Exchange Rate Pass-through to CPI and Inflation in Caucasian Countries

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Abstract

Exchange rate pass-through to CPI has been a subject of interest of researches for a couple of decades. However, most of the previous studies focus mainly on developed and emerging countries. Objective of this study is to analyze exchange rate pass-through in transitional, Caucasian countries. To perform proper analysis several equations must be estimated simultaneously, which nominates Vector Auto Regression as the best method for this study. Illustration of impulse response functions and variance decomposition show us degree of passthrough and share of variation in consumer prices explained by changes in exchange rate. Despite data limitation this research provides meaningful results. Caucasian countries have many similarities but each reveals its own uniqueness. Pass-through is relatively higher in Georgia and Armenia and very low in Azerbaijan. This is consistent with previous literature that countries with higher share of import have higher pass-through. Vector Error Correction model shows that the lowest deviation from long-term equilibrium is in Armenia, which probably is due to inflation targeting strategy. Trade balance has significant effect on CPI in Armenia and Azerbaijan. Variance decomposition shows significant share of exchange rates in explaining changes in CPI only in Georgia, which should suggest Georgian monetary authority to observe changes in exchange rate more carefully than other Caucasian countries.

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1. Introduction

After gaining independency in the beginning of 90-ies, like other former soviet republics, Caucasian countries (Georgia, Armenia and Azerbaijan) also passed several years of economic instability and hyperinflation. Magnitude of these problems was increased by war between Georgia and Russia, between Armenia and Azerbaijan. As a result Azerbaijan and Georgia received refugees and Armenia got isolated¹. Each country is small economy, although unique in its sense. Azerbaijan is oil producer country, Georgia is an important transit corridor in region (also has access to the Black Sea) and Armenia is isolated.

From 1995 National Banks of these countries started pursuing tough monetary policy part of which was several reforms to stabilize inflation and national currency. Success was reached in the beginning of 1997 when inflation dropped below 10% (See chart #1), while other CIS countries achieved this goal later. However success is never achieved without cost and the cost was high dollarization of economy and fluctuations in money demand.

Due to Russian financial crisis in 1998 and problems with domestic budget put pressure on Georgian Lari which was de facto pegged to US dollar. When foreign reserves went low The Nation Bank of Georgia let exchange rate (managed) float. Result was sharp depreciation of Georgian Lari against US dollar. In the same period there was relatively high increase in consumer prices (presented on chart 2a). By looking at chart 2b, we can see similar pattern in Armenia during first half of 1997. Actually these charts show that during 1996-2004 depreciation of domestic currency against USD is followed by increase in consumer prices and versa in these countries. Such relationship between exchange rate and CPI is supported by many empirical works. However we get opposite picture from 2005 (See charts 2a,b) which doesn't agree with previous studies. Azerbaijan differs from Georgia and Armenia to some extent: negative relation between exchange rate and CPI appears during 2000-2003 (See chart 2c).

In this study I will analyze whether exchange rate do matter for inflation in Caucasian countries. In other words: Exchange rate pass-through (ERPT) to consumer prices. Besides exchange rate, effect of monetary policy (through money aggregate M2) and foreign trade on inflation will be

¹ After Karabakh war, Turkey and Azerbaijan closed their borders to Armenia.

investigated as well. Foreign trade matters a lot for these countries. Georgia and Armenia highly depend on imported goods. Therefore sudden drop in import may lead to shortage of goods and increase in prices. Major part of Azerbaijanian export is oil. Indeed, growth rate of economy in this country gets higher when price of oil increases.

Economic intuition behind ERPT is following: Let's assume domestic currency depreciates ceteris paribus. Consequently same amount of domestic currency now has less value in terms of foreign currency. Therefore foreign exporters will receive less profit than before. To maintain certain profit margin they will have to increase prices. Domestic producers which use imported raw materials face higher cost and will have to set higher prices as well. Here we can conclude that the higher is import share in total production (more open is country), higher will be ERPT. As we will see in next section, previous literature confirms this hypothesis.

How much of changes in exchange rate can be compensated by increase in prices depends on several factors. As mentioned in An (2006) less substitutability of products, higher share of import, higher concentrated market provides greater opportunity for firms to maintain certain level of mark up. Therefore degree of ERPT increases.

Foreign trade is the main channel for exchange rate shocks to pass-through to CPI. Therefore, I include trade balance in analysis to separate effect of trade balance and exchange rate shocks. After Russian financial crisis most of CIS countries have experienced sharp depreciation of their national currencies because of high trade dependence on Russia and following sharp increase in prices. As Russia is the major consumer of beverages and/or agricultural products of many CIS countries, it uses its dominant trade position as an instrument of political pressure. In 2006 after Russia put embargo on Georgian export, Georgia managed to find new markets (China, Europe) for its products and decreased influence of Russia. Since 2006 Russia is no longer most major trade partner of Georgia², unlike Azerbaijan and Armenia. Therefore, I expect effect of trade balance shock to CPI to be higher in Azerbaijan and Armenia than in Georgia.

ERPT will be estimated by impulse response functions (IRF) From Vector Auto-Regression (VAR). Previous research on ERPT in CIS countries³ performed VAR on differenced series due

² Bulletin of Monetary and Banking Statistics of Georgia 2001-2007

³ See "likka Korhonen — Paul Wachtel: A note on exchange rate pass-through in CIS countries (2005)"

lack of data, consequence of which was instability of VAR. Differencing series eliminates longrun relationship and limits analysis. In contrast, data available for this study gives possibility for wider range of analysis.

The rest of paper is organized as follows: section II provides general overview of inflation behavior and macroeconomic development of Caucasian countries; section III summarizes previous studies about ERPT to inflation; Section IV describes statistical properties of data; Section V describes methodology used for this analysis; empirical results are presented in section VI; section VII is about discussion on results and trying some modifications of original model and finally last (VIII) section offers conclusion and some policy recommendation.

2. General overview

First years of independence was accompanied with hyperinflation which achieved peak in 1994 and was especially higher in Georgia (15607%). From 1995 National banks with support of IMF and World Bank, passed necessary reforms to decrease inflation and stabilize economy. New currency was introduced in each country. Monetary authorities of Caucasian countries kept exchange rate fixed in the beginning. As mentioned in Banaian, Kemme and Sargsyan (2006), fixed exchange rate was maintained to enable central/national banks to gain credibility and to limit volatility of exchange rate. However in long-term perspective fixed exchange rate appeared to be not right choice. Currency mismatch and speculative attacks (which lowered foreign reserves of most of transitional countries) along with Russian financial crisis (Major trade partner of Caucasian countries in that times) brought countries to financial crisis. As a result, Armenia in 1997 and Georgia in 1998 let exchange to float (managed float in Armenia). Armenian Dram and Georgian Lari significantly depreciated followed by sharp increase in inflation (See chart #1). Since 2000, inflation in Caucasian countries remains stable, though it has slightly upward trend in Azerbaijan.

