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Measuring Russia's Core Inflation: A Common Trends Approach

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Abstract – In this study, we estimate core inflation in Russia using a common trends model over the period from January 2018 to January 2022. In this framework, core inflation is estimated from the information contained in the following variables: the Consumer Price Index (CPI), the Money Supply (M3), and the Industrial Production Index (IPI). Unlike other commonly used measures such as the structural VAR model, the core inflation obtained by the common trends method has a strong correlation with monetary growth and less volatile than headline inflation. It provides an estimate of underlying inflation based on broader information, integrating macro-economic variables which play an important role in determining the long-term inflation rate. It thus makes it possible to identify the strategies of monetary and budgetary policies making it possible to achieve the inflation target and an economic growth objective.

Keywords – Core inflation, Common trends model, Structural VAR, Monetary policy.

1. Introduction

The headline inflation rate can often be unstable due to large fluctuations in commodity or energy prices.

Because of this instability in a key price indicator, policymakers may have difficulty in properly assessing the core inflation and its outlook, and it may be useful to rely on the core inflation rate, which excludes or minimizes the most volatile price changes in order to highlight the permanent or more durable component.

As a result, Central banks must have a good indicator of the long-term evolution of inflation or be able to isolate this long-term component from the supposed monetary inflation and the short-term price factors that are supposed to be transitory or cyclical.

Faced with this situation, several measures of the core inflation rate have been proposed and used in practice to conduct monetary policy well. One approach relies on the use of estimators with limited influence, such as trimmed means or the (weighted) median, instead of the classical weighted mean calculated over the complete cross-sectional distribution of individual price elements (Bryan and Cecchetti, 1994). Various techniques have been applied to the set of price series variations to measure the underlying inflation component. For example, the technique of simple moving averages calculated over various time periods (from 3 to 6 months up to 36 months, the simple exponential smoothing) where more sophisticated methods (for example, the model of unobservable components, the dynamic factor index), are used to eliminate noise the inflation fluctuation component.

Other measures are used on econometric methods which aim at the economic decomposition of time series into permanent and transient components. In particular, Quah and Vahey (1995) applied a bivariate vector structural (VAR) model to the UK to estimate

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core inflation. This method is based on the assumption of long-term neutrality of permanent shocks of the inflation rate on production.

This document extends the two-dimensional analysis, production and inflation advanced by Quah and Vahey (1995) in a multivariate framework applied to Russia's inflation from January 2018 to January 2022. In this context, we interpret core inflation in Russia as the long-term inflation forecast obtained from a small-scale model of common trends. Stock and Watson (1988); King et al. (1991), built around a (suitably tested) long-run equilibrium relationship between the rate of inflation and what is believed to be its main long-run determinant, the nominal growth rate of the money. In doing so, we follow the approach of Bryan and Cecchetti (1994), who define core inflation as the persistent component of the observed inflation rate, and "that is related in some way to money growth".

Also Quah and Vahey (1995) argue that it would be interesting to allow the monetary variable in the VAR system used to estimate core inflation. Bagliano and Morana (2000)[1] have already provided evidence of a strong long-term relationship between growth in M2 and inflation rate in the US since the beginning of the sixties (60), we interpret and test this relationship in terms of cointegration into a system. In this framework, the identification of permanent shocks is obtained and a measure of inflation is constructed, which only reflects the effect of these permanent disturbances.

2. Expected results

Stable and low inflation in the interest of maintaining balanced and sustainable economic growth is among the main macroeconomic policy objectives in Russia. Through this study we will identify the following points:

- Should the Central Bank of Russia (CBR) target observed inflation or core inflation?
- Is it the interest rate instrument or the fiscal instrument that has more effect on inflation?
- What are the level of economic growth, money supply growth and inflation rate compatible with any core inflation target?

