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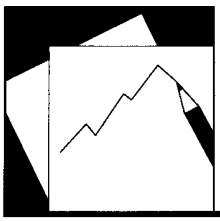

IMF Working Paper

Transmission Mechanisms of Monetary Policy in Armenia: Evidence from VAR Analysis

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Transmission Mechanisms of Monetary Policy in Armenia: Evidence from VAR Analysis

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Abstract

This paper examines monetary policy transmission in Armenia in light of the authorities' intention to shift to an inflation-targeting regime over the medium term. We find that the capability of monetary policy to influence economic activity and inflation is still limited, as important channels of monetary transmission are not fully functional. In particular, the interest rate channel remains weak, even though there is some evidence of transmission to prices of changes in the repo rate, the central bank's new operating target for inflation. As in other emerging and transition economies with a high degree of dollarization, the exchange rate channel has a strong impact on the inflation rate. Moreover, we find that inflation does respond to broad money shocks, once foreign currency deposits are included.

JEL Classification Numbers: O53, E4, E5

Keywords: Armenia, monetary policy, transmission mechanism

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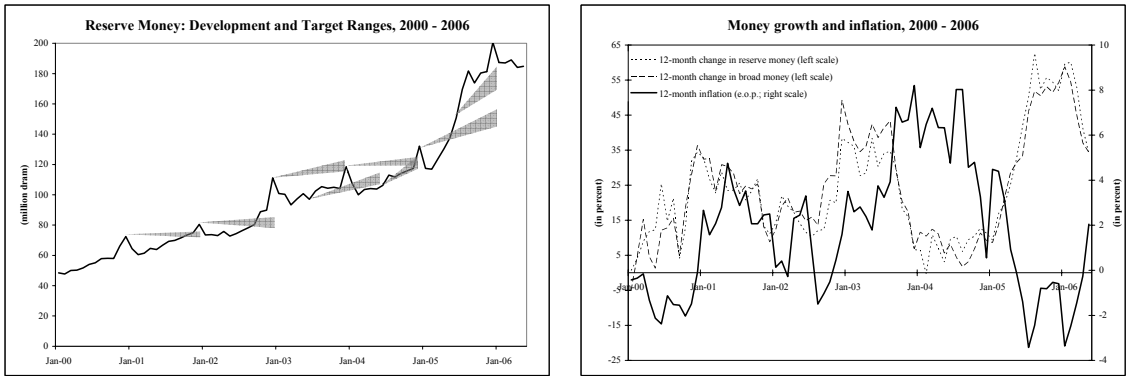
I. INTRODUCTION

Armenia has succeeded in stabilizing prices after years of very high inflation in the early and mid-1990s. Despite this favorable inflation performance, like many other small open and emerging market economies, it faces a number of challenges in the conduct of its monetary policy. Emerging remonetization and dedollarization have contributed to instability in money demand. Monetary targets have been frequently missed, while inflation has remained subdued (see Figure 1). This has led to concerns about the Central Bank of Armenia's (CBA) credibility in using a money targeting regime for anchoring inflation expectations.[1] As a result, the CBA announced the move to an implicit inflation-targeting (IT) regime effective January 1, 2006, with the intention of moving to a full-fledged inflation-targeting framework over the medium term. The monetary policy framework now uses the repurchase rate as the main instrument to signal the stance of monetary policy. At the same time, the CBA will maintain elements of its previous money targeting strategy to smooth the transition to the new regime and to preserve financial stability (CBA, 2005).

Figure 1. Reserve Money Targets, Money Growth, and Inflation



A sound understanding of how fast and to what extent changes in the central bank's interest instrument impact inflation is crucial and lies at the heart of inflation targeting. Given the uncertainties with regard to the transmission of monetary policy initiatives to aggregate demand and inflation, the study of these intricate links between policy instruments and key economic variables is crucial to ensure that correct policy measures are taken now to effect a specific outcome in the future. This paper provides a preliminary evaluation of the potential channels for the transmission of monetary policy to aggregate demand and inflation in Armenia. First, it provides a qualitative assessment with respect to the effectiveness of individual channels for the transmission of monetary policy in the Armenian economy. Second, it uses vector autoregression analysis (VAR) to assess whether monetary policy shocks, specifically shocks to the policy interest rate, have an impact on output and prices.

[1] For an overview of the evolution of the monetary policy framework in Armenia see Grigorian, Khachtryan, and Sargsyan (2004).

In recent years, VAR analysis has been used extensively to examine the effect of monetary policy on output and prices in other transition countries (see Ganev and others, 2002; Starr, 2005; and Hericourt, 2005, among others).[2] This paper adds to the evidence on the real and nominal impacts of monetary policy in transition countries by examining the experience of Armenia. VARs provide a useful tool for analyzing monetary policy in the context of transition economies, where short data series, a recent history of macroeconomic instability, and significant structural changes make reliance on structural models questionable. The VAR approach also places minimal restrictions on how monetary shocks affect the economy. Moreover, it explicitly recognizes the simultaneity between monetary policy and macroeconomic developments (reaction function) as well as the dependence of economic variables on monetary policy.

The empirical results indicate that the capability of monetary policy to influence economic activity and inflation are still limited, as important channels of monetary transmission are not effective. In particular, the interest rate channel remains weak, even though there is some evidence for a transmission of repo rate changes to CPI inflation. As in many emerging and transition economies with a high degree of dollarization, the exchange rate channel has a stronger impact on inflation than other transmission channels.

The paper is organized as follows. Section II discusses the channels of monetary transmission and reasons why these channels may not operate efficiently in Armenia. Section III presents the empirical analysis. Section IV summarizes the main findings and offers some broad policy considerations on how to improve the monetary transmission mechanism.

II. Impediments for Monetary Policy Transmission in Armenia

The monetary transmission mechanism describes the ways in which monetary policy impacts aggregate demand and prices by influencing the investment and consumption decisions of firms, households, and financial intermediaries. Although the neoclassical view of the long-run neutrality of money appears to be widely accepted, monetary policy is thought to influence economic activity in the short to medium term through changes in interest rates or money supply, either because of the presence of nominal price rigidities (Keynesian view) and/or owing to a number of wealth, income, and liquidity effects, and by its impact on inflationary expectations.[3] Although the specific classification varies at times, the following

[2] There is a vast literature that investigates monetary policy and macroeconomic relationships using a VAR estimation for developed countries. See, for example, Blanchard (1989), Friedman and Kuttner (1992), Sims (1992), Bernanke and Woodford (1997), and Christiano, Eichenbaum, and Evans (1999).

[3] The different transmission channels of monetary policy are not entirely independent, but rather complement each other. For example, the income effect of the interest rate channel impacts net wealth through the cost of servicing short-term and floating-rate debt, thus affecting the balance sheet channel. At the same time, some channels may counteract each other.

six channels of monetary policy transmission are generally distinguished: (1) interest rate channel; (2) bank lending channel; (3) balance sheet channel; (4) asset price channel; (5) exchange rate channel; and (6) expectation channel.

The operation of monetary transmission channels varies systematically across countries due to differences in the extent of financial intermediation (Table 1); the size, concentration, and health of the banking system; the development of capital markets; and structural economic conditions (Checetti 1999). The depth, breadth, and structure of the financial system determines the link between the monetary policy instruments under the control of the central bank (short-term interest rate, reserve requirements) and the variables that drive the conditions in the nonfinancial sector (e.g., loan and deposit rates; asset prices; and the exchange rate). The macroeconomic environment as well as structural features of the economy (e.g., degree of monetization and dollarization; cash-based payments system; size of the informal sector; openness of the economy; and inflows of private and official financing resources) in turn determine the link between financial conditions and spending/investment decisions among households and firms (Créel and Levasseur, 2005).