Exchange rate dynamics of each country is somewhat similar (especially Georgian and Armenian). National currencies are in depreciation phase first (except Azerbaijan). Then there is sharp depreciation (1997 in Armenia, 1998 in Georgia and Azerbaijan). After wave of Russian financial crisis until 2004 exchange rate is stable, though domestic currencies continue to depreciate slightly. From 2004 appreciation phase starts in each country. Experts link this change with construction of oil-pipeline "Baku-Tbilisi-Ceyhan". This project had impact on geopolitics in region. Influence of Russia was supposed to decrease, western partners participating in project seemed confident about stability and safety in Caucasus. This allowed Georgia and Azerbaijan to attract investors in other spheres (besides oil-pipeline) as well. Flowing foreign currency in these countries went in favor for domestic currencies. Armenia is out of "Baku-Tbilisi-Ceyhan" project and reason of dram Appreciation should be something else.

Armenia is isolated today. Borders are closed from Turkey and Azerbaijan. Majority of Armenian export and import moves through Georgia. Country is offside from participating in certain regional projects (for Example "Baku-Tbilisi-Ceyhan" pipeline). In result foreign investments bypass Armenia and from abroad economy is supported Armenian Diasporas around the world including USA, Russia, Canada, Europe and so on. When economies of these countries perform well, more money is being transferred in Armenia (mainly USD), in result Dram appreciates and vice versa. Of course money transfers from residents abroad are important for Georgia and Azerbaijan too, but they are more essential to Armenia. Additionally, amount of Armenian residents abroad is much higher than Georgian and Azerbaijanian, which means more people are sending money to relatives in Armenia than in other Caucasian countries.

Trade balance and actually welfare of economy in Azerbaijan depend on oil prices. In middle of 2008 due to high oil prices export exceeded import 20 times. Growth rate of non-oil GDP is much less than growth rate GDP including oil. From chart #3 below we can see how GDP of Azerbaijan drops significantly when oil is excluded.

Chart #3: GDP and Non-oil GDP of Azerbaijan



(in MLN Azerbaijanian Manat)

3. Literature review

There is big literature available about EPTR to inflation (and not only). However, big majority of these works describe EPTR in developed, industrialized and emerging markets and very few about transitional countries.

Two things which most of previous works have in common are: **I**) ERPT is higher in countries which have: small and open economy; less volatile GDP, high share of import in GDP, higher inflation less volatile and more persistent exchange rate. See: McCarthy (2006), Lian An (2006), Zorzi, Hahn and Sanchez (2007) and etc. **II**) Degree of ERPT decreases along distribution chain. (ERPT is the highest in import prices, moderate in producer prices and the lowest in consumer prices).

3.1 Literature about developed countries

McCarthy (2000) performed multi-country panel regression and found negative but insignificant effect of exchange rate on inflation in some developed countries (U.K., Sweden, Switzerland) and positive for countries like France and Japan.

Behavior of ERPT in Euro area is analyzed in Faruqee (2004). As author concluded, similar to United States, pass-through in Euro Area is very low in short-run. But it increases over time and in import prices it gets very close to unity.

Majority of researchers when performing VAR analysis rely on Choleski decomposition to identify effect of shocks. In contrast to this: Lian An (2006) when studying ERPT at different stages of distribution chain of pricing on 8 major industrialized countries, uses VAR with sign restriction method. This finding is that "The degree of pass-through declines and time needed for complete pass-through lengthens along the distribution chain."

3.2 Literature about emerging market countries

Some authors doing research on ERPT in emerging market countries conclude that ERPT is higher in these countries than developed world. For example in their study Liu and Tsang (2008) concluded that ERPT to inflation and import prices is much higher in Hong-Kong than in OECD countries (average). Zorzi, Hahn and Sanchez (2007) also found higher ERPT into import and consumer prices in emerging than in developed countries.

Ito and Sato (2006) mention about importance of monetary policy to affect ERPT. They found that ERPT is highest in Indonesia (and very high) at each stage of distribution channel. ERPT is positive and significant in South Korea and Thailand and insignificant in Singapore and Malaysia. Authors suggest such difference in ERPT is partly due to monetary policy of central bank.

Other studies done on ERPT in emerging countries shows similar results. As mentioned in Barbakadze (2008) papers by Kuijs (1998), Callen and Chang (1999), Ubide (1997), Cerisola and Gelos (2005), Leigh and Rossi (2002), Hossain (2002), Sacerdoti and Xiao (2001), Khan and Schimmelpfennig (2006) analyzing inflation dynamics respectively for Nigeria, India, Mozambique, Brazil, Turkey, Bangladesh, Madagascar and Pakistan suggest negative relationship⁴ between the exchange rate and inflation in developing economies. (See Ivane Barbakadze: "Explaining Inflation in Georgia: Do Exchange Rate and Nominal Wage Matter?" The National Bank of Georgia, Working Paper #04; September, 2008; page 9).

3.3 Literature about transitional countries

Now few words about studies which explored influence of exchange rate on inflation in transitional countries. Authors find higher pass-through of exchange rates (Indicating big significance of exchange rate in explaining inflation), compared to industrialized and emerging countries.

In his most recent work, I. Barbakadze (2008) analyses relation between exchange rate (bilateral exchange rate against USD), CPI, wages and M2. He found that exchange rate do matter for inflation in Georgia. Effect of 1% depreciation of Georgian Lari to US dollar causes rise in inflation by 0.28% in short-term and 0.43% in Long-term. Effect of exchange rate is stronger than effect of other variables. Wages matter only in short-run (coefficient is 0.03) but becomes insignificant in long-run. Although author believes that still wages have important role to explain inflation in Georgia.

Nominal effective exchange rate seems to be the most important determinant of inflation in Serbia. As Nikola Tasić (2008) ERPT is incomplete but coefficient is about 0.5 in long-run. It reaches 0.9 if retail price index is used. Explanation of author of such high coefficients lies in

CEU eTD Collection

⁴ Which means that depreciation of domestic currency has positive impact on inflation.

fact that Serbia is small open economy, import has huge share in GDP and also low level of competition. But these estimates are subject of concern as data is very small (not more than 7 years).

Similar result got Grigorian, Khachatryan and Sargsyan (2004) by studying relation between CPI, exchange rate and wages in Armenia. Prices are most sensitive to changes in exchange rate, but correlation is negative. Authors explain this by overshooting of prices in response to changes in exchange rate before returning to the level consistent with the new exchange rate. Like previous paper, this study also has very limited data (7 years and half).

Extent and speed of ERPT in CIS member countries⁵ is analyzed by Korhonen and Wachtel (2005). They assessed structural VAR on log-differences and found that exchange rate have significant impact on price movements. Speed and extent of pass-through is higher than in emerging market countries. Like other studies sample size is also very small here (1999-2004).

Darvas (2001) asses VAR framework on ERPT on 4 EU member coutrnies (in 2001 Hungary, Slovenia, Czech and Poland were not part of EU). Long-run pass-through was found to vary from 0.15 to 0.4.

⁵ Georgia left CIS in 2008.

4. Data

Data is taken from IMF statistics, also either statistical offices or central banks of these countries (if some variables were not available at IMF statistics). For each country data is up to December 2008 and starting point is January 1996. Data is availlable for earlier period, but for these countries even 1995 was unstable period and data from earlier period brings distortion to analysis. In time-frame of 1993-1994 there was very high inflation in these countries and in 1995 governments started real actions. A graphical analysis of data proves that prior 1996 there are distortions in data (huge spikes and etc).

