Modelling Inflation Dynamics in Transition Economies: The Case of Ukraine

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Abstract

The paper explores dynamics of inflation in Ukraine in the period of relative macroeconomic stabilization. The analysis of interrelationship between inflation, money growth, wage growth, and a proxy for depreciation expectations is based on impulse responses and variance decomposition of a vector autoregression model. We find that changes in depreciation expectations appear to be the most important factor driving price development, while money supply growth has negligible impact on inflation. In addition, our results evidence of high degree of inflation inertia in the economy, which may reflect the specific institutional settings of Ukrainian economy.

Keywords: Transition economy, Inflation

JEL code: E31, C32, P24.

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1 Introduction

Since the breakdown of the Soviet Union in 1991, Ukraine became an independent state. On the way of restructuring its economy from the planned to the market oriented, Ukraine had to overcome a number of common to other transition economies of the Central and Eastern Europe (CEE) problems: falling output, rising unemployment, rampant inflation.

In this paper we address the inflation determinants in Ukraine in the period when a relative stabilization of its economy has taken place. There exist a number of studies that look at the inflation dynamics in the CEE countries such as Albania (Haderi et al., 1999), the Czech Republic, Hungary, and Poland (Kutan and Brada, 1999), Slovenia (Ross, 2000), Croatia (Payne, 2002), *inter alia*. The common among these studies is that they try to determine which factors have been contributing to the inflation dynamics in the respective countries by means of the impulse response functions and the variance decompositions.

Among very scarce literature that examines inflation in Ukraine the impulse response and variance decomposition analysis is used by Piontkivsky et al. (2001), who apply vector autoregression analysis to investigate effect of budget deficit on inflation in 1995 - 2000. They find that budget deficit (even not monetized) has significant albeit small effect on price development, whereas inflation response to shock in monetary base is the weakest. The other study by Lissovolik (2003) tests two theoretical models of inflation on Ukrainian data - a mark-up model and a money market model. The results evidence that the mark-up model, in which inflation is determined by fluctuations in costs of production(labour and raw materials costs) and changes in a mark-up is more applicable in Ukrainian context than the money market model which envisages close relationship between money and inflation. In this paper we will undertake more general approach than in the previous works and examine influence of various factors on inflation development in Ukraine.

The paper proceeds as follows. We examine the economic background in Ukraine in Section 2. The data are described in Section 3. In Section 4 we explain the methodology used and report the obtained results. The final section concludes.

2 Stylized facts about inflation and other macroeconomic indicators in Ukraine

Similar to other post-Soviet economies, the first years of Ukraine's independence were marked by a sharp decline in real output, accompanied by severe impoverishment of population and hyperinflation. In 1991 - 1995 prices were growing at an average monthly rate of 28% sometimes increasing more than thrice during a month.

The relative macroeconomic stability was achieved only in 1996, in a year when new currency, the hryvnia, was introduced. Binding hryvnia to the US dollar by the exchange rate corridor helped Ukrainian government to

abate turbulent inflation. As a result, the 12-month inflation rate reduced to a modest two-digit level in 1996 and continued to fall later on. The decline in output also became less severe due to gradual implementation of structural reforms initiated several years before.

Notwithstanding these achievements, in 1996 - 1997 fiscal balance remained negative at the level of 5% of GDP. To cover the persistent budget deficit government started to borrow heavily from domestic and foreign investors. Monetization of the budget deficit was often in practice as well, fuelling inflation against a background of stable exchange rate (see Figure 1).

The situation became dangerous after 1997 Asian crisis, which negatively affected foreign investors' perception of emerging market economies and provoked a rapid outflow of foreign capital from many of them, including Ukraine. Despite the efforts of Ukrainian monetary and fiscal authorities to stabilize the situation, the confidence in domestic economic policy has not been restored. The continuous capital outflow, difficulties in servicing state debt, and the spill-over effect of 1998 Russian crisis resulted in a financial crisis in Ukraine. Hryvnia was devalued sharply causing considerable loss of people's confidence in national currency and further progress of dollarization process. Growth of prices accelerated substantially as well.