3. Econometrics Methodology: Common Trends Model

The general idea of this measure is to extract the core inflation with a model with common macroeconomic trends of reduced dimension. In this framework, core inflation is interpreted as the long-term forecast of inflation, obtained from the information contained in the variables of the system which are modeled on the basis of their cointegrating properties. The existence of cointegrated relationships between these variables implies that there are long-term equilibrium relationships between them, and that these variables are influenced by a set of common structural shocks. The latter give permanent effects on the cointegrated variables and therefore lead these variables to evolve according to the same stochastic trends. The variables oscillate around their common equilibrium trends and cannot permanently deviate from these trends. When they become of their equilibrium trends, rebalancing mechanisms are put in place to establish the equilibrium situation. Therefore, each variable in the system can be considered as the resultant of two components: one captures its permanent trends which are like with the other variables, and the other gathers its own transitory movements which are conditioned only by the temporary shocks to the system.

In the case of inflation, the common trends of this variable, which can be derived from the common trends model, is considered as the core inflation because it is only conditioned by the permanent shocks of the system. It therefore clearly expresses the underlying movements of this variable. It is from this that Bagliano and Morana developed their approach for a measure of core inflation in the United States, United Kingdom and Italy.

[1] **Bagliano, F. C., &Morana, C. (2003b).**Measuring US core inflation: A common trends approach. Journal of Macroeconomics, 25, pp.197–212.

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Compared to the usual statistical approaches, this method has many advantages. First, it makes it possible to identify and capture the factors that have an impact on the long-term evolution of inflation-something that is completely impossible with purely statistical approaches of the exclusion type (excluding food and energy), weighted average or trimmed mean. Second, this model contains a greater source of information about inflation by including other macroeconomic variables like money supply, in addition to inflation and output.

4. Estimation

According to the quantity theory of money or money demand, we consider a system with three variables, the logarithm of industrial production index (y), the logarithm of money supply M3 (m), and the logarithm of consumer price index (p). The price index series is seasonally adjusted (i.e. seasonally adjusted). Data on the money supply (m), the consumer price index (p), and real production (y) were obtained from Federal Reserve Economic Data. The unit root test presented in Table 1 showed that all the variables are integrated of order 1, i.e. I(1). We used a cointegration test according to the maximum likelihood method of Johansen (1991).

We chose one lag in the long-term specification of the model as suggested by the information from AIC (Akaike Information Criterion). The results of the cointegration tests are shown in Table 2. As expected, the data suggest the existence of a cointegration vector at the 5% significance level. For the normalized eigenvector coefficients, a long-term relationship between production, money supply, and inflation becomes clear. Nominal production has a very low coefficient (close to zero). As shown in Table 2, a formal test cannot reject the hypothesis that the cointegrating vector captures the real money constancy (m-p) in the long run. This restriction was therefore imposed in the rest of the analysis.

Within the framework of a model with common trends described in the previous section, the existence of one cointegration relationship between the three variables implies the presence of two different sources of shocks having permanent effects at least on part of the variable. We make the following assumption about the nature of the two permanent shocks in the system: we consider a nominal supply shock (φ_y) driven by movements in the nominal supply shock throughout the period studied, and a monetary shock (φ_m) that the source of this latter shock has no long-term effect on output (a long-term neutrality assumption).

Table1 : Unit root test

Variables	Trend significance	Augmented Dickey-Fuller statistics	Critical values			Existence of unit root
			1%	5%	10%	
Log(IPI)=y	With trend	-0.93	-3.57	-2.92	-2.59	Yes
Log(M3)=m	With trend	0.01	-3.50	-2.89	-2.58	Yes
Log(CPI)=p	With trend	1.38	-3.50	-2.89	-2.58	Yes

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Table2 : Cointegration analysis

Hypothesis	λ trace	Trace in 90%	Trace in 95%
r=1	17.93	30.45	29.80
r=2	12.43	12.51	15.41
r =3	0.08	0.08	3.84
Unretricted cointegrating vector :			
	y	m	p
	0.066	1	-1.08
Restricted cointegration vector :			
	y	m	p
	0	1	-1
χ^2 (p-value)		7.312(0,15)	