In order to have reasonable sample size, I use monthly series. Variables are taken in nominal values, as this form is used describing situation in country. To capture effect of percentage change, logarithmic form is chosen. Some authors used in their analyses up to 7 variables, but due to small sample size I maintain their number as small as possible (in order to have system identified at least and normal amount of degree of freedom). Descriptive statistics of these variables are provided in appendix 1. Let's discuss variables I use.

Bilateral exchange rate vis-a-vis USD (BERUSD): Like other of post Soviet countries, US dollar is used in absolute majority of export and import operations in Caucasian countries (at least with the biggest trade partners). Well, one may suggest using Nominal Effective Exchange Rate (NEER) instead, as trading with Euro zone countries are performed in Euros. But when calculating NEER, bilateral exchange rates vis-à-vis currencies of major trading partner countries are used (with corresponding weights). Therefore weight of USD will be much less than it should, which may make NEER not reliable in this study. Let's see example: Georgia performs majority of export and import operation with Turkey (which is one of the biggest trading partner) in US dollars; but in NEER of Georgian Lari weight of USD is equal share of trade volume with USA in total foreign trade of Georgia. Weight of Turkey is given to Turkish Lira. Same happens with currencies of other major trade partners. As a result weight of USD is deflated (is much less than it should be) in all three countries. Additionally share of Trade volume (in total foreign trade) with Euro zone countries is very small compared to share of trade performed in USD and therefore I choose BERUSD instead NEER. One may suggest analyzing pass-through of Euro

separately, but bilateral exchange rate vis-à-vis Euro is available from 2002 and sample size would be too small (less than 100 observations) to make precise analysis.

CPI (indexed: 2000=100). CPI is used mostly for transitional countries to describe level of prices. Additionally, other price indexes are not available for full period for all countries and I would have to reduce sample size to add more variable (Producer prices for example), which is going to result in less precise estimates. Therefore in this study I concentrate on pass-through to CPI only and leave other prices indexes for future research (when there will be sufficient number of observation to perform reliable analysis).

Money aggregate M2 (For each country M2 = Currency outside Banks + Deposits in national currency): as an instrument of monetary policy of Central Bank. Some previous studies use interest rate as policy instrument. After graphical analysis of interest rates (actually of refinance rate) I found that there were periods when interest rate was same for several months. So probably interest rate would serve well with quarterly data, but less likely with monthly data. Therefore I use M2 as a policy instrument.

Trade balance: Caucasian countries are small and open and they have high dependence on imported goods. Georgia and Armenia never had positive trade balance since gaining independence (See appendix 1). In certain periods Azerbaijan has positive trade balance but it is much more volatile than for other countries. Such high volatility can be explained by high oil's share in export of Azerbaijan (therefore fluctuations in oil prices probably have significant influence volatility of Azerbaijanian export). Negative sign of trade balance creates one problem: logarithm of negative numbers cannot be taken. Solution is to take another measure of trade balance which won't have negative signs. Such solution is export/import ratio as it will always be positive and import never equals to zero. As this variable is already ratio, one may think that there is no necessity to take logarithm of it, but I will use logarithmic values for interpretation purposes.

Additionally I include exogenous variable: **Crude Oil** prices. None of these countries can affect oil prices: although Azerbaijan is oil exporter country, its share in total oil export is very small so

this country cannot influence oil prices. Georgia and Armenia are very small country and their share in total world demand for oil is miserable and they also cannot influence oil prices. Therefore oil prices enter in this analysis as exogenous variable. As mentioned in An (2006): "The fluctuation of local currency oil prices largely reflects not oil price fluctuation per se but the variability of bilateral exchange rate vis-à-vis the US dollar". Of course it is not desirable to let changes in oil prices to capture changes in exchange rate. Therefore having oil prices in local currency is not desirable and USD denominated oil prices (in logarithmic form) is chosen instead.

It would have been very interesting to perform analysis by including variables like import price index, industrial production index (and some others) but unfortunately they are not available for all transitional countries. Some variables like GDP are reported on quarterly bases, so they cannot be included in analyses⁶. Most of variables are given at the end of period (M2, export/import), therefore I will use exchange rate at the end of period.

Authors try to handle situation about seasonality in data: either by adjusting (X-12 procedure) or including seasonal dummies. As mentioned in Lada and Wójcik (2007): "standard 0-1 seasonal dummies affect both the mean and the trend of the level series". As a solution, they suggest method proposed by Johansen to create centralized (orthogonalized) seasonal dummies. Advantage of this method is that these centralized dummies shift only mean and have no influence on trend. (See Katarzyna Lada, Piotr Wójcik: "VEC model– the influence of export on economic growth"; (2007); page 3). It may be questionable whether it is reasonable to include seasonal dummies at all in relatively small sample. But as mentioned in Barbakadze (2008), there are works like Kumah (2006) emphasizing importance of seasonality in inflation behavior. (See Ivane Barbakadze: "Explaining Inflation in Georgia: Do Exchange Rate and Nominal Wage Matter?"; (2008); page 16).

⁶ Sample size would become too small.

5. Methodology

To estimate effect of shock in exchange rate and in trade balance on CPI inflation in selected transitional countries VAR methodology will be used. Before I choose how to perform VAR, I need to check data on stationarity. I use Augmented Dickey-Fuller (ADF) tests for unit root. KPSS is recommended for relatively bigger samples (approximately at least 400) so I won't use it here. As we can see from Appendix 2: For all countries CPI, Exchange rate and M2 are integrated of order 1 I(1) with exception of M2 in Azerbaijan (follows I(2) process). Export/import ratio follows I(1) process in Armenia, but is stationary in Georgia and Azerbaijan.

Major disadvantage of VAR is its linear nature. But VAR estimates system of simultaneous equation which is a big advantage that outweighs weak side of VAR.

First unrestricted VAR is constructed and later it can be progressed in two ways: **Structural VAR** (SVAR) and/or **Vector Error Correction Model** (VECM).

First of all, unrestricted VAR must be stable (stationary), otherwise we may get misleading results. For example: impulse response functions (IRF) will not be valid, because impulse response errors are invalid. VAR is stable if all roots are inside the unit circle (they have modules less than one). If all roots lie inside unit circle, then we can analyze pass-through by IRFs and Variance decomposition and determine how much of 1 unit (1% in our case) shock in exchange rate is transferred to CPI within 1-2 year (degree of pass-through).

If stability condition is not satisfied, there is an option to estimate VAR by using log-differences (first differences) of original variables. This way, stationary variables are included in VAR and stability condition should be satisfied. But Taking log-differences will encounter one problem. It shows only short-term effect: effect between 2 periods which is just a month in our case. It takes away long-term effect. Additionally in this case coefficients are interpreted in different way: how change (shock) in change of 1 variable affects change in other variables. In other words this technique leads to analysis of relation between monthly growth rates of variables, which may not so much interesting. Therefore, if stability condition is not satisfied in model with original series, I will try to modify sample period.

5.1 SVAR

In order to give unrestricted VAR (which is simply a kind of econometric tool) some more economic meaning, I will impose certain structural model on variables and this way unrestricted VAR becomes SVAR. If correct structure (model) is imposed than standard errors will be reduced as a result, estimates and IRFs become more precise. However if structural model will be wrong obtained results are less likely to be precise.

