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ARE MONETARY AGGREGATES GOOD PREDICTORS FOR THE BULGARIAN INFLATION RATE? [1]

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Abstract: The purpose of this article is to study the relationship between the increase of the money stock and the increase of the price level in the Bulgarian economy through the implementation of a monetarist price gap model and through the study of VAR forecasting performances. Firstly, we obtain that the price gap, namely the difference between the theoretical sustainable price level as defined using the equation of exchange and the observed price level is a relevant predictor for inflation dynamics in Bulgaria. Secondly, the analysis of the performance of VAR forecasts of inflation show that the M2 money supply is a fundamental variable present in the best forecasting models, evaluated through their predictive accuracy, when tested on the recent inflationary upswing which began in the third quarter of 2021. This finding is especially important for Bulgaria, given that its monetary policies are bonded to those of the European Central Bank (ECB) through its local currency board. The ECB's expansionist monetary policy in the wake of the COVID-19 pandemic can thus be seen as one of the factors explaining the unusually high inflation level in Bulgaria.

Keywords: inflation, post Covid inflation, Bulgaria, monetarist approach, price gap modelling, VAR forecast performance

JEL codes: E37, E47, C22, P22

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Introduction and motivations

The recent inflation surge has highlighted the heterogeneity of the European economies. Central and Eastern European Countries have experienced much higher headline inflation

[1] This article is the result of research conducted at the Macroeconomic Statistics Department of the Bulgarian National Statistical Institute during the summer of 2023. I'm grateful for the advices and encouragements that were given to me by Svilen Kolev, the Vice President of the Bulgarian Statistical Institute. I would also like to thank Metodi Metodiev, Georgi Chukalev, Albena Dancheva, Alain Redslob and Krzysztof Malaga for the fruitful discussions that we had together. I would also like to express my gratitude to the anonymous referee for providing valuable advice to enhance the final version of this article.

levels and a much stickier core inflation than their Western and Southern counterparts (BNB, 2023). This divergence of inflation rates poses a challenge for both European and local policy makers, who often fail to coordinate their monetary and fiscal policies. High and sticky inflation is especially problematic for Bulgaria, which has to attain a strict inflation target in order to fulfil its objective to join the Euro Zone by January 2025. The inflation shock in Bulgaria has an exogenous component: the supply chain disruptions due to the prolonged Covid-19 restrictions on the economy and the economic and geopolitical impacts of the Russian invasion of Ukraine in 2022 (Estachy, 2023) have led to a spike in both energy and food prices, which account for a greater share of the Bulgarian CPI basket than in Western Europe (their share is around 36.2% in Bulgaria vs 22.5% in France for example). A study by Minasyan et al. (2023) show that in the Western Balkans, the pass-through of international food prices is not only an important determinant of headline inflation, but of core inflation as well.

However, there are very few studies of the impact of the accommodating monetary policy of the European Central Bank, entirely transmitted to the Bulgarian economy through the mechanism of the local currency board, on the recent inflation dynamics in Bulgaria[2]. Most recent models of inflation are conducted in the New Keynesian tradition and aim at explaining inflation using the output gap and argue that among the tools available to central banks, the interest rate is the most effective and widely preferred instrument for managing monetary policy. Hence, we decided to study the link between the increase of monetary creation in Bulgaria and inflation. Our perspective is mostly monetarist in nature. This perspective, underestimated for a long time, today enjoys a certain revival (for example, Tim Congdon emphasizes the role of the money supply in predicting inflation Congdon, 2023)[3].

In fact, the pernicious effects of the heightened fluctuation of the price level (or the real value of money) have often been discussed. Due to the difficulty that people find in thinking in real terms instead of nominal terms, there is an incomplete indexation of contracts to the inflation level. Maurice Allais (1990), a strong proponent of full and mandatory indexation of all contracts to the price level, explained that inflation is the source of both inefficiencies and inequality. During inflationary periods, the weight of debt is considerably attenuated. This leads to over-investment and therefore to waste of capital. During deflationary periods, once sustainable investments become unbearable and hinder economic activity. Moreover, inflation is caused according to Allais due to "the excessive growth of money created *ex nihilo* and the increase of wage-related costs above the increase of productivity, the latter only being possible to the extent that a sufficient quantity of money is created through the credit mechanism

[2] Zlatinov et al. (2023) consider that the EU inflation passes through to Bulgaria through imports from the EU and through the fixed exchange rate between the euro and the lev, a consequence of the Currency Board.

[3] The monetarist approach is well represented in Humphrey (1986).

in order to finance them" (Allais, 1990, p. 17). This leads to the spoliation of the wages of those workers who obtain wage increases with a delay compared to those who obtained them first, as are creditors are spoliated in favor of debtors. During deflationary periods a completely symmetrical effect takes place. Allais thus considered the complete indexation of all contracts to inflation as a "major condition for efficiency, equity and honesty"[4].

Inflation has been a much-debated topic ever since the fall of the centrally planned economy in 1989. Official price liberalization in the country only took place after 1991, however price in the shadow economy increased dramatically immediately after the fall of the socialist system. Inflation was seen at first as a practical method by the government to reduce the mounting public and private debt inherited from the past decades (Vucheva, 2011)[5]. However, as the economic conditions worsened inflation soon grew out of hand and its increase culminated in the hyperinflation of 1996/1997 which led to the collapse of the socialist government ruling the country at that time. A root cause of the financial crisis was the presence of severe moral hazard in the Bulgarian banking sector due to the Bulgarian Central Bank acting as a lender of first resort (Berlemann and Nenovsky, 2003). The introduction of a currency board in Bulgaria after 1997 subdued very quickly inflation in the country, although it remained at a much higher level than in Western European countries. This is in a large part due to the important difference in price levels observed in both countries and price contagion due to the Balassa – Samuelson effect (Chukalev, 2002).

The paper is organized as follows: in the first part we will present some stylized facts about inflation in Bulgaria. In the second part we implement a monetarist approach for modeling inflation using the monetary aggregates to predict the inflation rate. In the third part we implement a Vector Autoregression approach to determine if the M2 monetary aggregate is a good forecast variable for Bulgarian inflation.

