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European Department

Inflation Dynamics in FYR Macedonia[1]

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Abstract

In this paper we study the dynamics of inflation in Macedonia, provide three forecasting tools and draw some policy conclusions from the quantitative results. We explore three forecasting methods for inflation. We use a Dynamic Factor Model (DFM) for short-term, monthly forecasting. We also develop two quarterly models: A Vector Error Correction Model (VECM), and a New Keynesian Phillips Curve (NKPC) for a more structural model of inflation. The NKPC shows a significant effect of output gap and inflation expectations on current inflation, confirming that the expectations channel of monetary transmission mechanism is strong. In terms of forecast-error variance, we show that all three models do very well in one-period ahead forecasting.

JEL Classification Numbers: E30, E31, E37

Keywords: Inflation forecasting, VECM, DFM, Phillips Curve

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[1] I am grateful to Wes McGrew and Alexander Tieman for their comments and helpful suggestions. I also thank the National Bank of Republic of Macedonia (NBRM) for sharing their data.

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I. Introduction

Understanding inflation dynamics is not only important for forecasting, but is also essential in order to manage inflation expectations and thus to achieve (implicit) inflation targets. This paper aims to quantify the dynamics of inflation in FYR Macedonia between 2005 and 2011, provide forecasting tools and draw some policy conclusions.

To this end, we use three quantitative methods for studying inflation dynamics—a Dynamic Factor Model, a Vector Error Correction Model (VECM), and an estimated New-Keynesian Phillips curve—and evaluate their respective forecasting performance.

The first forecasting method, a Dynamic Factor Model (DFM), allows us to summarize the information in various high frequency (monthly) economic indicators with potentially important impact on inflation in just 4 principal components or factors. This method is increasingly used for inflation forecasting, where potentially important data are available but do not fit into a model in obvious ways. The data are different indicators of consumption and investment, such as consumer confidence, car loans, housing permits, and the like. These indicators often contain leading and lagging information about economic activity and inflation and as such, they are very informative for forecasting.

Second, we examine the effect of the policy instrument, namely the policy rate, as well as external factors on domestic inflation using a VECM analysis. We find a strong cointegration between domestic inflation, output, policy rate, and inflation in Euro area and argue that this suggests the existence of at least some monetary autonomy, despite the pegged exchange rate in Macedonia.

Furthermore, the VAR form of the error correction model allows us to identify monetary policy shocks. In other words, we can evaluate the periods where monetary policy has been “too tight” or “too loose” relative to the average. Overall, the analysis shows that monetary policy shocks are small, indicating no major regime changes in the conduct of monetary policy over the period of analysis. Given the stable monetary policy regime, an obvious question is whether we observe evidence for central bank credibility. This leads us to the third exercise in this paper.

We estimate a hybrid New-Keynesian Phillips Curve (NKPC) based on a structural model that explicitly links policy outcomes with expectations and allows for a more direct interpretation of the results and policy conclusions. The estimated NKPC for Macedonia shows a large and significant forward looking component of the Phillips curve, indicating an important result. The expectations channel of monetary policy is strong and effective. This is linked to the question we raised earlier; in the absence of major policy regime changes it is not surprising that the central bank builds up credibility which can be effective in the conduct of monetary policy. A credible monetary authority can influence inflation expectations (and thus current inflation) through announcements of its policy intentions.

Finally, we evaluate the forecasting performance of each of these models. We show that the two quarterly models (VECM and NKPC) do very similarly in terms of the forecast error variance. Furthermore, we find that the combined forecast of the three models is significantly

more efficient than each of the underlying forecasts, indicating that each forecasting method is capturing information orthogonal to the others and sheds light on a different set of policymaking issues.

The paper is organized as follows. Section II discusses the three methodologies, presents the empirical analysis and compares the forecasting results. Section III summarizes the main findings and offers some broad policy considerations.

II. Methodologies

A. Dynamic Factor Model

The first model we consider is the dynamic factor model (DFM). The DFM assumes that a panel of macroeconomic data can be decomposed into two orthogonal unobserved components: common components and idiosyncratic components. The common components capture the covariance between the series in the panel and are driven by a small number of shocks, while the idiosyncratic components account for the rest of the variance.

The common dynamics are captured by a $K \times 1$ vector of unobserved factors, F_t, where K is relatively small. These unobserved factors may reflect general economic conditions such as "economic activity," the "general level of prices," or the level of "productivity," which are not easily captured by a few time series, but rather are reflected in a wide range of economic variables. We assume that the joint dynamics of F_t are given by

$$F_t = \Phi(L)F_{t-1} + v_t \qquad (1)$$

where $\Phi(L)$ is a conformable lag polynomial of finite order d. The error term v_t is i.i.d. with mean zero and covariance matrix Q. We assume that the factors summarize the information contained in a large number of economic variables. We denote by X_t this $N \times 1$ vector of "informational" variables, where N is assumed to be "large," $N > K + 1$. We assume furthermore that the large set of observable "informational" series X_t is related to the common factors according to

$$X_t = \Lambda F_t + e_t \qquad (2)$$

where Λ is an $N \times (K + 1)$ matrix of factor loadings, and the $N \times 1$ vector e_t contains (mean-zero) sector-specific components that are uncorrelated with the common components F_t. These sector-specific components are allowed to be serially correlated and weakly correlated across indicators. Equation (2) reflects the fact that the elements of F_t, which in general are correlated, represent pervasive forces that drive the common dynamics of X_t.