SVAR works in this way. Let y_t be vector with length k of endogenous variables and $\Sigma = E[e_t e_t']$ the residual covariance matrix. We can write SVAR as $Ae_t = Bu_t$, where e_t and u_t are vectors with k elements. e is reduced form residuals (which are observed) and u is structural innovations (which are unobserved). A and B are $k \times k$ matrices we have to estimate. Structural innovations are assumed to be orthogonal, which means: $E[u_tu_t'] = I \Rightarrow A\Sigma A' = BB'$ [1] (identifying restrictions for error structure). But actually by doing so, we impose k(k+1)/2 restrictions on $2k^2$ unknown parameters, which means that for identification we need additional k(3k-1)/2 restrictions. Of course restrictions must be linear and independent.

The most popular tool to restrict matrix A is "Cholesky Decomposition", which restricts matrix A to a lower triangular matrix. This means variables are ordered according to contemporaneous effect (first variable is affected contemporaneously only by its own shock, and other variables are contemporaneously affected by variables prior to them in ordering and their own shocks).

Following ordering of variable is imposed as structural restricption: M2 is placed first. Here I assume that monetary authorities don't react immediately to shocks. For example they don't want to make money supply very volatile. Or not enough time passes for shocks to transfer in money aggregates. Well the latter assumption would be doubtful for quarterly data, but for 1 month horizon we can assume so. Exchange rate is placed second. This assumption is based on general knowledge: appreciation of domestic/national currency stimulates import and depreciation _ export. Therefore changes in exchange should have effect on trade balance. Trade balance is placed third. In Caucasian countries, CPI responds quickly to shocks in other variables especially to monetary and foreign trade shocks; therefore it will be placed last.

From [1] we get the relationship between the reduced-form VAR residuals and the structural innovations as:

$$\begin{pmatrix} e_t^M \\ e_t^E \\ e_t^T \\ e_t^P \\ e_t^P \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ A_{21} & 1 & 0 & 0 \\ A_{31} & A_{32} & 1 & 0 \\ A_{41} & A_{42} & A_{43} & 1 \end{pmatrix} \begin{pmatrix} u_t^M \\ u_t^E \\ u_t^T \\ u_t^P \\ u_t^P \end{pmatrix} \Rightarrow \begin{pmatrix} e_t^M = b_{11}u_t^M \\ e_t^R = \alpha_{21}e_t^M + b_{22}u_t^E \\ e_t^T = \alpha_{31}e_t^M + \alpha_{32}e_t^E + b_{33}u_t^{TB} \\ e_t^P = \alpha_{41}e_t^M + \alpha_{42}e_t^E + \alpha_{43}e_t^{TB} + b_{44}u_t^M \end{pmatrix}$$

The system is just identified (we impose sufficient amount of 0s) so we can analyze how these variables response to shocks of other variables and its own as well. α_{ij} -s are elements of A matrix and b_{rr} diagonal elements B matrix.

But assumption to order variables according to contemporaneous effect may not be realistic. Therefore I will try to impose other theoretical (assumed) restrictions and compare results. IRFs are given as response to 1 structural S.D. Therefore IRFs will be scaled to retrieve response to 1% shock.

5.2 VEC

Beside SVAR original VAR can be turned in to VECM. But for VECM at least 1 cointegrating relationship is necessary. Cointegration is tested on non-stationary variables. Therefore for Armenia all variables will be tested for cointegration; for Georgia and Azerbaijan _ all variables except export/import ratio. There are two ways to test for cointegration. Engle-Granger and Johansen approach. First one is used to test cointegration between two variables and second is used when we have two or more variables. Well Johansen approach has some weaknesses: it is not recommended for small samples and is sensitive to the number of lags chosen. But Engle-Granger approach is used to check cointegration between two non-stationary variables. This method won't help much to detect if 3 or more variables converge to equilibrium values. Therefore I will use Johansen approach to find possible cointegrating relation among selected variables.

Econometric package Eviews 6.0 allows several options when performing test on cointegration depending on data property. Most of Data series available for this study shows stochastic and/or linear trend. Therefore test should assume trend in variables. Options 3 and 4 in Johansen cointegration test fit this requirement. But there is difference also: Option 3 assumes only constant in cointegration equation, while option 4 assumes linear trend as well. Generally option 3 is used if all series are believed to have stochastic trend and option 4 is used if some (not

necessarily all) variables are trend stationary. Therefore for each country if test results do not coincide, decision will be made based on whether variable has stochastic trend or is trend stationary. Eviews produces two test statistics: Trace and maximum eigenvalue statistics. Trace statistics is more robust to deviations from normality. If we look at appendix 1b, we can see that almost all series are rejected to be normally distributed at 5% significance level (See Jarque-Bera statistic in appendix 1). Exceptions are **lcpi**⁷ in Armenia and **lexpimp** in Georgia. Therefore if trace and maximum eigenvalue test statistics give conflicting results, trace test statistics will be chosen (So I will report result of trace test only).

If at least one cointegrating (long-term) relationship is found, then we can build VECM to find short-term adjustment process toward long-term equilibrium values. Choice of deterministic trend specification should be same as in Johansen cointegration test. However I will check estimation result using option 4 first. If coefficient of trend is insignificant, then VEC estimation will be based on assumption of no trend cointegrating relation.

⁷ See definition of variables in appendix 1a.

6. Empirical Results

I start with unrestricted 4 variable VAR. CPI, Ex. Rate M2 and Ex/Im (in logarithmic form) are taken as endogenous variables and centralized seasonal dummies and logarithm of oil prices as exogenous. Amount of lags is arbitrarily chosen to be 5 in the beginning and then lag length criteria test chooses how many lags should be included.

Eviews offers 5 criteria for choosing number of lags in VAR. They are presented in table 3 (Appendix 2). As we see Schwarz and Hannan-Quinn information criterions suggest including 1 lag for all countries, but by doing so VAR model (for all countries) becomes unstable. Alternatively sequential modified LR test statistic, final prediction error and Akaike information criterion suggest including 2, 3 and 5 lags for Armenia, Azerbaijan and Georgia respectively. Now VAR model for each country is stable and we may proceed further.

Model for Azerbaijan was unstable for full sample (Starting from January 1996) for any number of lag included. I reduced sample period for this country till Jan. 1998 to Dec. 2008 and model with 3 lags becomes stable as suggested lag length criteria.

6.1 Impulse Response Functions

Structural restrictions are imposed on unrestricted VAR by using Cholesky decomposition. Following ordering is assumed for variables: 1st is M2, 2nd Ex. Rate, 3rd trade balance and CPI last (As discussed in previous section). To check robustness, I will try different structural restrictions later and compare results.

Accumulated response of consumer prices (in %age points) to 1% exchange rate shock.							
Country	Country6 months12 months18 months24 months						
Armenia	0.062	0.151	0.203	0.228			
Azerbaijan	0.086	0.104	0.055	0.024			
Georgia	0.051	0.097	0.129	0.159			

Table 4

ERPT to consumer prices is presented on table 4 above. The highest ERPT appears for Armenia. Accumulated response of CPI to 1% shock in Exchange rate after 1 year in this country is almost 0.15% and almost 0.23% after 2 years. In Georgia pass-through coefficients are lower than in Armenia: 0.1 and 0.16 after 4 and 8 quarters respectively. And finally, in Azerbaijan ERPT is showing interesting pattern; it is maximum after 11 months (reaches 0.113) and starts declining afterwards. After 2 years ERPT is just 0.024. This means that in Azerbaijan consumer prices are overshooting to shock in exchange rate.

