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Determinants of Monetary Transmission in Armenia

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Determinants of Monetary Transmission in Armenia

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Abstract. A well-functioning monetary policy transmission mechanism is a guarantee for a successful monetary policy, therefore examination of the impacts of its main determinants in Armenia was of a great interest, and served as an inspiration for the given research. Following the research objectives, a proxy variable for the strength of monetary pass-through in Armenia was estimated, and then the resulted variable was used in an empirical model to assess the long-run and short run relationship with its main factors.

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Keywords: Monetary policy; Transmission mechanism; Time varying parameter VAR model; Armenia

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1. Introduction

Armenia began to implement independent monetary policy since early 90s. The Central bank of Armenia developed the first monetary policy program and adopted the strategy of monetary targeting as the method of monetary regulation since 1994. During the first period the primary goal of the Central bank was the domestic and external stability of the national currency. In 1996 the national assembly of Armenia adopted the law “On the Central bank of the Republic of Armenia”, according to which the primary goal of the Central bank was to keep prices at a low and stable level. The Central bank used indirect instruments to regulate the monetary aggregates for attaining the primary goal of price stability. Despite the difficulties, through the monetary targeting strategy the Central bank of Armenia was able to significantly reduce the inflation rate starting from mid-1994, and in 1998-2004 it was stabilized nearby 2.4% average rate.

However, the further implementation of this strategy was problematic. Decreasing relationship between monetary aggregates and inflation rate made them less reliable predictors of the future inflation. The underdeveloped financial markets and highly dollarized economy made the predictions and control of monetary aggregates challenging. To achieve its primary goal, the Central bank had to implement frequent revisions of monetary policy programs. Weak transmission to the real economy and inflation created further complications for effective implementation of monetary policy and decision making. All these problems harmed the credibility of the Central bank, and it was pressing to make changes in the monetary policy framework.

In 2006 the Central bank of Armenia passed to a new monetary policy regime and began to implement inflation targeting strategy. Since then the Central bank of Armenia adopted by law the official quantitative target of 4 percent within ±1.5 tolerance band for the inflation rate for a one year time horizon, and tried to achieve this target through an effective monetary policy. The new monetary policy framework created new requirements for development and implementation.

Among the other criteria for a successful implementation of inflation targeting, one of the crucial conditions is clear understanding of the process through which monetary policy shocks transmit to the real economy. After adopting the new strategy for monetary policy the Central bank of Armenia made essential steps towards the achievements of developed and effective monetary policy framework. However, the overall macroeconomic situation and the stage of financial developments still do not let the Central bank to achieve effective transmission of monetary policy changes to the real economy and inflation. Like in many other developing countries similar to Armenia the main channels of monetary transmission in Armenia are not fully functional.

The evidence can be observed by simply looking at the historical developments of actual inflation levels and the targeted bands in Armenia. Inflation targets and actual inflation levels for years 1998-2014 are presented in the figure 1. After adopting inflation targeting strategy, the inflation rate was in the targeted band only in 38% times within the period 2006 to 2014. This result was relatively one of the worst among the countries which have adopted inflation targeting monetary policy strategy[1], although most of the times the causes of these “failures” came mainly from supply side or external shocks, which were not under the control of the Central bank. Regardless, this is a big signal of a weak monetary transmission in Armenia.

[1] This conclusion was achieved based on the calculations by using the database from IMF: http://www.imf.org/external/pubs/ft/weo/2014/01

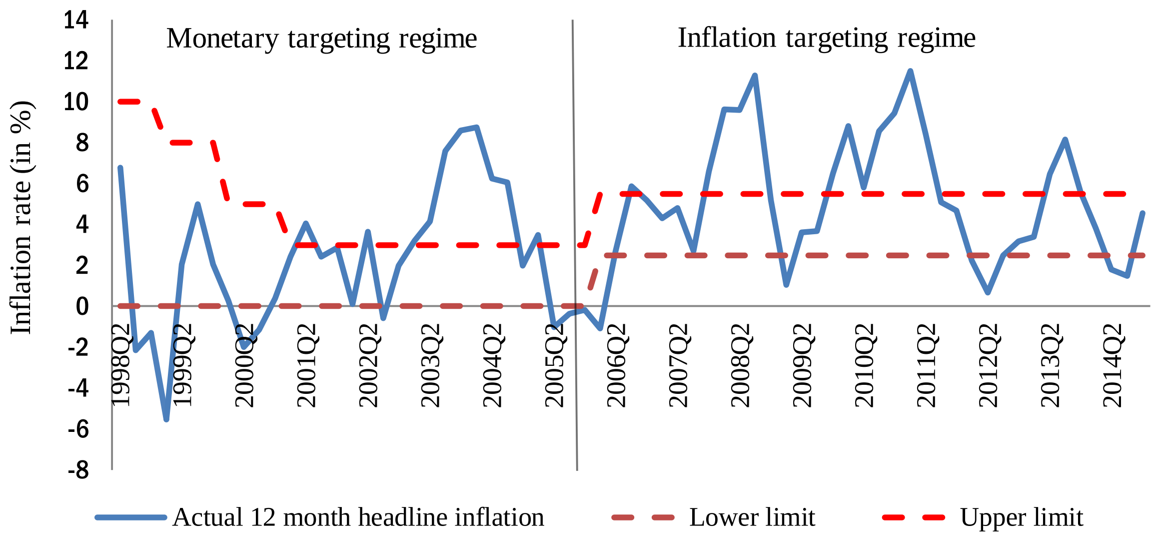


Figure 1.
The figure illustrates the developments of 12 month headline inflation in Armenia for two periods; monetary targeting regime (before 2006) and inflation targeting regime (after 2006).
Source; Central bank of Armenia.

The evidence identifying weakness of monetary transmission in Armenia can also be found in the literature. Dabla-Norris and Floerkemeier (2006) reported that the influence of monetary policy to the economic activity and inflation in Armenia are limited, as important channels of monetary transmission are not fully functional. In another, more recent working paper, Bordon and Weber (2010) concluded that the impact of the policy rate on prices in Armenia remains weak although there was evidence that it was strengthened after the regime switch in 2006.

The central objective of this paper is to reveal the main determinants of a well-functioning monetary policy transmission mechanism in Armenia, and the rest of the paper is structured as follows. The section II includes the discussion of the literature. In section III the estimation procedure of a proxy variable for the historical developments of monetary policy pass-through coefficient is presented. The next section is dedicated to investigation of the main disturbing factors of efficient monetary policy transmission in Armenia. The paper goes further, and also empirically estimates the influence of those factors on the monetary policy pass-through coefficient. Finally, section V concludes and makes policy recommendations.

2. Literature Review

To implement a successful monetary policy and make reasonable decisions concerning the policy instruments, monetary authorities must have a thorough understanding of the timing and the effects of their policies on the real economy and inflation. Well-functioning transmission mechanism is a guarantee for a successful monetary policy. This makes monetary policy transmission mechanism and the determinants of its effectiveness one of the most studied areas of monetary economics.

The interest in this research topic is understandable, and there can be found a lot of relevant literature. For example, Cechetti (1999) examined differences in the banking system characteristics across the countries of the European Union, and concluded that the differences in financial structure are an immediate cause for national asymmetries in the monetary policy transmission mechanism in those countries. Furthermore, he argued that the differences in financial structures across the European countries are a consequence of their dissimilar legal structures, and so he led to the possibility that it is the legal system in a country that forms the basis for the structure of financial intermediation and, hence, for the impact of monetary policy on output and prices.

Aysun et al (2010) found statistically significant relationships between the level of financial frictions and the effects of monetary policy shocks on the economy. Based on the predictions of the financial accelerator model, and by using firm level data, they measured the sensitivity of bond spreads to financial leverage of firms that issue these bonds. The results indicated statistically significant relationships between financial frictions and monetary policy pass-through.

Another relevant study was presented by Mishra et al (2010). Cross-country evidence on the effectiveness of the monetary transmission mechanism led them to conclude that at the limited degree of financial developments, the transmission mechanism in low income countries mainly dominated by the bank lending channel, and the strength and reliability of the monetary pass-through depends critically on the effectiveness of this channel. They also argued that the transmission from central bank monetary policy actions to bank lending rates in the low income countries is both weak and unreliable.

The next relevant paper was suggested by Medina Cas et al (2011), who examined the key factors that influence the strength of the interest-rate transmission mechanism in Central American countries. They employed a panel regression analysis, the results of which suggested that the interest rate pass-through has a negative and statistically significant relationship with dollarization, and a positive and statistically significant relationship with exchange rate flexibility and financial system development. They also tried bank concentration ratio as a determinant of the effectiveness of monetary transmission. Although bank concentration also had a negative relationship with the interest-rate transmission mechanism, its statistical significance was not confirmed.

