The Effect of Interest Rates on Economic Growth

by

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Abstract

This paper explores the mechanisms, direction and extent to which interest rates can affect economic growth. The authors analyze theoretical concepts and international economic practices in high-interest-rate environments to justify that high nominal and real interest rates may not dampen economic growth if there are mechanisms such as low inflation expectations, economy's attractiveness to foreign investors, the technological transfer effect, the accumulation of domestic savings. By using a structural vector autoregression (VAR) to evaluate econometrically the effectiveness of the interest rate channel of Bank of Russia's monetary policy transmission mechanism, the paper provides evidence to suggest that interest rate policy is partially efficient after the global financial crisis.

Keywords: monetary policy, inflation, inflation expectations, nominal interest rate, real interest rate, economic growth, interest rate channel, SVAR model

JEL Classification: E20, E31, E52, E58, G15

The Effect of Interest Rates on Economic Growth

1. Introduction

Interest rates is a key indicator for financial markets, which has a strong effect on the economy as a whole. However, the mechanisms and direction of relationships between interest rates and economic activity are extremely difficult to investigate. Also, the management of short-term interest rates is an important element of monetary policy in any country, including in Russia. In particular, the Bank of Russia raised the key interest rate to 17% in December 2014 amid geopolitical tensions, plunging Russian ruble, accelerating inflation, and therefore this led to an increase in interest rates across the country. Since then, the matter of whether or not to cut interest rates has become the subject of increasing debate in Russia. On the one hand, the decision to tighten the monetary policy was intended to stabilize the foreign exchange market and hence inflation. On the other hand, high interest rates tend to stall the pace of economic recovery, as evidenced by most of the theoretical models. For example, a program drafted by the Stolypin Club[1] (an expert forum of Russian entrepreneurs and lead economists) builds on, among other things, the concept of lowering interest rates on loans for the private sector in order to encourage growth.

Note that the Bank of Russia announced its intention to switch to an inflation-targeting regime by 2015. And so it did, after transforming its monetary policy, including the transition to using the key interest rate which reflects where monetary policy is heading, and after completing the interest rate band formation in 2013. Efficient implementation of interest rate policy and the effectiveness of the interest rate channel of monetary policy transmission are known to be critical for successful transition to the inflation-targeting regime. A study of this subject based on pre-crisis data [1] provides evidence that the interest rate was not an efficient monetary-policy instrument and that the key role for the transmission mechanism of monetary policy was attributed to the channels of exchange rate and of bank loans. Also, note that the growth in ruble-denominated interest rates could not affect the borrowing rate amid foreign capital inflows in the banking sector during the pre-crisis period because foreign exchange rates remained low and the ruble's appreciation made foreign-currency loans look even more lucrative against the backdrop of high key interest rate.

[1] http://stolypinsky.club/economica-rosta/

However, the situation gradually improved after the crisis of 2008−09. Conditions for enhancing the efficiency of certain stages of the interest rate channel of monetary policy transmission mechanism were created as a result of enhancing the elasticity of exchange rate formation mechanisms, changing sources of the broad monetary base formation (the Bank of Russia reduced its currency interventions and increased its lending to the banking sector), broadening the range of Bank of Russia's liquidity providing/absorbing instruments.

Thus, it is pertinent to investigate whether the Russian economy responds to interest rate changes and, if it does, how it responds to them. A respective investigation uses empirical data to evaluate the effectiveness of the final stage of the interest rate channel of monetary transmission or to evaluate the extent to which changes in retail and corporate loan interest rates can affect the real economy's key performance figures. In addition, it is of special interest to answer the question of whether it is only low and not high interest rates that can attend economic growth. Note that this subject is difficult to study because interest rates are endogenous. The majority of economic models show that the interest rate itself is influenced by many aspects, such as money supply, technology shifts, output. It therefore seems impossible to elucidate explicitly causal-effect relationships between interest rates and economic growth.