To estimate the system (1) — (2), we follow the two-step principal component approach described in (Bernanke, Boivin and Eliasz 2005) as well as (Boivin, Giannoni and Mihov 2009). In the first step, the space spanned by the common components, F_t, is estimated using the first K principal components of X_t. (Stock and Watson 2002) show that the principal components consistently recover the space spanned by F_t, when N is large and the number of

principal components used is at least as large as the true number of factors. In the second step, a structural VAR is estimated on these common components.

This procedure has the advantages of being computationally simple and easy to implement. As discussed by (Stock and Watson 2002), it also imposes few distributional assumptions and allows for some degree of cross-correlation in the idiosyncratic error term e_t. (Boivin and Ng 2005) document the good forecasting performance of this estimation approach compared to some alternatives.

Data

The dataset used for the DFM analysis is a balanced panel of 28 series (*N=28*) of monthly data, for the period 2005:2 to 2011:3.[2] All data are transformed to induce stationarity. The details of the data set, as well as the transformation applied to each particular series are included in Appendix I. The data set includes measures of monetary policy, real economic activity, price levels, and their foreign counterparts, as well as commodity prices.

We estimated the system (1)—(2), assuming four latent factors. We experimented with more factors, and the results were very similar. With the factors in hand, we conduct a VAR analysis which forms the basis of our projection. We use 13 lags of the factors, given that they are at a monthly frequency. We form projections for the forecast and use the factor loadings estimated in equation (2), $\hat{\Lambda}$, to forecast each series. Specifically,

$$\hat{X}_t = \hat{\Lambda}\hat{F}_t \tag{3}$$

The results are shown in Figure 1 to Figure 3.

Figure 1 shows the actual factors, and their one-month-ahead projections using the VAR. The VAR is a very good predictor of all the factors in the one-period-ahead forecasting. Figure 2 shows the relationship between actual inflation and inflation as spanned in the space of the four factors. Note that in this figure, we have used the actual factors extracted from data. The figure shows how a linear combination of these four factors captures the majority of the dynamics of the inflation series. The correlation of the two series is 0.97.

Figure 3 shows actual inflation series and the one-period-ahead projected series by DFM. This graph is very close to that in Figure 2. The reason is that factors are predicted very well with the VAR and the majority of discrepancy between actual inflation and that predicted by DFM is due to projecting inflation on to the space spanned by the four factors.

B. Vector Error Correction Model

Vector Autoregression (VAR) analysis offers a statistical forecasting method without imposing too many restrictions on the form of these relationships. Therefore, we examine the

[2] The DFM method is very powerful in dealing with much larger number of data series. For instance, (Boivin, Giannoni and Mihov 2009) use 653 series, including disaggregated price data. In the case of Macedonia, we are constrained by the number of series that go back in time long enough to make the VAR analysis meaningful.

relationship between prices and output, monetary policy and external variables using an estimated VAR as a benchmark.

We examine the relationships between monetary policy variables and both output and prices in Macedonia using a VAR analysis. We consider the effect of official policy rate as the instrument of monetary policy.[3] Macedonia is a small open economy, and potentially inflation in its trading partners plays a role in determining domestic inflation.[4] We also include nominal effective exchange rates (NEER). Although Macedonia has a fixed exchange rate regime, the NEER varies due to changes in trading partners' exchange rates relative to each other. UIP stipulates the relationship between domestic interest rates (policy rate), domestic inflation and foreign inflation.

Policy rate *(r)* is the target interest rate set by the central bank. Output *(y)* is measured by real GDP. Domestic (p) and foreign (p^*) prices are measured by consumer prices in Macedonia, and in Euro area respectively. NEER is denoted by *s.* All data are expressed in natural logs and are seasonally adjusted using ARIMA X12.

In order for the VAR to be correctly specified, we need to check the stationarity properties of the data. The Augmented Dickey-Fuller (ADF) test suggests that the null hypothesis that the variables are *I(1)* cannot be rejected (see Table 1). Furthermore, all variables are stationary in first difference form, indicating that a VAR in first differences is valid. It is plausible that the variables of interest are cointegrated. If so, imposing this restriction can increase the efficiency of the estimation. We test for a cointegration relationship which imposes the reduced form relationship of these variables in the long-run. As shown in Table 2 both Trace and Maximum Eigenvalue test point to one cointegration relationship.

The VAR is of the following form

$$\Delta x_t = \varphi(L)\Delta x_t + \delta x_t + \varepsilon_t \qquad (4)$$

where $x_t = (p_t, p_t^*, y_t, r_t, s_t)$. We use the Akaike (AIC) and Schwartz (SIC) Information Criteria to determine the lag length of the VAR estimation test and the residuals were tested for autocorrelation.

The cointegration relationship has an important interpretation. In an economy with a pegged exchange rate and perfect capital mobility, economic theory would imply that prices are a function of foreign prices and NEER. Domestic policy rates would have to be set to follow foreign interest rates, to prevent an infinite outflow or inflow of capital. Furthermore, the output gap would absorb all the shocks to the real exchange rate. Therefore, in the cointegration relationship above, we would expect that domestic interest rates and output gap

[3] The results using interest rates and monetary aggregates are very similar. We only present the results using interest rate for brevity.

[4] Note that by including foreign prices, and domestic prices, theoretically, we eliminate the need for including interest rates, since under UIP these three variables are a linear combination of each other.

would not be significant, once the effect of foreign prices and NEER is taken into account. However, the data clearly indicates that these two variables are cointegrated with domestic prices, as if there was an autonomous monetary policy.[5] This is a consequence of the imperfect capital mobility between Macedonia and the rest of the world which allows for a certain amount of monetary policy autonomy, despite the pegged exchange rate.

Finally, we test for weak exogeneity of foreign prices. It is plausible that prices in the euro area are weakly exogenous to the cointegration relationship. Estimating the VECM with this restriction imposed, we find that the null hypothesis of weak exogeneity cannot be rejected. Imposing the restriction increases the log-likelihood and results in more efficient estimates. Figure 4 shows the one-period-ahead forecast inflation.

