing IRFs from specific innovations of interest in the system, observing shock propagation patterns on specific variables and providing the relevant economic interpretations. To start with, we introduce standard single innovations and provide respective IRFs focusing on demand, supply, exchange rate and financial sector shocks. Thereafter, we conduct specific policy experiments to illustrate the role of expectations in the model and the way they can alter the behavior of rational economic agents and policymakers. Next, we focus on model sensitivity analysis to test model impulse responses under different coefficient parametrizations and provide a range of possible impulse responses for certain shocks. Finally, we perform a shock decomposition exercise in order to assess the model's power in identifying historical structural shocks hitting the economy.

4.3.1 Output Gap - Demand Shock

To assess the model's reaction to a demand shock, we introduce an unexpected 1 percentage point shock to the domestic output gap for one quarter. The latter would immediately generate upward pressure on prices through excess demand that cannot be immediately matched by domestic production. In addition, credit default risk premium in domestic currency will fall, reflecting perceived better economic prospects in the short term. To cool down the economy and to pre-empt inflationary pressures gathering momentum, monetary policy reacts by increasing the short term policy rate on par with the expected deviation of inflation from equilibrium and increased output gap. The monetary contraction prevents domestic market interest rates from receding further. The domestic currency appreciates to prevent arbitrage stemming from the positive interest differential by means of subsequent depreciation. The real interest rate channel works through discouraging extra consumption and investment and pushing for higher savings, whereas real exchange rate appreciation works through reducing foreign competitiveness, engendering higher export prices and lower import prices in domestic currency terms.

As a counterbalance, the appreciating exchange rate reduces credit default risk premium in euros and improves unhedged borrowers' balance sheets. The excess demand is in a large part met through increased imports, which are now relatively cheaper. Combined with lower exports, a deteriorating foreign balance and an increasing demand for foreign currency depreciates the domestic currency. At this point, as inflationary pressures from the output gap recede, inflation slowly moves back to target.

Figure 11 - Simulation of a demand shock



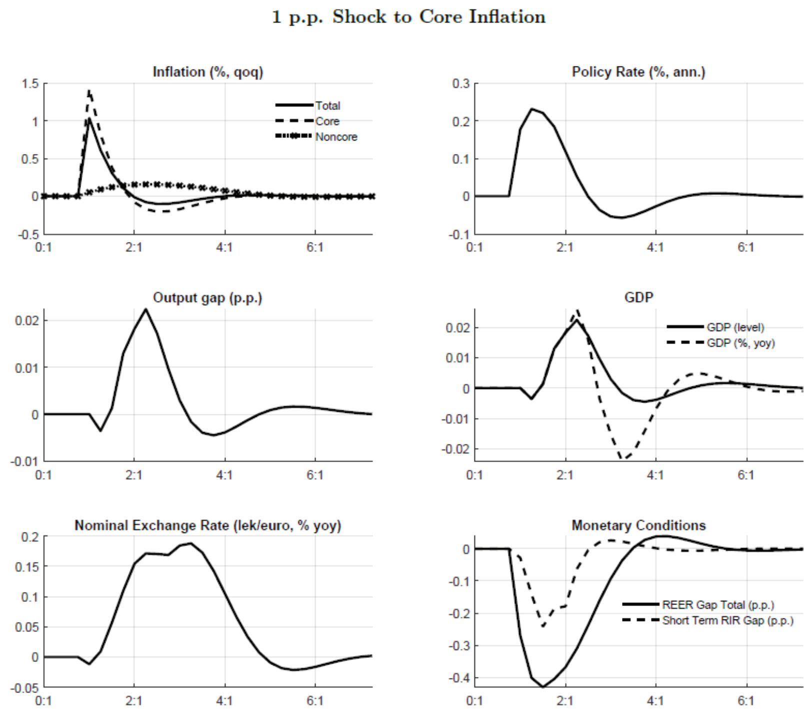
Source: MPD, authors' calculations.

4.3.2 Core inflation - Supply Shock

In Figure 12, we investigate the reaction of the economy to a 1 percentage point unexpected supply shock to the core annualized quarter-on-quarter inflation rate due to, for example, an increase of production costs in the economy because of a tax hike. In this scenario, core inflation reacts immediately and the impact on headline inflation is strong, owing to the large share of core inflation in total inflation. Monetary policy reacts at a lower magnitude than the increase of headline inflation due to the supply shock. The cyclical component of the exchange rate risk premia increases due to inflation jumping above target and induces a depreciation of the currency. This depreciation is less pronounced than the increase of core and total inflation and since foreign prices do not move, both the overall real exchange rate and its core component start an appreciation cycle. The former leads to a fall in the credit default risk premium, which combined with the improved purchasing power of unhedged borrowers, impacts positively the output gap. The effect on the output gap through the competitiveness channel is negative. In addition, real interest rates in domestic currency become more accommodative as the policy reaction is smaller than the hike in total inflation. The combined effect on the cyclical position of the economy from the above four components is broadly neutral.