Mishra and Montiel (2012) examined the results of a large number of studies that have estimated the effects of monetary policy in low-income countries. They concluded that a wide range of empirical approaches used by different researchers failed to yield a considerable evidence of effective monetary transmission in low-income countries, and only relatively more institutionally developed countries, such as some Central and Eastern European transition economies, appear to have some evidence for effective monetary transmission.

One more relevant research in the given topic was introduced by Saborowski and Weber (2013), who found that exchange rate flexibility, banking sector concentration, liquidity ratios, along with non-performing loans ratios and financial dollarization were important determinants of interest rate pass-through. They proved that in more developed markets monetary policy shocks almost fully transmit to retail lending rates. In contrast, the pass-through in developing countries is significantly lower at around 30–45 percent. This is mainly explained by the existence of flexible exchange rate regimes, lower liquidity and NPL ratios, and more developed financial systems in advanced economies.

3. The Proxy Variable for Monetary Transmission in Armenia

The final goal of this research is to identify the main disturbing factors for the monetary policy transmission to CPI inflation in Armenia, and measure the influence of those factors on the effectiveness of monetary pass-through. Led by this purpose, first of all we were required to find a proxy variable which described the effectiveness of monetary policy transmission (hereafter MTS) in Armenia, and then this variable was used as an outcome variable in the final regression analyses. This section is dedicated to the estimation of the proxy variable for monetary transmission in Armenia. Initially, brief theoretical introduction will be presented, and then discussion of the used dataset and the empirical results will be followed.

3.1 Theoretical Approaches for Approximation of MTS

The literature provides two relevant approaches for approximation of MTS. By the first approach many authors (Christiano et al. (1996), Kim (1999), and Kim and Roubini (2000)) estimated VAR models to measure the responses to an unanticipated shock of monetary policy rate and then used forecast error variance decompositions (FEVD) to obtain the coefficients of MTS. The strength of monetary transmission in these studies was measured by the percentage of variations in output or CPI inflation explained by the monetary policy rate.

Alternatively, impulse response analyses in VAR models can be used to obtain the values of MTS. For example, Ceccheti (1999), Aysun et al (2010) implemented impulse response analyses in their VAR models and used the maximum amplitudes of output and inflation responses to a one standard deviation shock to interest rates as a measure of monetary policy effectiveness. An example is illustrated in the figure 2, where the maximum cumulative response of CPI inflation to one standard deviation shock of policy rate, which was in the fifth quarter, can be approximated as the coefficient of monetary policy pass-through.

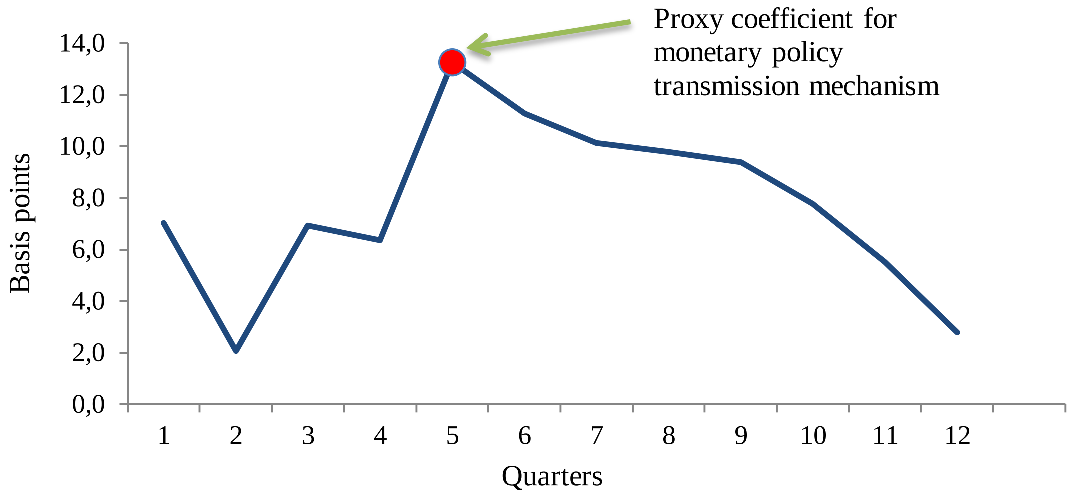


Figure 2.
The graph illustrates the results of IRF analyses, where each point shows the negative response of CPI inflation to 100 basis points monetary policy shock in each quarter.
Source: Author`s estimation.

However, with a simple VAR model it is impossible to get proxy coefficient for MTS, which will vary over time. Therefore, to estimate historical time series of MTS, instead of a simple VAR model a time varying vector auto regressive model (hereafter TVP_VAR model) should be employed. This approach gives the opportunity to estimate time varying parameters and variance covariance matrices, and enables implementation of impulse response analyses at each point in time. As a result, for the whole analyzed time horizon time varying MTS coefficient can be obtained.

A TVP_VAR model supposes that the matrixes of coefficients and variance covariance of error terms are changing across time. The fluctuations in the coefficients capture the possible nonlinearities or time variation in the lag structure of the model. The fluctuations in the multivariate variance covariance matrix capture possible heteroskedasticity of the shocks and nonlinearities in the simultaneous relations among the variables of the model. The time variation in the coefficients and variance covariance matrix may also capture structural changes and possible regime switches in the economy.

Thorough introduction of the essence of a TVP-VAR model can be found in Primiceri (2004) and Nakajima (2013). For the convenience, a brief presentation of the model will be introduced here, and the notations used by Primiceri (2004) will be kept.

So, a TVP-VAR model takes the following form:

$$Y_t = C_t + B_{i,t}Y_{t-i} + e_t; \qquad e_t \sim N(0, \Omega_t) \tag{1}$$

Where Y_t is the $n \times 1$ vector of endogenous variables, C_t is the $n \times 1$ vector of time varying coefficients that multiply constant terms, $B_{i,t}$ are $n \times n$ matrices of time varying coefficients, e_t are heteroskedastic unobservable shocks with time-varying $n \times n$ variance covariance matrix Ω_t, $t = 1 \ldots T$ is the observation number, $i = 1 \ldots L$ is the lag order, and $n = 1 \ldots N$ is the number of endogenous variables in the model.

Time-varying $n \times n$ variance covariance matrix can be presented in the following form:

$$\Omega_t = {A_t}^{-1}\Sigma_t\Sigma_t'{A_t}'^{-1}, \tag{2}$$

Where, A_t is the lower triangular matrix of time-varying covariances of the errors with ones on the diagonal, and Σ_t is the diagonal matrix of the time-varying standard deviations of the errors. For estimating the model parameters one need to define $\beta_t = (B_{1,t} \ldots B_{s,t})'$ as the arranged row vector of the model parameters, $a_t = (a_{1,t} \ldots a_{q,t})'$ as the arranged row vector of the free lower-triangular elements of the time-varying covariance, and $h_t = (h_{1,t} \ldots h_{k,t})'$, where $h_{i,t} =$

$\log(\sigma^2{}_{i,t})$, as the arranged row vector of the diagonal matrix of the error time-varying standard deviations.

The time-varying parameters of the model are assumed to follow the random walk process dynamics:

$$\begin{aligned} \beta_{t+1} &= \beta_t + u_{\beta t} \\ a_{t+1} &= a_t + u_{at} \\ h_{t+1} &= h_t + u_{ht} \end{aligned} \qquad (3)$$

Also all the innovations in the model are assumed to be jointly normally distributed with the following mean and standard deviation:

$$\begin{pmatrix} \varepsilon_t \\ u_{\beta t} \\ u_{at} \\ u_{ht} \end{pmatrix} \sim N\left(0, \begin{pmatrix} I & 0 & 0 & 0 \\ 0 & \Sigma_\beta & 0 & 0 \\ 0 & 0 & \Sigma_a & 0 \\ 0 & 0 & 0 & \Sigma_h \end{pmatrix}\right) \qquad (4)$$

Finally, the model parameters, variances and covariances are assumed to be normally distributed with some initial distribution, which should be given by the author;

$$\begin{aligned} \beta_{t+1} &\sim N(\mu_{\beta_0}, \Sigma_{\beta_0}) \\ a_{t+1} &\sim N(\mu_{a_0}, \Sigma_{a_0}) \\ h_{t+1} &\sim N(\mu_{h_0}, \Sigma_{h_0}) \end{aligned} \qquad (5)$$

3.2 Used Dataset and the Empirical Results of the First Stage

For obtaining the proxy variable of the monetary pass-through coefficient in Armenia, this research employed the second approach (presented in the previous chapter). A small quarterly VAR model with four variables (policy rate, inflation rate, GDP growth rate, and exchange rate) and one lag was estimated for Armenian economy. The choice of the lag length was done based on the appropriate statistics and is presented in the table 1, given in the Appendices. The sample included the database from the first quarter of 1998 to the end of 2014. The weighted average of interbank overnight loan rate was taken as the policy rate. The choice of this rate is mainly due to the fact that it is considered as the operational target of the monetary policy in the Central bank of Armenia[2]. Quarterly inflation rate of seasonally adjusted CPI was taken as an inflation rate. As GDP growth rate was taken the quarterly growth rate of seasonally adjusted real GDP. Seasonal adjustment was implemented in order to escape the bias generated by significant seasonality in the CPI and GDP data of Armenia. Seasonal adjustments were performed by X-12 approach and are presented in the Figures 3 and 4, given in the Appendices. Finally, as exchange rate was used depreciation rate of real effective exchange rate. The sources of the used dataset are the National statistical service of the Republic of Armenia, Central bank of Armenia and Armenian Stock Exchange (NASDAQ OMX ARMENIA). Based on Augmented Dickey-Fuller tests for unit root (Table 2, in the Appendices), the conclusion was that all the variables were stationary, thus VAR model in levels was an appropriate one for the problem.