CIS and Baltic Countries: Selected Financial Sector Indicators 2005 (In percent)

	M2/GDP	Bank Assets/GDP	Bank Deposits/GDP	Bank Credit to Private Sector/GDP 3/	Domestic Currency Lending-Deposit Spread	Average Inflation	Average Real Deposit Rate
Armenia	16.4	20.2	10.7	8.2	12.2	0.6	5.8
Azerbaijan 1/	18.0	26.8	12.7	9.1	8.5	...	8.5
Belarus	19.9	31.3	20.0	10.2	2.1	10.3	9.2
Estonia	29.5	112.6	44.8	60.0	2.8	4.1	2.1
Georgia	16.6	26.3	12.8	14.8	14.1	8.2	7.6
Kazakhstan	26.6	63.3	25.6	26.7	...	7.6	...
Kyrgyz Republic	21.3	51.3	9.2	6.2	20.8	4.4	5.8
Latvia	23.1	123.2	36.7	60.1	3.3	6.8	2.8
Lithuania 2/	23.4	61.7	31.9	34.7	4.5	2.7	...
Moldova 1/	38.3	54.1	30.8	18.6	6.0	12.0	13.2
Russia	33.3	44.6	24.9	23.8	6.7	12.7	4.0
Tajikistan 1/	7.0	20.7	8.9	12.9	13.5	...	...
Ukraine	46.1	53.1	32.3	33.8	7.6	13.5	8.6

Sources: WEO, IFS, and MBTS (Money and Banking) databases.

1/ M2/GDP, Assets/GDP, Deposits/GDP, and Credit/GDP for 2004.
2/ Domestic currency deposit-lending spread for 2004.
3/ Credit to private sector, where available. Claims on private sector otherwise.

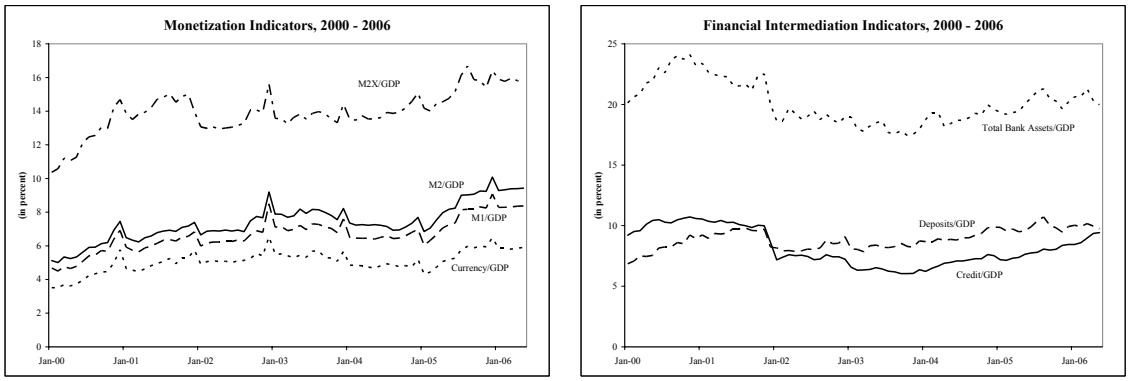
Empirical evidence has shown that, although the interest rate channel is the most important transmission channel in industrial countries with developed financial markets, the exchange rate channel is generally the dominant channel of monetary policy transmission in transition economies (Coricelli, Égert, and MacDonald, 2005). Likewise, the exchange rate channel is particularly important in small open (developing) economies with flexible exchange rates. Interest rate, credit, balance sheet, and asset price channels remain largely ineffective in the face of underdeveloped financial intermediation and only rudimentary capital markets and nonbank financial institutions. On the other hand, the effectiveness of the exchange rate channel is enhanced because it not only affects aggregate demand but also affects aggregate supply through the cost structure (Juks, 2004).

In Armenia, as in most other transition economies, the effectiveness of the monetary transmission channel is constrained by a number of factors. In general,
(i) the transmission of policy interest rates to market interest rates may be incomplete, and
(ii) spending and investment decisions may be insensitive to the availability and cost of credit. Both factors seriously hamper the effectiveness of monetary policy. In what follows, we discuss the main impediments to the monetary transmission mechanism in Armenia.

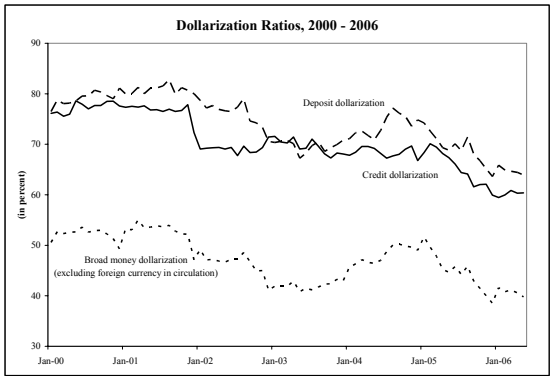
Interest rate channel

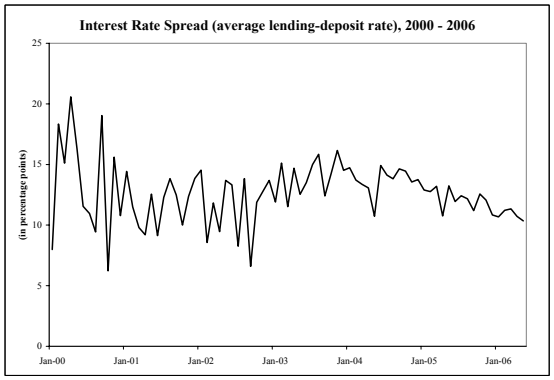
The interest rate channel works through the effect of real interest rate developments on aggregate demand. The traditional Keynesian view postulates that monetary policy can influence the *real cost of borrowing* by setting nominal short-term interest rates. Owing to price rigidities, nominal interest rate changes lead to corresponding real interest rate changes, which have an impact on business, housing, and inventory investment as well as on consumer durable spending. Aggregate demand in Armenia responds very little to changes in bank lending rates due to low levels of monetization and financial intermediation (Figure 2), which are among the lowest in the CIS (Table 1). Moreover, cross-subsidization within conglomerates and related-party lending may contribute to a low interest elasticity of credit demand. The high level of foreign currency-denominated loans to the private sector further reduces the sensitivity of borrowers to domestic interest rate movements (Figure 2).[4]

Figure 2. Monetization, Dollarization, and Financial Intermediation Indicators



[4] Banking system loan and liability dollarization ratios stood at 64 percent and 67 percent, respectively, at end-2005. Moreover, foreign currency deposits as a share of broad money stood at 39 percent at end-2005. There is also extensive cash dollarization (the CBA estimates that as much as US$1 billion is held in cash, three times larger than the value of drams in circulation). In the face of substantial dollarization, a contractionary monetary policy may have an opposite effect than intended as it could cause an appreciation of the exchange rate, which would lead to a reduction of the foreign-exchange-denominated debt in domestic currency terms (Coricelli, Egert, and MacDonald, 2005).