The permanent part of the common trends representation is then the following bivariate random walk:

$$\begin{pmatrix}\tau_y\\ \tau_m\end{pmatrix}_t = \begin{pmatrix}\mu_y\\ \mu_m\end{pmatrix} + \begin{pmatrix}\tau_y\\ \tau_m\end{pmatrix}_{t-1} + \begin{pmatrix}\varphi_y\\ \varphi_m\end{pmatrix}$$

Where μ_t is a vector of constant drift terms; φ_y and φ_m are respectively a nominal supply shock and monetary shock (two permanent shocks)

The common trends representation of the variables in levels is therefore the following:

$$\begin{pmatrix}y\\ m\\ p\end{pmatrix}_t = \begin{pmatrix}y\\ m\\ p\end{pmatrix}_0 + \begin{pmatrix}c_{11} & c_{12}\\ c_{21} & c_{22}\\ c_{31} & c_{32}\end{pmatrix}\begin{pmatrix}\tau_y\\ \tau_m\end{pmatrix}_t + C(L)\begin{pmatrix}\tau_y\\ \tau_m\\ \gamma\end{pmatrix}_t$$

The estimated core inflation series from common trends model is then computed as:

$$p_t^{CORE} = p_o + c_{31}\tau_{y,t} + c_{32}\tau_{m,t}$$

This estimate takes into account the long-term effects on inflation by a set of identified permanent shocks and allows interpretation of long-term inflation, when all transitory inflation shocks have disappeared.

The procedure of Quah and Vahey (1995), applied to a non-cointegrated bivariate system, including production and inflation, would only allow the identification of two permanent shocks and no disturbance of a purely transitory shock was not determined. Core inflation shocks would be identified by imposing a zero restriction on their long-term effect on output and the core inflation series

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would then be constructed using only this type of disturbance. This identification scheme does not make it possible to estimate long-term inflation attributable to movements in nominal supply shocks (which affect production in the long term) and does not exploit the direct long-term link between the money supply and inflation (one of the main features of our study).

Table3 : The estimated common trends model

Long-run effects of permanent shocks

Variable	Supply shock	Monetary shock
Production(y)	0.014	0.000
Money(m)	0.001	0.005
Inflation(p)	0.001	0.005

Long-run forecast error variance decomposition

Variable	Supply shock	Monetary shock
Production(y)	1.000	0.000
Money(m)	0.076	0.924
Inflation(p)	0.076	0.924

The main results of the estimation of the common trends model are presented in Table3 above with the estimated values of the long-term impact matrix and the decomposition of the variance of the variable forecast errors. While examining this table, we noticed certain characteristics on the estimated values of the model. First of all, the supply shock has a positive effect on this variable and does not have a permanent effect on the money supply. And also, its effect on the price level is small (about 0.1 %).Finally, the last two variables (money supply and price) show their positive relationship following a monetary shock verifying the constancy of real money.

Regarding the decomposition of the variance of the long-term forecast errors, the table3 explains that 92% of the variance of the money supply and inflation can be attributed to the monetary shock. This means that in the long term inflation is always a monetary phenomenon.

Following a money supply shock, prices quickly converge to their long-term levels, which explains the very short-term effect of money supply shocks on the level of production (the assumption of the neutrality of the money was always verified).

5. Graphic analysis

Below graphs 1 and 2 that we obtained during our estimation (in percent)

GRAPH1: OBSERVED INFLATION (INFCPI), COREINFLATION (COREINFL) AND CORETRANSIT (transitory inflation interpreted as additional demand) (year –on-year)