One of the crucial parts of TVP_VAR estimation was the calibration of initial values of the parameters in the equation 5, presented earlier. The choice of these initial parameters was implemented by employing Kalman filter estimation technology, and after several robustness checks the most probable priors for initial states were chosen. Based on the posterior distributions of initial values, the numerical estimation of the parameters and variance covariance matrices for

[2] As the Central bank introduced this toolkit since the second quarter of 2010, up to that point the weighted average of interbank repo rate was used.

the whole given time period was implemented by an efficient Markov chain Monte Carlo (MCMC) algorithm[3]. MCMC iteration was performed 100000 times.

By employing a TVP_VAR model, eventually, $t - i$ (the observation number less the lag order) sets of estimated parameters and variance covariance matrices were estimated, so it was possible to implement impulse response analyses $t - i$ times. As a result, the time series of MTS was obtained, which replicated as the strength of monetary policy transmission mechanism in Armenia. The results of the first stage estimation procedure are summarized in the figure 5, where the developments of estimated MTS variable for the examined period are illustrated.

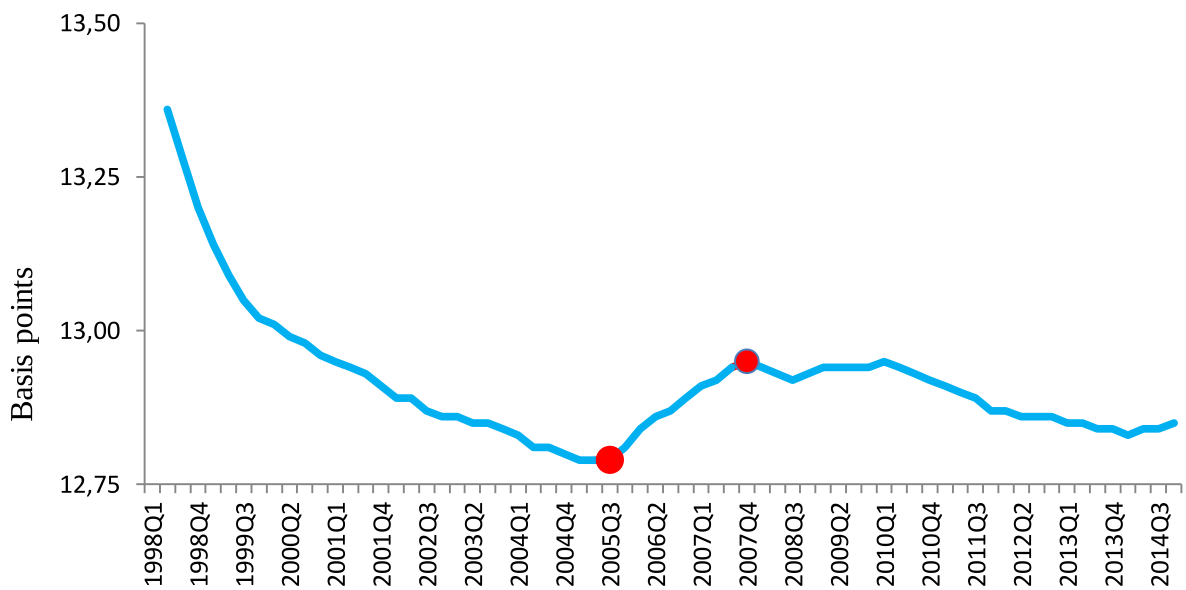


Figure 5.
The graph illustrates the developments of MTS coefficient estimated by TVP_VAR model. Each point shows the negative response of CPI inflation to 100 basis points monetary policy shock in each quarter.
SD shock of policy rate was transformed to percentage change (1 SD=0.6673%)
Source: Author's estmations

[3] MCMC simulation was performed by the toolbox written by Jouchi Nakajima and adapted for Armenia by the author.

The line represents the negative value of the response of CPI inflation to 100 basis points increase in the policy rate of Armenia. The first thing to notice is the negative relationship between interest rates and CPI inflation rate. This finding corresponds to the general theory, and indicates that during the expansionary monetary policy periods the inflation rate is increasing, meanwhile during the contractionary monetary policy periods it is decreasing.

From the developments of the estimated MTS variable, it is obvious that initially when the Central bank of Armenia was implementing monetary targeting, 100 basis points increase in the policy rates brought to approximately 13.36 basis points decrease in the CPI inflation rate. But the effectiveness of monetary transmission decreased gradually reaching nearly 12.79 basis points at the end of 2005. In the beginning of 2006 the Central bank moved from monetary targeting regime to the new inflation targeting regime. The graph obviously catches this period of regime switch from monetary targeting to inflation targeting. After adopting new framework of monetary policy, the effectiveness of monetary transmission improved by about 0.15 basis points until 2008, then Armenian economy was influenced by the global financial crisis, MTS began to decrease, and eventually approached to 12.85 basis points.

The developments of the estimated proxy variable, obtained as a result of the first stage analyses, correspond to our general understanding of the monetary policy implemented in Armenia, and can be considered realistic and be used as a measure of monetary policy transmission mechanism in Armenia.

4. Factors of Effective Monetary Transmission in Armenia

The empirical results of the previous section state that the mean value of MTS in Armenia for the given period of 1998-2014 was about 12.92 basis points, which deviated between 12.79-

13.36 basis points. To evaluate the effectiveness of the monetary policy in Armenia from the obtained results, similar analyses and comparison with other countries are needed. This is an interesting subject for the future researches, and is not included under the scope of the purposes of the given research. At this point we are more interested in the factors of monetary transmission and estimation of their influences on the effectiveness of MTS.

This section is dedicated to the estimation of the second stage of the empirical research, where, led by the final purposes of the research, the estimated MTS variable, along with the potential determinants affecting monetary transmission in Armenia, were used in a regression model to estimate the long-run and short-run relationship between the strength of monetary pass-through and the given potential factors. The first part of the chapter includes the discussion of potential factors and their theoretical influence on the monetary policy effectiveness. It will be followed by the section of used dataset and employed empirical approach. Finally, the empirical results will be discussed.

4.1 Possible Factors Affecting the MTS in Armenia

Theory suggests a variety of potential constraints to an effective monetary policy transmission mechanism, of which as the possible ones for Armenia were selected financial dollarization, financial developments, exchange rate flexibility, and inflation rate.

Financial dollarization is considered as one of the main factors affecting the monetary policy efficiency. There is a common view among the economists that dollarization makes monetary policy more complicated and less effective. The literature emphasizes that in highly dollarized financial systems, the Central bank has only limited control over the interest rates. The reason comes from the fact that foreign currency funding is linked to the external factors which cannot be directly influenced by the monetary authorities. Thus, money supply mainly follows the behavior of the agents holding foreign and domestic-currency denominated assets. This understandably complicates the Central bank’s ability to control the inflation. Additionally, Leiderman et al (2006) mentioned that in highly dollarized financial markets there is a fear of capital outflow that can be damaging for effective interest rate transmission.

The next possible factor for the effective monetary policy is the degree of financial developments. Although economic theory has recognized the role of financial developments in the effectiveness of monetary transmission and the subject has been widely discussed in the literature over the last decades, empirical studies examining this relation remain limited. The effectiveness of monetary policy transmission to the real economy is crucially affected by the degree of development in financial markets, as monetary policy is implemented mainly through operations in these markets. As was mentioned in Cottarelli and Kourelis (1994) developed financial systems typically offer a greater variety of financial products, which increases the competition in these markets. Increased competition constrains the profit margins and makes market rates more responsive to the policy rate shocks.

Monetary policy can also be significantly affected by the rate of exchange rate flexibility. According to the theory exchange rate flexibility contributes to the strength of monetary policy pass-through. A lack of exchange rate flexibility indicates that the changes in policy rate are not aiming to influence market rates. Changes in the policy rate influences the capital flows which, under flexible exchange regimes lead to currency changes. Under fixed exchange regimes such capital flows are fully sterilized, which affects the liquidity and results as pressur on the interest rates.

Finally, to explain the changes in MTS, inflation level as a control variable, was also included in the model to understand whether the effectiveness of monetary policy transmission mechanism in Armenia is influenced by the changes in the level of inflation rate.