Market segmentation (possibly resulting in high bank switching costs) together with a low degree of competition between banks may also lower the interest rate elasticity of demand for deposits and loans. This is evidenced by the high and persistent banking spreads, which have remained in excess of 10 percentage points, despite reductions in real interest rates over the last decade (Figure 2). Finally, since a large portion of external (largely concessional) capital inflows is driven by external financing, economic agents are less sensitive to domestic interest rate fluctuations.[5]

Bank lending channel

The bank lending channel operates via the influence of monetary policy on the supply of bank loans, that is, the quantity rather than the price of credit. A contractionary monetary shock reduces bank reserves and therefore the total amount of bank credit available, leading to a fall in investment by bank-dependent borrowers and possibly in consumer spending. For the bank lending channel to work in Armenia, a monetary policy tightening must effectively limit banks' ability to supply loans by reducing bank reserves. However, high excess reserves and the ability to substitute bank reserves with alternative sources of investment funds make Armenian banks rather indifferent to restrictive policy measures. Equally important is the low extent to which economic agents are dependent on bank financing. Substantial inflows of remittances have served as an alternative source of finance for business and real estate investment in Armenia, limiting the development of the credit market.[6] Furthermore, firms can substitute trade credit for bank credit.[7] Finally, Armenia has a large shadow economy

[5] Grigorian, Khachatryan, and Sargsyan (2004) note that this also strengthens the need for the CBA's foreign exchange interventions and shifts the asset side of the CBA balance sheet toward foreign reserves and away from domestic assets, further limiting the scope for credit and open-market-type interventions.

[6] Remittance flows account for around a quarter of GDP. Preliminary data show gross private transfers were US$327 million in 2004 and around 25 percent higher in 2005, but actual flows may be as much as 50 percent higher, reflecting substantial unrecorded remittances.

[7] Trade credit is particularly important for SMEs, however, trade credit and other kinds of interfirm loans are also strongly related to transnational networks created by FDI (Coricelli, Égert, and MacDonald, 2005).

unofficially estimated to account for at least one-third of GDP. This informal sector relies exclusively on cash for transactions, rendering the bank lending channel ineffective.[8]

Balance sheet channel

The balance sheet channel is based on the notion of asymmetric information in credit markets, emphasizing the role of collateral in reducing moral hazards. An expansionary monetary policy, by causing a rise in financial and physical asset prices, increases the net worth of firms and hence the value of collateral, company cash flow, and firms' creditworthiness. In addition, a rise in asset prices increases the ratio of liquid financial assets to household debt, reduces the probability of financial distress, and therefore increases consumption and housing investment (Mishkin, 2001). In Armenia, the inability of banks to properly assess credit risk due to both insufficient risk management expertise and opaque corporate accounting practices increases banking spreads and reduces the effectiveness of the balance sheet channel. The functioning of this channel is also hampered by practices such as related-party lending.

Asset price channel

Like the balance sheet channel, the asset price channel operates by way of the monetary policy impact on the net wealth of economic agents. The argumentation rests on Tobin's q theory, which can be applied both to firm investment and to the housing market. Monetary transmission through the asset price channel can further be derived from Modigliani's life-cycle model, according to which an increase in financial wealth raises consumption. The asset price channel is likely not operating in Armenia due to the underdevelopment of capital markets. The financial sector is dominated by banks, which account for more than 95 percent of financial system assets, and the nonbank financial sector (stock market, debt securities market, mortgage market, insurance industry) is in its infancy. Market financing matters little, which largely precludes the channel's working through wealth and income effects.

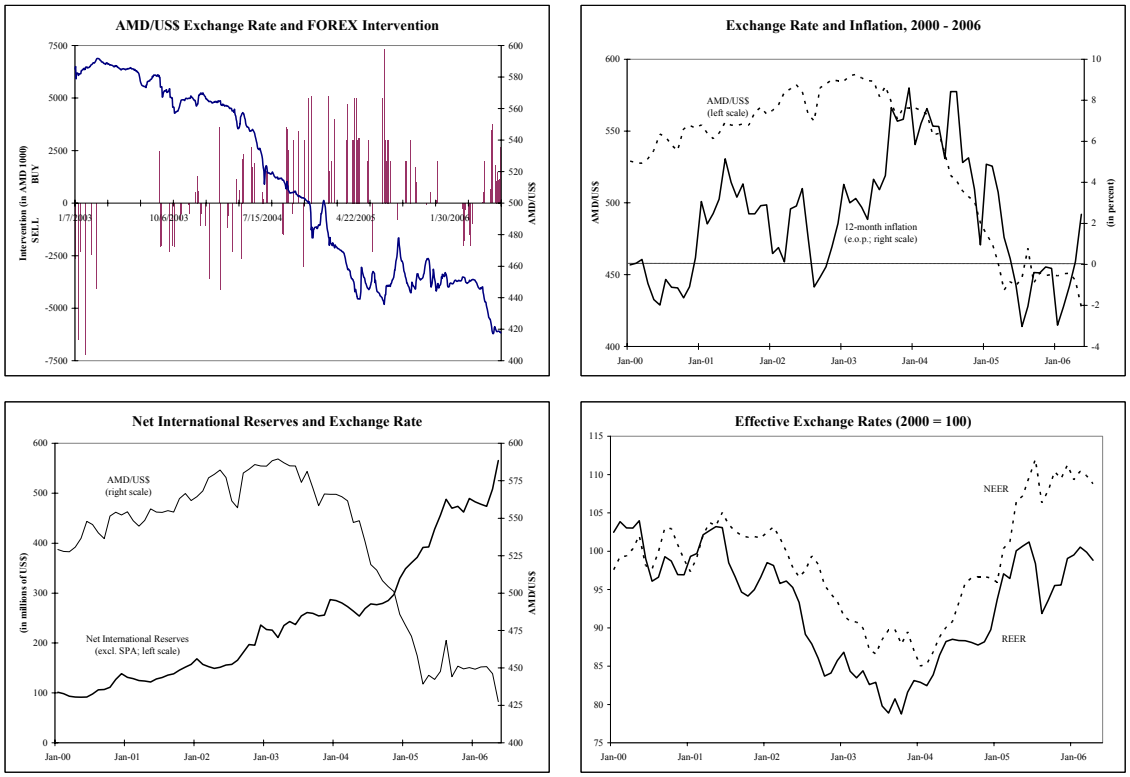
Exchange rate channel

Monetary policy can influence the exchange rate through interest rates (via the risk-adjusted uncovered interest rate parity), direct intervention in the foreign exchange market, or inflationary expectations. Changes in exchange rates affect aggregate demand and the price level through their influence on (1) the cost of imported goods; (2) the cost of production and investment; (3) international competitiveness and net exports; and (4) firms' balance sheets in the case of high-liability dollarization. There are several reasons to expect the nominal exchange rate to have an important influence on CPI inflation and aggregate demand in Armenia (Figure 3). First, the effect of exchange rate changes on inflation may be significant

[8] Armenia has a cash-based payments system and high share of cash in household asset portfolios (domestic currency outside banks was 65 percent of total deposits in 2005).

due to the relatively high share of imports in GDP (estimated to be around 31 percent in 2005). Second, there is a significant amount of foreign currency cash in Armenians' portfolios (see footnote 4), and Armenian aggregate demand is substantially affected by the development of remittance flows from abroad. Consequently, any appreciation or depreciation of the local currency (dram) can result in a wealth effect with a potential impact on consumption spending. Third, changes in the real exchange rate have implications for the international competitiveness of exports and import-competing goods.

Figure 3. Exchange Rate, Intervention, and Inflation



The U.S. dollar has been the benchmark currency since the introduction of the Armenian dram in 1993, mainly due to the high degree of dollarization of both assets and liabilities, and the dollar denomination of the majority of remittances and official development aid, as well as a great part of imports and exports (energy, base metals, precious stones). The dram's nominal exchange rate vis-à-vis the U.S. dollar appears to be driven mainly by the development of remittances, import demand, and the strength of the U.S. dollar vis-à-vis the euro. Periodic interventions in the foreign exchange market have also played a role. In contrast, balance of payment (BOP) data reveal that capital flows (reflecting the sensitivity of the exchange rate to the interest rate differential) are very small. This suggests that neither the direct exchange rate channel (import prices) nor the real exchange rate (demand) are substantially influenced by CBA's interest rate decisions at present. At the same time, monetary policy actions can influence inflation and exchange rate expectations. Consequently, intervention in the foreign exchange market has remained an important policy tool for the central bank.