From chart 4a we see that CPI is not sensitive to trade balance shocks in Georgia (coefficient is between 0 and -0.03). Extents of response of M2 and exchange rate respond to foreign trade shock are almost same, but they have different signs: Coefficient is negative for M2 and positive for exchange rate.

Unlike Georgia trade balance shocks have significant impact on CPI in Armenia (pass-through is -0.09 and -0.07 after 1 and 2 year respectively). Prices seem to overreact to foreign trade shock. Chart 4b indicates high degree of responsiveness of M2 to trade balance shock: Coefficient is 0.22 after 12 months, 0.53 after 24 months and increases further. Therefore trade balance do matters for monetary policy of Armenia.

In Azerbaijan, response of CPI to trade balance shock is almost same after 2 years as in Armenia (see chart 4c), however prices don't tend to overreact in this country (rather increase gradually). Money aggregate responds negatively to positive shock in foreign trade like Georgia and unlike Armenia.

Response of consumer prices to monetary policy shocks is significant in all countries (low passthrough during 1st year: 0.06, but increases up to 0.14 in Georgia and Armenia and even more in Azerbaijan). Degree of monetary shock pass-through (to CPI) is same, lower and higher as ERPT in Georgia, Armenia and Azerbaijan correspondingly. Georgia is the only country where exchange rate is responsive (moderate extent) to monetary policy shock. The rest of impacts of impulse innovations are presented on charts 4a,b,c.

6.2 Variance Decomposition

Let's further examine relationship between endogenous variables by analyzing Variance Decomposition of each. This will allow us to see how important shocks in each variable are in explaining forecast error of CPI, Ex. Rate, M2 and Ex/Im. Ordering of variables is important as in IRFs and I maintain variables in same order as in previous section⁸. Variable's own shock always has significant (in most cases they explain most of variance in that variable) explanatory power, so I will pay attention to shocks of other variables.

Variance Decompositions are presented in charts 5a,b,c. Exchange rate shock is a very important determinant for variance of CPI in Georgia: it accounts for over 52% after 1 year and gradually declines afterwards (converging to 33%). After 2 years it accounts for 45.9% and after 3 years 40.4%. As for shock in M2, it doesn't explain much during first 1 year (6-9% during first 4 months and 3-5% until 12 months). Then its explanatory power increases: 21.4% after 24 months and 32.7% after 36 months. As we see shock in exchange rate and M2 matters for CPI in Georgia unlike trade balance, shocks of which never explain more than 1.25% of variance in CPI.

Results are somewhat different for Azerbaijan and Armenia. While pattern of exchange rate shock in these countries is similar to Georgian one (their explanatory power increases during fist year and then gradually decrease), they explain much less of variance of CPI compared to Georgia. Exchange rate shock in Armenia accounts for less than 1.7% of CPI variance for the aftershock period (it even exhibits declining trend in the end of 3rd year). Share of shock in M2 increases moderately during first two years reaching 22.4% (after 24 months) and after 3 years reaches convergence at 26%. Shock in trade balance explains little during first year (less than 1.6%), but it gets increasing trend afterwards: it explains 8.2% and 11.3% of CPI variance after 24 and 36 months correspondingly.

Shock in exchange rate seems to have nothing to do with variance of CPI in Azerbaijan. The highest share it gets after 6 months (2.43%) and converges to 0 afterwards. The most what matters for CPI variance are M2 shocks. Its share increases with a steep slope and after 1 year hits 52.2%, after 2 years _ 77.2% and reaches convergence after 3 years (82.4%). This indicates that consumer prices in Azerbaijan are very sensitive (more than in Georgia and Armenia) to monetary policy. Shock of trade has very small explanatory power. Its share is almost 0 in beginning and increases very slowly (reaches convergence at 5.6% after 3 years).

⁸ Actually changing order of variables does not cause significant changes.

M2 seems to be influenced by only its own shocks in Georgia and Azerbaijan (over 90% of variance). But In Armenia significant part of M2 variance is explained by trade balance shock (its share is equal to 24.9%, 30.3% and 30.4% after 1, 2 and 3 years respectively).

More than 87% of variance in trade balance is explained by its own shock in Azerbaijan. Monetary policy shock has small share (10%). Exchange rate and CPI shock seems to account for miserable share. In Georgia except its own shocks, significant share in variance of trade balance have M2 and exchange rate shocks (27.8% and 15.9% respectively after 2 years). And finally in Armenia exchange rate shock accounts for quarter of trade balance variance after 2 years. M2 shock have miserable share and CPI have significant share 2 and 3 years. As we know appreciation of national currency is good for importer and depreciation is good for exporters. Therefore it is not surprising why exchange rate shock have significant explanatory power in trade balance variance in Georgia and Armenia. As for Azerbaijan, such high explanatory power of its own shock (of trade balance) can be explained by the fact that Azerbaijan is oil producing country and oil has significant share in Azerbaijanian export. Most probably it is oil prices which cause variance in trade balance in this country.

6.3 Vector Error Correction

To construct VEC first we need to check whether cointegration exists between variables. As trade balance is stationary in Georgia and Azerbaijan, cointegration will be checked between CPI, exchange rate and M2. But as M2 is I(2) in Azerbaijan, for this country log difference of M2 will be included in test. As for Armenia, trade balance will be included as it is (1) in this country. Number of cointegrating relationships suggested by Johansen approach (trace statistic) for different number of lags is presented in table 5.

As we see test is sensitive to the number of lags chosen. Due to conflicting results I assume 1 cointegrating relationship: the least suggested among test results. I estimated VEC assuming Trend in CE. Coefficient of trend is significant only for Azerbaijan. Therefore for Georgia and Armenia I assume only constant in CE. Results of VECM are presented on tables 6a,b,c.

As we see, about 10% of deviation from equilibrium is corrected by changes in domestic prices each month in Georgia and 7% in Armenia. As for Azerbaijan price changes do not participate in adjusting toward equilibrium (coefficient is very small and statistically not different from zero).

Changes in exchange rate account more share in correcting disequilibrium than changes in prices. Coefficients are 19%, 13% and 3% for Georgia, Armenia and Azerbaijan respectively (and statistically significant). Changes in money aggregate accounts even more numerically (with exception of Armenia) than changes in exchange rate, but effect is significant only in Azerbaijan (25,5%).

Chart 7a,b,c illustrates cointegrating relationship between CPI, exchange rate and M2 (and trade balance for Armenia). Armenia had the largest deviation from equilibrium in 1997, in period when national currency depreciated sharply and inflation also increased significantly. In Azerbaijan the largest disequilibrium happened in the beginning of 1999, probably due to Russian financial crisis. But actually, high deviations from equilibrium are frequent event in this country. And finally Georgia experiences largest deviation from equilibrium these days, which is quite surprising, but I will try to explain why it is so.

7. Discussion and Robustness

7.1 Discussion

ERPT after 2 years is very low (close to 0) in Azerbaijan and moderate in Georgia and Armenia. Result is consistent with the previous literature in sense that countries which heavily depend on import have higher ERPT. However, prices are overshooting to exchange rate shock in Azerbaijan. ERPT after 1 year in this country is approximately the same (0.1) as in Georgia and less than in Armenia.