4.2 Used Dataset and the Empirical Approach

For the purposes of the given research, financial dollarization was measured as the ratio of foreign currency deposits to broad money (M2X). Broad money in this contest is the sum of M2 and all foreign currency deposits (including accounts) of residents (real sector entities)[4].

During the empirical analyses the value of private credit as the share of GDP was used as a measure of financial developments in Armenia. This is a preferred measure of financial developments in the recent literature. For example, Ross et al (2000) mention that higher levels of private credit indicate higher levels of financial services and therefore greater financial intermediary development.

Since exchange rate flexibility is a measure that is not directly observable, there is no clear answer in the theory how to measure it. For the purposes of the following research the methodology suggested by Levy Yeyati and Sturzenegger (2005) was employed. To classify exchange rate regimes of different countries they used the volatility of the nominal exchange rate, the volatility of its rate of change and the volatility of international reserves. Then they employed the K-means cluster analysis, based on the nearest centroid sorting, to define 5 exchange rate regimes (inconclusive, flexible, dirty float, crawling peg, and fixed). The same variables and methodology were also employed by the given research to construct a dummy variable with two clusters

[4] Detailed definition and calculations can be found in the manual on compilation of monetary and financial statistics in Armenia: (https://www.cba.am/Storage/EN/publications/statistics/monetary_stat_manual/aggregates.pdf)

(flexible, not flexible) which describe the exchange rate volatility in Armenia (details are in the Table 3, Appendices).

The sources of the used database during the second stage of the analyses are the Central bank of Armenia, and also the author's calculations.

Augmented Dickey-Fuller tests for unit root (presented in the Table 4, Appendices) indicated that the time series of MTS, financial dollarization, financial developments, and CPI were non-stationary, but appeared to be integrated of the first order, which means they were stationary after being first-differenced. Johansen tests for cointegration (presented in the Table 5, given in the Appendices) additionally showed that these data were also cointegrated, and there was only one cointegration vector. So, MTS, financial dollarization, financial developments, and CPI share a stochastic component and a long-run equilibrium relationship, and deviations from this equilibrium relationship as a result of shocks are corrected over time. An appropriate model for these types of time series was a Vector Error Correction Model (VECM), which specifies long and short term effects of control variables on the outcome variables.

So, for the empirical analyses of the second stage of the research a VECM model with the above mentioned endogenous variables was employed. Based on the appropriate lag order selection criteria, the results of which are presented in the Table 6, given in the Appendices, four lags were included in the model. Furthermore, in the VECM model as an exogenous variable was taken the exchange rate volatility in Armenia. However, exchange rate volatility was restricted to have only short-term influence on the effectiveness of monetary policy transmission. This assumption came from the fact that Armenia has free floating exchange rate regime and the Central bank intervenes only to prevent high fluctuations, so in the long-run in any case exchange rate in Armenia is volatile.

In the final model it was also assumed that in the short-term CPI level is not a crucial explanatory variable for MTS, and the effects of CPI were restricted to be only in the long-term horizon. Instead, it was assumed that in the short-term horizon it is more important for explaining the changes of MTS whether the inflation rate is in the targeted band. So, a dummy variable which takes the value 1, if inflation rate was in the targeted band, and 0, otherwise, was constructed and included it in the short-term part of the model.

As a result, the final representation of the VECM model takes the following form:

$$\Delta MTS_t = \sum_{j=1}^{4} c_{1,j}{}^{MTS}\Delta MTS_{t-j} + \sum_{j=1}^{4} c_{2,j}{}^{MTS}\Delta Doll_{t-j} + \sum_{j=1}^{4} c_{3,j}{}^{MTS}\Delta FD_{t-j} + \sum_{j=1}^{4} c_{4,j}{}^{MTS} Inf_{t-j} + \sum_{j=1}^{4} c_{5,j}{}^{MTS} Ex_{t-j} + \alpha^{MTS}(MTS_{t-1} - \beta_0{}^{MTS} - \beta_1{}^{MTS} Doll_{t-1} - \beta_2{}^{MTS} FD_{t-1} - \beta_3{}^{MTS} CPI_{t-1})$$

$$\Delta Doll_t = \sum_{j=1}^{4} c_{1,j}{}^{Doll}\Delta MTS_{t-j} + \sum_{j=1}^{4} c_{2,j}{}^{Doll}\Delta Doll_{t-j} + \sum_{j=1}^{4} c_{3,j}{}^{Doll}\Delta FD_{t-j} + \sum_{j=1}^{4} c_{4,j}{}^{Doll} Inf_{t-j} + \sum_{j=1}^{4} c_{5,j}{}^{Doll} Ex_{t-j} + \alpha^{Doll}\left(Doll_{t-1} - \beta_0{}^{Doll} - \beta_1{}^{Doll} MTS_{t-1} - \beta_2{}^{Doll} FD_{t-1} - \beta_3{}^{Doll} CPI_{t-1}\right)$$

$$\Delta FD_t = \sum_{j=1}^{4} c_{1,j}{}^{FD}\Delta MTS_{t-j} + \sum_{j=1}^{4} c_{2,j}{}^{FD}\Delta Doll_{t-j} + \sum_{j=1}^{4} c_{3,j}{}^{FD}\Delta FD_{t-j} + \sum_{j=1}^{4} c_{4,j}{}^{FD} Inf_{t-j} + \sum_{j=1}^{4} c_{5,j}{}^{FD} Ex_{t-j} + \alpha^{FD}(FD_{t-1} - \beta_0{}^{FD} - \beta_1{}^{FD} Doll_{t-1} - \beta_2{}^{FD} MTS_{t-1} - \beta_3{}^{FD} CPI_{t-1})$$

$$\Delta CPI_t = \sum_{j=1}^{4} c_{1,j}{}^{CPI}\Delta MTS_{t-j} + \sum_{j=1}^{4} c_{2,j}{}^{CPI}\Delta Doll_{t-j} + \sum_{j=1}^{4} c_{3,j}{}^{CPI}\Delta FD_{t-j} + \sum_{j=1}^{4} c_{4,j}{}^{CPI} Inf_{t-j} + \sum_{j=1}^{4} c_{5,j}{}^{CPI} Ex_{t-j} + \alpha^{CPI}(CPI_{t-1} - \beta_0{}^{CPI} - \beta_1{}^{CPI} Doll_{t-1} - \beta_2{}^{CPI} MTS_{t-1} - \beta_3{}^{CPI} FD_{t-1}) \qquad (6)$$

Where MTS is the strength of monetary policy transmission mechanism, $Doll$ is dollarization rate, FD is financial developments rate, CPI is seasonally adjusted CPI level, Inf is inflation dummy, and Ex is exchange rate volatility dummy. The fragment in the parenthesis shows the error correction mechanism. When it is equal to 0, it means that MTS, financial dollarization, financial developments, and CPI level are in their equilibrium state. Parameters ${c_{i,j}}^{MTS}$ show the short term effects of control variables on MTS. α^{MTS} shows the speed of return to equilibrium after a deviation. In order to have an appropriate VECM model, the following inequality should hold $-1 < \alpha < 0$. ${\beta_i}^{MTS}$ are the estimates of long term effects of financial dollarization, financial developments, and CPI level on the strength of monetary policy pass-through in Armenia. These effects will be distributed over future time periods according to the rate of error correction α^{MTS}.

4.3 Empirical Results of the Second Stage

Before the estimation of the final model, it was also tested whether the short-term effects of financial developments and financial dollarization were statistically significant. Based on the Wald test results, given in the Table 7 (Appendices), it was concluded that financial developments and financial dollarization do not have any short-term influence on MTS, so the model was re-estimated with the given restrictions. Then the compliance of the model was ensured by employing model stability test, residual serial correlation LM Tests, and heteroscedasticity test (the results are given in the Figure 6 and Tables 8 and 9, Appendices). The empirical estimation results of the final model are summarized in the table 10, below.

	Coefficient	Std. Error	t-Statistic	Prob.

Short-term part				
ΔMTS_{t-1}	0.427395	0.107922	3.960222	0.0001
ΔMTS_{t-2}	0.177921	0.115721	1.537501	0.1261
ΔMTS_{t-3}	0.075104	0.109544	0.685604	0.4939
ΔMTS_{t-4}	-0.019264	0.092978	-0.207188	0.8361
INF_{t-1}^{DUMMY}	0.000106	0.000155	0.687694	0.4926
INF_{t-2}^{DUMMY}	-0.000134	0.000156	-0.859762	0.3911
INF_{t-3}^{DUMMY}	-2.47E-05	0.000155	-0.159292	0.8736
INF_{t-4}^{DUMMY}	-0.000502	0.000161	-3.126311	0.0021
Ex_{t-1}^{DUMMY}	-4.65E-05	0.000151	-0.307187	0.7591
Ex_{t-2}^{DUMMY}	0.000206	0.000147	1.400412	0.1632
Ex_{t-3}^{DUMMY}	-0.000272	0.000150	-1.816386	0.0711
Ex_{t-4}^{DUMMY}	0.000568	0.000157	3.626957	0.0004
C	-0.000102	0.000193	-0.529056	0.5975
Long-term part				
α	-0.050888	0.023178	-2.195572	0.0295
FD_t	0.018699	0.002928	6.386121	0.0000
$Doll_t$	-0.009373	0.002982	-3.143539	0.0025
CPI_t	-0.071280	0.009244	-7.711089	0.0000
C	3.137473	0.073781	42.52406	0.0000

Observations	62	Mean dependent var.	-0.000298
R-squared	0.698223	S.D. dependent var.	0.001014
Adjusted R-squared	0.616492	Sum squared residual	1.89E-05
S.E. of regression	0.000628	Durbin-Watson stat	1.945446

Table 10 – 2nd stage estimation outputs.