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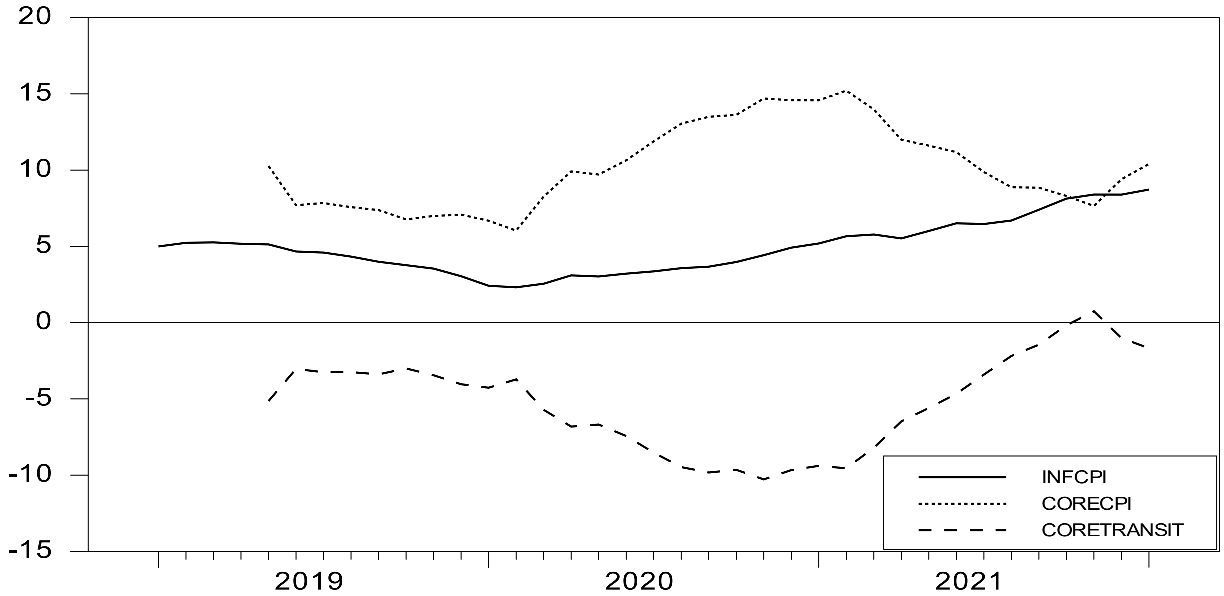
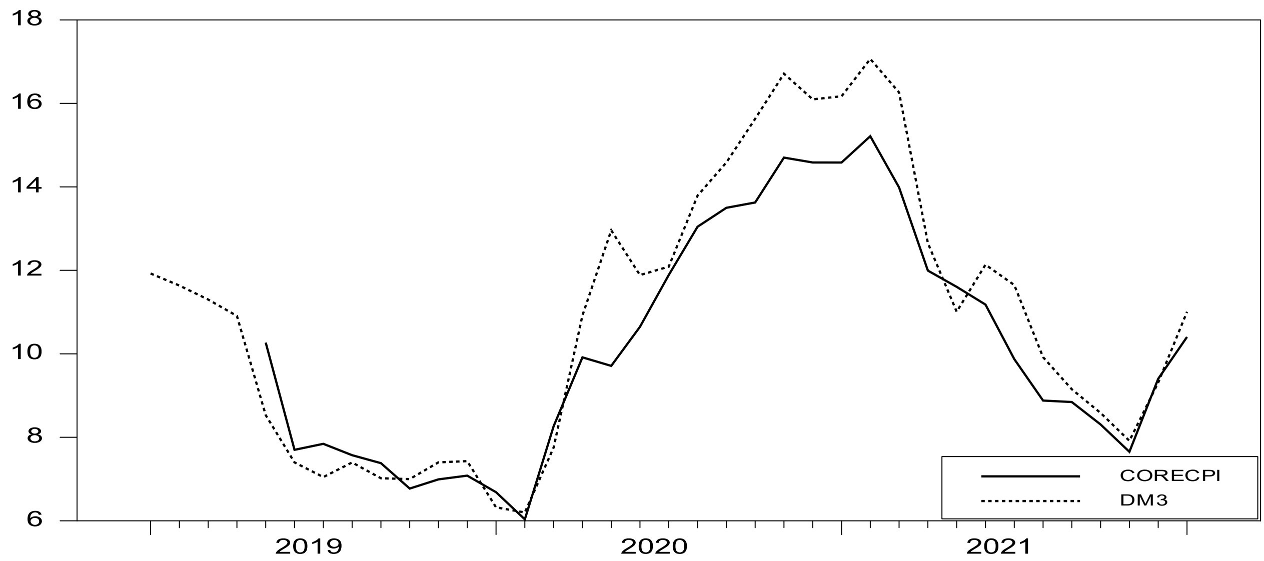