Stylized Facts

Ever since the establishment of the currency board in 1997, Bulgaria has enjoyed moderate and stable levels of inflation (Figure 1 in the appendix). From 1998 to today, the mean quarterly inflation level was 0.84%, with a yearly mean of 3.2%, as measured by the Harmonized Consumer Price Index (HICP). This is above the mean inflation rate for countries in the eurozone in the same time period, whose inflation rate was usually much below the ECB's mandate of 2%. This is to be expected since

[4] "La réalité, c'est qu'une indexation généralisée est une condition majeure d'efficacité, d'équité et d'honnêteté." [The reality is that generalized indexing is a major condition for efficiency, fairness and honesty.] (Allais 1990, 13)

[5] For a survey on this issue see also Dobrinsky (2000) and Mihov (2002).

Bulgaria's economy is converging to that of its European peers, it has to exhibit higher rates of inflation. Unlike most European countries, Bulgaria exhibited a prolonged period of price deflation (Q1 2013 to Q1 2016). According to the International Monetary Fund's 2016 Article IV consultation for Bulgaria, this was mainly due to the sharp fall of energy prices due to oversupply at a global level and the large share of energy in the Bulgarian HICP basket. Since the opening up of the economy after a period of prolonged sanitary restrictions and the beginning of the Russian invasion of Ukraine, Bulgaria has experienced unusually high inflation. This phenomenon began around the second and third quarters of 2021, with a high of 15.6% yoy in the third quarter of 2022.

The Bulgarian labour market has experienced a profound transformation in recent years. After the much-delayed wave of privatizations (1997-2001), the unemployment rate reached a high of 18.7% in 2000. Over time this rate has gone down, reaching a low of 5% in 2008. A second unemployment surge took place during the Financial and European Debt crisis, with a high of 13.8% in 2013, and went down again reaching historic lows in 2022 (3.7%) (Figure 2). The vacancy rate, measured with the percentage of firms experiencing recruitment difficulties, observed in the Bulgarian private sector has followed a symmetrical evolution with vacancies increasing to historic levels in recent years. Some sectors experienced vacancy rates of up to 44% (construction sector). A root cause for this problem is the severe demographic crisis that the country has experienced since 1989 due to low birth rates and high levels of emigration. This leads to an ever-aging workforce, which cannot be renewed as is the case in Western Europe thanks to high immigration.

Thus, because of an aging workforce and workers which are relatively mobile inside the EU, there is a much better indexation of salaries to the inflation level. Bulgaria was one of the few EU countries which experienced real wage growth in 2022 (of around 2.8% yoy as measured at the end of 2022).

P-Star Model of Inflation

1. A basic monetarist model of inflation

In this section we will present and implement a basic monetarist approach for inflation modelling proposed by Hallman et al. (1991). The intuition behind this model is that, in the long run, the observed price level in an economy should not diverge considerably from the theoretical price level that it can support according to its money stock. By writing a long run quantity equation, we obtain the following:

$$P_t^* = \frac{MV_t^*}{Q_t^*}$$

With P^*, the theoretical long run price level, M money aggregate, V^* the long run velocity of the given money aggregate, Q^* the potential real output at time t. Hallmann et al. (1991) argue that the gap between this equilibrium price level P* and the observed price level in the economy P is a good predictor for the direction of future inflation; this proposition can be tested with the following econometric specification:

$$\pi_t = \beta_0 + \beta_1(p^*_{t-1} - p_{t-1}) + \varepsilon_t$$

With π_t the observed inflation at time t and ε_t a stochastic term. The difference between the equilibrium price level and the observed price level is called the *price gap* (an analogous expression to the output gap). We test this the effects of the price gap on inflation with a lag since in theory the increase of money supply takes time to spread to the whole economy.

2. Implementation

In order to test this hypothesis in Bulgaria, we need to construct the P* variable. We used quarterly data from 1998 to 2022 of the real Bulgarian GDP as a measure of output, the M2 money aggregate as a measure of the money stock and the GDP deflator as a measure of the current observed price level in the country. The data for the Bulgarian GDP is provided by the Bulgarian National Statistical Institute (NSI) while the data for the M2 money aggregate is provided by the Bulgarian Central Bank (BNB).

We use the M2 money aggregate (narrow money M1 + deposits with short term maturity) in this analysis since it is a good measure of the quantity of money used by all agents in the economy. The M3 money aggregate is not appropriate in the Bulgarian case since due to the lack of use of marketable instruments it is almost exactly equal to the M2 money supply (the average monetary value of these instruments has only been 0.1% of M2 since 1998 and has been nil since 2019). We must first compute the velocity of the M2 monetary aggregate in Bulgaria using the following relation:

$$V_t = \frac{\widetilde{Q_t}}{M_t}$$

with $\tilde{Q}_t$ the Bulgarian nominal GDP. This method of measuring the velocity of the M2 money supply is indirect; a direct approach would have required the use of the total nominal value of transactions T_t in the economy in a given period (Irving Fisher's "volume of trade").

$$V_t = \frac{PT_t}{M_t}$$

Such a statistic is not available for Bulgaria. GDP is a good proxy for the total value of transactions in an economy, even though it does not fully capture the monetary transactions for intermediary goods not accounted for by value added[6].

[6] Since 2014 the U.S. department of commerce has begun publishing on a quarterly basis the U.S. gross output (GO), which unlike GDP includes sales for intermediary outputs. Mark Skousen (2015) argues that

In order to obtain the potential (or long term) values of the velocity of money, we extracted its cyclical component using a high frequency Hodrick-Prescott filter. The same method is used in order to obtain the long-run values of all other data that requires it (nominal output and M2). In the Annex we have provided a plot for the velocity of M2 in Bulgaria (Figure 3). We can observe that there is a persistent decline in the velocity of money in the Bulgarian economy since 1998: from a level of 4 in 1998 it has continuously declined and seems to converge towards a level of 1. This marks one substantial difference from the study conducted by Hallman et al. (1991) whose US data spanning from 1955 to 1988 exhibited a stable constant velocity level of around 1.65.

However, it is in line with the secular decline in the velocity of money observed in developed countries since 2000. In Bulgaria this could be due to increased demand for currency intended for hoarding due to the stabilizing effect of the introduction of the currency board (Nenovsky and Hristov,2000). The authors also identify an important increase in the transactional demand for banknotes intended for servicing both the official and shadow economy, the latter having mainly operated with foreign currency before the introduction of the currency board. We used this computation of V^* in order to compute the sustainable price level P* for the Bulgarian economy. We plotted on the same graph the observed price level (GDP deflator) and the price gap (Figure 4 and Figure 5). There seems to be graphical evidence for the link between P* and P on the long run; a Johansen co-integration test shows that the two series are co-integrated, although only at a 10% significance level.