The stabilization of prices is done through the appreciation of the real exchange rate, which decreases import prices in domestic currency, and through the expectation channel. In this case, aggregate demand does not move and hence the increase in prices is expected to be short-lived by rational agents. Consequently, inflation expectations, as opposed to the demand shock scenario, converge faster to the target and warrant a milder policy reaction in response to the shock.

Figure 12 - Simulation of a supply shock

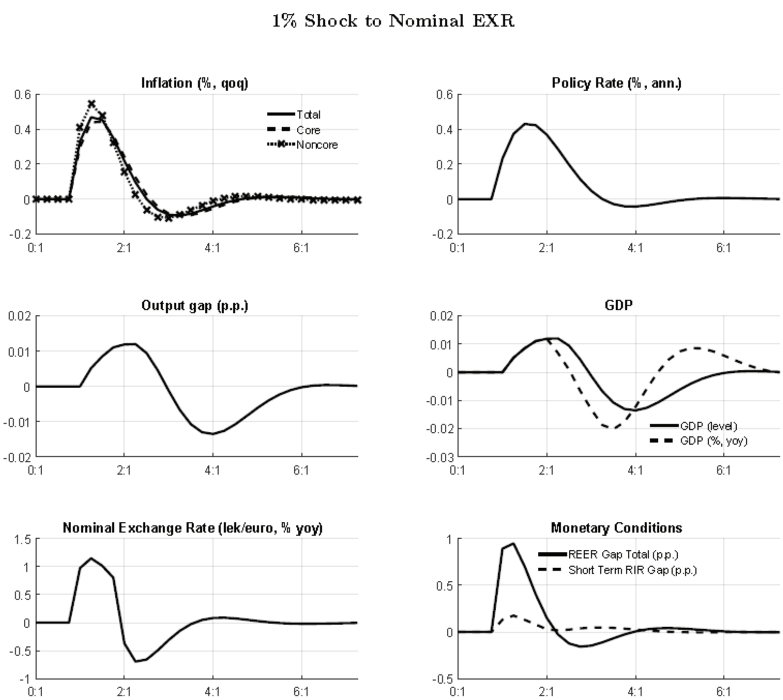


Source: MPD, authors' calculations.

4.3.3 Exchange Rate – Temporary Risk Premium Shock

In the third simulation, we explore the model's dynamic response to an unexpected temporary risk premium shock that depreciates the currency by 1 percent annually in the first period. The nominal exchange rate depreciates for about four quarters with maximum impact reached one quarter after the introduction of the shock. The immediate reaction of the nominal exchange rate to the shock reflects the forward-looking nature of the UIP equation. The depreciation of the exchange rate is passed through immediately to prices. In response to increasing relative prices captured through the real exchange rate, both the core and noncore components of inflation react similarly. In order to control higher expected inflation and persistent deviation from target, monetary policy contracts rapidly and remains contractionary for a longer period of time, compared to previous simulations.

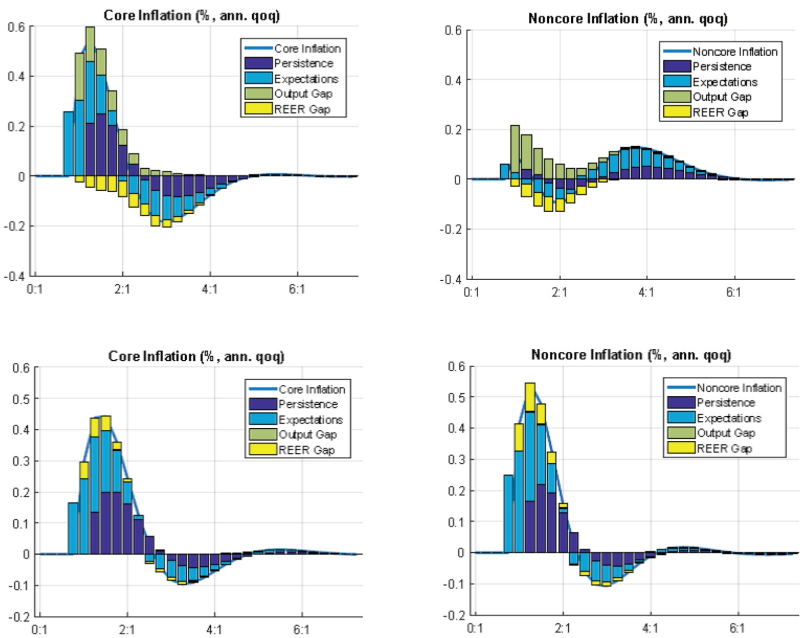
Figure 13 - Simulation of an exchange rate shock