Expectation channel

Monetary policy actions may have an effect on the economy through their impact on the confidence and expectations of economic agents about the future outlook of the economy. In particular, expectation effects may improve monetary policy transmission through the other channels by shortening reaction lags (Mayes, 2004). The expectation channel is more effective the higher the credibility of the CBA.

III. EMPIRICAL ANALYSIS

We examine the relationships between monetary policy variables and both output and prices in Armenia by using a VAR analysis. To focus on macroeconomic dynamics in the post-stabilization and post-Russian crises years, we use monthly data for 2000:5–2005:12.[9] We first present results of Granger causality tests and then estimate a reduced-form VAR and identify monetary policy shocks through assumptions about variable ordering.

Data and choice of variables

We consider the effects of three policy instruments, namely interest rates, exchange rate, and money supply. In developed countries, short-term interest rates are the main instrument of monetary policy. We use the repo rate (s), which is the key short-term interest rate used by the CBA to signal its monetary policy stance. The second policy-related variable is the nominal exchange rate (x). We focus on the nominal effective exchange rate (NEER) to examine the effects of exchange rate changes on output and prices. Using the NEER as opposed to a real effective exchange rate (REER) makes it easier to distinguish the exchange rate channel from other channels. The third policy-related variable is domestic narrow money or M1. In general, broad money (M2) is more highly correlated with output and prices than M1. However, factors other than monetary policy contribute to fluctuations in M2, which complicates its interpretation as a policy variable.[10]

Output is measured as real GDP (y) and the consumer price index (p) is taken as the measure of the general price level. All data are expressed in natural logs and are seasonally adjusted using ARIMA X12, with the exception of the repo rate, which is in levels and not seasonally adjusted.

In characterizing relationships between output, prices, and policy-related variables, stationarity properties of the data are important. The Augmented Dickey-Fuller (ADF) test

[9] Results may have to be qualified by possible measurement issues with regard to monthly GDP data.

[10] In Armenia, data series for domestic broad money (M2) and narrow money (M1) are virtually identical.

suggests that the null hypothesis that the variables are I(1) cannot be rejected.[11] As in most VAR models of the monetary transmission mechanism, we do not perform an explicit analysis of the economy's long-run behavior. By conducting the analysis in levels, we allow for implicit cointegrating relationships in the data. Imposing cointegrating restrictions on a VAR in levels could increase efficiency in the estimation, but given the short data series, may result in inconsistencies. Since the monetary transmission mechanism is a short-run phenomenon, most comparable studies employ unrestricted VARs in levels to evaluate impulse responses over the short to medium term (Favero, 2001).[12]

The lag length of the VAR estimation was selected using the Akaike (AIC) and Schwartz (SC) Information Criteria, and the residuals were tested for autocorrelation. Both tests suggest a lag of the first order, and the Lagrange Multiplier Test suggests that the residuals are not serially correlated.

Granger causality tests

Table 2 presents the results of the multivariate and bivariate block Granger causality tests for Armenia. Overall, the results suggest the joint significance of all three policy variables for output and prices.

Table 2. Multivariate and Bivariate Block Granger Causality Tests

	p-values
Effect on output	
Block (p, s, x, M1)	0.00***
Interest rate (s)	0.16
Exchange rate (x)	0.64
Money supply (M1)	0.00***
Effect on prices	
Block (p, s, x, M1)	0.06**
Interest rate (s)	0.05**
Exchange rate (x)	0.05**
Money supply (M1)	0.21

Note: The block Granger non-causality statistic is calculated using an LR test and follows a X^2 distribution. *, **, and *** denote rejection of the null at the 10%, 5%, and 1% levels, respectively.

[11] However, it should be noted that in relatively short time series, such as the one employed for Armenia, traditional unit-root tests, such as ADF, may have little power to distinguish between unit roots and stationary series that mean-revert but do so slowly. Hence, these tests can be biased towards non-rejection of unit-roots for short time series (see DeJong, 1992). Although first-differencing all variables checks against the possibility of mis-handling a non-stationary variable, Christiano and Ljunqvist (1998) demonstrate that series should not be differenced unnecessarily because of the low power of time-series tests on growth variables. To examine the stationarity properties of the data, we used a variety of tests for unit roots. Most other unit-root tests also suggested that the data are I(1).

[12] Moreover, Sims, Stock, and Watson (1990) show that if enough of the variables are cointegrated, an analysis in levels is still correct because the ordinary least squares (OLS) estimator of the reduced-form VAR efficiently estimates the cointegrating relationship.

The bivariate tests indicate that monetary aggregates have a significant Granger effect on output but not on prices. This result is consistent with the fact that since 2005, there has been emerging remonetization and dedollarization so that relationships between money, output, and prices may be unstable. We also find that exchange rates and interest rates have predictive power for prices at the 5% significance level but have little predictive power for output. The results of these tests should, however, be interpreted with caution as they are sensitive to the choice of lag length.[13]

VAR analysis

The VAR representation is given by

$$Y_t = A(L)Y_{t-1} + B(L)Z_t + \varepsilon_t \quad (3)$$

where Y_t is a vector of endogenous variables and Z_t a vector of exogenous variables. In the first model (baseline), the vector of endogenous variables consists of real GDP (y_t), the consumer price index (p_t), repo rate (s_t), and the NEER (x_t):

$$Y_t = [y_t, p_t, s_t, x_t] \quad (4)$$

Output is ordered before prices on the assumption that it adjusts more sluggishly. This ordering is appropriate for a transition economy like Armenia as prices are relatively flexible. In the second variant, we include the monetary aggregate (m_t), with the endogenous variables written as

$$Y_t = [y_t, p_t, s_t, m_t, x_t] \quad (5)$$

We order money supply (M1) after the interest rate and before the exchange rate to reflect the likely degree of endogeneity of the policy variables to current economic conditions. The underlying assumption is that in the short run, shocks to the policy variables have no contemporaneous impact on output and prices due to the real sector's sluggish reaction to monetary and exchange rate shocks. The nominal interest rate responds contemporaneously to shocks to output and prices, but not to changes in financial variables. Monetary aggregates—and, in the extended VARs, other financial variables—are assumed to reflect contemporaneous shocks to output, prices, and monetary policy. Finally, the nominal exchange rate is immediately affected by all types of shocks. We experimented with alternative orderings and, although some results are sensitive to ordering over variables, the qualitative findings are robust to changes.

[13] Assuming a high number of lags tends to reduce the significance of the effect of the interest rate as well as the exchange rate on prices.

The vector of exogenous variables is given by

$$Z_t = [oilp_t, s_t^{US}] \quad (6)$$

where $oilp_t$ is an index of world oil prices, and s_t^{US} is the U.S. Federal Funds Rate. The latter is included to account for interest rate parity, whereas the former is a proxy for the development of remittances, which are an increasingly important source of foreign exchange inflows. In Armenia, 80 percent of remittances are estimated to come from Russia. A recent CBA study suggests that the rapid growth of remittances is mainly due to the energy-related economic boom in Russia, which has led to significant income growth and prices in Russia's nontradable sector, where most Armenian emigrant workers are employed.