2. Theoretical models of relationship between interest rates and economic growth

Various theoretical concepts differ largely in tracing the direction in which interest rates can affect economic growth. Many approaches to analyze the investment channel show that the relationship between interest rates and output is negative. For example, Tobin's monetary growth model (see Tobin J. [2]) posits that a higher real yield on money as an alternative asset to capital has a negative effect on demand for capital in the medium term, but it says nothing about the short-term period. Monetary authorities can affect the investable premium (the term was originally introduced by James Tobin) by influencing the supply/demand for money or other alternative assets, thereby changing the yield on money. Another theory, also known as Tobin's q (see Tobin J. [8]), shows that stock prices rise as a result of a deposit rate cut, boosting, according to the model, investment and hence output.

Like Neo-Keynesian models (see Wickens M. [11]), the neo-classical theory of investment (see Haavelmo T.A. [6] and Jorgenson D. [7]) posits that the negative relationship between interest rates and output is accounted for by the real interest rate negative effect on firms' cost of capital. The real business cycle theory (see Kydland F.E., Prescott E.C. [12], Hansen G. [13] and King R., Watson M. [14]) as well as cash payment models (see Fuerst T.S. [18] and Alvarez F., Atkeson A., Kehoe P.J. [19]) show that interest rate growth as a result of technology shock leads to a fall in labor supply and thus adversely affects output. Equilibrium theories of the business cycle (see

Lucas R.E. [15], Tobin J., Brainard W.C. [16] and Fischer S. [17]) show that an increase in anticipated inflation rates lowers the expected real interest rate and triggers a shift in the investment portfolio, which is also detrimental to output.

Some models show that the interest rate has a mixed effect on output. For example, the theory of irreversible investment (see Arrow K.J. [9], Bertola G., Caballero R.J. [10]) states that an interest rate hike, on the one hand, has an adverse effect on output because of growth in the cost of borrowing, and, on the other hand, it has a positive effect on output because of increasing investment activity in the current period, with economic agents expecting further growth of interest rates and, therefore, of costs associated with putting off the investment decision. In addition, open economy models (see Wickens M. [11]) discover the mechanisms by which the interest rate can affect output; in particular, an interest rate growth leads to local currency appreciation which on the one hand boosts import volumes for intermediate products (materials and means of production, i.e., capital investment) and output, while on the other hand it is a factor that deteriorates the competitiveness of locally manufactured products and, therefore, of net exports and output (the consumption channel). The open economy models thus show that the interest rate has a mixed effect on economic growth.

When analyzing the consumer channel, a special emphasis is given to the intertemporal consumer choice, in which case the ratio of net creditors to net borrowers in the economy is the key for tracing the direction in which interest rates affect output. Both neo-classical growth models (see Acemoglu D. [20]) and Neo-Keynesian models (see Wickens M. [11]) explain that positive relationship would be observed between the interest rate and output if the economy is dominated by creditors because an interest rate rise would boost their revenues and, therefore, consumption and output, whereas the relationship would be negative if the economy is dominated by borrowers whose revenues would decline as a result of an interest rate rise.

Also, note that the real interest rate has a positive short-and mid-term effect on economic growth in response to financial liberalization, according to the McKinnon-Shaw approach (see McKinnon R.I. [3] and Shaw E.S. [4]). Financial liberalization means keeping interest rates rising until they reach equilibrium levels that are appropriate for a competitive free market. Financial liberalization comes after a period of financial repression, when interest rates are maintained at an artificially low equilibrium level, thus having an adverse effect on the accumulation of savings and on setting the stage for further investment. Furthermore, the "neo-structuralist" approach (see Lin J.Y. [5]) predicts a stagflation, i.e., accelerating inflation and slowing economic growth as a result of financial liberalization in the short term. In the medium term, the saving rate may reach a high enough level to offset the effect of asset portfolio adjustment. In general, the neo-

structuralists believe that the effect of income turns out to be stronger than the effect of savings, and they predict a negative effect of real interest rates on economic growth.