Source: MPD, authors' calculations.

There is a clear distinction in how the exchange rate shock propagates in the economy when compared to the demand shock scenario. As illustrated in more detail in Figure 14, here the overall cyclical position of the economy, captured by the output gap, remains unaffected. The rapid depreciation of the exchange rate improves the competitiveness of the Albanian economy with its effect counterbalanced by higher interest rates in euros and reduced buying power. In addition, the short-term interest rate hike pushes up market interest rates in domestic currency. Domestic demand cannot mitigate inflationary pressures as the output is close to its potential level. The convergence of the economy to equilibrium is reached through prompt monetary policy reaction that results in an appreciation of the nominal exchange rate.

Figure 14 - Decomposition of IRFs, demand shock vs exchange rate shock

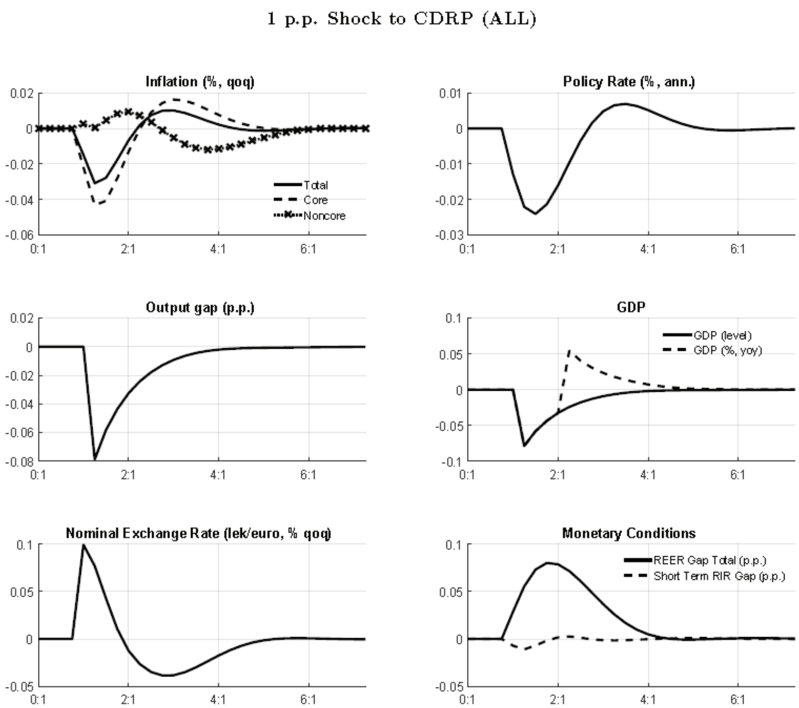


Source: MPD, authors' calculations.

4.3.4 Financial Sector – Credit Default in ALL Risk Premium Shock

In the last simulation we introduce an unexpected 1 percentage point shock to the credit default risk premium in domestic currency. In this scenario, market interest rates on loans denominated in domestic currency increase immediately and drag down domestic economic activity. Concurrently, the exchange rate depreciates as demand for imported goods decreases. The previous two factors' combined effect on inflation is minimal, prompting little reaction from monetary authorities. In addition, as the impact on the output gap is small and as monetary policy reacts little, the overall effect of the shock on the real variables in the system dies out quickly without major implications.