Only in the second half of 2000, foreign exchange market was eventually stabilized. At that time Ukraine officially proclaimed a switch from managed peg to free floating exchange rate regime. However, de-facto the National Bank of Ukraine (NBU) has been keeping the exchange rate at almost constant level with respect to the US dollar. Thus, even after the official regime change the monetary policy remained almost fully subordinated to the exchange rate policy and growth rate of money supply was determined by current account and capital account balances. Accordingly, large current account surplus in the year 2000 and later on promoted considerable monetary expansion . Notwithstanding sizeable growth rates of money supply of 40-45% per year, inflation has remained at a quite low one-digit rate.

Besides describing basic economic trends, it worths paying attention to administrative regulation of commodity prices and wages. Ukrainian economy is characterized by quite high degree of state intervention in the price formation mechanism, which concerns first of all commodity prices and to lesser degree wages. Control over commodity prices takes different forms from explicit fixing of prices and tariffs for some goods and services to indirect administrative regulation through bans on exports, firms mark-up constraints, etc. As to the wage setting mechanism, wages are not linked to inflation development through official backward indexation. State interventions in private sector takes a form of administrative increases in minimum wage, which is rather binding, while wages in budget sector are regulated more heavily by direct setting of salaries for employees of all ranks.

In light of the described facts several inferences important for modelling should be emphasized here. First, as evident from Figure 1, there is a close link between exchange rate development and inflation. Since prices on majority of imported goods were fixed by special arrangement with the supplying countries (mainly with Russia), most likely this link works through peoples expectations. Second, the relationship between money supply and inflation was subject to changes. While the developments of monetary aggregates and prices were

not characterized by large discrepancies before 2000, the fact that rapid monetary expansion did not evoke acceleration of price growth after 2000 undermines the traditional money-inflation link. Third, since commodity prices and wages are regulated differently, the development of wages is likely to have an autonomous influence on prices in the short-run. We will make use of these inferences when building a model.

3 Data and variables

Data used in this study are monthly spanning January 1996 – November 2003 (92 data points). We start with the year 1996 as it was marked by relative stabilization of macroeconomic indicators compared to severe economic decline and hyperinflation observed in earlier periods. Basing on our conclusions from the previous section and following the empirical studies for transition economies (Haderi et al., 1999; Kutan and Brada, 1999; Payne, 2002; Ross, 2000) we estimate interrelationship between the following variables:

Consumer price index:	CPI_t
Average wage per capita:	AW_t
Money supply	
broad monetary aggregate M2:	$M2_t$
Proxy for expected devaluation	
cash market spread:	$Spread_t$

All variables, except *Spread*, are in logs. The data[1] are displayed in Figure 2.

We do not include budget deficit as done by Piontkivsky et al. (2001) since it affects inflation either through money supply or through expectations both used in our model. One more important determinant of inflation could be exchange rate. However, there are two reasons not to include official exchange rate as an endogenous variable in the model. First, over the period of investigation official exchange rate of Ukrainian hryvnia to US dollar was under NBU control and, thus, development of exchange rate variable is more comparable to deterministic process rather than to the stochastic one. Second, as explained above, changes in the exchange rate are likely to propagate into prices through stirring up expectations; hence, some expectation proxy would be more relevant here. To approximate people's expectations towards future devaluation of hryvnia we use the cash market spread variable, calculated as a difference between average ask exchange rate on the cash market for foreign currency and official exchange rate. Intuitively, the higher the spread the stronger people's believe that hryvnia will devalue soon[2].

[1] Data on consumer prices and average wages are from the monthly reports of the State Statistics Committee of Ukraine. Monetary aggregate as well as official exchange rate and ask rate on a cash market used for calculation of cash market spread variable are from the National Bank of Ukraine. Seasonal dummies and an impulse dummy for September 1998 crisis enter the model as well

[2] Although the cash market spread variable has some shortcomings because of restrictions sporadically imposed and abolished by the NBU on cash foreign exchange operations, it is quite helpful to track development of people's expectations.

The relationship between wages, commodity prices and money supply require additional attention. Since wage is basically a price for labor, wages along with commodities prices should be affected by the same long-term factors like money supply growth. However, as explained before due to administrative regulation the wage setting mechanism in Ukraine differs from the commodity price formation. Thus, the development of wages is likely to have an autonomous influence on prices over the short time period as ours. This indicates that wage growth affects inflation independently from money supply growth and may enter the model as a separate variable. It also worths noting that we do not tend to interpret average wage as a pure cost-push factor of inflation. The reason for this is a relatively low share of wages in the production costs (about 18%) on the one hand, and its high share in households income (about 50%) on the other. Thus, in interpreting effect of wages on inflation it is rather difficult to separate its demand-pull and cost-push components[3].