The VECM analysis also allows us to identify monetary policy shocks, the non-systematic part of monetary policy reaction to developments in other variables (p_t, p_t^*, y_t, and s_t). We take the residuals of the policy rate in the VECM as fundamental shocks to monetary policy rate. These shocks can be interpreted as the reaction of monetary policy to prices, output gap and real exchange rate that is beyond the average reaction function.

The results are shown in Figure 5. As the chart demonstrates except a few episodes monetary policy shocks are small (within 50 basis points). The two largest shocks appear in 2001:Q3, when the policy rate was abruptly raised from 12.5 to 20 and in 2005:Q1. However, overall the monetary policy shocks are small and unbiased in their direction. This implies a relatively stable monetary policy without regime changes over the sample under study. We will discuss the implications of this stability and its effect on the conduct of monetary policy in the next section.

[5] Similarly, in an open economy with flexible exchange rate, once domestic interest rates, output gap and nominal exchange rates are controlled for, foreign inflation should not have any explanatory power for domestic inflation.

C. New Keynesian Phillips Curve

The New Keynesian approach to monetary policy analysis has emerged in recent years as one of the most influential and fruitful areas of research in macroeconomics. It has provided a framework that combines the theoretical rigor of the Real Business Cycle (RBC) theory with Keynesian ingredients like monopolistic competition and nominal rigidities. The framework has also become the basis for a new generation of models being developed at central banks, and increasingly used for simulation and forecasting purposes. At the heart of this framework is the New Keynesian Phillips Curve (NKPC), a relationship derived from profit maximization problem of firms, assuming Calvo-type nominal rigidities (Calvo 1983). The NKPC is a forward-looking version of the traditional Phillips curve and implies that

inflation today depends on expectations about future inflation and the output gap — deviation of output from its natural level:

$$\pi_t = \beta E_t \pi_{t+1} + \lambda x_t + u_t \quad (5)$$

where
π_t denotes year − on −
year inflation, $E_t \pi_{t+1}$ denotes the expectation of inflation at time t +
1 conditional on time t information, x_t denotes the output gap and u_t is a "cost-push" shock.

The key feature of the NKPC is the forward looking nature of inflation. However, as emphasized by (Gali and Gertler 1999), the purely forward-looking NKPC cannot capture the persistence in inflation observed in the data. To address this issue they suggest estimating a "hybrid" version of the NKPC. In this modification, it is assumed a subset of firms set prices according to a backward looking rule of thumb. Estimating this hybrid NKPC, (Gali and Gertler 1999) find that the fit improves significantly. Furthermore, they find that the majority of inflation dynamics is explained by the forward looking component (60 to 80 percent for the US data), although backward-looking portion is significant. Starting with that study, the empirical literature has adopted the hybrid version of the NKPC (see (Linde 2005) for a survey). Specifically, the hybrid NKPC takes the following form

$$\pi_t = \gamma_f E_t \pi_{t+1} + \gamma_b \pi_{t-1} + \lambda x_t + u_t \quad (6)$$

In this paper, we follow (Gali and Gertler 1999) and estimate the hybrid NKPC (6) for Macedonia using the Generalized Method of Moments (GMM). Assuming rational expectations the forecast error of π_{t+1} is uncorrelated with information dated *t* and earlier, thus it follows from equation (6) that

$$E_t\{(\pi_t - \gamma_f E_t \pi_{t+1} - \gamma_b \pi_{t-1} - \lambda x_t - u_t)\mathbf{z_t}\} = 0 \quad (7)$$

where $\mathbf{z_t}$ is a vector of variables dated t and earlier. This orthogonality condition for inflation surprise in period *t+1* forms the basis for estimating the model via GMM.

We also estimate an open economy version of the NKPC. Macedonia is a small open economy and thus foreign determinant of inflation can potentially be important. We follow

(Mihailov, Rumler and Scharler 2011) who estimate an open-economy version of the NKPC, based on (Galí and Monacelli 2005). It can be shown that in an open-economy version with profit maximizing firms, inflation dynamics follow:

$$\pi_t = \beta E_t \pi_{t+1} + \lambda x_t + \theta(\Delta s_t - \beta E_t \Delta s_{t+1}) + u_t$$

where s_t is the multilateral terms of trade (ToT). This equation resembles the standard forward-looking NKPC (5) where inflation is driven by expected inflation and the domestic output gap, but augmented with an additional term, the expected change in the ToT relative to current period ToT change. Intuitively, an expected improvement in the ToT in the next relative to the current period ($\Delta s_t > \beta E_t \Delta s_{t+1}$) would increase current demand for domestic goods because their price is relatively lower than what is anticipated in the future, and this increased demand exerts upward pressure on current inflation. This pressure is stronger the higher is the degree of openness to trade, so that θ can be thought of as a proxy for openness or exchange rate pass-through. Inversely, an expected deterioration of the ToT in the next period relative to the current period ($\Delta s_t < \beta E_t \Delta s_{t+1}$) would lower current-period demand for domestic goods as agents expect their relative price to decline in the future, and thus exerts downward pressure on current inflation.

Similar to the closed economy version, we will estimate a "hybrid" version of the open economy NKPC, where we assume a fraction of firms set prices according to a backward looking "rule of thumb". Specifically, we estimate:

$$\pi_t = \gamma_f E_t \pi_{t+1} + \gamma_b \pi_{t-1} + \lambda x_t + \theta(\Delta s_t - \beta E_t \Delta s_{t+1}) + u_t \qquad (8)$$

To proxy ToT we use deflators for import and export. Deflators are known to be a poor measure of changes in ToT. A more accurate measure would be calculating the ToT directly from its definition, , forming a basket of imports, and exports and following their international prices. However, this data is not available for Macedonia. Therefore, we resort to export and import deflators for calculating ToT in the open economy NKPC.