Note that the real interest rate is regarded as endogenous by the foregoing concepts, that is, the real interest rate varies as a result of shocks of the nominal or real variables of the model and of their spreading to other variables of the economic system.

Conditions of optimality obtained from solving the macroeconomic problem of a profit-maximizing firm indicate that the real interest rate equals the marginal product of capital. Generalizing this approach to the economy at large, which is used particularly in dynamic stochastic general equilibrium models, allows saying that real interest rates may be high in countries with high marginal product of capital, which, according to the assumption of diminishing marginal product, can be seen only in (developing) countries with insufficient level of capital stock.

The premise of real interest rate exogeneity can be usefully applied only when it comes to certain components (sectors) of the aforementioned models. In particular, the process of fixed capital formation in complex dynamic general equilibrium models is most often presented by the theory of irreversible investment according to which the real interest rate is exogenous, which leads to the conclusion that interest rates can affect economic growth rates. Households' behavior in the foregoing models is generally described based on the life cycle theory and the permanent income hypothesis, both of which also assume that the real rate of return on accumulated wealth is exogenous. These premises also allow concluding that interest rates (yield) have a unidirectional effect on economic growth.

Thus, all the channels through which the interest rate affects the real economy can be reduced to the investment channel or the consumption channel. The existing theoretical approaches that explain the relationship between interest rates and economic growth are classified in Table 1. Many of the presented theoretical models show that real interest rates are negatively related to economic growth, whereas a series of approaches reveal that real interest rates have a positive effect on economic growth rates. Note that these approaches are based on fairly strong assumptions. For example, the theory of irreversible investment suggests that agents anticipate further growth in interest rates, and Neo-Keynesian models indicate that the economy requires a bigger share of households as creditors. Thus, the academic literature shows that the relationship between interest rates and economic growth rates can be both negative and positive depending on the premises underlying particular models.

Table 1. Classification of theoretical models that consider the effect of interest rate on economic growth

Channels	Interest rate effect on output		
	Positive	Negative	Mixed (there can be positive and negative effects depending on various mechanisms)
Investment channel	The McKinnon-Shaw hypothesis (McKinnon, 1973; Shaw, 1973)	Tobin's monetary growth model (Tobin, 1965); The neo-classical theory of investment (Haavelmo, 1960; Jorgenson, 1963); The Tobin's q theory (Tobin, 1969); Neo-Keynesian models (Wickens, 2008); The real business cycle theory (Kydland and Prescott, 1982; Hansen, 1985; King and Watson, 1995); "Equilibrium" theories of the business cycle (Lucas, 1975; Tobin and Brainard, 1977; Fischer, 1979); Cash payment models (Fuerst, 1992; Alvarez, Atkeson, Kehoe, 2002)	The theory of irreversible investment (Arrow, 1968); Bertola and Caballero, 1994); Open economy models (Wickens, 2008)
Consumption channel	Open economy models (Wickens, 2008)		Neo-Keynesian models (Wickens, 2008); Neo-classical growth models (Acemoglu, 2008)

Source: own compilation.

The question that remains to be answered is whether real or nominal interest rates should be applied when analyzing the relationship between the interest rate and economic growth. On the one hand, based on the assumption of perfect global capital markets, of no money illusion,[2] and of strong wealth and redistribution effects associated with fixed-interest rate assets[3], the economic theory considers the real interest rate as a variable associated with economic growth rates. On the other hand, the nominal interest rate is essential when considering the effect of cash flow on economic agents' behavior and on market performance (see Minsky H.P. [21] and [22]). This is explained by the fact that a nominal interest rate rise – even if such rise exclusively accounts for a well-predicted increase in inflation – has a very strong effect on cash flows.

[2] Money illusion describes the tendency of economic agents to think in real terms about nominal changes in values (e.g., prices, wages, return on assets), disregarding change in the purchasing power of money.
[3] For example, wealth will be redistributed from borrowers to savers as a result of a rise in deposit interest rates.