The question of state intervention in the process of commodity prices formation also should be addressed here. High degree of price regulation may pose problems for econometric modelling of inflation, since it undermines the relationship between price growth and development of other macroeconomic variables and introduces distortions not easily caught by econometric model. However, one justification would be that administratively regulated prices react to shocks as well, albeit with lag and by smaller amount than market prices. This is clearly demonstrated by close relationship between consumer prices and exchange rate developments in Ukraine over 1998 - 1999. Bearing this justification in mind, we will embark on estimation.

4 Methodology and empirical results

Our estimation procedure comprises several steps. First, we test for the order of integration of time series at hand and address the cointegration properties of the data. Then we explore the pairwise causality between the employed variables by means of the Granger causality test. Grounding on the findings of these preliminary tests, we formulate a vector autoregressive (VAR) model, which we further use to evaluate direction and strength of relationship between economic variables based on the orthogonalized impulse response functions (IRF) and on the orthogonalized forecast error variance decompositions (FEVD).

The results of the ADF test suggest that all the variables are I(1), see Table 1. Hence, the next step is to determine whether there are any cointegration relations exist between these variables. For this purpose we apply the Full Information Maximum Likelihood (FIML) method of Johansen (1995). We find that there is no firm evidence for the existence of the long-run equilibrium relations in the data of interest.[4] Therefore, for the further analysis and final conclusions we consider only the first difference transformation of the variables.

The next exploratory step for determination of the strength and direction of causality between the economic

[3]The way out would be to use households' income, which more certainly affects inflation from the demand side; however, the due to drastic changes in the methodology of calculating income, the income variable does not fit for econometric study.

[4]Not reported for the sake of exposition conciseness.

variables is provided by the Granger causality test. We report the results for lag length from one to twelve in Table 2. As evident from first row of each panel, growth of monetary aggregates, change in average wage and change in people expectations all Granger cause growth of prices, indicating that all three variable are potentially good determinants of inflation. At the same time, the reverse causality is not revealed, since inflation does not help to predict movement of neither money nor wages as shown in panel three of the table.

Below we specify the VAR model and use it to identify the IRF and FEVD. In this approach we follow Ross (2000), who also considered orhtogonalized IRF and FEVD. In particular, we used the following ordering of the variables: DLM2-DLCPI-DLAW-DSpread. It is, however, well known that the estimated IRF and FEVD depend on the ordering of the variables in the VAR model unless the estimated residual covariance matrix is diagonal. As shown below, the estimated residual covariance matrix has no large off-diagonal elements. Therefore our results reported for this particular ordering are rather robust to the alternative orderings of the variables.

Estimation of the VAR model starts by determining its lag order. It is interesting to observe that the various information criteria have selected the optimal lag length rather differently, i.e. the Akaike Information Criterion (AIC) 12 lags, the Final Prediction Error (FPE) and the Hannan-Quinn (HQ) - 1 lag, and the Bayesian (BIC) - 0 lags. The outcome of the order selection procedure is consistent with the strength of the penalty a particular information criterion imposes on the extra parameters. Thus, the AIC, which imposes the least penalty, selects the largest order, whereas the BIC, which imposes the strongest penalty - the smallest.

This poses us with a dilemma. On the one hand, imposing the zero lag order on the VAR suggests that all the variables are random walks (with drift) and there are no interrelations among these economic variables themselves as well as their past, which contradicts the results of the unit root and of the Granger causality tests. In addition, by selecting the VAR(1) model we risk to omit the higher-order dynamics, whose presence is also indicated by the results of the ADF and of the Granger causality tests. On the other hand, by selecting VAR(12) model, as the AIC criterion suggests, we run into the 'curse of dimensionality' problem. This means that for the given sample size the number of estimated parameters is too large, which results in overfitting of the model. Hence, as the compromise between these two extremes we specify a subset VAR using the VAR reduction technique (e.g. see Brüggermann and Lütkepohl, 2001).