The table illustrates the results of estimated VECM model. Sample includes 1999Q3 2014Q4, 62 observations. MTS, Financial developments, financial dollarization and CPI levels are in logs. Source; Author`s estimations.

From the estimated results given in the table 10, it is obvious that the error correction coefficient (α) is statistically significant and belongs to $-1 < \alpha < 0$ interval. The magnitude of α shows the speed of return to the equilibrium of the endogenous variables after a deviation. The model variables are in their long-term equilibrium state when;

$$log(MTS_{t-1}) = 3.1375 + 0.0187log(FD_{t-1}) - 0.0094log(D_{t-1}) - 0.0713log(CPI_{t-1}) \quad (7)$$

This means that 1% increase in financial developments rate in the long-run horizon improves monetary transmission by 0.0187%, 1% decrease in dollarization rate in the long-run horizon improves MTS by total of 0.0094%, and 1% decrease in CPI level in the long-run horizon improves MTS by total of 0.0713%. The coefficients of the exchange rate flexibility indicate that if the exchange rate is volatile, then the MTS will be improved in the short-run horizon. Finally, if the inflation rate is out of the targeted band, then the monetary transmission improves in the short-run horizon. This result is very interesting one, and can be described by the fact that when the inflation rate is in the targeted band, the Central bank can implement less aggressive policy.

By using the estimated VECM model of the second stage, it was possible to implement impulse response analyses and forecast error variance decomposition, to understand the structural relationships of MTS with the controlled factors of monetary policy effectiveness. Figure 7 reports the responses of MTS to a one standard deviation positive innovation to the four structural shocks for a three year horizon, using the Cholesky ordering. The first graph of the figure (top left) demonstrates the response of MTS to its own shock. It can be observed that subsequently MTS returns smoothly towards the initial steady state, and within 6-7 quarters the initial innovation disappears. The second graph (top right) illustrates that positive shock to financial developments slightly increases the effectiveness of monetary policy transmission mechanism. The influence of this shock lasts approximately 4-5 quarters. Two bottom graphs demonstrate that positive shocks to both dollarization rate and CPI level decrease the effectiveness of monetary transmission and influences of the both shocks persist about 4-5 quarters.

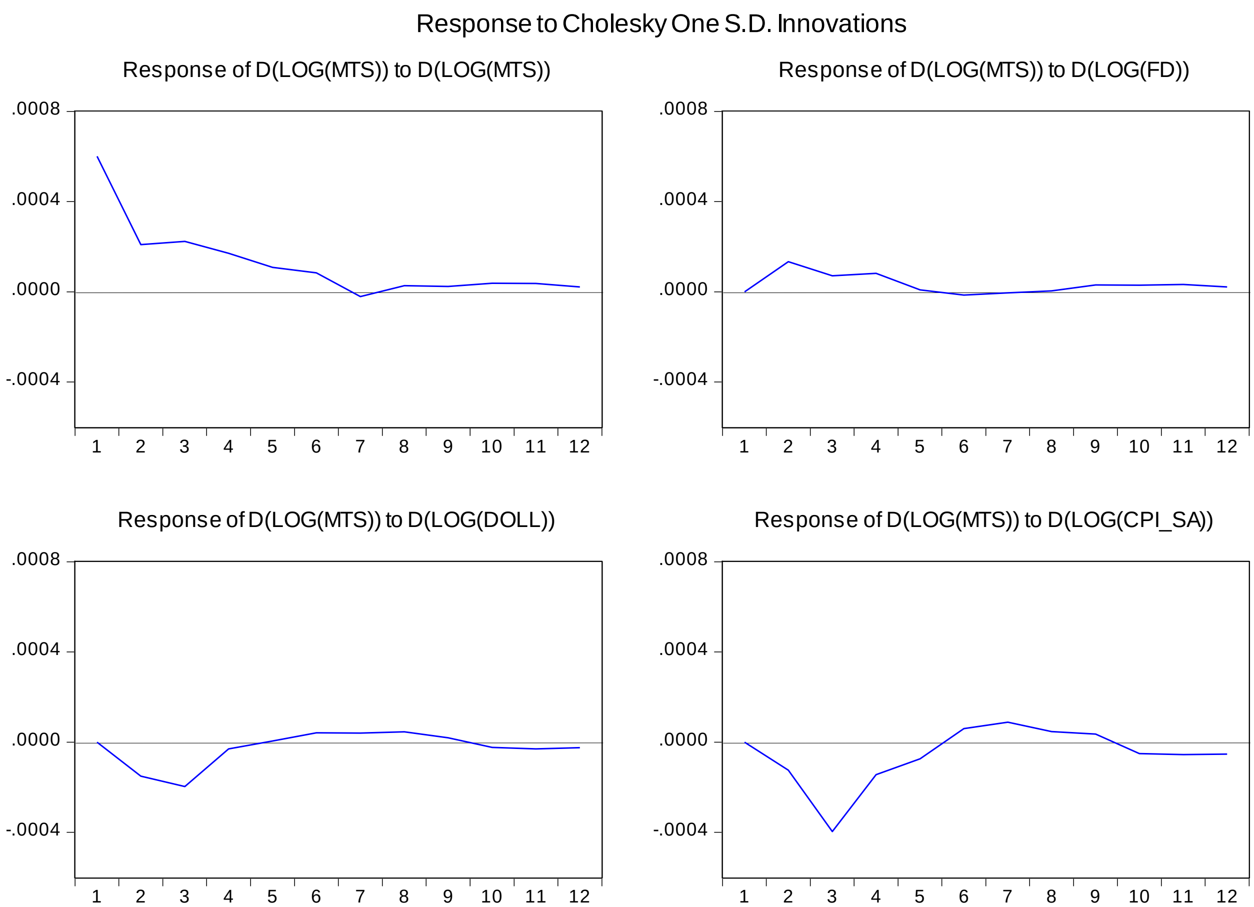


Figure 7 – Impulse Response Analyses

Figure 8 demonstrates the forecast error variance decomposition of MTS for a three year horizon. The figure illustrates that initially MTS itself, then CPI have the biggest share in the variance of monetary transmission. This result may indicate the fact that stable inflation level in the long run increases the Central bank`s credibility among the market participants and they become more responsive to the policy changes.