In order to perform our regression analysis, we performed a series of regressions using the Price gap as a dependent variable. We first regressed the inflation rate at time t with the Price Gap the previous year. Since the data is quarterly, to study the effects of the price gap a year after it increases, we have used four lags[7]. We obtained a positive link between the price gap and inflation, in line with theory. The coefficients can be interpreted by saying that if the price gap increases by 1%, we can expect the inflation rate to increase by 0.187% in the following year. We obtain an adjusted R^2 of 0.118, meaning that our model explain 11.8% of the variance of inflation. In the second regression model we have added the GDP output gap and the velocity gap as control variables. The velocity gap consists of the difference between the velocity trend and the actual velocity level. We have included the output gap in order to compare its statistical significance and its coefficient to the price gap, since it is a more classical variable of interest for inflation prediction. The output gap seems to be nil

GO is a good measure of the volume of trade in Fisher's equation of exchange.

[7] In the annex we provide some regressions with different choices of lags. The results do not change dramatically using 3, 5 or 6 lags. The significatively is however much lower if we use 0,1 or 2 lags, which shows that the price gap has a lagged effect on inflation. This makes such models useful for inflation forecasting

and not statistically significant[8]. Simultaneously, the velocity gap is significant at a 1% confidence level and negative. This is not in line with economic theory since we expect that a velocity level above its long-term trend should be linked to an increase in inflation later on. Moreover, we obtain an adjusted R^2 of 0.283, meaning that the price gap and the velocity gap explain 28.3% of the variance of inflation, a substantial improvement from our previous model.

In our last model we added lags of inflation at *t*-3 and *t*-4 as controls, we observe that the value of the coefficient of the price gap is much smaller. The coefficient can be interpreted as follows: for every 1% increase in the price gap at t-4, while controlling for the inflation level at t-4 and t-3, there is an associated increase of 0.075% in the inflation level. We obtain an adjusted R^2 of 0.647, which is to be expected when we add lags of the dependent variable into our analysis.

Table 1: P* regressions using deflator as measure of inflation

	Dependent variable:		
	Inflation		
	(1)	(2)	(3)
P-gap_{t-4}	0.187***	0.132***	0.075**
	(0.051)	(0.047)	(0.035)
GDP-gap_{t-4}		−0.000	−0.000
		(0.000)	(0.000)
$\text{Velocity-gap}_{t-4}$		−0.408***	−0.227**
		(0.135)	(0.100)
Inflation_{t-4}			0.490**
			(0.196)
Inflation_{t-3}			0.256
			(0.183)
Constant	1.138***	1.894***	0.795***
	(0.124)	(0.280)	(0.235)
Observations	95	95	95
R^2	0.127	0.306	0.647
Adjusted R^2	0.118	0.283	0.627
Residual Std. Error	1.207 (df = 93)	1.088 (df = 91)	0.785 (df = 89)
F Statistic	13.567*** (df = 1; 93)	13.365*** (df = 3; 91)	32.584*** (df = 5; 89)
Note:			*p<0.1; **p<0.05; ***p<0.01

Source. BNB, NSI, author's calculations.

[8] Gali and Gertler (1999) suggest that using the output gap as a predictor for inflation often yield unsatisfying results and propose a New Keynesian Philipps curve which uses marginal cost as a predictor for inflation.

3. Household Extension

Using a tighter monetary base in order to predict the price level that faces the consumer, namely the Consumer Price Index, is an interesting possible extension of the previous model. We can construct a theoretical consumer price level using the M0 money supply (the money base consisting of bank notes and coins in circulation) and the real household expenditure from the national accounts as a measure of consumer's contribution to output.

We can also use the nominal household expenditure in order to compute the velocity of the monetary base in Bulgaria[9]. We observe on Figure 6 the computed velocity of the M0 monetary aggregate. We observe a similar decreasing trend of the velocity of the monetary base, which is in line with the observed increase of demand for banknotes observed by Nenovsky and Hristov (2000) after the introduction of the currency board. From a high of 10.4 in 1998, it has decreased to a level slightly below 4 in 2023. Unlike the velocity of the M2 aggregate, the velocity of the monetary base is not monotonously decreasing, with a slight uptick observed from Q1 2007 to Q1 2012. This can be due to the slowing down of the Bulgarian economy after the global financial crisis and during the European debt crisis, when the savings rate of the population decreased and thus the hoarding of banknotes also decreased in the same time frame.

We obtained the following theoretical price level, which we have plotted against the Harmonized Index of Consumer Prices (HICP), which is the price level that the consumers face (Figure 7). The difference between the theoretical and observed price level constitutes the consumer price gap (Figure 8). A Johansen Cointegration test shows that the price levels are cointegrated, although only at the 10 % confidence level.

Following the same regression routine as before[10], we find that when regressing the consumer price gap on the first differences of the HICP, we obtain that there is a significant positive relationship between the two variables. If the price gap increases by 1%, then the HICP will increase by 0.083%. We obtain an R^2 of 0.157, meaning that the price gap explains 15.7% of the variance of the change of the HICP. Then we added the household expenditure gap (equivalent to the GDP gap in the previous model) and the velocity gap to the model, and obtain that both variables are not statistically

[9] There exist several direct and indirect measures of PT that have been proposed over the years other than nominal GDP or GNP. An insightful paper by Mary Morgan (2006) highlights how the definition and measurement of the velocity of money has changed over the years. Here we use the total nominal household expenditure as a proxy for PT. Richard T. Selden (1961) proposes a method of decomposing aggregate velocity as the sum of sectoral velocities computed as the ratio of spending in a given sector over the relevant sector money holdings.

[10] For regressions with different lag selection look in the annex.

significant for explaining the evolution of the HICP. Furthermore, we obtain a R^2 of 0.147, which is worse than our previous model. Finally, we added four lags of the HICP first differences to the model, and obtained that *ceteris paribus* by increasing the price gap by 1% leads to the increase of the harmonized inflation rate will be 0.046% after 4 quarters. Moreover, the price gap is now only significant with a 5% confidence interval. We obtain a R^2 of 0.369. This increase is due to adding lags of the dependent variable.