GRAPH2: COREINFLATION (CORECPI) AND MONEY SUPPLY M3 (DM3)

(Year –on-Year)



Graph1 shows us that the core inflation always remains above the observed inflation during the period studies and has never fallen above 6%. Since 2001, Russia's central bank has raised its key interest rate nine times to counter rising inflation and to counter the fall of the ruble. But this didn't yield any expected results on observed inflation and on core inflation. This means that Russia central bank has never reached its 4% target since January 2021.

According to the quantity theory of money or according to the simple monetarist model, any monetary increase greater than that in volume activity would result in an upward adjustment in trend inflation (or core inflation). For the case of the Russia, empirical analyze (Graph 2) show us that changes in the money supply is well and well correlated with changes in the core inflation.

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One possible explanation would be to say that excess money in circulation would be allocated more to the consumption of goods and services (consumer loans) than to financial investments (stocks, real estate, bonds). Consequently, increase in the money supply would generate high core inflation in highly financialized economy like the Russia.

Another explanation would also be to say that the Russian population, with very low purchasing power and in continuous decline for several years, is contracting more and more credits for its purchases or quite simple make ends meet. It also means that people don’t have money, so they take credits.

6. Empirical criterion

To ensure the reliability of the measures of the common trends model, a more scientific evaluation is necessary to understand if the estimated measures are compatible with the inflationary trend to come. Before assessing the predictive accuracy, we also examine some basic characteristics of underlying inflation using several criteria proposed in the literature. First, we examine unbiasedness, volatility, and how basic measures relate to variables such as the money growth rate.

In this regard, we present the standard deviation, and the correlation between core inflation

and the change in the M3 money supply shown in Table4. One of the important basic criteria is that underlying inflation must be unbiased to headline inflation. This implies that in the long run, the difference between average headline inflation and core inflation must be zero.

Looking at Table4, we noticed some following points.

First, the volatility analysis (based on standard deviation comparison) shows that the measure of underlying inflation based on a structural VAR is more volatile than headline inflation with the exception of the measure of underlying inflation based on a common trends model. This means that the volatility of core inflation based on a theoretical model is statistically significantly lower than that of headline inflation. Second, the correlation coefficients indicate that the measure based on the structural VAR is weakly correlated with money growth, but the correlation between core inflation based on a common trends model and money growth happens to be the largest with a high level of statistical significance. In short, the statistics in Table4 show that the core inflation based on a common trends model still meets the basic criteria of the study.

Table4: descriptive statistics of inflation

Variables	Standard deviation	Correlation with money growth M3
Observed inflation(ACTINFL)	1.75	0.08
SVAR inflation(CORESVAR)	1.79	0.34
Trend inflation(CORETREND)	0.02	0.97

7. Short-term forecasts of observed inflation and core inflation with STAR model:

Smooth transitions autoregressive models was initially introduced by Bacon and Wats(1971) and later popularized by Teräsvirta (1994,1998).

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Smooth transitions models STAR are state-dependent, on linear time serie model, where the variable varies two extreme regimes. In the case of Smooth transitions autoregressive model STAR, predetermined variable are lags of the dependent variables and regimes are endogenously determined:

$$y_t = \sum_{j=0}^{k-1} 1_j(s_t,c,\gamma)Z_t'\gamma_j + X_t\alpha + \varepsilon_t \quad (1)$$

$1_j(.)$ is a (0,1) regime indicator depending on the observed variable s_t

C is one or more thresholds

$\gamma > 0$ is the slope parameter of threshold

Z denotes the variables varying coefficients across the k regimes and X are the variables with regime invariant coefficients. Restricting ourselves to k = 2, as using the fact $1_j(.) = 1$ for exactly one j, equation (1) can be written as:

$$\begin{aligned} y_t &= 1_j\,(s_t, c,\gamma)Z_t'\gamma_0 + 1_j\,(s_t,c,\gamma)Z_t'\gamma_1 + X_t\alpha + \varepsilon_t \\ &= (1-1_j\,(s_t, c,\gamma))Z_t'\gamma_0 + 1_j\,(s_t,c,\gamma)Z_t'\gamma_1 + X_t\alpha + \varepsilon_t \quad (2) \end{aligned}$$