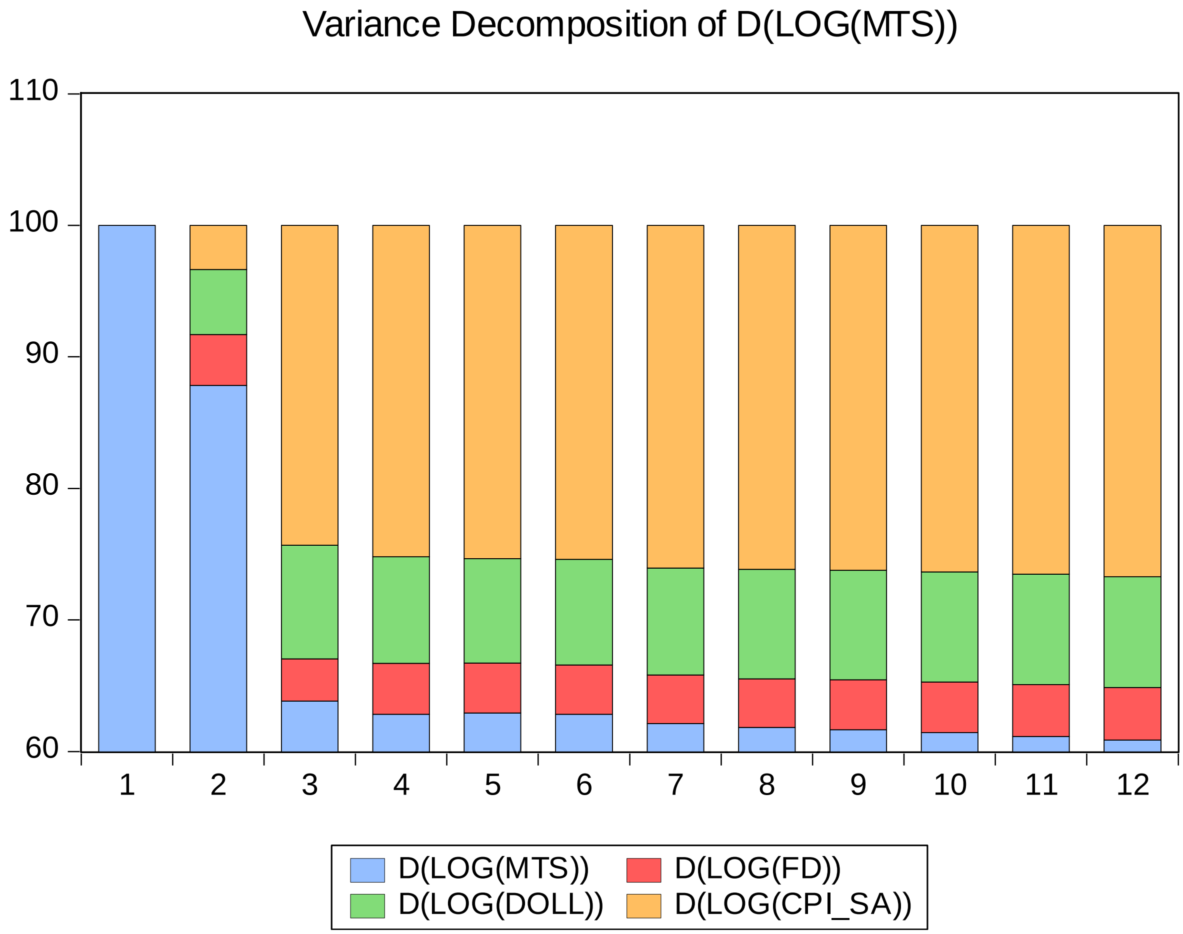


Figure 8 – Forecast Error Variance Decomposition

Finally, the empirical results were used to implement a representative scenario analyses to understand how the MTS will be improved under different scenarios. These results can serve as an example for more complicated scenario analyses and provide an opportunity for monetary policy authorities to implement cost-value analyses and understand whether it is worth to take steps towards the decline of financial dollarization to improve MTS, whether it will be better to contribute the further developments of the financial system, which will support to the decrease of financial dollarization and eventually bring to more effective monetary policy transmission mechanism, or alternatively keep inflation level stable and increase Central bank`s credibility, which will improve the effectiveness of monetary transmission. The results of the implemented scenario analyses are summarized in the table 11, below.

	Description of the Scenario	**Estimated MTS**	**Improvements of MTS from the Current Level of 12.85**
Scenario 1	Financial dollarization rate in Armenia from its current level of 48.5% will return to its historical minimum level of 19.51%, observed in 2008Q1	12.96	0.88%
Scenario 2	Financial dollarization rate in Armenia will somehow disappear	14.53	13.04%
Scenario 3	Financial intermediary in Armenia will increase from its current level of 45.8% up to 75%	12.97	0.92%
Scenario 4	Financial intermediary in Armenia will approach to100%	13.04	1.47%
Scenario 5	10% CPI deflation will be observed in Armenia	12.87	0.18%

Table 11 – Scenario Analyses.

The table summarizes the results of different scenario analyses. Column 3 displays the estimated MTS coefficient which, according to the model, will be observed under the given scenario, column 4 displays the possible improvements in MTS coefficient.

Source; Author`s calculations.

5. Summary and Conclusions

Up to this point the literature has only hypothetically suggested the possible hindering factors of the efficient monetary transmission in Armenia. This research is the first attempt to quantitatively measure the influences of financial dollarization, financial developments, inflation rate and exchange rate flexibility on the effectiveness of monetary pass-through in Armenia, which are believed to be the main factors.

Following the final objectives, the research implemented two stage analyses. During the first stage of the estimation process a proxy variable was found, which replicated the strength of monetary policy transmission mechanism in Armenia. Through a TVP_VAR model it was possible to obtain historical time series of a proxy variable MTS, which appeared to describe the evaluation of the effectiveness of monetary policy transmission mechanism during the years.

This is a valuable contribution to the literature which not only makes it possible to use the resulted time series in the second stage of the analyses, but also helps to understand the developments of monetary policy pass-through in Armenia during different periods, and finally, the results can be used in the further research projects as an explanatory variable in different empirical studies.

During the second stage the estimated MTS variable was used to evaluate the relationships of monetary transmission and its main determinants. The final results provide the long-run and short-run effects of financial dollarization, financial developments, and other factors on the monetary policy pass-through in Armenia. According to the results, there are statistically significant long-run negative correlation between financial dollarization and monetary policy pass-through, and statistically significant long-run positive correlation between financial developments and MTS. Another interesting result of the model is the fact that the monetary transmission improves in the long-run if the CPI level decreases, but worsens in the short-run if the inflation level is in the targeted band. At last, a short-run statistically significant positive relationship between monetary policy pass-through and exchange rate flexibility was found.

All these results were supported by the theory and correspond to our initial beliefs. Therefore, the results of this research are considered realistic and provide an opportunity for monetary policy authorities in Armenia to think about monetary policy transmission mechanism and the ways of its improvements.

The main limitations of the research are the short history of the time series, which may generate some bias during the estimation. The complications of choosing appropriate priors for the TVP_VAR model while estimating the monetary pass-through coefficient. It is crucial, to give such a priors to the model, which will not create distortions while estimating the coefficients. Another issue of the research is connected with the second stage. Literature suggests other factors, for example financial system competition and health, or excess liquidity, which theoretically affect the strength of monetary transmission. The inclusion of these variables was not possible first of all because of their short history, and also these variables for Armenia do not have explanatory power because of the lack of vulnerability. It is also reasonable, to think about the existence of many country specific factors, which may have significant influences on the monetary transmission. So, we understand that the given research is the first step of a continuing process and will be improved over time.

Appendix

Appendix 1 - Lag-order selection statistics for the first stage

To choose the lag length for the TVP_VAR model a simple VAR model with the same model specification was estimated. Then a VAR lag order selection criterion was employed to choose the appropriate lag length.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-717.8382	NA	73566.46	22.55744	22.69237	22.61060
1	-635.7502	151.3498	9339.056	20.49219	21.16684*	20.75797*
2	-619.1208	28.58177	9214.381	20.47252	21.68690	20.95093
3	-609.4796	15.36558	11414.61	20.67124	22.42533	21.36226
4	-568.1858	60.65035*	5332.114*	19.88081*	22.17462	20.78445

Table 1 - VAR Lag Order Selection Criteria

Endogenous variables: IR INF DRGDP REER, Exogenous variables C, Sample: 1998Q1 2014Q4, Included observations: 64

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Source; Author`s estimation.

Some of the test statistics (SC, HQ) indicate 1 lag model as the best one, but another group of criteria (LogL, LR, FPE, AIC) find 4 lag model as the best one. The both models were estimated and 1 lag model was chosen as 4 lag model was not stable (one of the autoregressive parameters was greater than 1).