The obtained coefficients appear to be much smaller than those for the previously defined inflation.

Table 2: P* regressions for Consumer Price Index first differences

	Dependent variable:		
	Inflation		
	(1)	(2)	(3)
P-gap$_{t-4}$	0.083***	0.086***	0.046**
	(0.019)	(0.020)	(0.018)
Expenditure gap$_{t-4}$		−0.000	−0.000
		(0.000)	(0.000)
Velocity-gap$_{t-4}$		0.291	0.203
		(0.308)	(0.277)
Inflation$_{t-4}$			0.222*
			(0.112)
Inflation$_{t-3}$			0.132
			(0.125)
Inflation$_{t-2}$			−0.137
			(0.124)
Inflation$_{t-1}$			0.493***
			(0.105)
Constant	0.620***	0.611***	0.177
	(0.130)	(0.131)	(0.137)
Observations	95	95	95
R^2	0.166	0.175	0.441
Adjusted R^2	0.157	0.147	0.396
Residual Std. Error	1.146 (df = 93)	1.153 (df = 91)	0.970 (df = 87)
F Statistic	18.498*** (df = 1; 93)	6.419*** (df = 3; 91)	9.792*** (df = 7; 87)
Note:			*p<0.1; **p<0.05; ***p<0.01

Source: BNB, NSI, author's calculations.

In all regressions we have found much smaller and less significant coefficients for the price gap using the household expenditure than when we use GDP. In the annex we show that this is true for any choice of lags.

Vector Auto-regression Model

A widely used method for forecasting of macroeconomic variables are Vector Auto-Regression (VAR) models, first proposed by Christopher Sims (1980). These models were introducing as an improvement on structural macroeconomic models, as the one above, which suffered from "the incredible identification restrictions" that were required for their parameters to be identified.

In this section we will model the Bulgarian inflation rate using a series of VAR models and use the Root-Mean-Square-Forecasting-Error (RMSFE) and a Theil Statistic in order to select the best models of inflation prediction. We will show that the monetary aggregates appear constantly in the best predictive models of inflation.

1. VAR Modelling of the Bulgarian Inflation Rate

VAR models are the multivariate generalization of the univariate autoregressive models, which model an output based on its own lagged values and some stochastic term. VAR models estimate a vector of dependent variables by using lags of all variables in the vector and some vector of uncorrelated stochastic terms. Such a specification considers all variables as endogenous to the process which is modelled in opposition to standard structural models, which aim to account for exogenous shocks to the economy due to deliberate policy decisions or a change in the economic environment. It is possible to add a structural component to VAR models in order to tackle this problem, as for example imposing restrictions of the sums of the model's parameters, as did Blanchard and Quah (1989) in order to study positive demand and supply shocks to the US GNP.

For illustrative purposes we provide an example with a vector of three dependent variables x, y and z, and using a one lag VAR model:

$$\begin{pmatrix} x_t \\ y_t \\ z_t \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix} \begin{pmatrix} x_{t-1} \\ y_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{pmatrix}$$

We observe that the number of parameters to be estimated with such a model increase in a quadratic fashion with the number of dependent variables which we wish to include in our model. Because of the small dimensions of macroeconomic time series data-sets, models with too much variables tend to be over-fitted and exhibit poor out of sample forecasting performance. Thus, we expect our best VAR models to contain only a few predictors.

In order to select the best VAR models, we closely followed a methodology proposed by the Swiss Central Bank (Lack, 2006) which consists of an algorithm which computes VAR models with all possible combinations of a set of variables that we consider to be relevant for inflation forecasting and sorts them according to their RMSFE. The models will all be trained on a train set and their performance will be evaluated on a same test set consisting on the last n periods of the time series. Their performance will be evaluated using the RMSFE, which can be written as:

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(\pi_i - \hat{\pi}_i)^2}$$

where n is the number of forecasted periods, π_i represents the observed value of the inflation rate at time i, and $\hat{\pi}_i$ represents the forecasted value.

Another useful statistic that can be computed is the Theil statistic that is the ratio between the RMSFE and a naive predictor of inflation which consists of taking the last observed value of inflation in the train set and consider it as the forecasted value of future inflation. Since theory suggests that inflation should be a stationary process that follows a random walk around its mean, using the last observed value of inflation as a predictor is relevant.

$$Theil = \frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}(\pi_i - \hat{\pi}_i)^2}}{\sqrt{\frac{1}{n}\sum_{i=1}^{n}(\pi_i - \pi_{i-1})^2}}$$

A Theil Statistic above 1 indicates that our forecast fares worse than the random walk forecast, while a Theil statistic under 1 indicates that our forecast is better. These statistics will also be used to select the number of lags that we will use in all models. It must be stressed that, as Lack (2006) states in his presentation of the methodology, the choice of both variables and lags may not be fixed and must be updated over time as new data is available for training and testing.

2. Implementation

In order to implement this methodology, we have used in order to predict the HICP the following variables: the M1 and M2 monetary aggregates, the real Bulgarian productivity rate, the Brent crude oil price index, the GDP gap, the German GDP gap[11],

[11] We have added the German GDP gap as an explanatory variable since Germany is the paramount trading partner of Bulgaria, and the biggest investors in its economy. We expect that the cycles of the Bulgarian

the Unit Labour Cost, the Euro-Dollar exchange rate, the EU import price index and the European Central Bank (ECB) main refinancing operations rate.

Data was provided by Bulgarian official institutions (NSI and BNB), the ECB and Eurostat. We have taken the logarithm of all variables in order to perform the analysis, except for variables that are already rates (the HICP, the interest rate, the Unit Labour Cost or the exchange rate) or variables that may be negative, such as the output gaps.

The choice of variables reflects the naive nature of VAR forecasting, since both variables in the monetarist and Keynesian tradition are used, in addition to other potentially relevant variables. My data spans from Q1 2000 up to Q4 2022. All VAR models will be trained using a train set from Q1 2000 up to Q4 2020, and the forecasts will be evaluated over a test set from Q1 2021 to Q4 2022 (two years). This test period was used in order to evaluate the forecast's performance over a period of unusually high inflation.