There is complexity in calculating the real interest rate because it requires evaluation of inflation expectations which are modeled as part of a separate task. In practice, inflation and the nominal interest rate do not vary synchronically, i.e., the real interest rate varies over time, but changes in the nominal interest rate and in inflation tend to move in the same direction. Practice also shows that the real interest rate in developing countries varies substantially over time, whereas it is stable enough in developed countries. In addition, the nominal interest rate and inflation in developing countries are higher than in developed countries.

There are known two principal ways of calculating the real interest rate. The ex-post real interest rate is defined as the difference between the nominal interest rate in period t and the actually realized inflation rate in period t, whereas the ex-ante real interest rate is the difference between the nominal interest rate at the point of time t and the anticipated inflation rate. For instance, if the premise of inflation expectations adaptiveness is applied, the inflation rate in period t-1 is subtracted from the nominal interest rate in period t. When rational expectations are analyzed, the ex-ante real interest rate coincides with the ex-post interest rate. In practice, the divergences between ex-post and ex-ante interest rates describe the specifics of economic agents' inflation expectations and the extent to which they deviate from the actual inflation data.

Note that the extent and direction in which nominal and real interest rates affect economic growth rates depend largely on the level of economic development, institutional environment features, macroeconomic situation, etc. We will now consider, using Russia and some foreign countries as an example, the conditions and mechanisms by which interest rates can affect economic growth.

3. Analysis of international practices and of situation in Russia

There are international examples of interest rates having a positive effect on economic growth. The practice of some countries, particularly of Brazil (2000−2008), Turkey (2002−2007), India (1980−2013) and Chile (1984−2013), shows that economic growth can be seen in high-real-interest-rate environments. A macroeconomic analysis of the foregoing countries shows that medium and long-term economic growth rates can be high amid high interest rates if the following mechanisms are present in the economy.

First, a rise of interest rates contributed to a decline in the inflation rate and inflation volatility, which was relevant for the Brazilian, Turkish and Chilean economies because they suffered from severe foreign-exchange and/or banking crises before entering periods of high economic growth.

Second, high interest rates made these economies more appealing to foreign capital and therefore they attracted foreign direct and portfolio investments. Third, high interest rates

encouraged households to accumulate savings, which created the resource base for further expansion of domestic fixed investment and indicated, according to classical economic growth models, that the initial level of fixed capital was insufficient in the economy. The fourth and the last mechanism was most pronounced in India and Chile, which were experiencing long periods of high economic growth financed with accumulating domestic savings. Note that the decline in the cost of technology imports as a result of the local currency appreciation induced by high domestic interest rates had a positive effect on economic growth rates in Brazil.

Note that high rates of growth in the above countries were also encouraged by institutional reforms. Turkey implemented a banking reform (restructuring, privatization, as well as banking supervision changes), trade liberalization, a tax reform (corporate profit and income tax cuts), a labor market reform which contributed to a substantial growth in the proportion of women in the labor force. In addition, the privatization of state-owned enterprises triggered inbound capital flows. A pension reform in Chile encouraged the accumulation of savings and enhanced the national financial system. India's polices aimed at developing the banking system and other financial institutions created incentives for growth in money savings. A comparative analysis of a series of indicators for the above countries is presented in Table 2.

Table 2. Comparative analysis of indicators in selected countries

	Turkey	**Brazil**	**Chile**	**India**
Period of growth	2002-2007	2000-2008.	1984-2013	1980-2013
Periods of crisis	Foreign-exchange crisis of 2001	Foreign-exchange crises of 1999 and of 2001	Banking crisis of 1981-1984	_____
Average economic growth rate	6.8%	3.7%	5.6%	6%
Average nominal borrowing interest rate	29.5% (deposits)[4]	52.8%	18.2%	14.1%
Average ex-post real borrowing interest rate	11.1% (deposits)	43.1%	8%	5.4%
Inflation	Down to 8.8% from 45%	Down to 5.7% from 7.0%	Down to 1.8% from 19.9%	Around 6% on average (lowest - 0.5%, highest 9.6%)
Gross domestic investment, % of GDP	Up to 21% from 18%	18% in 2000 and 2008; upward trend was observed	Up to 23.8% from 12.4%	Up to 33% from 18%
Gross domestic savings, % of GDP	Down to 15% from 18%	Up to 15% from 14%, with an uptrend	Up to 20.6% from 2.3%	Up to 32% from 20.2%

[4] The data for Turkey's borrowing interest rates are available only for the period since 2009. Deposit interest rate is used as proxy variable.