Figure 15 - Simulation of a financial market shock



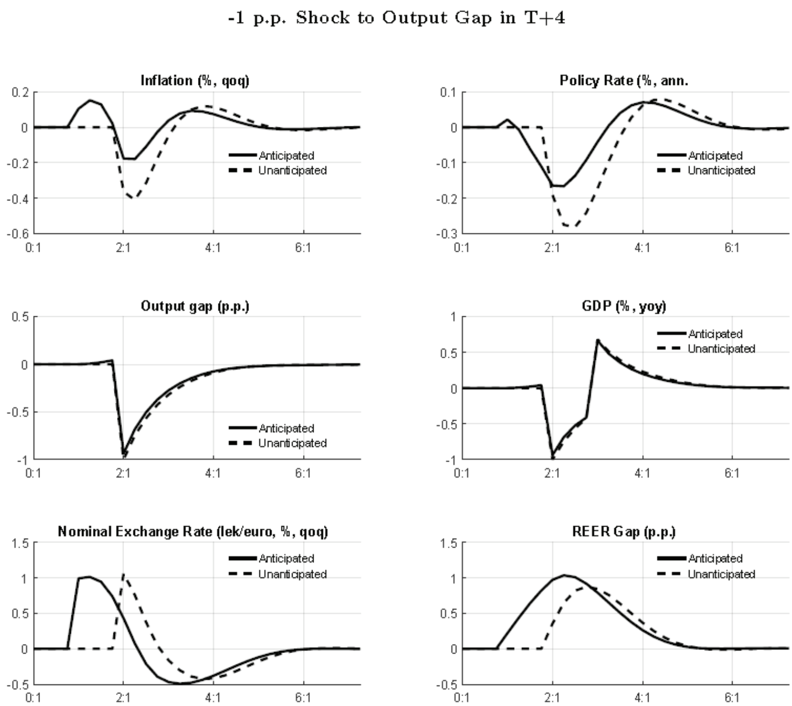
Source: MPD, authors' calculations.

4.4 Expectations

4.4.1 Future Demand Shock

In the first policy experiment carried out to illustrate the role of expectations (Figure 16), we track the dynamic response of the model to an introduction of a shock anticipated by rational economic agents, vis-à-vis a similar case when the shock is not anticipated. For this, we assume a 1 percentage point negative demand shock in time "T+4". In practice, this shock could take the form of the termination of a large public infrastructure project 1 year ahead from time "T", which would entail a lower budget deficit and a negative fiscal impulse. We conduct two separate simulations. In the first one, economic agents know and anticipate the exact time of when the negative demand shock hits the economy and adjust their behavior today. In the second simulation, they are taken by surprise.

Figure 16 - Simulation of anticipated and unanticipated shocks



Source: MPD, authors' calculations.

When the shock is anticipated, economic agents immediately adjust their behavior. In anticipation of a more accommodative monetary policy in the future, the domestic currency depreciates directly to prevent arbitrage stemming from the negative interest differential. In parallel, the real exchange rate depreciates and increases inflationary pressures in the short-term through higher import prices. Monetary policy, targeting inflation one year ahead, turns expansionary anticipating lower demand-led inflation in the future. The output gap takes a negative hit in "T+4". The drop in the output gap is slightly smaller than the value of the shock introduced. As the output starts to recover after the shock, monetary policy initiates its normalization path in anticipation of increasing expected inflationary pressures. This normalization introduces appreciating pressures on the domestic currency and allows the real effective exchange rate to move back to its equilibrium. In contrast to diminishing price pressures from the real exchange rate, the improving cyclical position of the economy allows demand-side inflationary pressures to gather pace and allows inflation to converge slowly to target. In case of an unanticipated shock, the economy reacts in a similar fashion as in the standard IRFs to a demand shock albeit with a different sign. Nevertheless, the distinction between the two simulations is inherently important. When the shock is anticipated, monetary policy has to react less aggressively to keep inflation close to target by acting in a forward looking manner and by steering agents' expectations. This behavior results in less price fluctuations and helps to better anchor inflation around the target. The opposite is true when monetary policy takes a more wait-and-see approach, as illustrated in the next policy experiment.