Appendix 2.1 - Seasonal adjustment of CPI

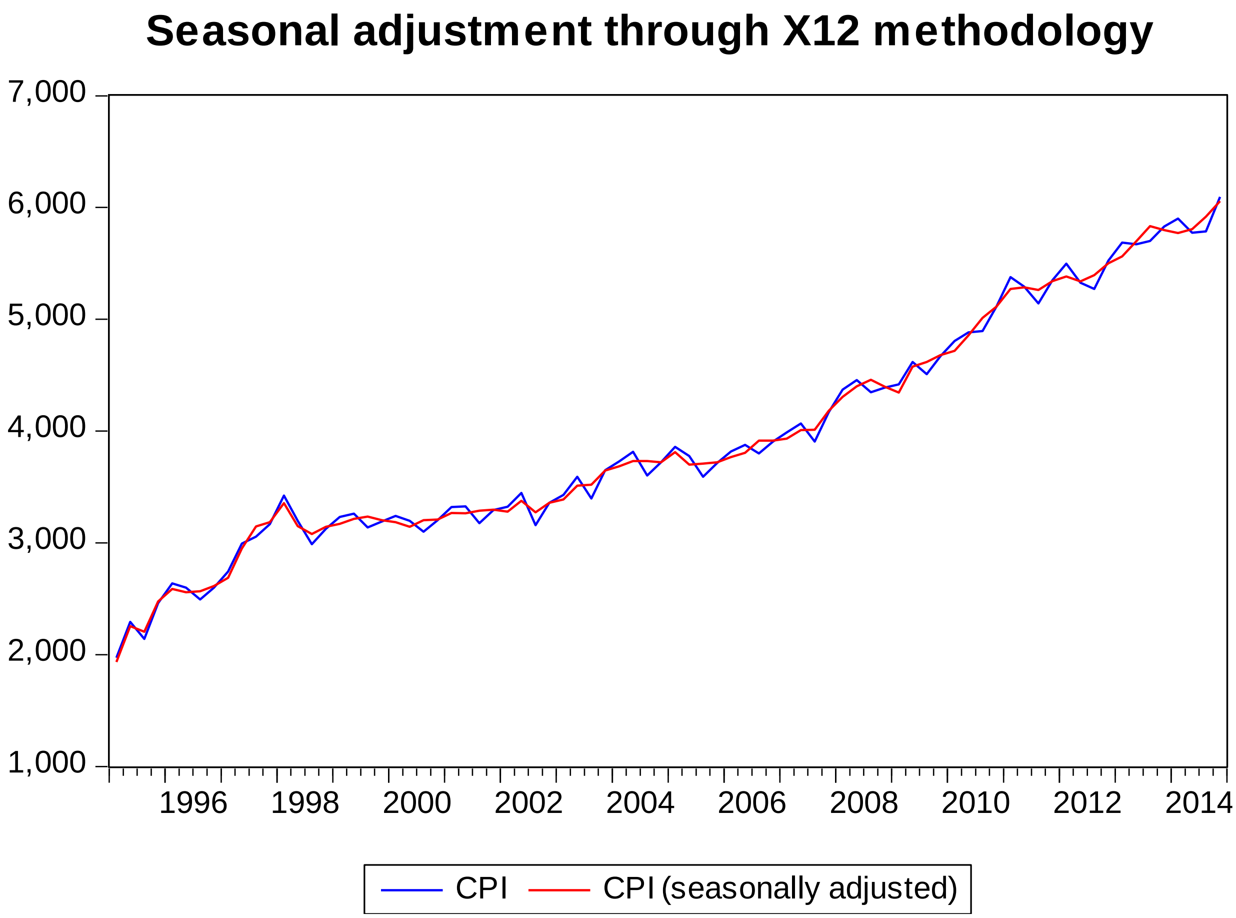


Figure 3 - Seasonal Adjustment of CPI

Source; Author`s estimation.

Appendix 2.2 - Seasonal adjustment of real GDP

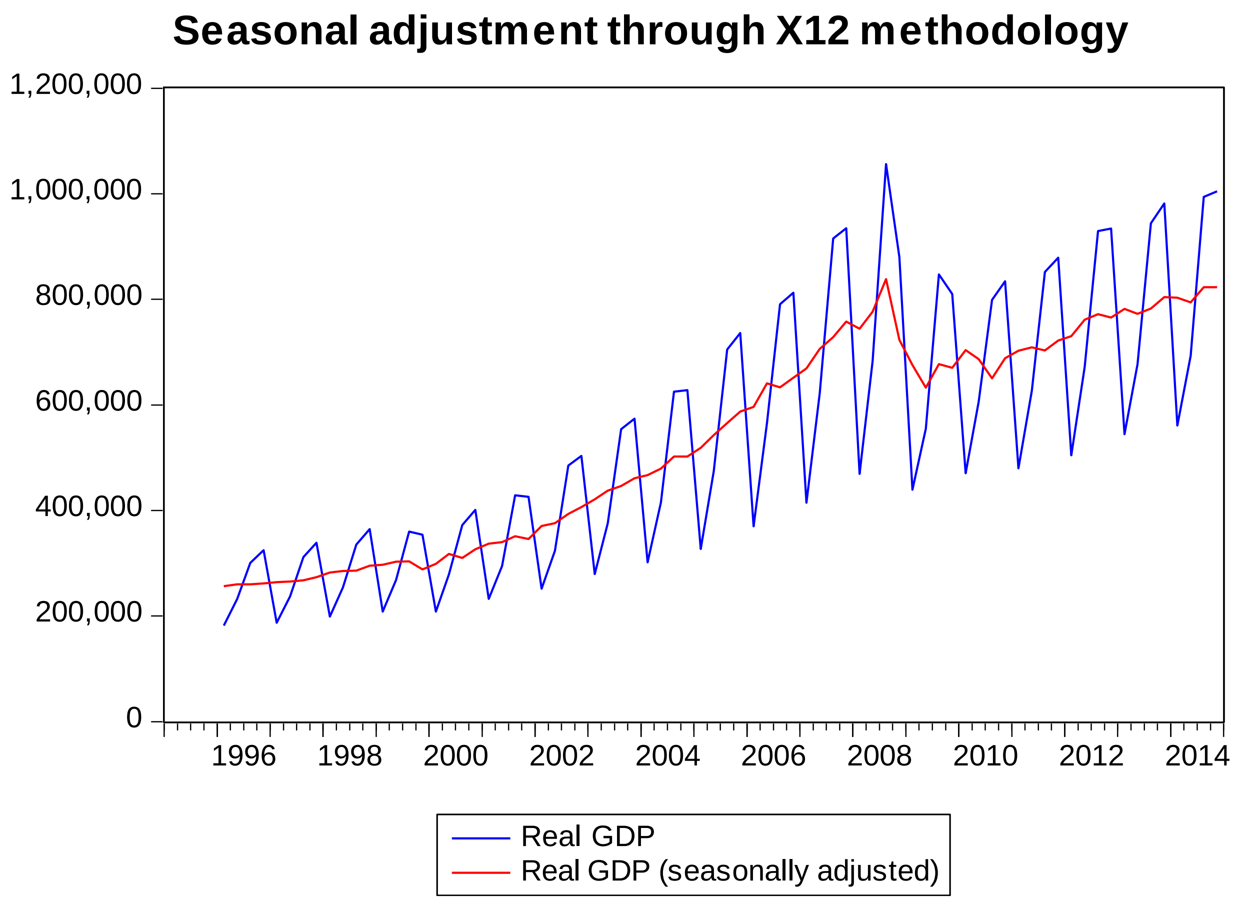
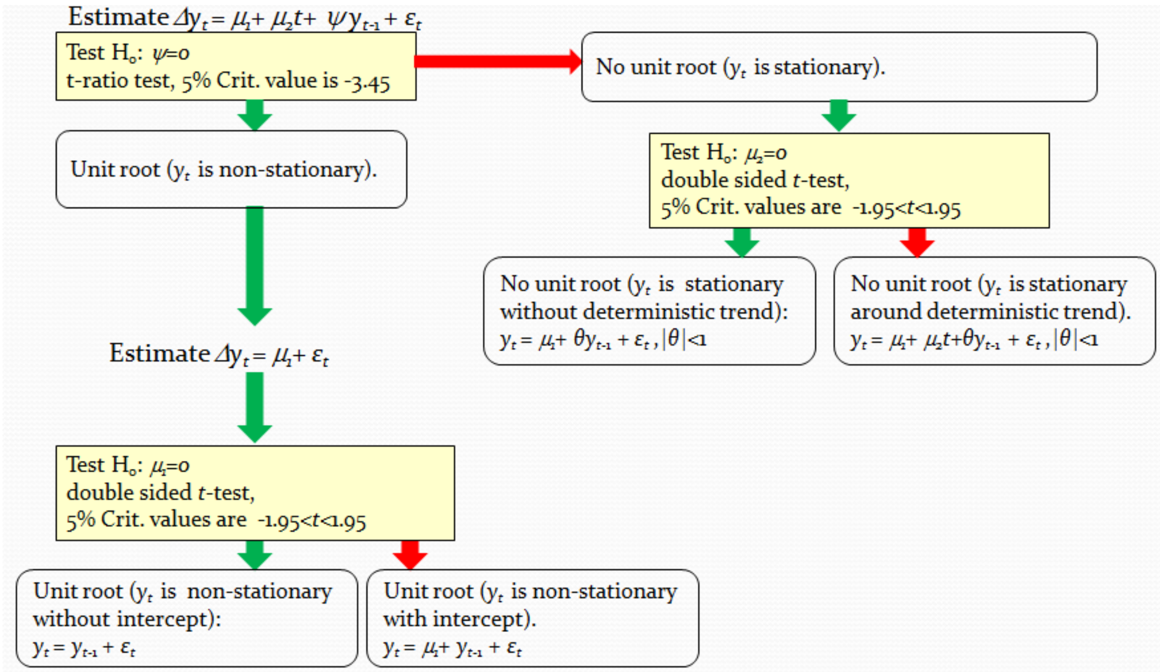


Figure 4 - Seasonal Adjustment of Real GDP

Source; Author`s estimation.

Appendix 3 - Augmented Dickey-Fuller unit root test for the first stage

For choosing appropriate test strategy "Elder and Kennedy Strategy" was employed. The strategy in a graphical representation is given below:



Source: Lecture notes from JVI /ICD Macroeconomic Forecasting JV15.05 course. Lecturer Mikhail Pranovich.