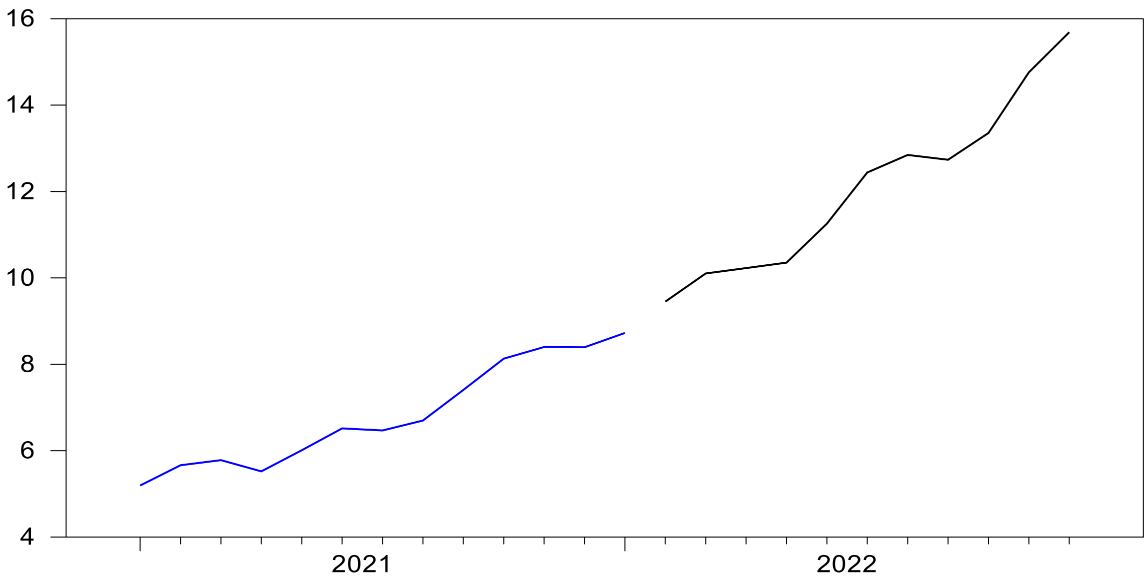
To construct the two-regimes STAR model, the indicator function must be replaced with continuous transition function H that returns values between 0 to 1. Then, we have:

$$y_t = (1-H\,(s_t, c,\gamma))Z_t'\gamma_0 + H\,(s_t,c,\gamma)Z_t'\gamma_1 + X_t\alpha + \varepsilon_t \quad (3)$$

Where, H has different properties as $s \to -\infty$, $s \to +\infty$ and $s = c$, depending on the specific functional form. The key modeling choices in, are the choice of the threshold variables s and the selection of a transition function H. For a given s and H, we may estimate the regression parameters (γ_0, γ_1, α) and the threshold values and slope (c, γ) with non linear least squares.

Below the forecast results obtained by the STAR model:

GRAPH 3: INFLATION RATE (IN PERCENT, YEAR-ON-YEAR)



Graph4: CORE INFLATION (IN PERCENT, YEAR-ON-YEAR)