4.4.2 Delayed Monetary Policy Response

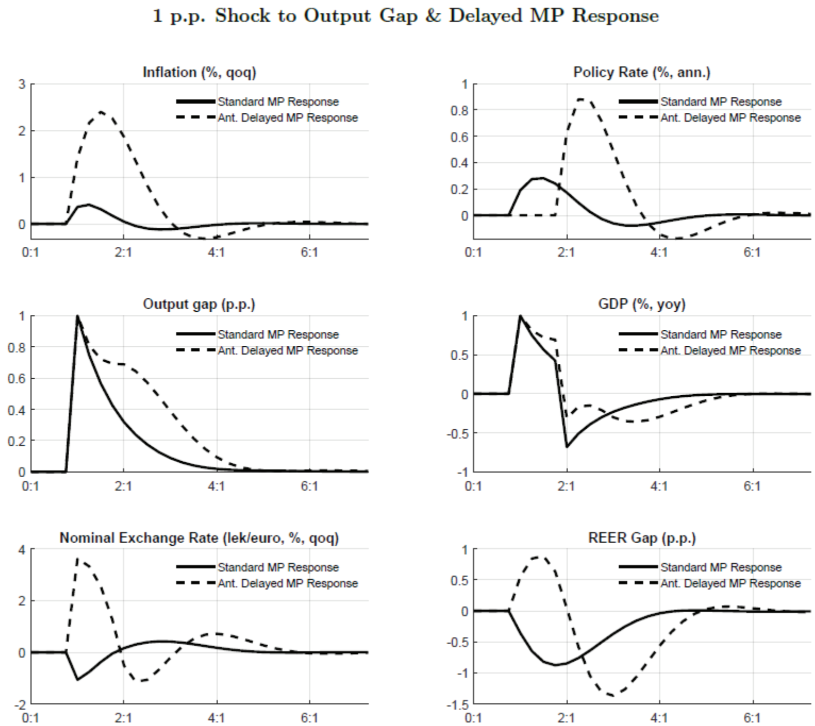
In this policy experiment, we conduct two separate simulations to capture the behavior of rational economic agents, conditional on their expectation formation on the behavior of the central bank, to illustrate the importance of a pro-active conduct of monetary policy within the model framework and the importance it has on macroeconomic stabilization. In the simulations, captured below in Figure 17, the economy is hit by a positive demand shock that raises output gap by 1 percentage point. First, we quantify the standard monetary policy reaction when the central bank reacts to the shock without any delay. Second, we run an additional simulation, assuming the central bank adopts a "wait-and-see" approach, whereby monetary policy delays its reaction to the shock, in this case by four quarters.

The distinction in economic outcomes between the standard and the delayed policy response scenarios is related to the expectation formation of rational economic agents. In the delayed policy response scenario, the monetary authority's course of action is fully anticipated and economic agents bring forward their planned consumption expenditures and investment plans, prior to their expected base interest rate hike. This intensifies inflationary pressures and exerts depreciating pressure on the exchange rate, until the expected interest rate hike occurs in time "T+4". Thereafter, monetary policy reacts to growing demand-led and imported inflation pressures, the exchange rate starts to appreciate, real interest rates increase and as a result, inflationary pressures start to recede.

In terms of economic outcomes and when compared to the standard monetary policy response scenario, if monetary policy response is delayed, the demand shock dissipates more slowly at the expense of higher inflation and of a subsequent more aggressive monetary policy reaction. In the standard scenario where monetary policy is pro-active and acts in time, economic fluctuations are milder and inflation volatility is lower. Any delayed response, makes the stabilization of the economy more daunting, allows for more significant deviation of inflation from the target and for a longer period of time, and erodes the credibility[16] of the central bank.

[16] *Credibility effects are not taken into account in the model simulations above. In real life monetary policy decisions these effects should be discussed and communication strategies adjusted accordingly.*

Figure 17 - Simulation of a delayed monetary policy response with anticipated shocks.



Source: MPD, authors' calculations.

4.5 Sensitivity Analysis

As we already highlighted in the previous subsection, the Impulse Response Functions describe the dynamic behavior of a model in response to some external change. They depend on certain characteristics such as the model structure, parameters and standard deviation of the exogenous i.i.d. shocks. In general, the trajectory of the IRFs should adhere to economic intuition and country specific features, if present.

In order to check whether the reactions to the shocks displayed in the IRFs mentioned above are stable and make economic sense, one can check the sensitivity of the model towards different parametrizations. This can be done by running IRFs for given shocks by changing the parameters used in the model (autoregressive and other model related coefficients calibrated in the model). In theory, if different values of parameters generate very diverse IRFs, the model may be valued to be unstable in its reaction to exogenous shocks.

Table 10 - List of sensitivity analysis tests

Unit Shock (j)	Variable Response (i)	Parameter	Description	Parameter Range	Incremental
Nominal Exchange Rate Shock (res_dl_s) -1p.p.	Output gap, Inflation, Policy Rate	a5_3	Inflation deviation aggressiveness	0.1 - 5.0	20
Core Supply Shock (res_dl_cpi_core) 1p.p.	Output gap, Inflation, Policy Rate	a3_2	Real Marginal Costs elasticity	0.1 - 1.0	20
Foreign Output Gap Shock (res_l_y_gap_eu) 1p.p.	Output gap, Inflation, Policy Rate	a1_7	Foreign Output Gap in Aggregate Demand	0.1 - 1.0	20
Nominal Exchange Rate Shock (res_dl_s) -1p.p.	Output gap, Inflation, Policy Rate	a3_3	Output Gap/ Exchange Rate Pass-through (Core Inflation)	0.0 - 1.0	20

Source: MPD, authors' calculations.