	$\Delta y_t = \mu_1 + \mu_2 t + \psi y_{t-1} + \varepsilon_t$ $Test\ H_0: \psi = 0$			$\Delta y_t = \mu_1 + \mu_2 t + \psi y_{t-1} + \varepsilon_t$ $Test\ H_0: \mu_2 = 0$		
variable	T statistic	Probability	Conclusion	T statistic	Probability	Final Conclusion
Policy rate	-3.504	0.047	No unit root	-0.392	0.696	Stationary without deterministic trend
Inflation rate	-9.207	0	No unit root	1.826	0.073	Stationary without deterministic trend
GDP growth	-8.533	0	No unit root	-1.283	0.204	Stationary without deterministic trend
REER	-7.054	0	No unit root	0.782	0.437	Stationary without deterministic trend

Table 2. Summary of Augmented Dickey-Fuller unit root test.

Source; Author`s estimation.

Appendix 4 - Cluster analyses for constructing dummy variable of exchange rate flexibility

Final Cluster Centers		
	Cluster	
	Flexible	Not flexible
Zscore (sigma_r*)	-0.2648	0.0360
Zscore (sigma_ex)	0.9884	-0.4143
Zscore (sigma_d_ex)	0.5271	-0.2912

Number of Cases in each Cluster		
Cluster	Flexible	17
	Not flexible	51
Valid		68
Missing		0

Table 3 - Cluster analyses for constructing dummy variable of exchange rate flexibility

*sigma_r is the volatility of international reserves, sigma_ex is the volatility of the nominal exchange rate, and sigma_d_ex is the volatility of exchange rate changes.

Source; Author`s estimation.

Appendix 5 - Augmented Dickey-Fuller unit root test for the second stage

	$\Delta y_t = \mu_1 + \mu_2 t + \psi y_{t-1} + \varepsilon_t$ $Test\ H_0: \psi = 0$			$\Delta y_t = \mu_1 + \varepsilon_t$ $Test\ H_0: \mu_1 = 0$		
variable	T statistic	Probability	Conclusion	T statistic	Probability	Final Conclusion
MTS	-2.0450	0.563	Unit root	-3.117	0.003	non-stationary with intercept
Dollarization	-1.9645	0.6096	Unit root	0.5298	0.5980	non-stationary without intercept

Financial developments	0.120	0.997	Unit root	4.917	0	non-stationary with intercept
CPI	-1.742	0.721	Unit root	4.614	0	non-stationary with intercept
	$\Delta y_t = \mu_1 + \mu_2 t + \psi y_{t-1} + \varepsilon_t$ $Test\ H_0: \psi = 0$			$\Delta y_t = \mu_1 + \mu_2 t + \psi y_{t-1} + \varepsilon_t$ $Test\ H_0: \mu_2 = 0$		
d(MTS)	-4.188	0.008	No unit root	0.343	0.733	stationary without deterministic trend
d(Dollarization)	-8.0043	0.0000	No unit root	0.2645	0.7923	stationary without deterministic trend
d(Financial developments)	-5.678	0.0001	No unit root	3.321	0.002	stationary around deterministic trend
d(CPI)	-8.587	0	No unit root	2.665	0.0010	stationary around deterministic trend

Table 4. Summary of Augmented Dickey-Fuller unit root test.

Source; Author`s estimation.

Appendix 6 - Johansen test for cointegration

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.593766	84.30139	47.85613	0.0000
At most 1	0.309322	28.45018	29.79707	0.0709
At most 2	0.079954	5.505155	15.49471	0.7531
At most 3	0.005446	0.338581	3.841466	0.5606

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.593766	55.85120	27.58434	0.0000
At most 1 *	0.309322	22.94503	21.13162	0.0275
At most 2	0.079954	5.166574	14.26460	0.7207
At most 3	0.005446	0.338581	3.841466	0.5606

Table 5 - Johansen test for cointegration

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Sample (adjusted): 1999Q3 2014Q4, Included observations: 62 after adjustments

Trend assumption: Linear deterministic trend

Series: MTS DOLL FD CPI_SA

Lags interval (in first differences): 1 to 4

Source; Author`s estimation.

Appendix 7 - Lag-order selection statistics for the second stage

To choose the lag length in the second stage (VECM) model a VAR model with the levels was estimated and VAR lag order selection test was implemented, then one lag less for VECM was chosen.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-789.0282	NA	15.13684	25.58155	25.71879	25.63544
1	-384.7938	743.2697	5.516586	13.05786	13.74404*	13.32727*
2	-369.3242	26.44803	5.650399	13.07497	14.31008	13.55991
3	-352.9992	25.80403	5.687283	13.06449	14.84854	13.76495
4	-333.1943	28.74893	5.195734	12.94175	15.27474	13.85774
5	-309.8673	30.85195*	4.328773*	12.70540*	15.58732	13.83691

Table 6 - VAR Lag Order Selection Criteria

Endogenous variables: MTS DOLL FD CPI_SA, Exogenous variables: C, Sample: 1998Q1 2014Q4, Included observations: 62

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Source; Author`s estimation.

The test results suggest two choices among 0 lag VECM model (according to SC and HQ criteria) and 4 lag VECM model (according to LR, FPE and AIC test). 4 lag model was chosen, as alternatively it would not be possible to estimate any short term relationships.

Appendix 8 - Wald test for statistically significance of short-term effects of financial developments and financial dollarization on MTS

Wald Test:			
Test Statistic	Value	DF	Probability
Chi-square	3.641360	8	0.8879
Null Hypothesis: C(5)=C(6)=C(7)=C(8)=C(9)=C(10)=C(11)= C(12)=0 Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(5)		0.001449	0.001439
C(6)		5.58E-05	0.001491
C(7)		-0.000175	0.001456
C(8)		-0.000782	0.001387
C(9)		-0.000805	0.001179
C(10)		-0.000108	0.001227
C(11)		0.001312	0.001180
C(12)		0.000198	0.001095

Table 7 - Wald test for statistically significance of short-term effects of financial developments and financial dollarization on MTS
Source; Author`s estimation.

Appendix 9.1 - Model diagnostics (VAR stability test)

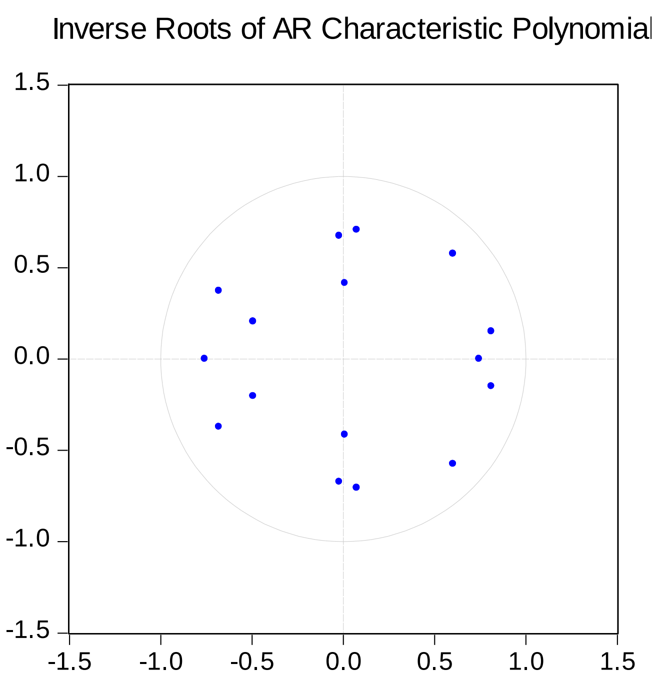


Figure 6 - VAR Stability Test

Source; Author`s estimation.

Appendix 9.2 - Model diagnostics (Test for autocorrelation)

Lags	LM-Stat	Prob.
1	16.96365	0.3880

2	10.14426	0.8590
3	9.673216	0.8831
4	11.03061	0.8076

Table 8 - VAR Residual Serial Correlation LM Tests

Null Hypothesis: no serial correlation at lag order h

Sample: 1998Q2 2014Q4, Included observations: 62

Probs. from chi-square with 16 DF

Source; Author`s estimation.

Appendix 9.3 - Model diagnostics (Test for heteroskedasticity)

Joint test:

Chi-sq.	DF	Prob.
410.0793	420	0.6263

Individual components:

Dependent	R-squared	F(42,19)	Prob.	Chi-sq. (42)	Prob.
res1*res1	0.657164	0.867144	0.6605	40.74416	0.5261
res2*res2	0.917733	5.046568	0.0002	56.89946	0.0622
res3*res3	0.660440	0.879875	0.6467	40.94727	0.5171
res4*res4	0.736944	1.267331	0.2940	45.69052	0.3214
res2*res1	0.495272	0.443905	0.9857	30.70684	0.9014
res3*res1	0.664025	0.894092	0.6312	41.16956	0.5073

res3*res2	0.842606	2.421815	0.0201	52.24158	0.1337
res4*res1	0.617212	0.729425	0.8062	38.26714	0.6356
res4*res2	0.643732	0.817397	0.7145	39.91140	0.5630
res4*res3	0.567270	0.593032	0.9210	35.17077	0.7630

Table 9 - VAR Residual Heteroskedasticity Tests:

No Cross Terms (only levels and squares)

Sample: 1998Q2 2014Q4, Included observations: 62

Source; Author`s estimation.

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