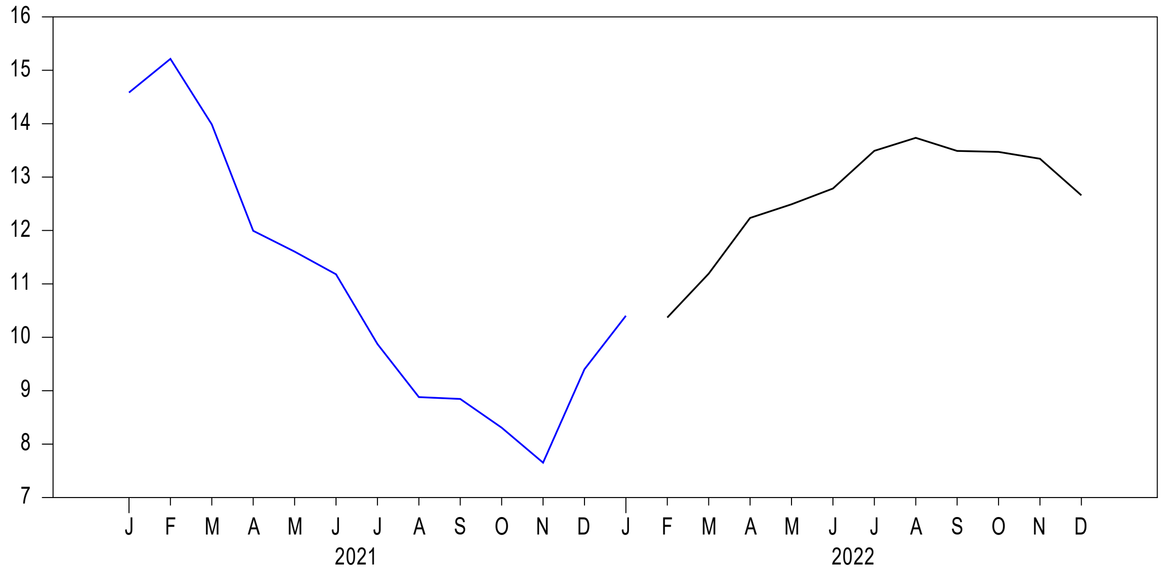


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Table 5: inflation rate and core inflation

	INFLATION RATE	CORE INFLATION
February 2022	9.4501	10.3708
March 2022	10.1028	11.1910
April 2022	10.2272	12.2354
May 2022	10.3532	12.4905
June 2022	11.2553	12.7859
July 2022	12.4404	13.4918
August 2022	12.8459	13.7343
September 2022	12.7347	13.4891
October 2022	13.3545	13.4712
November 2022	14.7594	13.3432
December 2022	15.6865	12.6595

Graphs 3, 4 and table5 explain to us that observed inflation and core inflation in Russia still remain above 10% from March 2022.

For observed inflation, this situation is due to the rise in the price of raw materials (oil, gas, wheat, etc…) and the rise of in the price of basic necessities (sugar, food oil, bread, etc…).

For the core inflation, this situation is due to the decrease in production and the increase in the money supply.

Moreover, the continuation of fiscal and monetary policies in Russia leads to an increase in the money supply and to increases in observed inflation and core inflation. This also means that an increase in the budget deficit by 1% of GDP over a quarter would lead to an increase in inflation from 1 to 1.2%, while an increase in the M3 money supply by 1% would lead to an increase in core inflation to 0.9%.

8. Conclusion and recommendation

We are trying to build a benchmark that can serve as an indicator of the upcoming inflationary trend. For this, we use monthly historical data for the period from January 2018 to January 2022, and we obtain two measures of underlying inflation from two different methods: the structural VAR method and a common trends model. Core inflation measures are subjected to empirical evaluation to serve as a predictor of future inflationary trends. In this regard, we examine whether core inflation satisfies the following empirical criteria such as unbiasedness, volatility, and high correlation with money supply.

Of these two measures, the estimates calculated from a common trends model appear to have met the empirical criteria used to substantiate core inflation as a predictor of future inflation. Moreover, the model-based measure of underlying inflation outperforms the structural VAR technique if we observe the characteristics of underlying inflation. However, the successful application of the model for monetary authorities is highly dependent on the availability and reliability of data. On the other hand, the central bank can potentially use core inflation based on a theoretical model for internal policy decisions.

Finally, it would be important to prohibit the subscription of new loans to households which already devote more than 50% of their monthly income to repayments and it's necessary to use the monetary instrument instead of using the interest rate instrument according to the Poole model.

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