Table 3 shows the results. It presents the estimated coefficients for both closed and open economy versions of the NKPC, equations (6) and (8). A few points about the results are noteworthy. First, note that in both versions expected inflation and output gap have the correct sign and are highly significant. Second, θ, the coefficient on terms of trade, is not significant and including it does not change the estimates of the other coefficient materially. This indicates the closed economy version is a better fit to the Macedonian inflation data. This result may be due to imprecise measure of ToT. Deflators are often a poor measure of changes in ToT, and in particular revisions to deflators in Macedonian data are often large, pointing to large measurement errors.

Most importantly, the coefficient of the lagged inflation is highly significant. The coefficient on expected inflation term,
γ_f, is larger than the coefficient on the backward-looking component, γ_b, in both specifications. This result indicates that expectations channel in an important channel of

monetary policy transmission mechanism, and could be used effectively for conducting monetary policy.

To put this claim in perspective, we compare the closed economy hybrid NKPC, with the results in (Mihailov, Rumler and Scharler 2010) in Table 4. In a similar paper to their (Mihailov, Rumler and Scharler 2011), the authors estimate an NKPC for new EU member countries. Their results are directly comparable to the estimates of equation (8). The forward looking component of the Phillips curve in Macedonia is among the highest, only below Slovakia and Estonia, both Euroized economies.

The estimated Phillips curve also has an important policy interpretation. The Phillips curve implies that the expectations channel of monetary policy is strong and effective. As a considerable contemporary literature emphasized (see, for instance, (Clarida, Gali and Gertler 1999)), since private sector behavior depends on the expected course of monetary policy, as well as on current policy, the credibility of monetary policy becomes relevant. The ability of the central bank to credibly commit to fight inflation in the future can improve the current output/inflation trade -off that a central bank faces.

Note, that since Macedonia has a fixed exchange rate any inflation or output targets are secondary to the stability of the peg. However, due to capital mobility, we do observe some degree of monetary autonomy by the central bank, which can be used for implicit inflation targeting when reserve levels are comfortable.

D. Comparison of Forecasting Methods

In this section, we compare the forecasting performance of the three methods presented above.

Figures 1 to 6 show the forecasting performance of these three measures. All three measures do a good job in capturing the dynamics of inflation. However for a quantitative assessment we need to compare the forecast-error variance.

Note that without assumptions about the true dynamics of inflation series, it is impossible to translate forecast error variance of a monthly forecast method to that of a quarterly model. Therefore, the forecast-error variance of the DFM model is not directly comparable to those of the VECM and NKPC.

Table 5 summarizes the properties of each of the three forecast methods. The forecast error variance in all three methods is very small as a share of the overall inflation variance, and the correlation between the actual and (statically) forecasted series are very high under all three methods. Also we see that the VECM marginally outperforms NKPC in its forecasts.

However, a lower forecast error variance does not imply a dominated (in a statistical sense) forecast model. In fact, NKPC can outperform VECM in some states as long as the information sets for the two forecasting models are not identical. With this insight, we can combine forecasts one can improve the performance of the underlying methods (see (Diebold 2007), Chapter 11).

We employ a simple weighted average scheme. Denote forecast-error variance of the NKPC method by σ_{pc}^2 and that of the VECM method by σ_{VECM}^2. Now consider the following forecast combination scheme:

$$E_t\pi_{t+1}^{comb} = \frac{\sigma_{pc}^2}{\sigma_{pc}^2 + \sigma_{VECM}^2} E_t\pi_{t+1}^{VECM} + \frac{\sigma_{VECM}^2}{\sigma_{pc}^2 + \sigma_{VECM}^2} E_t\pi_{t+1}^{pc}$$

This combination scheme puts a larger weight on the forecast method with the lowest forecast error variance, which is VECM in our example. The results of this combination method are presented in Table 5. Clearly, the combined forecast is an improvement to both VECM and NKPC forecasts.

III. Summary and Policy Conclusions

In this paper we explore three forecasting methods for inflation in Former Yugoslav Republic (FYR) of Macedonia. A high frequency (monthly) Dynamic Factor Mode (DFM) model was developed for short-term, monthly forecasting. The DFM analysis shows that there are strong leading indicators of inflation among the high frequency data available in Macedonia. These indicators efficiently summarize the data, and provide useful forecasting tools.

The VECM analysis shows a strong cointegration between domestic inflation, output, policy rates, and inflation in Euro area. From a policy perspective this result indicates significant pass-through of foreign prices (cointegration with Euro area inflation) as well as some monetary policy autonomy (cointegration with policy rates). This might seem paradoxical, in that a country with a fixed exchange rate regime can yield little influence by exercising monetary policy. Therefore, in a cointegration relationship we would expect domestic interest rates and foreign prices to be linearly dependent. Yet, they seem to be independently affecting monetary policy in Macedonia.

This observation is consistent with the monetary policy regime in Macedonia, which has a fixed exchange rate regime, yet, some degree of monetary policy at the same time. This is not a violation of the impossible trinity, but mostly due to imperfect capital mobility. Exploring monetary policy reaction functions and the conduct of monetary policy in such an environment is an important question to explore.

In such an environment, the monetary authority has an official target, which is the value of the exchange rate, yet its instrument, , the policy rate, allows some room for maneuver and thus the monetary authority might choose to target inflation at times where there is no pressure on foreign exchange reserves. The present paper does not offer any guidance on the conduct of monetary policy under such circumstances, yet, the VECM analysis confirms that domestic inflation is affected by movements in domestic policy rates which are independent of movements in foreign rates.