Caucasian countries do not support Taylor's Hypothesis of positive correlation between passthrough and inflation. Chart 7 (presented below) presents an opposite picture. On the other hand, we cannot exclude possibility that availability of additional data for more countries would give consistent evidence for Taylor's Hypothesis such as in Ca' Zorzi, Hahn and Sanchez (2007) who used data on 12 emerging countries.

Chart 7 (ERPT to CPI and Average Inflation in Caucasian Countries)

X-axis: Average inflation over estimation period.



Y-axis: Accumulated response of CPI to 1% exchange rate shock after 1 year)

Chart 7c shows that Azerbaijan deviation of cointegrating variables from equilibrium is most cases is rather high, amounting to around 20%. Taking into consideration that oil contributes

significant part of GDP of this country (see Chart 3), this may be consequence of oil prices fluctuations. High growth rate of GDP may be sign of economic success and progress, but such high deviations should be subject of concern for Azerbaijanian government.

The highest effect on CPI by trade balance shock is observed for Armenia. Most likely this is because of isolation of this country by Turkey and Azerbaijan. For Azerbaijan effect is significant, but less than in Armenia. Although Azerbaijan has positive trade balance, this country depends on import of agricultural products⁹. Therefore significant effect of foreign trade shock on CPI is no surprising. As for Georgia pass-through of trade balance to CPI is not significantly different from 0. In March-April of 2006, Russia put embargo on Georgian wine, mineral waters and agricultural products. Georgia managed to find alternative market quickly and reduced share of Russia in its export¹⁰ and this shock in foreign trade did not cause significant changes in macroeconomic indicators of Georgia.

From analysis of Variance Decomposition we can see that beside its own chock, changes in money aggregate explains significant part of CPI variance in Caucasian countries. In Georgia, exchange rate variation matters a lot too. This means, Georgian monetary authority should be very attentive to changes in exchange rate, besides changes in M2 too.

By looking at chart 7b, it is clear that in Armenia the biggest deviation from equilibrium took place in the beginning of 1997 during significant domestic currency depreciation. Since 2006 when CBA (Central Bank of Armenia) announced start of inflation targeting strategy, deviation from long-run equilibrium has been relatively low as compared to earlier periods.

In Georgia prior to 2008 the highest deviation from long-run equilibrium (more than 10%) occurred during Russian financial crisis. After the crisis exchange rate, CPI and M2 have been very close to cointegrating equilibrium; however at the end of 2008 deviation becomes almost 20%. Careful inspection of chart 7a reveals that cointegration vector has had a trend from beginning of 2004 and M2 starts to grow exponentially (see chart 8 below). Such a sudden jump of M2 is linked to social and military reforms of the new government and limiting the functions of NBG (The National Bank of Georgia). Comparison of Charts 7a and 8 shows that the higher is

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⁹ Actually there is let's say "hidden monopoly" on imported agricultural products

¹⁰ Russia uses trade dependence of former soviet countries as political instrument.

growth of M2 the higher gets deviation from equilibrium. Moreover, as table 7a indicates, changes in M2 do not help to adjust toward equilibrium. Therefore concentration should be on either inflation or exchange rate. Since tactic of targeting exchange rate, which is roughly same as fixing it, proved to be wrong for Caucasia countries, it might be a good idea for Georgian monetary authorities to consider implementing inflation targeting strategy similar to Armenia.



Chart 8 (Dynamics of M2 in Georgia)

7.2 Robustness

Since unrestricted VAR lacks some economic meaning, I specify model by imposing structural restrictions using Cholesky decomposition. However, since IRFs and variance decomposition are sensitive to the ordering of variables, to ensure robustness of results I check whether different structuring changes previous result significantly. I use several alternatives of structural VAR, described below.

1st alternative: In Cholesky ordering trade balance is placed first. This is based on the assumption that due to high dependence on foreign trade of Caucasian countries¹¹ there is no contemporaneous effect of monetary policy and exchange rate on trade balance. Like with benchmark ordering, this assumption may not sound realistic under quarterly data, but for

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¹¹ Georgia and Armenia on import, Azerbaijan on oil export

monthly series it is possible. For instance, it may need some time to switch to different suppliers. M2 is placed the second, exchange rate third and CPI last. Neither IRFs, nor variance decomposition changed significantly. Results are practically same as in benchmark framework.

2nd alternative: I change Cholesky decomposition slightly. As we know, Cholesky decomposition restricts A matrix to lower triangular matrix. I give non-zero value to necessary element of upper triangular part and give 0 value to corresponding element of lower triangular part. This way I allow contemporaneous effect of the variable that is next in ordering on the previous variable. Namely, relationship between the reduced-form VAR residuals and the structural innovations becomes:

$$\begin{pmatrix} e_t^M \\ e_t^E \\ e_t^T \\ e_t^P \\ e_t^P \end{pmatrix} = \begin{pmatrix} 1 & 0 & A_{13} & 0 \\ A_{21} & 1 & 0 & 0 \\ 0 & A_{32} & 1 & 0 \\ A_{41} & A_{42} & A_{43} & 1 \end{pmatrix} \begin{pmatrix} u_t^M \\ u_t^E \\ u_t^T \\ u_t^P \end{pmatrix} \approx \begin{pmatrix} e_t^M = b_{11}u_t^M + \alpha_{13}e_t^{TB} \\ e_t^E = \alpha_{21}e_t^M + b_{22}u_t^E \\ e_t^{TB} = \alpha_{32}e_t^E + b_{33}u_t^{TB} \\ e_t^P = \alpha_{41}e_t^M + \alpha_{42}e_t^E + \alpha_{43}e_t^{TB} + b_{44}u_t^P \end{pmatrix}$$

Here I assume contemporaneous effect of trade balance on M2 but not the other way round. This assumption is based on the idea that monetary authority should react immediately to trade balance shock to smooth fluctuation in prices. One month is not enough for changes in M2 to affect trade balance in same period. Several impulse responses changed slightly, but not significantly. In most cases change is less than 0.05 in absolute terms (after 2 years from shock and less in earlier time horizon). Exception is response of M2 to trade balance shock in Georgia which became significantly negative as compared to 0 in benchmark framework. ERPT to CPI changed by less than 0.02 percentage points in all countries, but pattern is exactly same¹². Minor changes happened in variance decomposition as well. For Armenia and Georgia results are almost same, for Azerbaijan variance of trade balance explains more of changes in CPI and M2, but general picture is similar.

¹² I don't plot graphically ERPT to CPI for alternative models, because it is almost exactly same as in benchmark model.

8. Conclusion

This research analyzes ERPT to CPI for Caucasian countries. By using VAR with IRFs I find that pass-through is incomplete in these countries. The lowest pass-through is observed in Azerbaijan: 0.1 after 1 year, 0.02 after 2 years; the highest in Armenia: 0.15 after 1 year, 0.23 after 2 years and Georgia is in middle: 0.1 after 1 year and 0.16 after 2 years. As expected, pass-through is higher than in developed countries, though Azerbaijan is exception, and more or less same as in emerging markets. Consistent with previous findings, ERPT is higher in countries which have higher import share in output and foreign trade (Georgia and Armenia). However, for Azerbaijan pass-through shows overshooting pattern, the reasons for which may be corruption and hidden monopoly on agricultural output in the country.