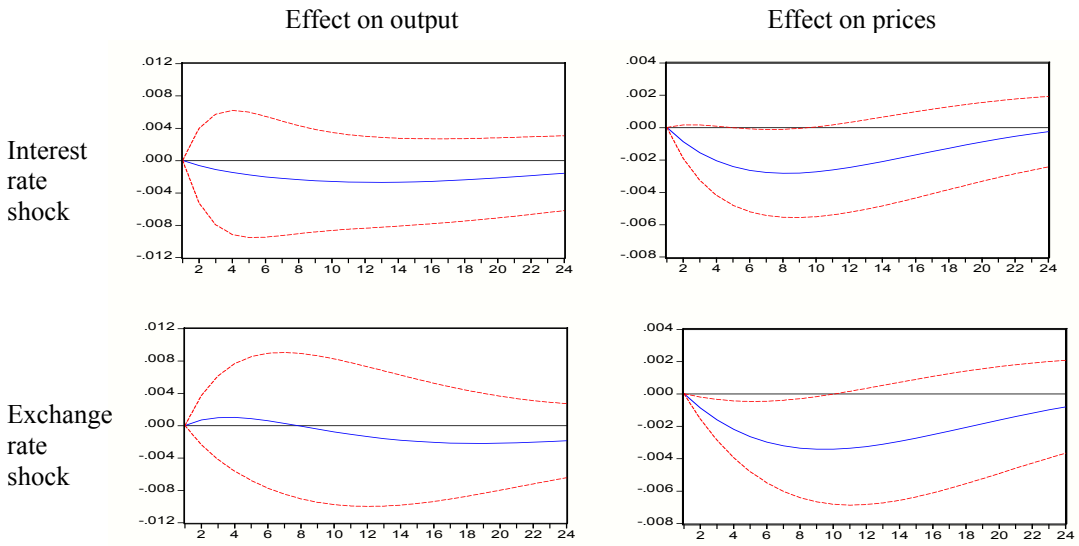
Impulse responses

Figure 4 presents impulse response functions indicating the impact of policy-related variables specified in the baseline model (equation 4) on output and prices, with the dotted lines representing 95% confidence intervals.[14] In general, the results using impulse response functions conform to those of the Granger analysis. A one-standard deviation shock to the interest rate is associated with a drop in output. While the shape of the response function is consistent with that found for more developed transition economies such as the Czech Republic and Poland, the effect is not statistically significant (see for example Ganev and others, 2002; Créel and Levasseur, 2005; Coricelli, Égert, and MacDonald, 2005). Moreover, consistent with the Granger analysis, the impulse response functions show no significant effect of a nominal appreciation on output.

The estimated effects of interest rate and exchange rate shocks on prices are as anticipated and similar to the findings for other transition countries. A monetary shock (one standard deviation increase in the repo rate), followed by an appreciation of the NEER, results in a modest decline in prices that is significant between 6 to 10 months, peaking after around 8 months. An appreciation of the NEER results in an almost immediate (within 2 months) decline in prices, which is significant for 10 months after the initial shock. The rapid pass-through of exchange rate changes to prices is consistent with findings from other transition countries. The results suggest that, while there is evidence of a modest impact of interest rate changes on prices, the exchange rate plays a significant role for monetary transmission in Armenia.

[14] See Appendix I for detailed results for this VAR. The detailed results for other variables are available from the authors upon request.

Figure 4. Impulse Responses for the Basic Model
(Response to One S.D. Innovations ± 2 S.E.)



Model extension

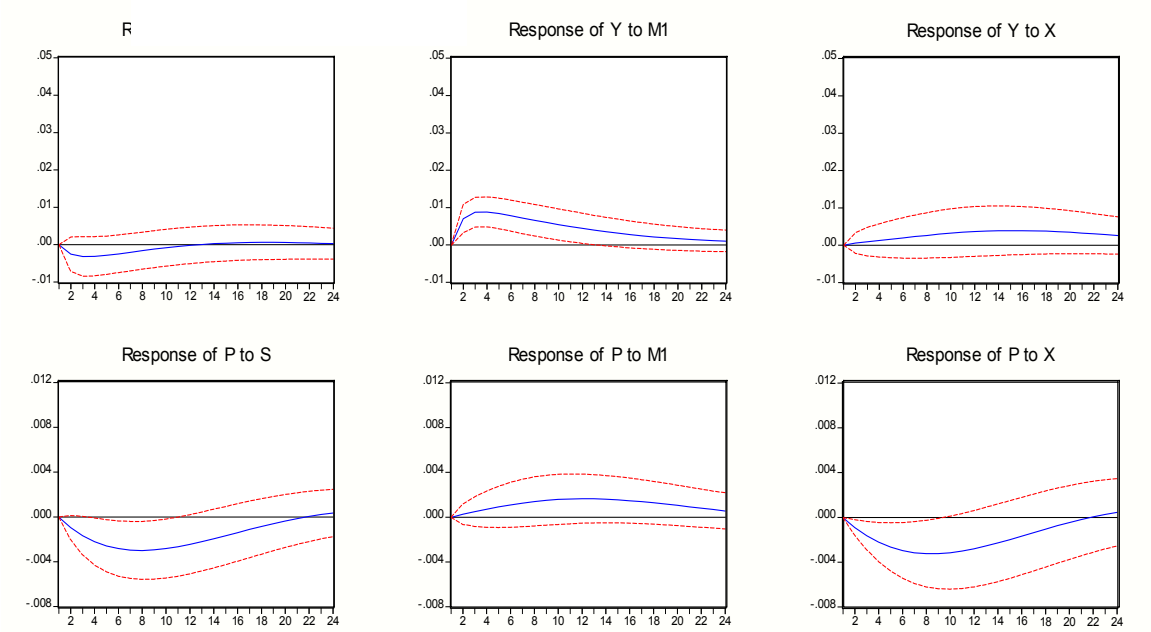
Figure 5 presents the results of the VAR model corresponding to equation (5) with the narrow monetary aggregate included as an endogenous variable. A shock to M1 appears to have a very rapid but modest effect on output which peaks after 3 months (Figure 5). Moreover, the estimated effect remains persistent for almost 1 year. This is consistent with the real effects of monetary aggregates found by Ghosh (1996) and Ganev and others (2002) for other transition countries and may be a reflection of the increasing dedollarization and remonetization that has taken place in Armenia over the period under study. Consistent with our baseline model, shocks to the interest rate and the exchange rate have no significant effect on output.

The estimated effects of a shock to M1 on prices are positive but insignificant.[15] An unanticipated shock to the monetary aggregate leads to higher prices as anticipated, but this effect is not significant. In recent years, Armenia has experienced rapid money growth while inflation has remained relatively low. Several recent studies on inflation in transition countries have also found a weak link between inflation and the growth of monetary aggregates (see Lissovolik, 2003, for Ukraine and Starr, 2005, for other CIS countries). The effects of interest rate and exchange rate shocks on prices are similar to those found in the baseline model (see Figure 5).[16]

[15] We obtain the same result if M1 is replaced by domestic broad money (M2).

[16] The negative and significant response of prices to a one standard-deviation interest rate shock is robust to alternative orderings of equation (5). For instance, we experimented with ordering M1 last, or after the interest rate and before the exchange rate. In all cases, both shocks to the monetary aggregate and the repo rate have modest but significant effects on prices.

Figure 5. Impulse Response Functions for Model with Money (M1)
(Response to One S.D. Innovations)



Variance decomposition

Following Morsink and Bayoumi (2001), we determine the share of fluctuations in output and prices that are caused by different shocks by calculating variance decompositions at forecast horizons of 1 to 3 years (Table 3). The second column in each sub-table shows the forecast error of the variable for each forecast horizon. The remaining columns present the percentage of the variance due to each shock, with each row adding up to 100. The results indicate that, within a year, innovations to M1 account for over 20 percent of the fluctuation in output, while interest rate innovations explain very little of the variance in output. Innovations to the exchange rate account for close to 20 percent of the price fluctuations, and the monetary and exchange rate variables together account for 35 percent of all variance in prices. These results confirm the significant influence of the exchange rate on prices in Armenia, and suggest that monetary factors (interest rate shocks) are also determinants of prices.