Finally, a hybrid NKPC is estimated for Macedonia. The NKPC is based on a structural model and thus lending itself more easily to policy interpretation. In particular, the large and significant forward looking component of the Phillips curve indicates that the expectations channel of monetary policy is strong and effective. This is an indication that the central bank is credible and thus announcement of its policy intentions can influence inflation expectations and thus current inflation.

The two latter models provide us with important forecasting tools. We also show that combining the VECM and NKPC forecasts improves the accuracy of either individual forecasting technique, indicating that each forecasting method is capturing information orthogonal to the others and sheds light on a different set of policymaking issues.

Table 1. ADF Tests

	Levels	First diff.
Y	-0.10	-9.31
	(0.94)	(0.00)
P*	-1.44	-5.21
	(0.55)	(0.00)
P	-0.64	-5.16
	(0.85)	(0.00)
M	-1.81	-4.52
	(0.37)	(0.00)
S	-0.99	-5.7
	(0.76)	(0.00)

Table 2. Cointegration Test Results

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.619830	84.70846	69.81889	0.0021
At most 1	0.393157	44.08874	47.85613	0.1081
At most 2	0.291278	23.11038	29.79707	0.2407
At most 3	0.160056	8.650124	15.49471	0.3987
At most 4	0.031043	1.324462	3.841466	0.2498

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.619830	40.61973	33.87687	0.0068
At most 1	0.393157	20.97836	27.58434	0.2775
At most 2	0.291278	14.46026	21.13162	0.3285
At most 3	0.160056	7.325662	14.26460	0.4514
At most 4	0.031043	1.324462	3.841466	0.2498

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 3. NKPC Estimates

	Equation (6)	Equation (8)
γ_f	0.625***	0.609***
	(0.00)	(0.00)
γ_b	0.482***	0.503***
	(0.00)	(0.00)
λ	0.130***	0.104***
	(0.00)	(0.00)
θ	n.a	0.109
	n.a	(-0.49)
R^2	0.83	0.84
DW	2.52	2.59
P(J-stat)	0.87	0.75
Obs	46	46

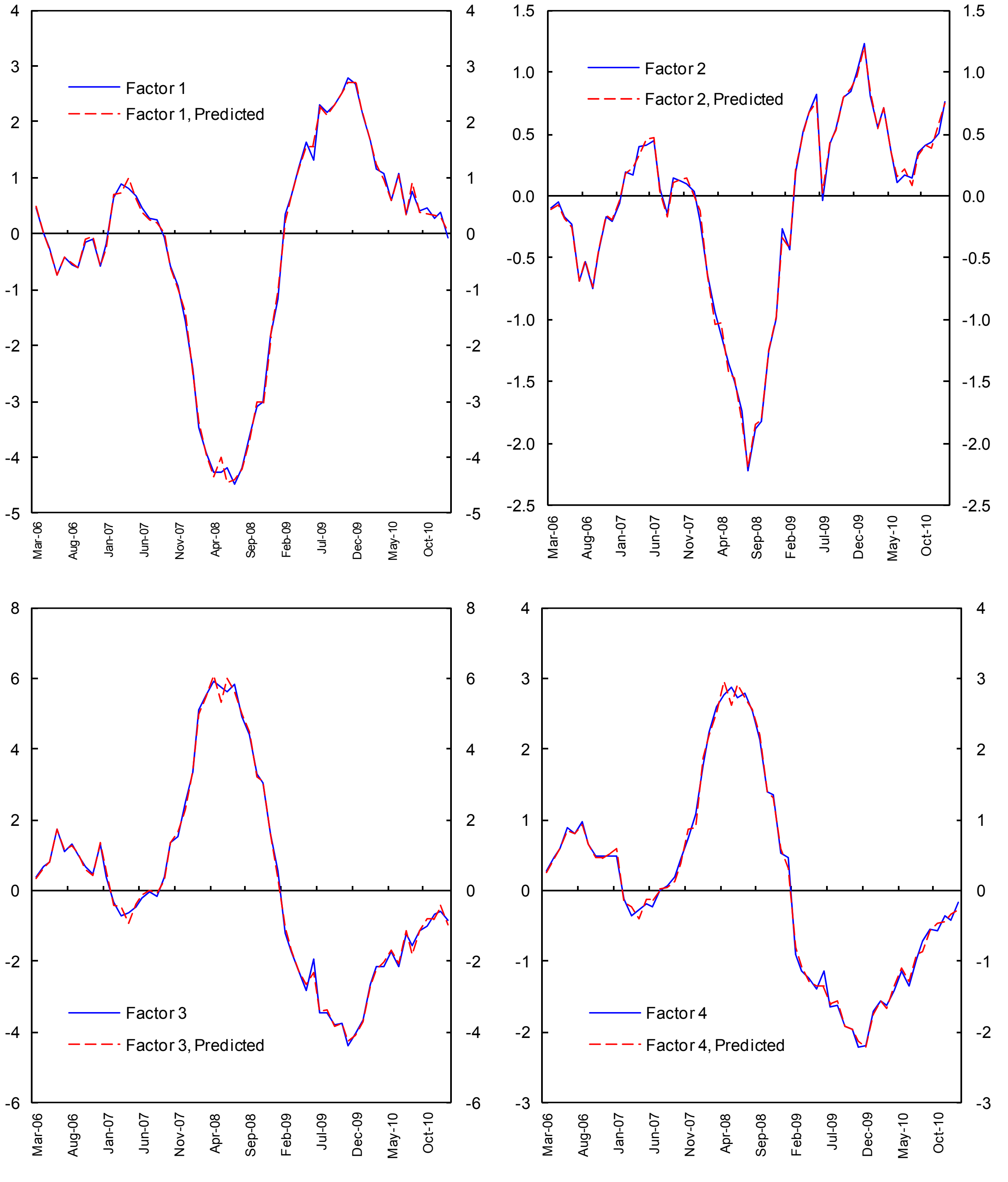
Table 4. Forward-looking Component of Inflation
Comparing Macedonia with New EU Member States
(based on Mihailov, et. al.)