In particular, we sequentially eliminate the regressors with the smallest absolute values of the $t-$ratios until the remaining regressors are significant at the 1% level.[5] In this way, we do not restrict the dynamic interaction between the variables by considering f.e. only one lag of the dependent variables, and at the same time, we solve the 'curse of dimensionality' problem by deleting the insignificant variables. We check the statistical adequacy of the estimated subset VAR model using the standard battery of the diagnostic tests reported in Table 3. As seen, there is no evidence of model misspecification. In addition, the correlation of the residuals is reported in Table 4. As seen, none of the estimated correlation exceeds 0.30 in the absolute value. This fact ensures that the orthogonalized IRFs and FEVDs (reported below) are rather robust to the alternative ordering of the

[5] We used the JMulti program, free available at www.jmulti.de.

variables in VAR. Hence we can base our subsequent analysis on this model.

The estimated IRFs along with the bootstrapped 95% confidence intervals are reported in Figure 3. Each row of the Figure demonstrates response of a particular variable to one standard deviation shocks in all the other variables of the model. The dying out IRFs reported in panel (a) indicate stability of the model. As becomes evident from the second row of each panel, the response of inflation to shocks in other variables is positive, as expected. While innovation in money variable produces very small, quickly subsiding and insignificant effect on price growth, shock in growth rate of wages as well as in depreciation proxy has more prolonged significant impact on inflation dynamics. At the same time, the FEVDs reported in Table 5 demonstrate that major part of the forecast error variance in inflation can be attributed to its own innovation. Nevertheless, it is interesting to note that among the explored variables innovation in the depreciation proxy has the largest proportion in inflation FEVD, while proportion of money supply growth innovation is close to zero.

Absence of close relationship between the variables may point to high degree of inflation inertia in the economy, partially caused by active state intervention in the price formation mechanism. The unimportance of money supply growth for inflation dynamics as indicated by insignificant IRFs and tiny proportion in variance decomposition is rather consistent with our inferences from Section 2 as well as with previous empirical findings for Ukraine (Piontkivsky et al., 2001; Lissovolik, 2003) and demonstrates very low sensitivity of price dynamics to monetary policy actions. In contrast, the fact that expectations play important role in determining development of inflation is quite interesting and indicates that inflationary process may be sensitive to changes in peoples' projection as to future depreciation of national currency. This result may serve as indirect evidence that exchange rate fluctuations spill over to domestic prices through expectations formation mechanism.

5 Concluding remarks

This paper was aimed at exploring dynamic interrelationship between inflation and three other macroeconomic variables: money growth rate, wages growth rate and changes in depreciation expectations in the transition economy of Ukraine. The analysis based on impulse response functions and forecast error variance decompositions of the VAR model gives grounds for several conclusions. First, there is evidence of substantial inflation inertia, which can be partially attributed to high degree of price control in the country. Second, among the explored variables the effect of money supply growth on price dynamics is the weakest. This finding is consistent with the results of previous research and indicates low power of monetary policy in controlling inflation. Finally, changes in the depreciation expectations have the largest impact on price growth. The last conclusion emphasizes importance of expectations as a factor fuelling inflationary process in transition economies.

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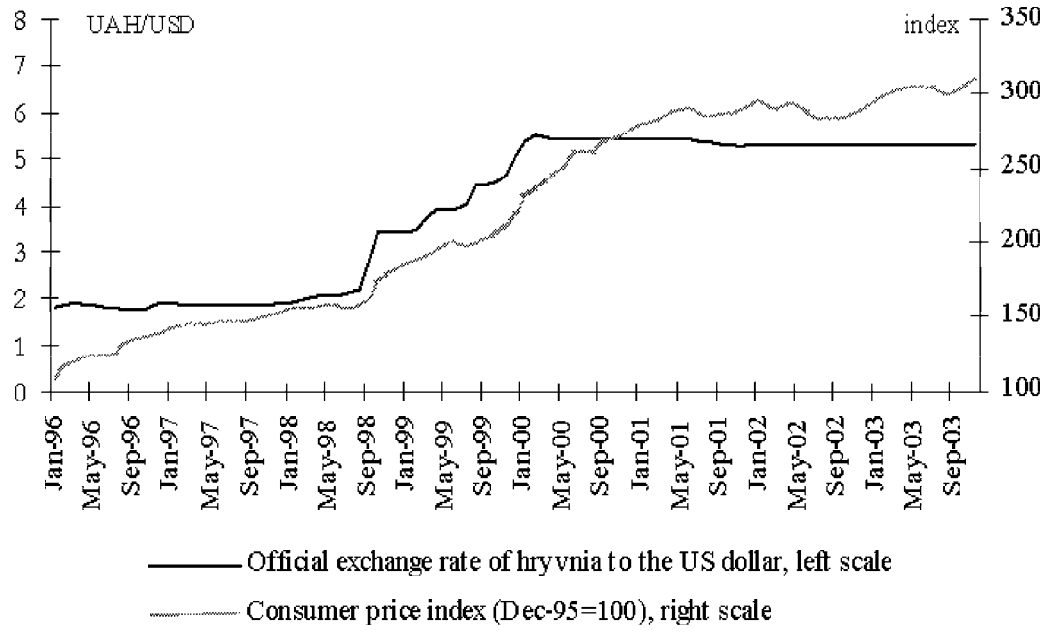