Table 3. Variance Decomposition (percent of total variance)

Variance Decomposition of Output

Period (quarters)	Forecast error	Output	Prices	Interest Rate	Money (M1)	Exchange rate
4	0.049	72.59	0.26	1.96	22.39	2.80
6	0.051	68.35	0.43	1.89	23.20	6.13
8	0.052	65.66	1.55	1.88	22.76	8.15
12	0.053	63.54	3.63	1.89	22.26	8.68

Variance Decomposition of Prices

Period (quarters)	Forecast error	Output	Prices	Interest Rate	Money (M1)	Exchange rate
4	0.021	3.78	58.64	15.65	3.80	18.12
6	0.023	4.45	54.41	16.05	5.81	19.28
8	0.024	4.35	55.78	15.21	6.34	18.32
12	0.024	4.27	54.78	15.47	6.21	19.28

Variance Decomposition of Interest rate

Period (quarters)	Forecast error	Output	Prices	Interest Rate	Money (M1)	Exchange rate
4	2.094	9.89	12.07	76.10	1.45	0.49
6	2.176	10.56	12.76	73.12	3.09	0.46
8	2.206	10.89	12.49	71.91	4.25	0.46
12	2.222	10.99	12.33	71.01	4.99	0.68

Variance Decomposition of Money (M1)

Period (quarters)	Forecast error	Output	Prices	Interest Rate	Money (M1)	Exchange rate
4	0.074	10.67	7.47	2.46	67.59	11.81
6	0.080	9.19	7.28	3.17	59.44	20.92
8	0.084	8.31	10.70	3.20	53.94	23.85
12	0.087	7.96	15.07	3.30	50.51	23.16

Variance Decomposition of Exchange rate

Period (quarters)	Forecast error	Output	Prices	Interest Rate	Money (M1)	Exchange rate
4	0.052	0.50	38.56	4.17	2.11	54.65
6	0.057	0.58	47.43	4.42	1.82	45.75
8	0.059	1.07	46.76	6.23	2.04	43.90
12	0.061	1.56	45.40	7.24	2.88	42.93

Interest rate and bank lending channels

To examine the interest rate channel more closely, we extend the basic VAR (equation 4) by adding the interest rate on new bank loans (the lending rate) ordered after the repo rate. We find that the lending rate responds immediately and significantly to an unexpected change in the repo rate (Figure 6). However, output and prices do not respond significantly to lending rate shocks.[17] These results point to the transmission of changes in the key policy interest rate to other interest rates in the economy, which is corroborated by the Granger Causality tests in Table 4. However, these results highlight the weakness of the interest rate channel in Armenia, as changes in bank lending rates do not affect economic activity and prices.

[17] These results are robust to alternative orderings. We still find that an innovation to the repo rate has a negative and significant effect on prices but not on output.

Figure 6. Response of Lending Rates to Repo Rate
(Response to One S.D. Innovations ± 2 S.E.)

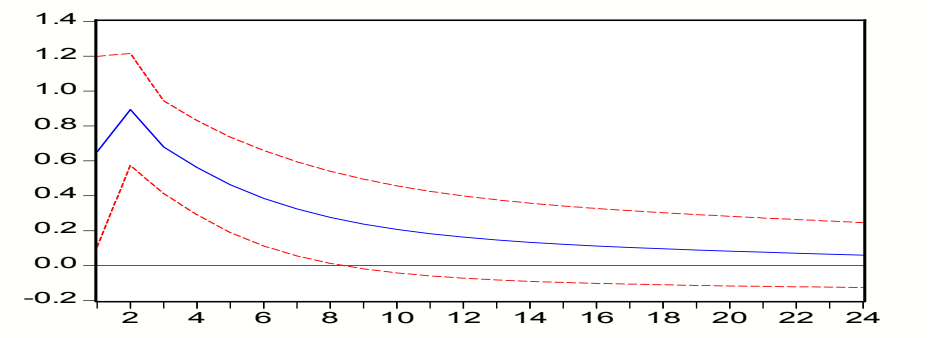


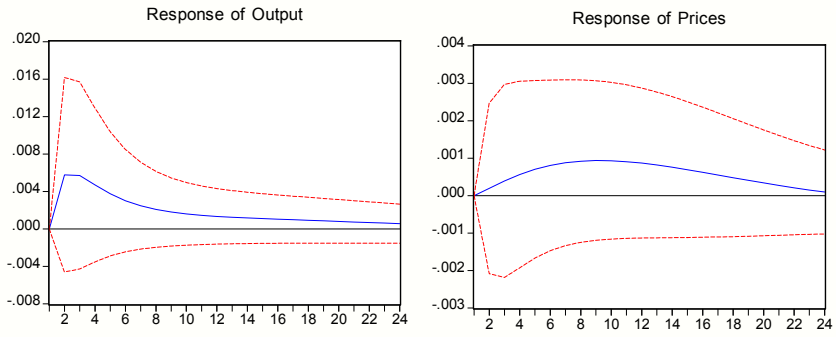
Table 4. Granger Causality for Key Interest Rates

Null Hypothesis:	F-Statistic	Probability
Interbank rate does not Granger Cause Repo	1.33	0.27
Repo does not Granger Cause Interbank rate	5.38	0.00
Lending rate does not Granger Cause Repo	2.70	0.05
Repo does not Granger Cause Lending rate	4.33	0.01
Deposit rate does not Granger Cause Repo	4.64	0.01
Repo does not Granger Cause Deposit rate	3.05	0.04
Lending rate does not Granger Cause Interbank rate	3.54	0.02
Interbank rate does not Granger Cause Lending rate	5.70	0.00
Deposit rate does not Granger Cause Interbank rate	4.72	0.00
Interbank rate does not Granger Cause Deposit rate	1.46	0.23
Deposit rate does not Granger Cause Lending rate	5.07	0.00
Lending rate does not Granger Cause Deposit rate	1.09	0.36

Note: Lag-length is 3; results are robust to longer lags

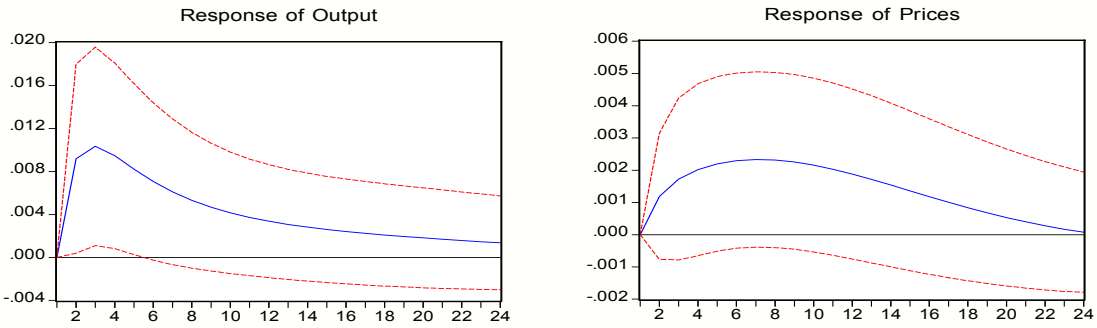
To address the issue of whether changes in the quantity of money and/or bank reserves have implications for output and prices in Armenia, we add bank reserves in domestic currency (as an indicator for the supply of loanable funds) to equation 4. As can be seen from Figure 7, the impulse response of aggregate demand to a change in domestic currency bank reserves is not significant. This result can be explained by the high degree of asset and loan dollarization in the banking system.