	γ_f
Poland	0.56***
Hungary	0.51***
Czech Rep.	0.28***
Slovakia	0.68***
Slovenia	0.16
Estonia	0.73***
Latvia	0.55***
Lithuania	0.40***
Bulgaria	0.00
Romania	-0.17***
Cyprus	0.61***
Malta	0.28**
Macedonia	**0.63*** **

Table 5. Comparison of Methods

	Number of observations	Correlation of projected and actual series	Forecast-Error Variance (FEV)	FEV / variance of inflation
DFM	60	0.98	0.46	0.05
VECM	43	0.93	1.39E-04	0.16
NKPC	44	0.92	1.48E-04	0.16
Combined	42	0.97	4.90E-06	0.001

Figure 1. One-period ahead forecast of the four factors



Sources: NBRM; and IMF staff estimates.

Figure 2. Inflation, as predicted by the four factors

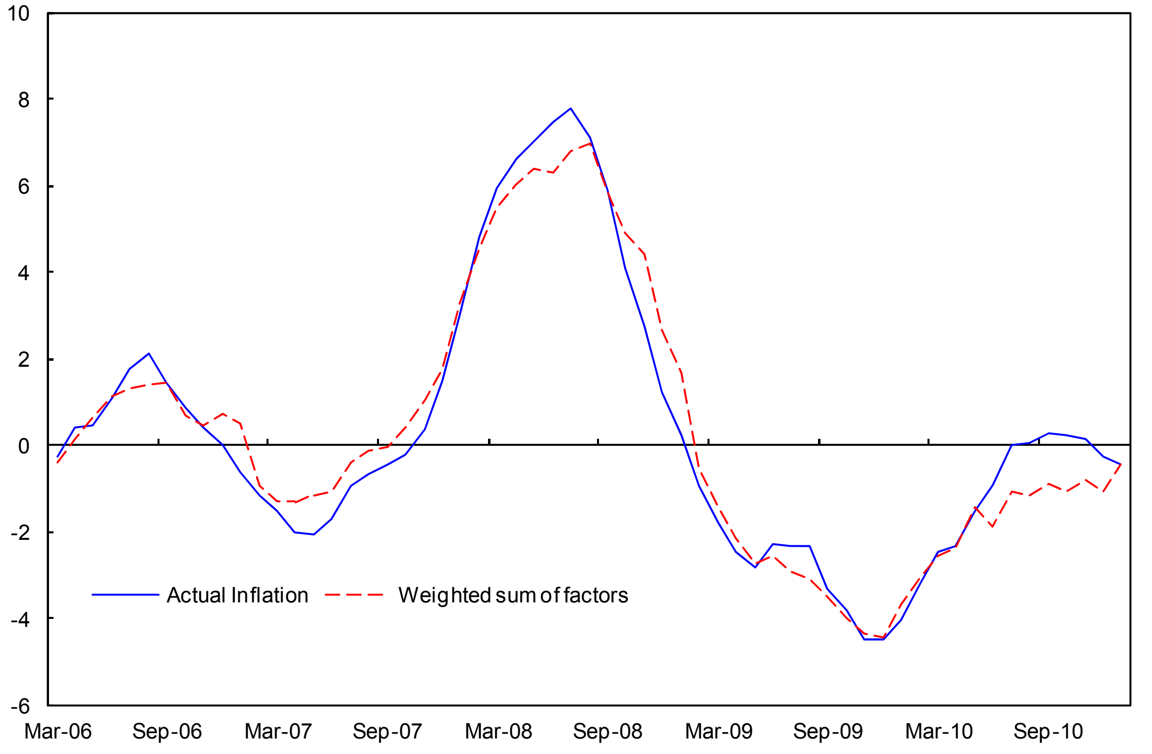
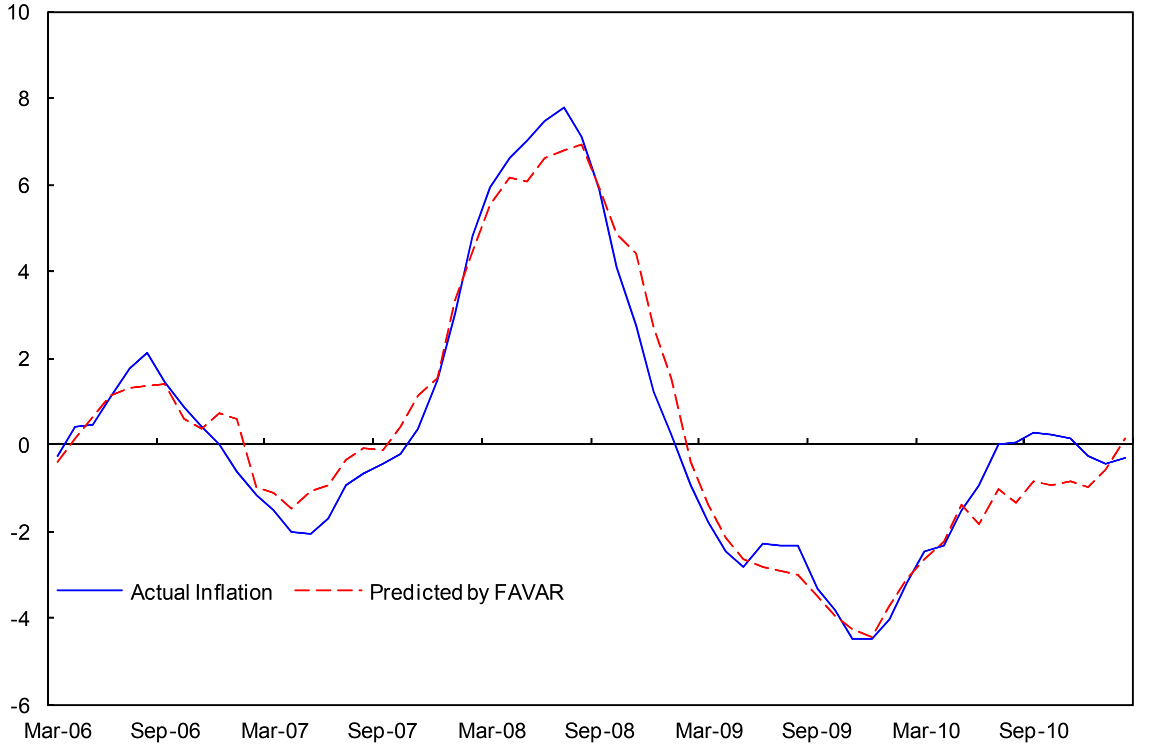