Figure 1: Development of official exchange rate and consumer prices in Ukraine in 1996-2003

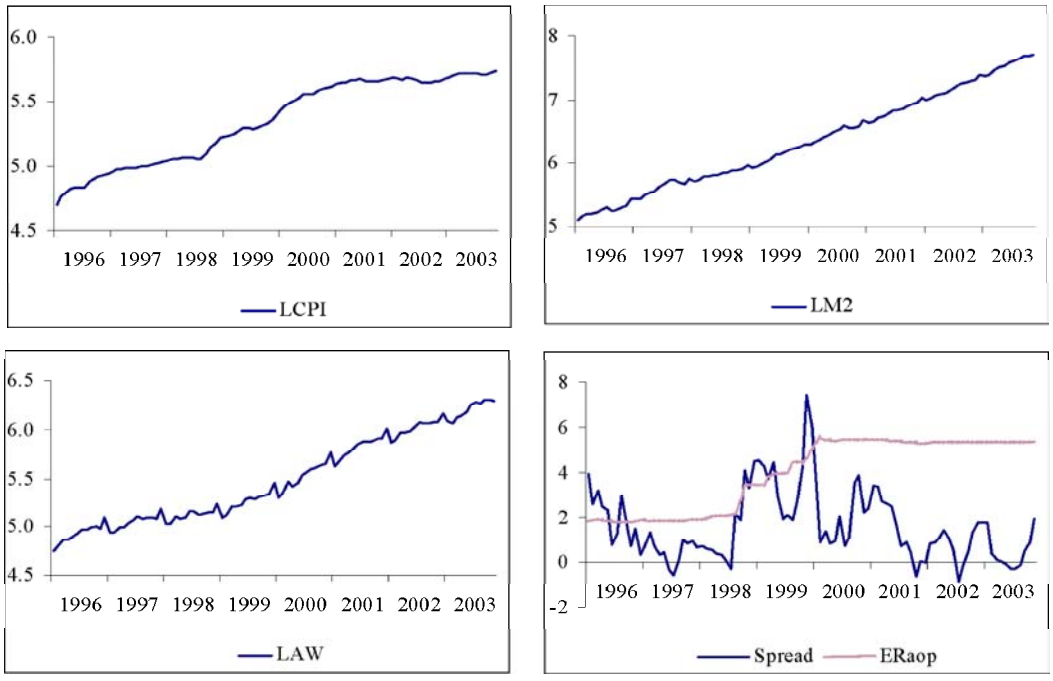


Figure 2: The variables.

Table 1: ADF test results.

	ADF-test statistic	Lags	Deterministic	LM(1-12)
LCPI	-0.497	1	intercept, trend, seasonal dummies	[0.665]
LM2	-0.631	12	intercept, trend, seasonal dummies	[0.601]
LAW	-2.97	1,6,9	intercept, trend, seasonal dummies	[0.096]
Spread	-2.14	5,11,12	intercept, seasonal dummies	[0.342]

Note: Bold font denotes significance of the estimate at the 5% level.