The table above depicts the list of sensitivity analyses carried out with the model. Theoretically, the exercise consists of a graphical representation of the response of variable i to a positive unit shock in variable j, while simultaneously testing different values for certain model parameters. Various shocks were used, such as shocks to the nominal exchange rate value, supply side shocks and foreign demand ones.

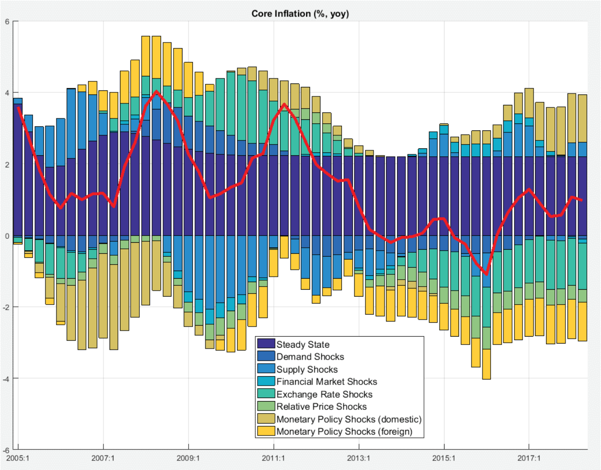
The results are presented in the Appendix A. For example, the sensitivity analysis allows for interpreting the effect that different parameter values have in the impulse responses of a 1 p.p. negative (appreciation) shock to the nominal exchange rate. By changing the weight of the output gap and real exchange rate gap in the RMC component of the Core Philips Curve, it can be derived that weak exchange rate pass-through coefficients help to dissipate the negative effects coming from a sudden appreciation of the exchange rate. Overall, the results of the tests follow economic logic, with no clear case of major divergence between impulse responses for different coefficients' parametrizations.

4.6 Shock Decomposition

Decomposition of the observed variables into structural shocks provides an additional check of the model calibration. The shock decomposition results should be "reasonable", i.e., consistent with the main driving factors of inflation as well as in line accumulated institutional knowledge and analyses on permanent and temporary shocks hitting the economy. The shock decompositions for core- resp. non-core inflation rates are presented in Figures 18 resp. 19.

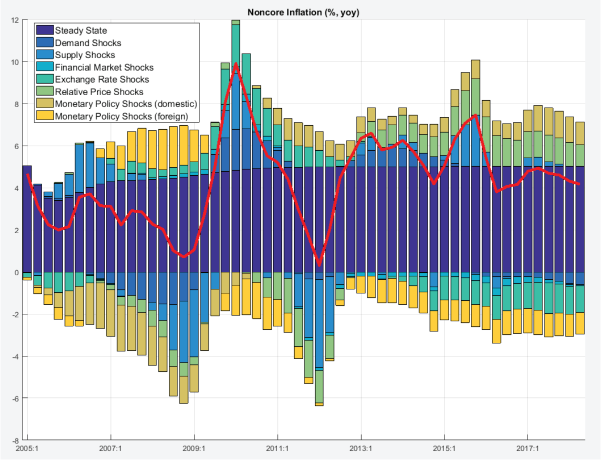
The results suggest a significant effect of shocks to the nominal exchange rate on both core- and non-core inflation during the observed 2005-17 period. The depreciation of the nominal exchange rate, explained largely by exchange rate shocks emerging after the burst of the global economic crisis in late 2008, fed gradually into core inflation. The exchange rate mitigated falling domestic inflationary pressures during the 2009-10 period, caused largely by highly negative supply shocks. Demand shocks were positive not only prior to the crisis, but also throughout 2009 - early 2011, only starting from mid-2011 they started to curb demand. Foreign monetary policy shocks were adding inflationary pressures during the pre-crisis period and were acting in the opposite direction afterwards. Financial market shocks were not playing a significant role for most of the time.

Figure 18 - Shock decomposition, core inflation, in %, y-o-y



Source: MPD, authors' calculations.

Figure 19 - Shock decomposition, non-core inflation, in %, y-o-y



Source: MPD, authors' calculations.