FDI net inflows (US$ billions and % of GDP)	Up from $1.1bn to $22.1bn and from 0.5% to 3.4% of GDP	Up from $32.8bn to $50.7bn; down from 5.1% to 3.1% of GDP	Up from $0.08bn to $222bn and from 0.4% to 8.5% of GDP	Up to $28.2bn from $0.08bn and to 1.5% from 0.08% of GDP

Source: own compilation using the data released by the IMF, OECD and World Bank.

Thus, analyses of the theoretical mechanisms by which interest rates and economic dynamics interact with each other and of international practices allow assuming that high nominal and real interest rates may at least not be a constraint on economic growth in Russia if the following mechanisms are present in the economy: lower inflation and inflation volatility would raise economic agents' confidence in the government policy; providing incentives for agents to accumulate savings, thereby creating resources for investment; attracting inbound foreign investment.

However, consideration must be given to the fact that Russia has relatively low real interest rates compared with some of the above developing countries. In Russia, for instance, real interest rates on loans with maturities of 1 year or less issued to non-financial organizations averaged 2.7% p.a. in 2013, 3.3% p.a. in 2014, 0.2% p.a. in 2015, whereas in Brazil (2000−2008), Chile (1984−2013), and India (1980−2013) real lending interest rates for end-borrowers during the reviewed periods of high economic growth stood at 43.1%, 8%, and 5.4%, respectively. The analysis of international practices provides no evidence to support the idea that interest rates is a factor constraining economic growth in Russia, because both nominal and, to a greater extent, real interest rates are by no means high in this country. They experienced some bearish periods (Fig. 1).