Figure 3. Inflation forecast using DFM



Sources: NBRM; and IMF staff estimates.

Figure 4. Inflation predicted using the VECM method

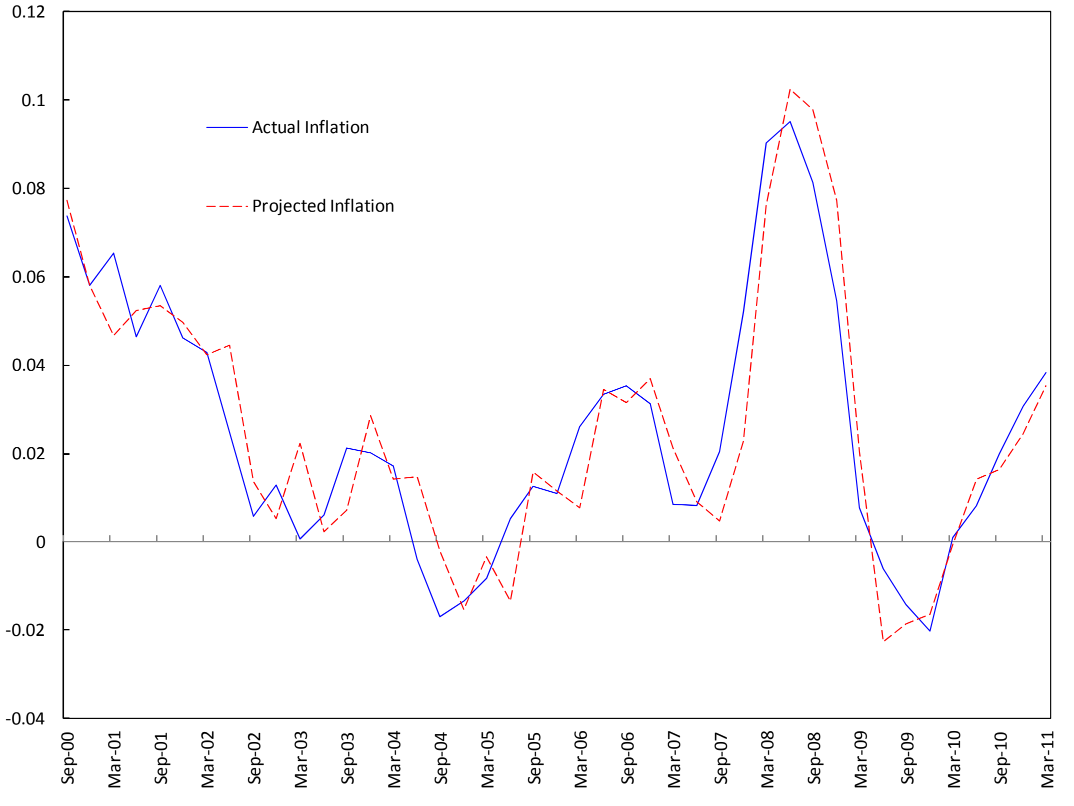


Figure 5. Monetary policy shocks

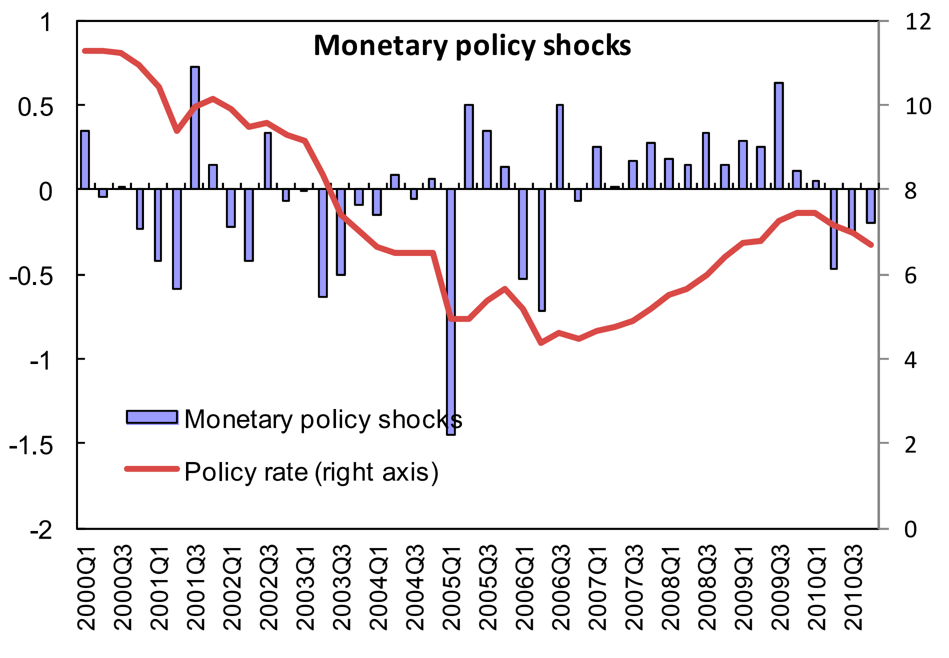
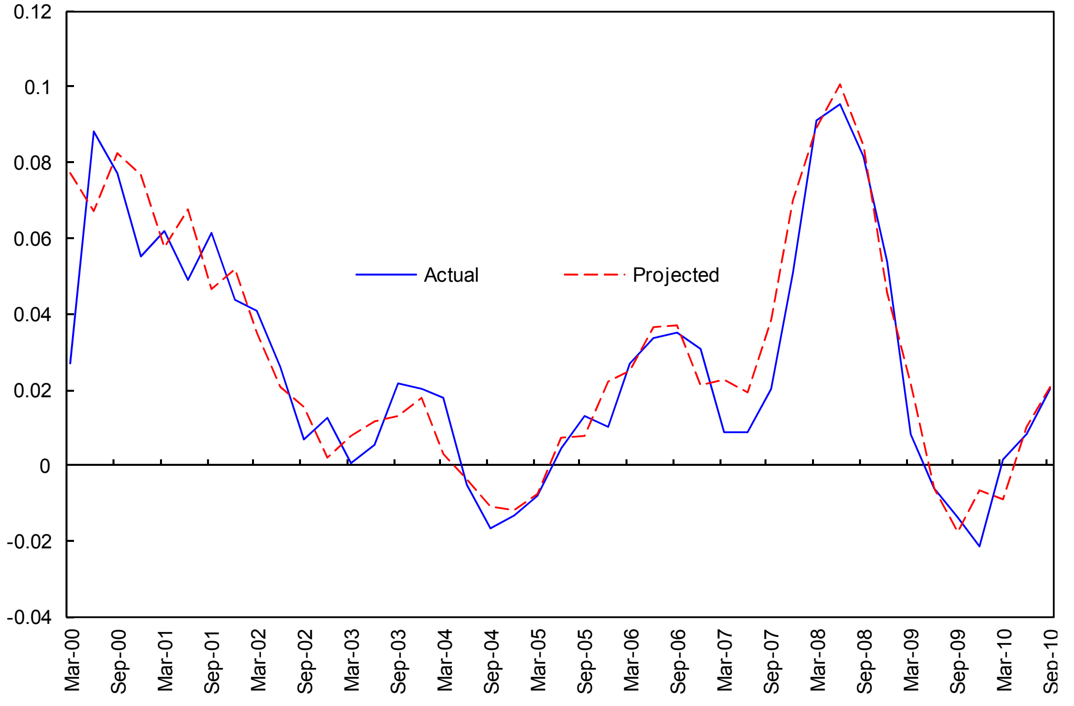


Figure 6. Inflation predicted using the estimated Phillips Curve



Sources: NBRM; and IMF staff estimates.

IV. Appendix I

Table 6 describes the format of the data used in the DFM analysis. There are three transformation codes: Code 1 denotes no transformation. Code 2 denotes a logarithm, and code 3 denotes first difference of logarithms, which is coded as 1.

Table 6 – DFM Data Set Description

	Transformation Code	Description
A1	3	CPI index
A2	3	Commodity Price: Natural Gas, U.S. (US$/Thous cubic meters)
A3	3	Avg Crude Price of UK Brt Lt/Dubai Med/Alaska NS heavy (US$/Bbl)
A4	3	World Energy Index (2005=100)
A5	3	World Commodity Price Index: Food (2005=100)
A6	3	Import of consumption goods
A7	3	Wholesale trade