The number of lags used in the models were selected based on the minimal RMSFE criterion. We obtain that 6 lags minimize the RMSFE (Figure 9). We obtain, for the ten best models, the following results:

Table 3: 10 best forecasts according to their RMSFE

Rank	Variables	RMSE	Theil
1	M2 rate dollar import productivity	0.2503	0.55659
2	M2 M1 rate dollar productivity	0.25519	0.56742
3	M2 dollar brent import productivity	0.27316	0.6073
4	M2 brent import productivity	0.27884	0.6199
5	M2 rate dollar productivity	0.28358	0.63053
6	M2 M1 rate productivity	0.28532	0.63440
7	M2 rate dollar productivity ULC	0.31125	0.69206
8	M2 rate dollar productivity	0.32216	0.7163
9	M2 rate brent import productivity ULC	0.32873	0.73093
10	M2 rate dollar brent productivity	0.32873	0.73625

Source: BNB, NSI, EUROSTAT, FRED.

The M2 monetary aggregate appears systematically in all best forecasts of inflation over a two years period. While testing with different lags and forecast periods, M2 was still present in the great majority of forecasts. This tends to support the idea that the evolution of money supply is a good indicator for future inflation. We should note that productivity is also present in all best forecasts. This could be explained through the Balassa-Samuelson effect, as summarized by Chukalev (2003): as Bulgaria raises its

economy should be synchronized to that of the German economy.

productivity level, the optimal level of inflation in the country will be higher in order for wages to catch up those in Western Europe.

We can also note that variables such as the output gaps for Bulgaria and Germany do not appear in our best forecasts, as is the case for aggregate wages and the number of employed people in the country.

When looking at the 50 best forecasts, M2 is present in 34 of them. It should be noted that however that productivity was present in 50 of the best inflationary models. It can be concluded that although M2 is a good forecast variable for inflation, productivity appears to be better. This illustrates our previous result in the P^* model where the output gap was not a relevant variable to predict the inflation rate. The results also highlight the naive nature of the VAR forecasting methodology: there needs not be a perfectly theoretical consistency between the selected forecaster variables.

The effectiveness of the forecasts, measured by the Theil Statistic is of 0.55 for the best forecast, and is of 0.65 for the mean of our 10 best models. This is in line with values found in the literature with VAR models (Lack, 2006) and with Bayesian VAR models (Kenny et al., 1998). When computing the mean forecast for the 10 best forecasts, we obtain a RMSFE of 0.5 and a Theil Statistic of 0.87. For the mean forecast of the 50 best models we obtain a RMSFE of 0.48 and a Theil Statistic of 0.84.

Conclusion

Both price gap specifications yielded a statistically significant positive link between the increase of the lagged money stock and the increase of inflation. Moreover, a VAR analysis showed that the M2 aggregate is a relevant forecast variable for inflation. We can conclude that the evolution of the money stock in Bulgaria is a good predictor for the direction of inflation in the following quarters. We can also infer that, since Bulgaria does not have an independent monetary policy due to its inflexible currency board, the inflation level in the country is heavily dependent on the ECB's monetary policy. It's expansionist policy after the Covid-19 crisis can thus explain to a great extent the unusually high inflation in Bulgaria. We should thus expect a sharp decrease of inflation due to the normalization of monetary policies in recent months. In a future paper we could look at how the ECB monetary policies impacts inflation in other countries on the periphery of the Eurozone, such as Poland, Hungary, Romania or the Western Balkans since they have a slightly greater leeway than Bulgaria in their domestic monetary policy.

However, money supply is only one determinant of inflation in the country. The monetarist model shows that the theoretical price level only explains a portion of the total variance of the HICP, and the VAR methodology shows that productivity is an even better predictor for the increase of the price level. Moreover, it should be noted that the link between the monetary stock and inflation may be endogenous in nature. The Central Bank's exogenous action on the money supply is limited, since it is to a large extent the result of the demand for loans from the real economy[12]. This is even truer in Bulgaria where the currency board *de jure* can only emit money in its local currency as foreign currency enters the Central Banks foreign exchange reserves. This is one of the reasons why most countries have shifted from monetary base targeting to an inflation targeting for their monetary policies since the end of the 1980' (Mishkin 2000). However, the recent inflation surge should remind policy makers that the link between monetary aggregates and inflation is still strong.

Conflict of interests

The author has no conflict of interests to declare.

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[12] Most of the "broad money" in the economy is created by commercial banks' lending money to the private sector. This fact is a major stepping stone for proponents of endogenous money. An example of such a school of thought is the Monetary Circuit Theory (Poulon, 2016).

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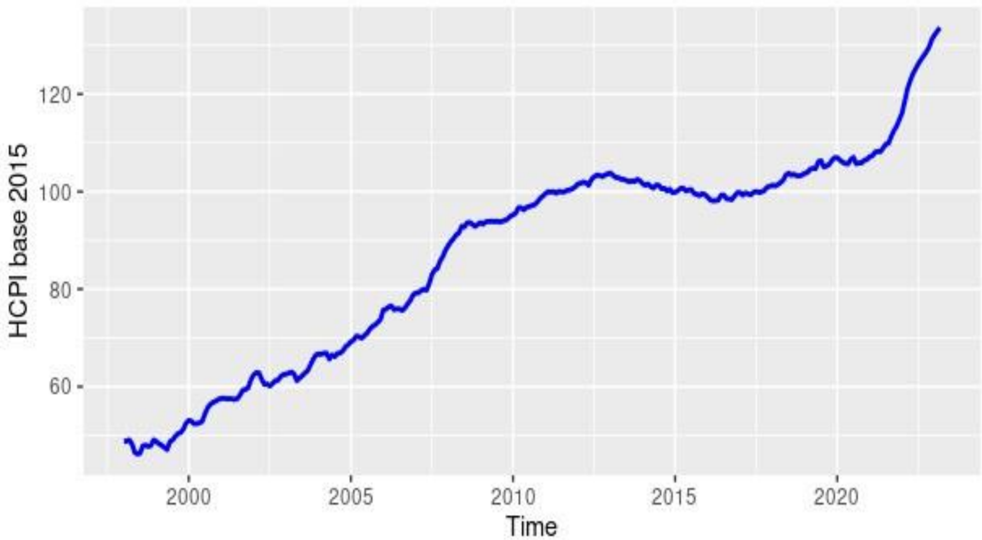
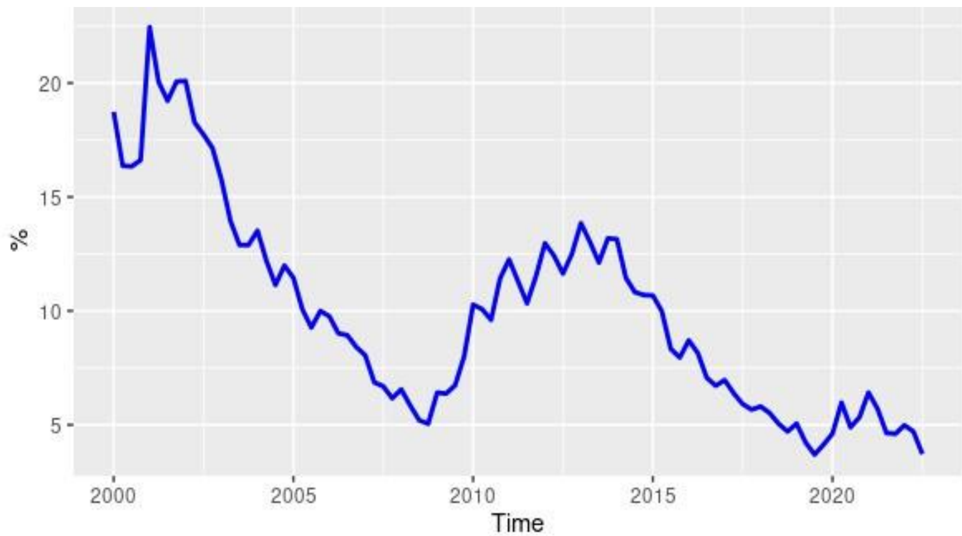
Appendix