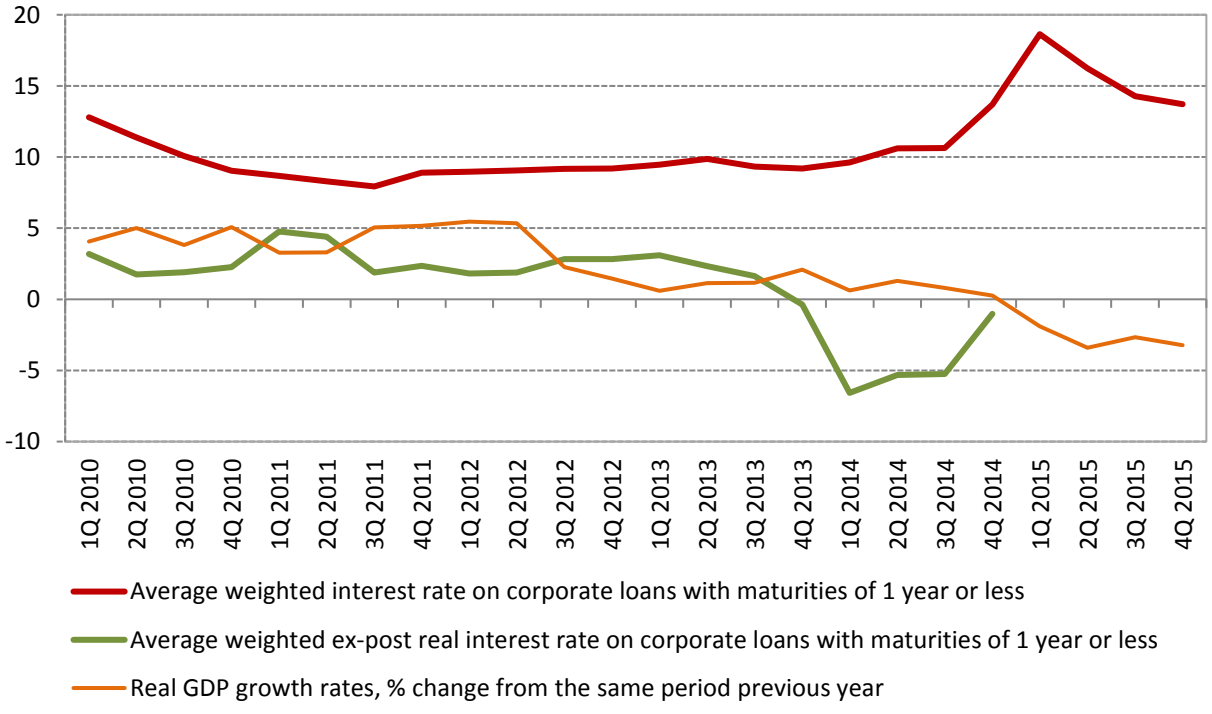


Figure 1. Dynamics of interest rates on loans, of inflation, and of real GDP growth rates

Sources: Rosstat, Bank of Russia, own computation.

It is, thus, of special interest for our research to assess the extent to which interest rates can affect economic growth in Russia, as well as the sensitivity of various macroeconomic indicators to movements in interest rates. Such relationships can be assessed empirically by evaluating the effectiveness of the interest rate channel of monetary policy transmission mechanism.

4. Analysis of the interest rate channel effectiveness for Russia

When evaluating the effectiveness of the interest rate channel for Russia, we employ a partial equilibrium approach in which we disregard, to some extent, the nature of interest rate shocks, as well as the spreading of shocks to the economic system as a whole. The results thus obtained is just an illustration of a possible direction in which the interest rate can affect output in the Russian environment.

The interest rate channel of the transmission mechanism of monetary policy can be generally viewed as comprising the following three key components:

- the effect of monetary policy rate on the money market rate;
- the effect of interbank interest rate on banking sector's interest rates;
- the effect of banking sector's interest rates on the real economy.

Since the effectiveness of the first and second components was already tested in papers [23] and [24], our research is intended to evaluate the effectiveness of the final stage of the interest rate channel, that is, analyze the effect of bank lending rates on the real economy dynamics.

4.1 The practice of empirical evaluation of the interest rate channel effectiveness

Empirical evaluation of the interest rate channel significance is traditionally performed using vector autoregression (VAR) models [25], [26], [27], [1] and structural vector autoregression (SVAR) models [28], [29], [30] which allow constructing impulse response functions to analyze monetary policy shocks to the real economy. Furthermore, correct identification of such shocks is a key for obtaining reliable impulse response functions. To this end, some papers evaluate SVAR models with sign restrictions on coefficients [28], [31], as well as vector autoregressions in which monetary policy shocks are defined by a variable expressed as deviation of the actual monetary policy rate from its model values obtained on the basis of the monetary policy rule [29], [28]. In addition, for the purpose of analyzing how stable the results of construction of impulse response functions are, the authors employ alternative approaches to identify structural shocks

while allowing for simultaneous interaction between endogenous variables in the model, as suggested by Bernanke B. [32] and Sims C. [26].

Monetary policy rates [29], [26], [27], [28], interbank interest rates [28], [33], [1], and interest rates on loans to the banking sector [33], [1] are used as a variable describing monetary policy shocks in the empirical literature investigating the interest rate effects on the real economy. Note that there is some literature studying the impact of monetary policy shocks on output growth rates [29], [28]. There are also some literature investigating the impact of monetary shocks on not only output but also individual components of output [26], [27], [33]. For instance, economic growth rates, the dynamics of the industrial production index, consumption, investment, net exports are used as real economy indicators that are potentially sensitive to interest rate shocks. Considering the specific features of the Russian economy, including a short period of free-floating exchange rate regime, it is of special interest to study the interest rate effect on not only output but also some of its components.