5 – CONCLUSION

In this paper we provide a detailed description of the upgraded Medium-Term Projection Model (MPM), as the core forecasting tool within the FPAS framework of the Bank of Albania, used to inform and support the monetary policy decision making process. The MPM model is fully calibrated and is similar to other versions of small semi-structural business cycle models, in use in other central banks, but also different in that it incorporates idiosyncratic traits of the Albanian economy and financial market within its structure.

The main contribution of this paper is related to improving the main equation blocks and adding new country-specific features into a standard framework already in place. In a forward-looking monetary policy environment, specific attention was paid towards the two endogenous variables of the MPM, namely the interest rate and exchange rate. The base monetary policy rate identification, captured through a forward looking Taylor Rule equation, attempts to reflect the relative policy preferences and trade-offs of policy makers in responding to inflation deviations from target and output stabilization. The exchange rate, is modeled through a UIP condition, consisting of the interest rate differential, trend appreciation and three risk premiums (permanent, cyclical and temporary). The inflation block was upgraded by including two distinct Philips Curves for both core and noncore inflation, while also strengthening the role of forward looking inflation expectations in bringing inflation to target in the medium term. The addition of a new financial block helps tracking in full the transmission mechanism of the policy impulse onto the real economy through the financial market. The evolution of loan interest rates is captured by modeling the relevant risk premiums that characterize the interest rate setting behavior in the domestic banking system, while also accounting for the euroization the financial system.

Parametrization and calibration choices bring the model as close as possible to the specific features and to the evolution of the Albanian economy in time and make it a highly effective and reliable tool for medium-term forecasting. For this, great importance is given to the analysis of observed historical features of the economy and its response to policy impulses and shocks. The econometric diagnostics show that the MPM model can approximate well the behavior of the economy in time and its shock propagation characteristics are in line with economy theory. In addition, the MPM model is a valuable tool in policy analysis exercises as well as in interpretation of historical shocks and their effects onto the real economy.

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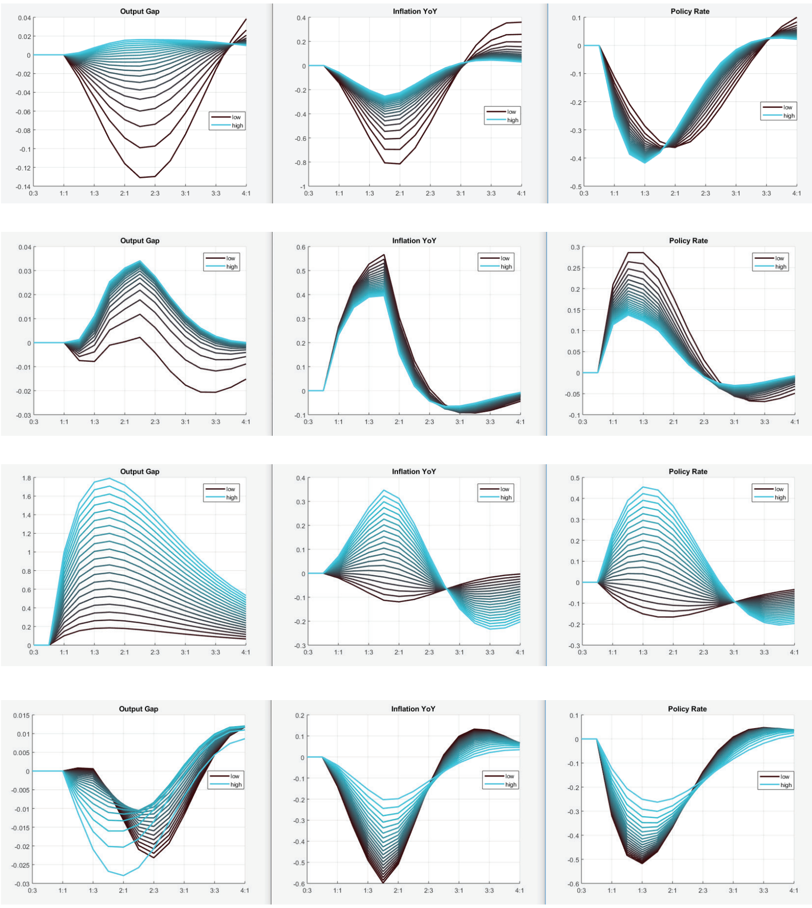
APPENDIX A