Shock in trade balance has significant effect on CPI in Armenia and Azerbaijan, but not in Georgia. I explain it by the influence of Russia which is the major trade partner of Caucasian countries except Georgia. Its dominant position is used for political pressure some times, which can help explain why trade balance shocks matters for Armenia and Azerbaijan. Effect is even greater in Armenia which is due to isolation of this country.

Deviation from long-term equilibrium in Armenia is very small after the country moved to inflation targeting strategy. Similar to Armenia changes in prices contribute in adjusting toward equilibrium in Georgia, but effect of M2 is insignificant. Therefore, implementing inflation instead of exchange rate targeting might serve well to this country to restore equilibrium relationship among macroeconomic variables. Azerbaijan frequently deviates from long-term equilibrium by more than 20% which could be explained by its high dependence on oil export. However, preciseness of results for Azerbaijan can be questioned.

In order to increase sample size I use monthly series instead of quarterly ones to have sufficient number of observations. Precision of the results may be deteriorating with inclusion of additional explanatory variables which are available for a shorter period of time. These limitations prevent from investigation of whether ERPT decreases along supply chain as in most of developed and emerging countries; analyzing ERPT of Euro; including quarterly data in VAR. These issues are left open for future research.

References:

An Lian: "Exchange Rate Pass-Through: Evidence Based on Vector Autoregression with Sign Restrictions"; Munich Personal RePEc Archive, Paper #527; (October 2006).

Banaian King, Kemme David M and Sargsyan Grygor: "Inflation Targeting in Armenia: Monetary Policy in Transition"; (August, 2006).

Barbakadze Ivane: "*Explaining Inflation in Georgia: Do Exchange Rate and Nominal Wage Matter*?" The National Bank of Georgia, Working Paper #04; (September, 2008).

Berument Hakan and Passaogullari Mehmet: "*Effect of the Real Exchange Rate, Output and Inflation: Evidence from Turkey*". The Developing Economies, XLI-4 (December 2003): 401–35.

Ca' Zorzi Michele, Hahn Elke and Sanchez Marcelo: "*Exchange Rate Pass-Through in Emerging Markets*"; European Central Bank, Working Paper Series No 739; (March 2007).

Campa Jose Manuel, Goldberd Linda S: "Pass-Through of Exchange Rates to Consumption Prices: What has Changed and Why?"; NBER working paper #12547; (September 2006).

Campa Jose Manuel, Goldberd Linda S. and Gonzalez-Minguez Jose M.: "*Exchange Rate Pass-Through to Import Prices in Euro Area*"; Federal Reserve Bank of New York, staff Report #219; (September 2005).

Darvas Zsolt:"*Exchange rate pass-through and real exchange rate in EU Candidate countries*"; Economic Research Center of the Deutsche Bundesbank, Discussion paper 10/01 (May 2001).

Faruqee Hamid: "Exchange Rate Pass-Through in the Euro Area: The Role of Asymmetric Prcing Behavior"; IMF working paper 04/14, (January 2004).

Help topics of econometric package Eviews 6.0.

Kiyotaka Sato and Takatoshi Ito: "Exchange Rate Changes and Inflation in Post-Crisis Asian Economies: VAR Analysis of the Exchange Rate Pass-Trough". NATIONAL BUREAU OF ECONOMIC RESEARCH, Working Paper 12395; (July, 2006).

Korhonen Likka and Wachtel Paul: "A note on exchange rate pass-through in CIS countries"; BOFIT Discussion Papers 2/2005; (10.6.2005).

Liu-gang Li and Tsang Andrew: "*Exchange Rate pass-Through to Domestic Inflation in Hong Kong*"; Hong Kong Monetary Authority, Working Paper 02/2008; (March 2008).

Maliszewski Wojciech: "*Modeling Inflation in Georgia*"; IMF Working Paper 03/212; (November 2003).

McCarthy Jonathan: "Pass-Through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialized Economies"; Federal Reserve Bank of New York, Staff report; (June 2006).

McCarthy Jonathan: "Pass-Through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialized Economies"; Federal Reserve Bank of New York; (September 2000).

Olidapo Olajide: "*Exchange Rate pass-Through: A Case Study of a Small Open Economy*"; Global Economy Journal, Volume 7, Issue 3, Article 4; (2007).

Sek, Siok Kun and Kapsalyamova Zhanna:"*Exchange Rate Pass-Through and volatility: Impacts on Domestic Prices in Four Asian Countries*"; Munich Personal RePEc Archive, Paper #11130; (August 2008).

http://www.imfstatistics.org _ International Financial Statistics.

www.cba.am _ Central Bank of Armenia.

www.nba.az _ National Bank of Azerbaijan.

www.nbg.gov.ge National Bank of Georgia.

Appendix

Definition of variables in charts:

CPI: Consumer price index; M2: Money aggregate M2; EREND or ER: bilateral exchange rate vis-à-vis US dollar, TB: trade balance, or expimp: export/import ratio; l denotes to natural logarithm, for example lerend is log(erernd).

Country	Variable	Mean	Median	Minimum	Maximum	Std. Dev.	Jarque-Bera
	CPI	108.42	105.885	78.26	140.85	14.866	1.489
enia	Ex. rate	479.59	502.85	300.97	589.52	86.78	16.555 ^{***13}
Arm	M2	157183.9	84047.5	27946.55	604329	158633.3	82.43***
7	Ex/Im	0.388	0.379	0.143	0.677	0.127	6.08**
u	CPI	119.83	106.27	88.93	203.74	29.585	72.28***
aija	Ex. rate	0.887	0.885	0.771	0.988	0.071	10.74***
zerb	M2	1128	448.7	211.4	6081	1477.5	115.04***
A	Ex/Im	1.61	0.93	0.19	21.04	2.69	8591***
	CPI	114.56	110.24	67.7	177.23	30.07	8.577**
rgia	Ex. rate	1.765	1.815	1.25	2.35	0.313	11.38***
Geo	M2	710058	414437	148213	2529779	623860.4	57.6***
-	Ex/Im	0.33	0.315	0.127	0.668	0.107	11.47***

Table 1

Sample period is: 1996M01-2008M12 for Armenia and Georgia; 1998M01-2008M12 for Azerbaijan;

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¹³ *** significant at 1%, ** significant at 5%

Country	From 1996	LCPI	LEREND	LM2	LEXIM
Armenia	Level	-0.778753	0.763349	0.645276	-2.341331
	First diff.	-3.912713***14	-9.822686***	-13.65803***	-12.29965***
Azerbaijan	Level	1.220013	-1.402833	0.204964	-3.461213**
	First diff.	-5.47905***	-3.788099***	-1.42037^{15}	
Georgia	Level	-0.803325	-2.098676	-0.083264	-3.485581***
	First diff.	-6.10583***	-8.681425***	-12.81494***	

Table 2 (Results of ADF unit root test)

Lag Order Selection Criteria

Table 3a: Georgia

VAR La	VAR Lag Order Selection Criteria (Georgia)						
Endogen	ous variables:	LEREND LO	CPI LM2 LEX	PIMP			
Exogeno	us variables: (C D1 D2 D3 I	D4 D5 D6 D7	D8 D9 D10 E	D11 LOILUSI)	
Sample:	1996M01 200	08M12					
Included	observations:	148					
Lag	LogL	LR	FPE	AIC	SC	HQ	
0	395.4973	NA	1.13e-07	-4.641856	-3.588781	-4.213994	
1	1095.651	1239.461	1.10e-11	-13.88718	-12.51008*	-13.32767*	
2	1120.647	42.89775	9.76e-12	-14.00874	-12.30762	-13.31758	
3	1139.262	30.94182	9.47e-12	-14.04408	-12.01894	-13.22127	
4	1163.181 38.46456 8.58e-12 -14.15110 -11.80193 -13.19664						
5	1184.347 32.89267* 8.08e-12* -14.22090* -11.54771 -13.13479						
6	1195.492	16.71834	8.74e-12	-14.15530	-11.15809	-12.93754	

* 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

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 ¹⁴ *** significant at 1%, **significant at 5%.
 ¹⁵ LM2 I(2). Test statistic for second differenced series is -8.736 (significant at 1%).