Table 2: F-statistics of Granger causality test, 1996:01 - 2003:11

	Lag length											
	1	2	3	4	5	6	7	8	9	10	11	12
Money growth												
dlM2 $\nRightarrow$ *dlCPI*	3.36**	6.08***	4.62***	4.28***	3.65***	3.13***	2.69**	2.04**	1.66	1.41	1.89*	1.79*
dlM2 $\nRightarrow$ *dlAW*	0.91	0.78	0.40	0.31	0.50	0.88	0.83	1.05	1.18	1.38	1.38	1.36
dlM2 $\nRightarrow$ *dSpread*	18.20***	11.42***	8.62***	6.46***	6.60***	5.75***	4.42***	3.51***	3.29***	3.16***	2.90***	3.01***
Wage growth												
dlAW $\nRightarrow$ *dlCPI*	3.65**	3.49**	1.04	0.45	0.93	4.64***	3.84***	3.87***	4.05***	3.62***	2.77***	2.56***
dlAW $\nRightarrow$ *dlM2*	0.89	2.81**	18.39***	17.02***	3.41***	2.89**	13.03***	3.80***	3.75***	10.94***	3.53***	5.69***
dlAW $\nRightarrow$ *dSpread*	0.91	0.86	0.70	0.55	1.05	1.74	1.47	1.88*	1.42	1.43	1.67*	1.88*
Inflation												
dlCPI $\nRightarrow$ *dlM2*	2.47*	1.65	1.67	1.31	1.34	1.43	1.43	1.57	0.83	1.61	0.57	1.00
dlCPI $\nRightarrow$ *dlAW*	0.42	1.08	0.65	0.54	1.05	1.17	1.06	0.99	1.52	1.20	0.91	1.02
dlCPI $\nRightarrow$ *dSpread*	9.69***	9.14***	6.65***	5.48***	4.03***	3.28***	2.49**	1.94*	1.49	1.48	1.52	1.73*
Expected depreciation												
dSpread $\nRightarrow$ *dlCPI*	2.79*	4.06***	3.66***	3.07***	2.47**	2.07*	1.89*	1.55	1.36	1.36	1.16	0.97
dSpread $\nRightarrow$ *dlM2*	8.18***	6.21***	6.11***	4.74***	3.98***	3.43***	2.63**	2.57**	2.04**	2.26**	2.87***	1.38
dSpread $\nRightarrow$ *dlAW*	0.36	0.25	0.17	0.40	0.95	1.74	1.89	2.12*	1.66	2.17**	1.41	1.26

Note: Superscripts *, **, and *** denote rejection of the null hypothesis of no Granger causality at 10%, 5%, and 1% significance levels respectively. All regressions are reduced to contain only significant seasonal dummies.

Table 3: Subset VAR(12) model: residual diagnostic test results.

	LM(1)	LM(1-4)	LM(1-12)	ARCH(1-4)	Doormik-Hansen
DLM2	[0.772]	[0.878]	[0.904]	[0.701]	[0.701]
DLCPI	[0.967]	[0.988]	[0.903]	[0.127]	[0.116]
DLAW	[0.562]	[0.426]	[0.680]	[0.831]	[0.674]
DSpread	[0.225]	[0.684]	[0.524]	[0.121]	[0.174]
System	[0.696]	[0.649]	[0.427]	–	[0.371]

Note: Table reports the $p-$values of the following residual diagnostic tests: LM - $F-$test for residual autocorrelation, ARCH - $F-$test for residual autoregressive conditional heteroscedasticity, Doornik-Hansen - χ^2-test for normality of the residuals.

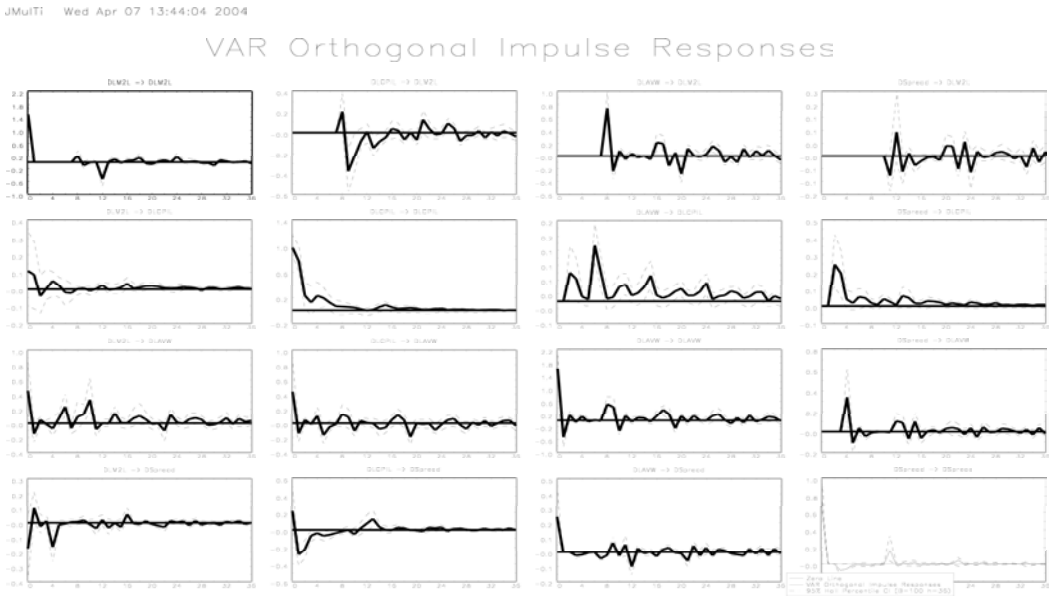
Table 4: Subset VAR(12) model: residual correlation matrix.