Figure 7. Response to a Shock in Bank Reserves (domestic currency)
(Response to One S.D. Innovations ± 2 S.E.)



Once bank reserves in both domestic and foreign currency are included in the VAR (Figure 8), the impulse response of aggregate demand to a change in bank reserves becomes significant, but is smaller than the response to the monetary aggregate (M1).[18] Moreover, it suggests that banks could potentially play a more important role in the transmission mechanism through the bank lending channel if financial intermediation could be deepened and the degree of asset and liability dollarization reduced, while at the same time draining structural excess liquidity from the system.

Figure 8. Response to a Shock in Bank Reserves (including foreign currency)
(Response to One S.D. Innovations ± 2 S.E.)



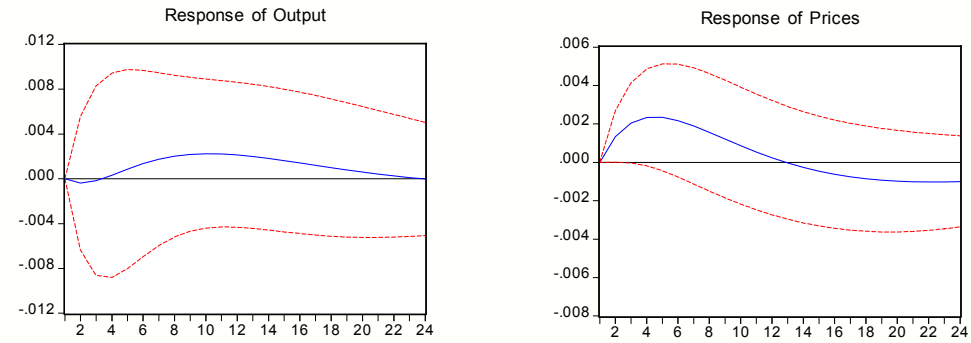
To further examine the role of credit (both domestic and foreign) in the transmission of monetary policy in Armenia, we replace bank reserves with total credit to the economy (bank loans) in the basic model.[19] We find that bank loans are an important conduit for the monetary transmission mechanism and a significant source of independent shocks to prices. Specifically, we find that a shock to bank loans results in an almost immediate increase in

[18] In June 2005 the CBA required that bank reserves be of the same currency as reservable deposits (previously, all required reserves were kept in domestic currency), which prompted banks to put foreign exchange on their correspondence accounts to meet the reserve requirements. To account for this structural break, we introduce a dummy variable in the VAR.

[19] Total credit to the economy (excluding the public sector) includes both dollar- and dram-denominated loans. Dollar-denominated loans account for over 60 percent of all loans.

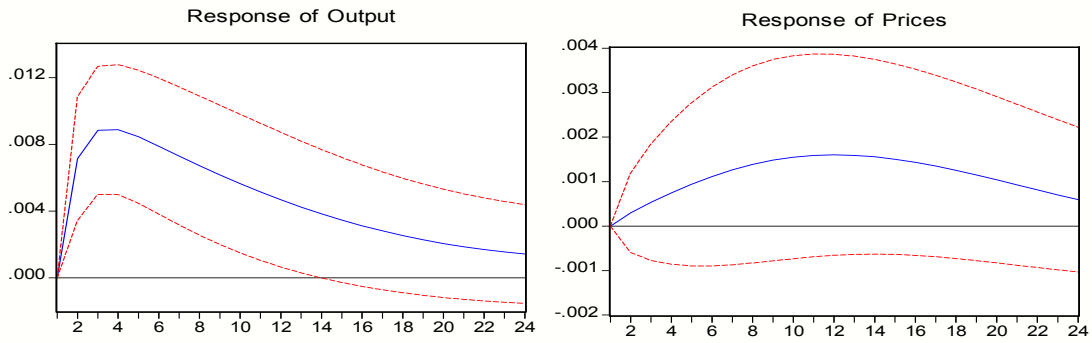
prices that is significant for 4 months (Figure 9). However, innovations to bank loans yield no significant output response. This result may be explained by the still comparatively modest share that credit to the economy has in total bank assets. Commercial banks with limited credit assessment capacity in an environment of opaque corporate accounting and reporting have tended to invest their funds in foreign and other assets rather than in credit portfolios.

Figure 9. Response to a Shock in Credit to the Private Sector
(Response to One S.D. Innovations ± 2 S.E.)



To further examine the role of monetary aggregates, we decompose M1 into currency in circulation and domestic demand and savings deposits. Figure 10 indicates that it is currency in circulation rather than dram deposits that affects real output. As in the previous models, the interest rate and exchange rate channels appear to significantly influence prices. However, as in the model with M1, we find that domestic narrow monetary aggregates are not good indicators of inflation in Armenia. Variance decomposition results (not presented here) suggest that shocks to currency in circulation account for 24 percent of the fluctuation in output in 2 years, but only for 6 percent of the variance in prices.

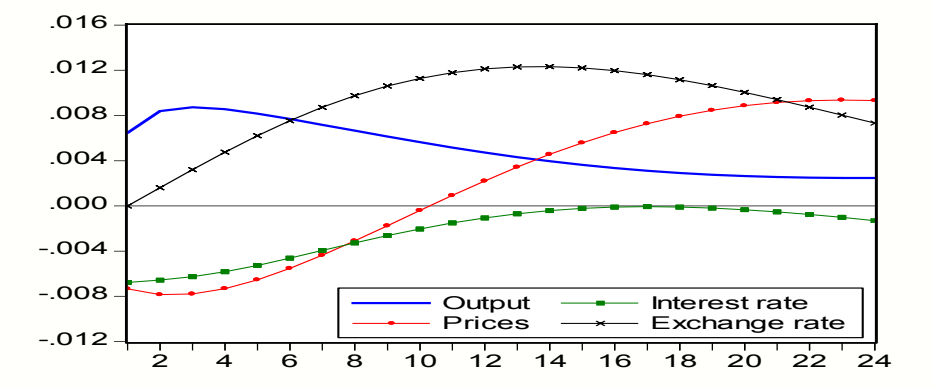
Figure 10. Response to a Shock in Currency in Circulation
(Response to One S.D. Innovations ± 2 S.E.)



We find that currency in circulation responds positively and significantly to an exchange rate appreciation (Figure 11), while price level innovations (adverse aggregate supply shocks) result in an initial (and significant) decline in households' dram cash holdings. This provides

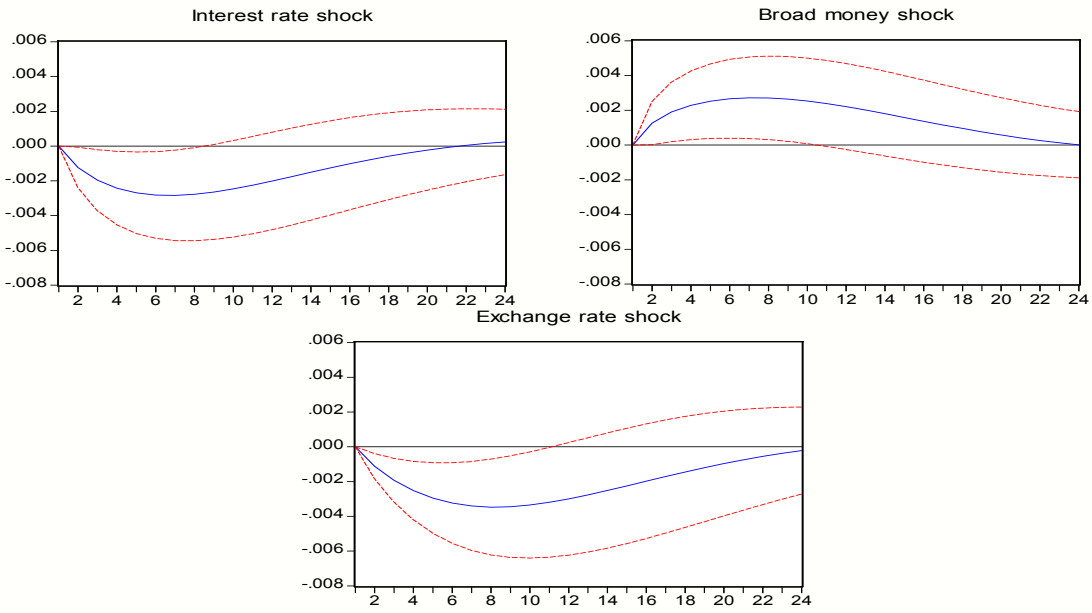
some evidence of currency substitution in Armenia, as it suggests that an appreciation of the domestic currency increases the returns on holding drams and, therefore, provides incentives to dedollarize. The effects of output shocks and interest rate shocks (tighter monetary policy), however, are not significant.