A8	3	Net Wages: All Sectors (NSA, Denars)
A9	3	Net Wages: Industry (NSA, Denars)
A10	3	Stock Price Index: MBI-10 (AVG, Dec-30-04=1000)
A11	3	International Reserves: Total (NSA, Mil. EUR)
A12	3	International Reserves: Total (NSA, Mil. EUR)
A13	3	Balance Sheet of the Central Bank: Assets (EOP, Mil.Denar)
A14	3	Central Bank Survey Assets: Claims on Private Sector (EOP,Mil.Denar)
A15	3	Exchange Rate: Euro (AVG, Denar/Euro)
A16	3	Exchange Rate: U.S. Dollar (AVG, Denar/Dollar)
A17	3	EU 27: Total CPI excl Energy & Unprocessed Food (NSA, 2005=100)
A18	3	EU 27: Consumer Price Index(NSA, 2005=100)
A19	1	Reference Rate (%)
A20	1	Interest Rates on Denar Loans (%)
A21	1	Interest Rates on Denar Deposits (%)
A22	1	Interest Rates on Denar Deposits with a Currency Clause (%)
A23	1	EU 27: Harmonized CPI: M/M %Change (NSA, %)
A24	1	Euro Area: Deposit Rate (%)
A25	1	CPI (NSA, M/M % Change)
A26	1	CPI (NSA, Y/Y % Change)
A27	1	3-month average inflation, mom
A28	1	3-month average inflation, yoy

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