	DLM2	DLCPI	DLAW	DSpread
DLM2	1.392	0.108	0.256	-0.212
DLCPI	0.108	0.919	0.277	0.242
DLAW	0.256	0.277	1.639	0.284
DSpread	-0.212	0.242	0.284	0.776

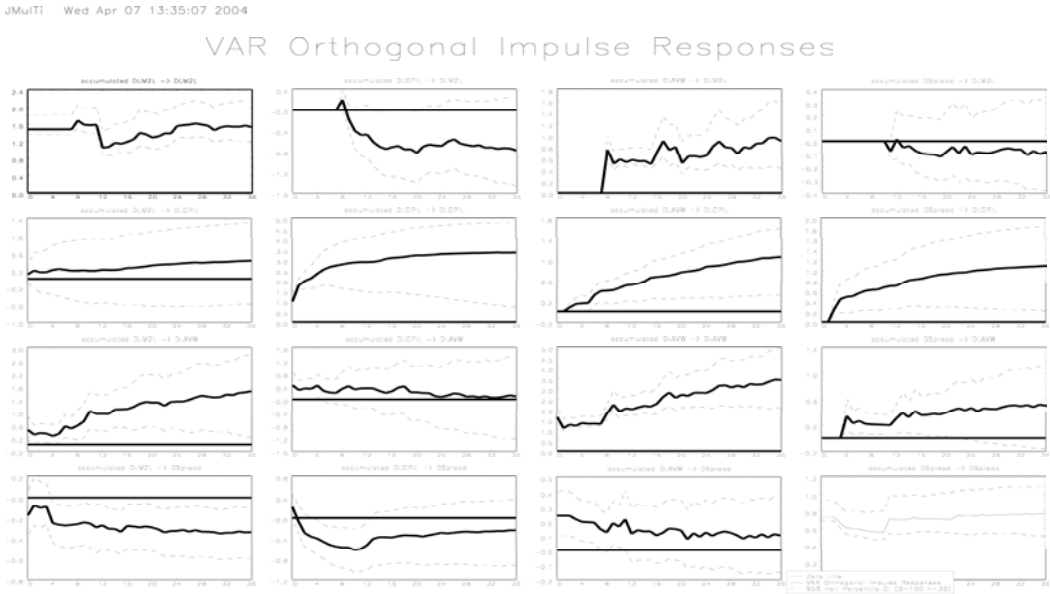
Note: Observe that the standard deviations of the appropriate equation residuals are reported on the diagonal.

Table 5: Subset VAR(12) model: Orthogonalized Forecast Error Variance Decomposition.

Proportions of forecast error in "DLM2" accounted for by:				
forecast horizon	DLM2	DLCPI	DLAVW	DSpread
1	1.00	0.00	0.00	0.00
12	0.72	0.08	0.20	0.00
24	0.69	0.08	0.22	0.01
Proportions of forecast error in "DLCPI" accounted for by:				
forecast horizon	DLM2	DLCPI	DLAVW	DSpread
1	0.01	0.99	0.00	0.00
12	0.01	0.91	0.02	0.06
24	0.01	0.90	0.03	0.06
Proportions of forecast error in "DLAVW" accounted for by:				
forecast horizon	DLM2	DLCPI	DLAVW	DSpread
1	0.07	0.06	0.87	0.00
12	0.10	0.07	0.81	0.03
24	0.10	0.07	0.79	0.04
Proportions of forecast error in "DSpread" accounted for by:				
forecast horizon	DLM2	DLCPI	DLAVW	DSpread
1	0.04	0.07	0.09	0.80
12	0.08	0.22	0.07	0.63
24	0.08	0.23	0.09	0.60



(a) Usual



(b) Cumulated

Figure 3: Subset VAR(12) model: Orthogonalized Impulse Response Functions