1. Plots



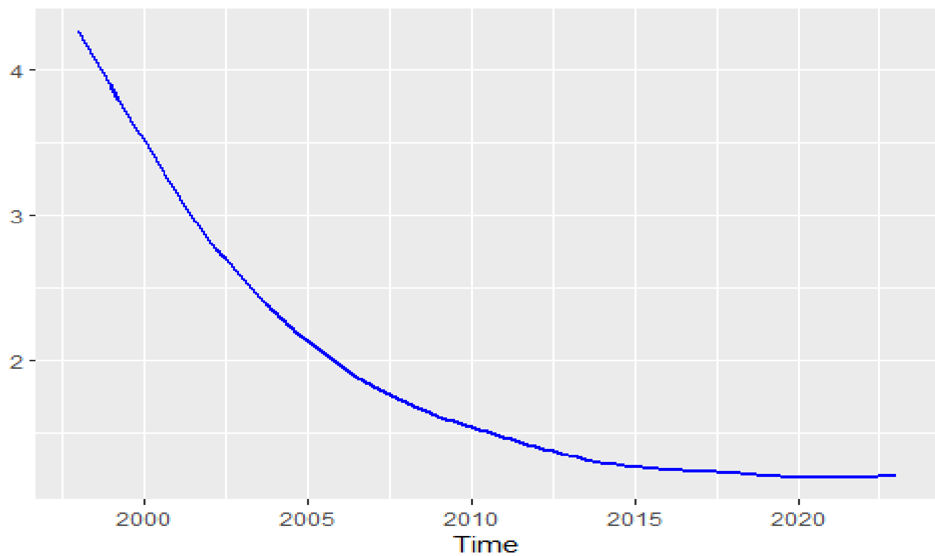
Source: NSI.

Figure 1. Harmonized Consumer Price Index Bulgaria



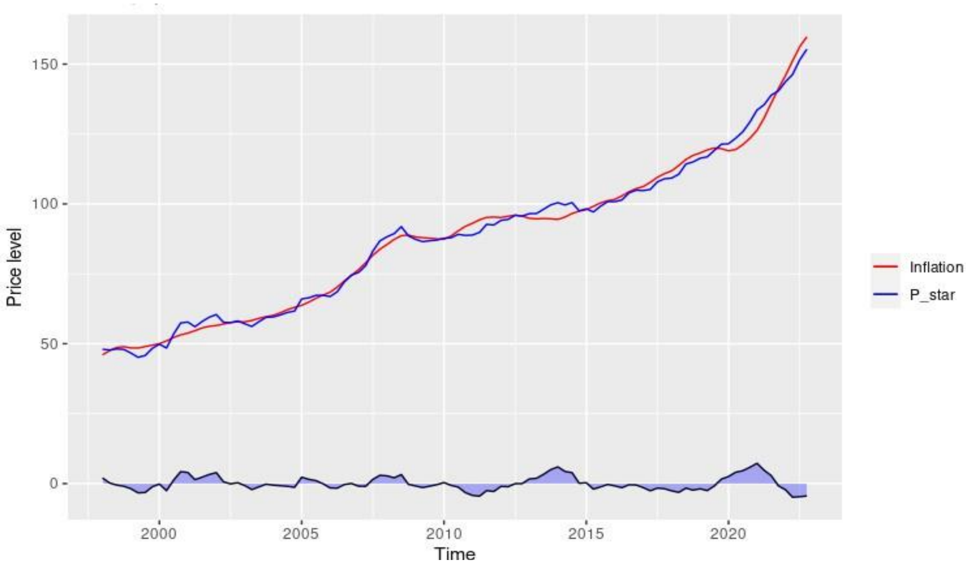
Source: NSI.