VAR La	VAR Lag Order Selection Criteria						
Endogen	ous variables:	LCPI LEREN	ND LM2 LEX	CPIMP			
Exogeno	us variables: (C D1 D2 D3 I	D4 D5 D6 D7	D8 D9 D10 D	D11 LOILUSI)	
Date: 06,	/02/09 Time:	: 11:22					
Sample:	1996M01 200	08M12					
Included	observations:	139					
Lag	LogL	LR	FPE	AIC	SC	HQ	
0	313.0146	NA	2.75e-07	-3.755606	-2.657817	-3.309493	
1	1119.256	1415.273	3.18e-12	-15.12599	-13.69042*	-14.54261	
2	1152.814	56.97523*	2.48e-12*	-15.37861*	-13.60526	-14.65797*	
3	1162.303	15.56607	2.75e-12	-15.28494	-13.17381	-14.42703	
4	1171.803	15.03482	3.04e-12	-15.19140	-12.74249	-14.19623	
5	1178.986 10.95659 3.50e-12 -15.06455 -12.27786 -13.93211						
6	1191.518	18.39107	3.73e-12	-15.01464	-11.89017	-13.74494	

Table 3b: Armenia

Table 3c: Azerbaijan

VAR La	VAR Lag Order Selection Criteria (Azerbaijan)						
Endogen	ous variables:	LCPI LEREN	D LEXPIMP I	LM2			
Exogeno	us variables:	C D1 D2 D3 D	4 D5 D6 D7 D	8 D9 D10 D11	LOILUSD		
Sample:	1998M01 200)8M12					
Included	observations	: 132					
Lag	LogL	LR	FPE	AIC	SC	HQ	
0	257.7928	NA	5.21e-07	-3.118073	-1.982423	-2.656597	
1	1075.978	1425.625	2.75e-12	-15.27239	-13.78731*	-14.66892*	
2	1096.738	34.91508	2.58e-12	-15.34452	-13.51001	-14.59906	
3	1116.840	32.58930*	2.44e-12*	-15.40667*	-13.22272	-14.51921	
4	1127.210	16.18356	2.68e-12	-15.32136	-12.78799	-14.29192	
5	1133.360 9.225691 3.16e-12 -15.17213 -12.28933 -14.00069						
6	1146.940	19.54697	3.34e-12	-15.13546	-11.90323	-13.82203	

				NT 1	6.1	• 1 1 1			
	Option		Number of lags included in test						
Country		4	4 (E) ¹⁶	8	8 (E)	12	12 (E)	16	16 (E)
Armenia	Option 3	2	2	2	2	2	2	4	4
7 milleniu	Option 4	2	2	2	1	2	2	2	3
Azerbaijan ¹⁷	Option 3	1	0	1	0	3	0	3	1
T izer o arjan	Option 4	1	0	1	0	0	0	0	1
Georgia	Option 3	0	1	0	0	1	2	1	2
0	Option 4	0	1	0	0	0	0	2	3

Table 5 (Johansen Cointegration Test Results)

Table 6a (VECM for Georgia)

Vector Error Correction Estimates					
Sample (adjusted): 1996M0	04 2008M12				
Included observations: 153	after adjustmen	ts			
Standard errors in () & t-st	atistics in []				
Cointegrating Eq:	CointEq1				
LCPI(-1)	1.000000				
	-0.388834				
LEREND(-1)	(0.03016)				
	[-12.8930]				
	-0.235368				
LM2(-1)	(0.02007)				
	[-11.7302]				
С	-1.396359				
Error Correction:	D(LCPI)	D(LEREND)	D(LM2)		
	-0.100985	0.193967	-0.273351		
CointEq1	(0.04355)	(0.07964)	(0.15945)		
	[-2.31897]	[2.43554]	[-1.71434]		

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 ¹⁶ (E): Exogenous variables included
 ¹⁷ Instead of log(m2) for Azerbaijan log difference of M2 is included, because log(M2) is I(2).

Table 6b (VECM for Armenia)

Vector Error Correction Estimates					
Sample (adjusted): 1996M	04 2008M12				
Included observations: 149	after adjustment	ts			
Standard errors in () & t-st	atistics in []				
Cointegrating Eq:	CointEq1				
LCPI(-1)	1.000000				
	-0.267090				
LEREND(-1)	(0.07102)				
	[-3.76058]				
	-0.154117				
LM2(-1)	(0.01898)				
	[-8.11996]				
	0.123920				
LEXPIMP(-1)	(0.03706)				
	[3.34372]				
С	-1.127588				
Error Correction:	D(LCPI)	D(LEREND)	D(LM2)	D(LEXPIMP)	
	-0.068038	-0.138088	-0.133449	-0.547850	
CointEq1	(0.02344)	(0.03331)	(0.09784)	(0.40140)	
	[-2.90324]	[-4.14609]	[-1.36401]	[-1.36486]	

Table 6c (VECM for Azerbaijan)

Vector Error Correction Estimates							
Sample: 1998M01 2008M1	Sample: 1998M01 2008M12						
Included observations: 132							
Standard errors in () & t-st	atistics in []						
Cointegrating Eq:	CointEq1						
LCPI(-1)	1.000000						
	1.040995						
LEREND(-1)	(0.13398)						
	[7.77001]						
	2.230162						
DLM2(-1)	(0.47465)						
	[4.69852]						
	-0.005872						
@TREND(93M01)	(0.00083)						
	[-7.10006]						
С	-3.984328						
Error Correction:	D(LCPI)	D(LEREND)	D(DLM2)				
	0.003265	-0.026153	-0.255503				
CointEq1	(0.01410)	(0.01179)	(0.05507)				
	[0.23148]	[-2.21887]	[-4.63982]				



Chart #1 (Annual inflation in Caucasian countries)

Chart #2a (Exchange rate and CPI in Georgia)





Chart #2b (Exchange rate and CPI in Armenia)

Chart #2c (Exchange rate and CPI in Azerbaijan)



Chart 4a (IRF – Georgia)

Accumulated response to 1% shock. Response variable first, impulse variable second.



Chart 4a (continued)





Accumulated response to 1% shock. Response variable first, impulse variable second.



Chart 4b (continued)





Chart 4c (IRF – Azerbaijan)

Accumulated response to 1% shock. Response variable first, impulse variable second.

Chart 4c (continued)



















Variance decomposition of endogenous variables for Azerbaijan



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Chart 6a





Chart 6b





Discontinuity on graph is because of missing observation.

Chart 6c