Figure 20 – Sensitivity analysis of a5_3, a3_2, a1_7 and a3_3



APPENDIX B

IS Curve

$$l\_y\_gap = 0.55*l\_y\_gap\{-1\} + 0.06*l\_y\_gap\{+1\} - 0.07*rr\_gap\{-1\} + 0.19*l\_z\_gap\{-1\} + 0.04*l\_y\_gap\_eur + res\_l\_y\_gap \quad (1)$$

Philips Curve

$$dl\_cpi\_core = 0.3*dl\_cpi\_core\{+1\} + 0.7*dl\_cpi\_core\{-1\} + 0.32*l\_y\_gap + 0.05*(l\_z\_gap - l\_z\_gap\{-1\}) + res\_dl\_cpi\_core \quad (2)$$

$$dl\_cpi\_ncore = 0*dl\_cpi\_ncore\{-1\} + 1*dl\_cpi\_ncore\_ss + res\_dl\_cpi\_ncore \quad (3)$$

$$dl\_cpi = 0.715*dl\_cpi\_core + 0.285*dl\_cpi\_ncore \quad (4)$$

Policy Reaction Function

$$rs = 0.8*rs\{-1\} + 0.2*((rr\_tnd + d4l\_cpi\{+4\}) + 1.7*(d4l\_cpi\{+4\} - dl\_cpi\_tar\_ss) + 0.05*l\_y\_gap) + res\_rs \quad (5)$$

UIP Condition

$$dl\_s\{+1\} = 0.7*dl\_s + 0.3*(rs - rs\_eur - prem\_p - prem\_t)/4 \quad (6)$$

$$prem\_p = 0.5*prem\_p\{-1\} + (1-0.5)*prem\_p\_ss + res\_prem\_p \quad (7)$$

$$prem\_p = rr\_tnd - dl\_z\_tnd - rr\_eu\_tnd \quad (8)$$

$$prem\_t = 0.67*prem\_t\{-1\} + res\_dl\_s \quad (9)$$

Figure 21 – Exchange rate in-sample comparison – upgraded MPM vs old model

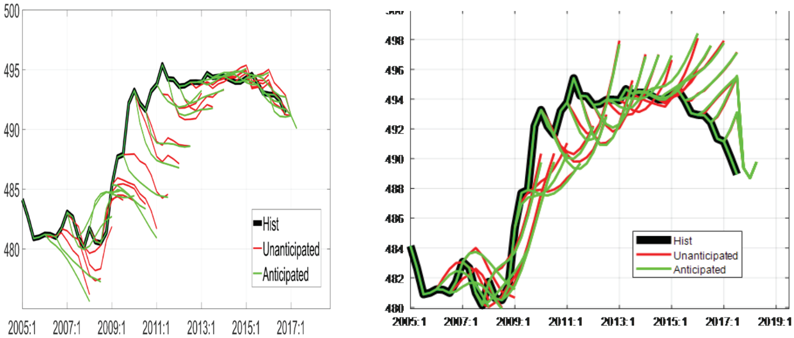


Figure 22 – Core inflation in-sample comparison – upgraded MPM vs old model

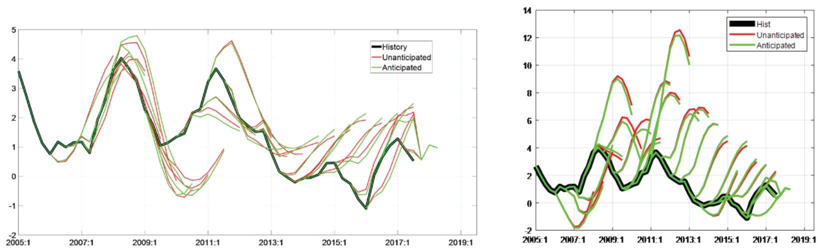
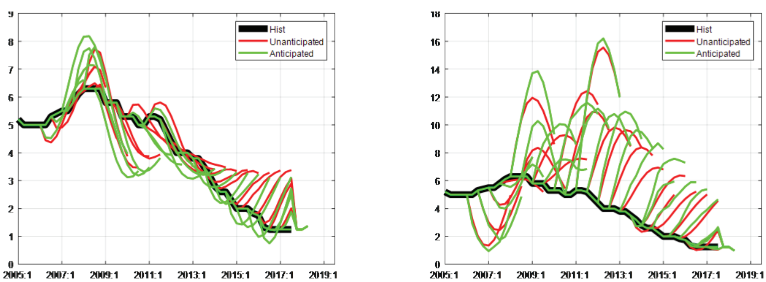


Figure 23 – Policy rate in-sample comparison – upgraded MPM vs old model



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