Figure 2. Total unemployment rate Bulgaria from 2000 onwards



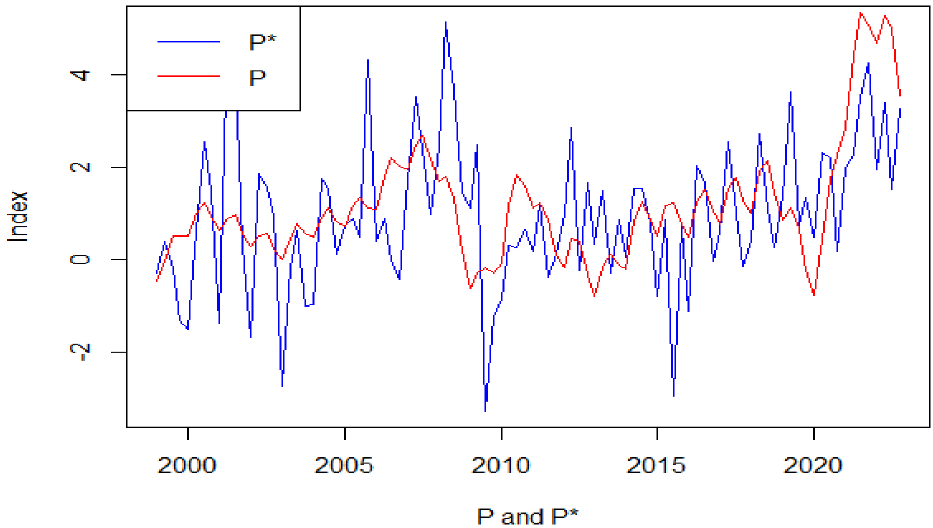
Source: BNB, author's calculations

Figure 3. Velocity of the M2 monetary aggregate



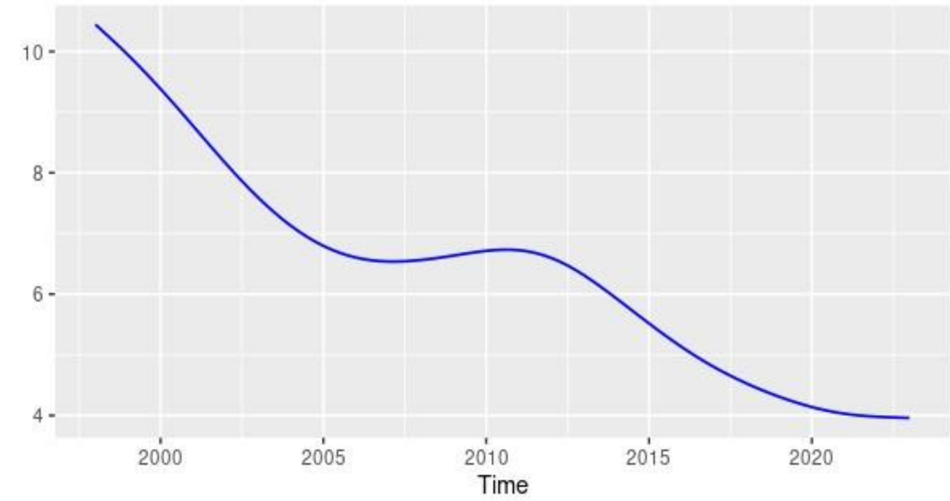
Source: NSI, BNB author's calculations.

Figure 4. Price Gap



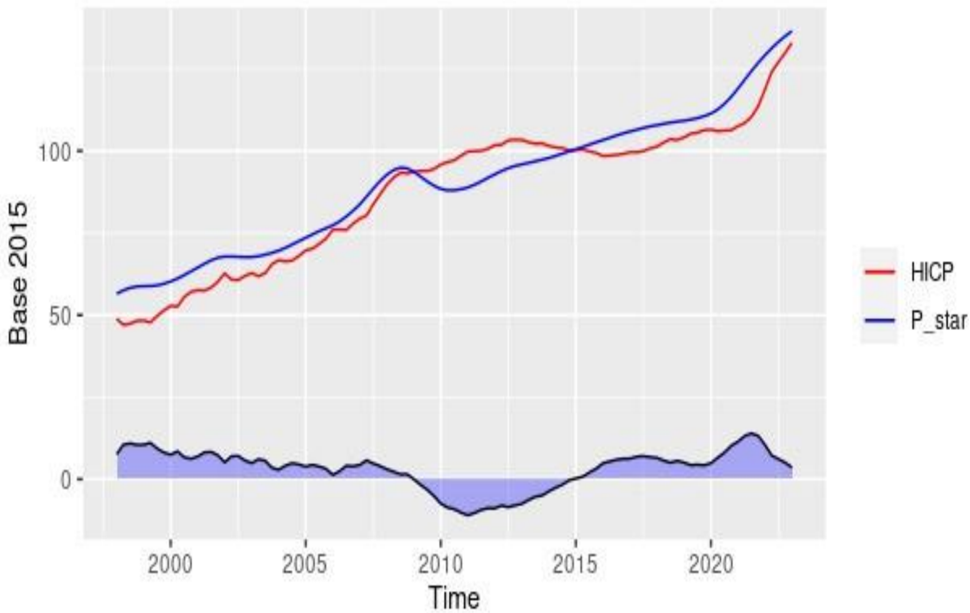
Source: NSI, author's calculations.

Figure 5. Equilibrium price level P* vs observed price level P



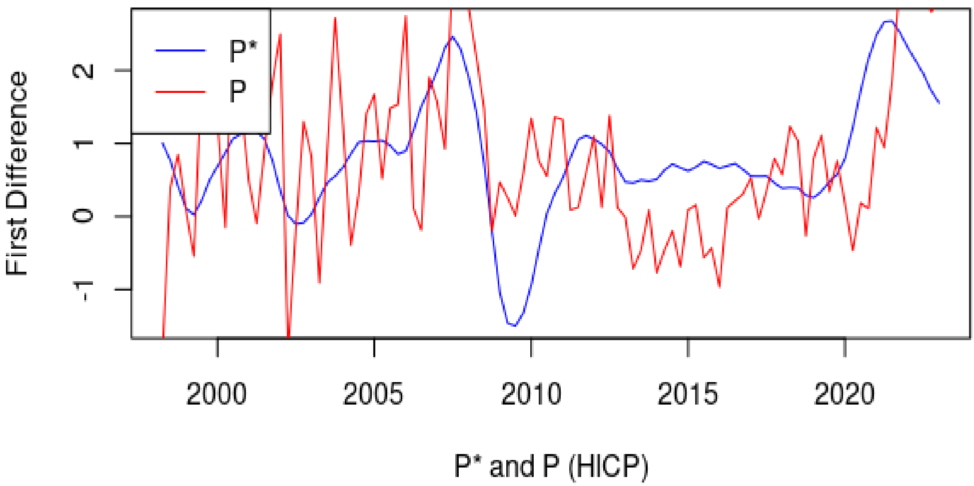
Source: BNB, author's calculations.