Figure 11. Response of Currency in Circulation
(Response to One S.D. Innovations)



Studying the case of Russia, Oomes and Ohnsorge (2005) find an effect of money on inflation when an estimate of foreign cash holdings is included in the money aggregate ("effective broad money"), while no link is found between inflation and other monetary measures. Foreign cash holdings are believed to be significant in Armenia (equivalent to more than 100 percent of M2X), however, no reliable data is available. We therefore consider broad money including foreign currency deposits (M2X) as the relevant monetary aggregate in equation 5.

Figure 12. Response of Prices
(Response to One S.D. Innovations ± 2 S.E.)



An unanticipated shock to broad money now results in an increase in prices that is significant after 3 months and persists for 12 months (Figure 11).[20] This result suggests that inflation in Armenia does respond to increases in broad money, once foreign currency deposits are included, but not to domestic monetary aggregates. The effects of interest rate and exchange rate shocks on prices are similar to those found in the baseline model and in the model with M1 (see Figures 4 and 5).

Variance decomposition indicates that shocks to broad money (M2X) account for 13 to 15 percent of the variation in prices, whereas narrow monetary aggregates, which exclude foreign currency deposits, only account for 6 percent of the fluctuation in prices in 2 years (Table 5).

Table 5. Variance Decomposition of Prices (percent of total variance)

Period (quarters)	Forecast error	Output	Prices	Interest Rate	Broad Money (M2X)	Exchange rate
4	0.021	5.11	46.46	13.94	13.58	20.91
6	0.023	7.35	42.47	13.40	14.02	22.77
8	0.024	7.67	43.29	12.92	13.66	22.46
12	0.024	7.65	43.35	13.02	13.67	22.32

IV. SUMMARY AND POLICY CONSIDERATIONS

Table 6 summarizes the empirical results of the previous two sections. Overall, shocks to domestic monetary aggregates significantly affect output, but appear to have no major impact on prices over the sample period. This result could be partly explained by the substantive shifts in monetization and dollarization since 2005. However, we find that inflation in Armenia does respond to changes in broad money, once foreign currency deposits are included. The interest rate channel remains weak, even though there is some evidence for a transmission of shocks to the repo rate to CPI inflation. As in many emerging and transition economies with a high degree of dollarization, the exchange rate channel appears to have a stronger impact on prices.

The empirical analysis has shown that the central bank's means to influence economic activity and inflation are still limited. The CBA has come a long way in developing its set of monetary instruments, but these instruments still lack effectiveness as the diverse channels of monetary transmission are not operating properly. Improving the performance of these channels will be paramount for a successful transition to a full-fledged inflation targeting monetary policy framework in Armenia. At the same time, Leiderman, Maino, and Parrado (2006) note that the way an economy responds to monetary policy is regime-dependent. A

[20] The lag length of 3 months for the transmission of a broad money shock to inflation in Armenia is consistent with that found in Russia by Oomes and Ohnsorge (2005).

regime shift toward IT may gradually induce changes in the way economic agents react to policy signals, thus improving the efficacy of the new monetary policy regime.

Table 6. Summary of VAR Results

Variable	Effect on output		Effect on prices	
	Direction	Significance	Direction	Significance
Repo rate	negative	no	negative	**yes**
Exchange rate	…	no	negative	**yes**
M1	positive	**yes**	positive	no
Currency in circulation	positive	**yes**	positive	no
Demand deposits	…	no	…	no
M2	positive	**yes**	positive	no
M2X	positive	**yes**	positve	**yes**
Bank lending rate	…	no	…	no
Bank reserves	positive	**yes**	positive	no
Credit to economy	positive	no	positive	**yes**

The key policy challenges are to (1) foster continued dedollarization; (2) integrate the shadow economy into the formal economy; and (3) deepen financial intermediation. Progress in these areas will be achieved only gradually. It is all the more important that the recent reform drive is kept up and regulatory improvements are implemented at an early stage.

The VAR results indicate that changes in M2X have a much higher impact on economic activity than domestic narrow or broad money due to the high degree of dollarization in the Armenian economy. Dollarization in transition countries has been rather persistent. The strong appreciation of the dram since 2003, however, has already initiated an emerging dedollarization in Armenia. Consolidating trust in the domestic currency and in the CBA's monetary policy will further contribute to this trend. A firm commitment to an independently floating exchange rate regime will also tend to reduce dollarization. Furthermore, the authorities could foster the development and deepening of domestic financial markets, for example by increasing the supply of medium- and long-term bonds denominated in domestic currency, or by helping develop markets in financial instruments to hedge foreign exchange risk (Leiderman, Maino, and Parrado, 2006). Lastly, the CBA aims at reducing the degree of dollarization by precluding pricing and payments in foreign currency.

Armenia has a large shadow economy, estimated to be about one-third of GDP, that does not rely on the formal financial sector. Firms and individuals rely on (foreign exchange) cash for transactions. This significantly diminishes the potential deposit base of the banking system and the market for products offered by banks and other financial institutions—thereby precluding any effects of monetary policy on activity and prices in the informal economy. In order to foster the assimilation of the informal sector into the formal economy, the authorities plan to improve regulation and supervision of foreign exchange cash operations and

strengthen the criminal code to fight economic crime and corruption. Equally important for reducing the shadow economy would be improvements made to the efficiency and transparency of the tax revenue administration.

Finally, improving financial intermediation and financial sector efficiency will require further regulatory reforms and the strengthening of monetary policy implementation:

- Several measures could be implemented in the short term to strengthen the *interest rate channel*. The CBA has already adopted some changes to its operating framework to improve liquidity management. As a next step, the sizable structural excess liquidity of the banking system should be removed using sales of longer-maturity securities and foreign exchange operations. Furthermore, the CBA is encouraging reputable foreign banks to enter the Armenian market, aiming at importing banking expertise, increasing competition and efficiency of bank operations, and lowering banking spreads. In the medium term, this would also contribute to the deepening of financial intermediation, which will be crucial to strengthen both the interest rate and bank lending channels.

- Monetary transmission through the *bank lending channel* could be bolstered by (1) tightening creditworthiness standards; (2) strengthening accounting standards, bankruptcy laws, corporate governance, and creditor rights; (3) improving bank credit assessment capabilities; and (4) strengthening the judicial system to improve banks' ability to enforce on collateral. A number of legislative and judicial reforms designed to simplify and reduce the cost of foreclosure on real estate and strengthen creditor rights have already been initiated by the authorities.

- While both the *balance sheet* and *asset price channels* are currently absent, they could gradually become effective with the implementation of the regulatory reforms mentioned above and the development of local capital and mortgage markets.

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Appendix: Impulse Response Functions for Basic Model

(Response to One S.D. Innovations ± 2 S.E.)