Figure 6. Velocity of the Monetary Base



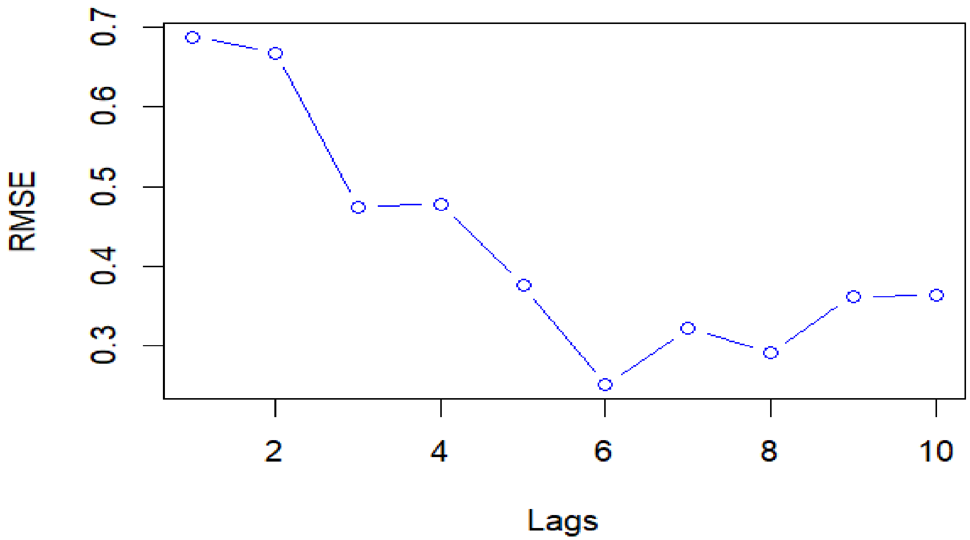
Source: BNB,NSI, author's calculations.

Figure 7. Price Gap



Source: BNB, NSI, author's calculations.

Figure 8. Equilibrium price level P* vs real price level P



Source: Author's calculations

Figure 9. Best RMSE according to lag selection

2. Regressions with different lag selection

Table 4: P* model with deflator and three lags

	Dependent variable:		
	Inflation		
	(1)	(2)	(3)
P-gap$_{t-3}$	0.178***	0.135***	0.089***
	(0.051)	(0.049)	(0.029)
GDP-gap$_{t-3}$)		−0.000***	−0.000***
		(0.000)	(0.000)
Velocity-gap$_{t-3}$		−0.439***	−0.229***
		(0.140)	(0.087)
Inflation$_{t-4}$			0.677***
			(0.165)
Inflation$_{t-3}$			0.309**
			(0.142)
Constant	1.127***	1.947***	0.534***
	(0.125)	(0.290)	(0.201)
Observations	96	96	95
R^2	0.114	0.247	0.753
Adjusted R^2	0.105	0.223	0.739
Residual Std. Error	1.219 (df = 94)	1.136 (df = 92)	0.656 (df = 89)
F Statistic	12.143*** (df = 1; 94)	10.073*** (df = 3; 92)	54.260*** (df = 5; 89)
Note:			*p<0.1; **p<0.05; ***p<0.01

Source: NSI, BNB, author's calculations.

Table 5: P* model with deflator and two lags

	Dependent variable:		
	Inflation		
	(1)	(2)	(3)
P-gap$_{t-2}$	0.109**	0.083	0.065**
	(0.052)	(0.051)	(0.027)
GDP-gap$_{t-2}$		−0.000	−0.000***
		(0.000)	(0.000)
Velocity-gap$_{t-2}$		−0.451***	−0.209**
		(0.149)	(0.085)
Inflation$_{t-3}$			0.653***
			(0.160)
Inflation$_{t-2}$			0.363***
			(0.138)
Constant	1.134***	1.980***	0.427**
	(0.128)	(0.306)	(0.195)
Observations	97	97	96
R^2	0.045	0.143	0.768
Adjusted R^2	0.035	0.115	0.755
Residual Std. Error	1.263 (df = 95)	1.209 (df = 93)	0.638 (df = 90)
F Statistic	4.443** (df = 1; 95)	5.174*** (df = 3; 93)	59.506*** (df = 5; 90)
Note:			*p<0.1; **p<0.05; ***p<0.01

Source: NSI, BNB, author's calculations.

Table 6: P* model with HCPI and three lags

	Dependent variable:		
	Inflation		
	(1)	(2)	(3)
P-gap$_{t-3}$	0.080***	0.078***	0.072***
	(0.019)	(0.020)	(0.018)
Expenditure-gap$_{t-3}$		0.000	0.000
		(0.000)	(0.000)
Velocity-gap$_{t-3}$		−0.170	−0.227
		(0.307)	(0.303)
Inflation$_{t-3}$			0.162
			(0.115)
Inflation$_{t-4}$			0.330***
			(0.119)
Constant	0.614***	0.619***	0.308**
	(0.130)	(0.132)	(0.145)
Observations	96	96	95
R^2	0.157	0.160	0.309
Adjusted R^2	0.148	0.133	0.270
Residual Std. Error	1.148 (df = 94)	1.158 (df = 92)	1.066 (df = 89)
F Statistic	17.498*** (df = 1; 94)	5.862*** (df = 3; 92)	7.958*** (df = 5; 89)
Note:			*p<0.1; **p<0.05; ***p<0.01

Source: NSI, BNB, author's calculations.

Table 7: P* model with HCPI and two lags

	Dependent variable:		
	Inflation		
	(1)	(2)	(3)
P-gap$_{t-2}$	0.080***	0.073***	0.065***
	(0.019)	(0.019)	(0.018)
Expenditure-gap$_{t-2}$		0.000	0.000
		(0.000)	(0.000)
Velocity-gap$_{t-2}$		−0.647**	−0.774**
		(0.297)	(0.300)
Inflation$_{t-2}$			0.180
			(0.111)
Inflation$_{t-3}$			0.199*
			(0.115)
Constant	0.609***	0.632***	0.385***
	(0.129)	(0.128)	(0.141)
Observations	97	97	96
R^2	0.160	0.202	0.311
Adjusted R^2	0.151	0.176	0.273
Residual Std. Error	1.141 (df = 95)	1.123 (df = 93)	1.061 (df = 90)
F Statistic	18.038*** (df = 1; 95)	7.835*** (df = 3; 93)	8.123*** (df = 5; 90)
Note:			*p<0.1; **p<0.05; ***p<0.01

Source: NSI, BNB, author's calculations.

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