4.2 Input data description

In our research, the key macroeconomic indicators for the state of the real economy are the industrial production index, the index of core economic activities' product and service output, and the fixed investment physical volume index. Note that household consumption was replaced (for lack of monthly data for this indicator) with retail trade turnover which describes indirectly the consumer spending dynamics.

Nominal and real interest rates on corporate and retail loans with maturities of 1 year or less (ir_nom, ir_nom_fiz, % p.a.) are used as banking sector's interest rates. Note that, considering a high level of correlation between interest rates on loans and on deposits, calculations using the deposit interest rate for checking the effectiveness of the interest rate channel deliver similar results. Further, when using monthly data, the ex-post real interest rate is calculated as the difference between the nominal interest rate in month t and the inflation accumulated over the next 12 months:

$$ir\_real\_ex\_post_t = ir\_nom_t - \pi_{t+12}. \quad (1)$$

The ex post interest rate is calculated using the data for actual inflation over the next 12 months because there is a lack of some inflation expectation data of the required length that are published (based on public opinion polls) by the Bank of Russia, as well as of data about the inflation-indexed federal bond yields.

Considering the premise of inflation expectations adaptiveness, the ex-ante real interest rate can be calculated as the difference between the current nominal interest rate and inflation over the previous 12 months.

The effectiveness of the final stage of the interest rate channel is checked in the manner described in [28], [29], [30], using a SVAR model in which structural shocks are identified. The benchmark variables are the ruble's real effective exchange rate (reer, as %, Jan. 2005=100%), the ruble-dollar nominal exchange rate (ner, rubles per US$), inflation (cpi, % change from the same period previous year), real personal cash incomes (real_inc_baz, Jan. 2009=100%). Note that, despite the fact that the indicator for real personal cash incomes is distinguished by high volatility and includes, among other things, foreign-currency sale, we think that this indicator describes indirectly changes in personal incomes. The price of Brent oil (US$ per barrel) is the exogenous variable which is considered in all specifications.

The studied time horizon is limited to the period of January 2010 to July 2015 because it is relatively homogeneous in terms of Bank of Russia's monetary policy.

The studied time series are seasonally smoothed using the Census X12 procedure of the Eviews program.[5] All the series, except for interest rates, are logarithm transformed. The results of standard statistical tests for the presence of unit roots indicate that most of the studied time series are characterized by the presence of a stochastic trend and are difference stationary.

We assume that the real interest rate is a first-order integrated series, despite evidence from some formal statistical criteria that the real interest rate is stationary. In our view, it is appropriate to apply this premise for a relatively short time series which is obtained by subtraction from the nominal interest rate inflation during previous (ex-ante) or next (ex-post) 12 months and does not reflect in full the dynamics of marginal efficiency of capital represented by a stationary series in the long term. In addition, real interest rates are made comparable with the other series included in the SVAR model by applying the premise of real interest rates nonstationarity.

We will now consider in detail the dynamics of bank lending rates. The dynamics of interest rates on corporate loans in nominal and real terms is shown in Figure 2. As noted above, our research deals with two (ex-post and ex-ante) types of real interest rates which differ from each other in how expectations are formed, where the ex-ante type is for adaptive expectations and the ex-post type is for rational expectations. Note that the average ex-post and ex-ante real interest rates were positive (1.1−2.6%) during the period under review. However, real interest rates diverged in value at times of abrupt inflationary upsurges leading to discrepancy between

[5] Except for the industrial production index being smoothed using a method developed by the Gaidar Institute, with decomposition into seasonal and calendar components.

economic agents' adaptive and rational forecasts for inflation. With a stable inflation rate, adaptive expectations work better and consist with rational expectations. Note that the widest gap between these interest rates was seen between December 2013 and November 2014, when the ex-post interest rate was found to be far below the ex-ante interest rate (the gap reached a peak of 10.5 p.p. in February 2014), that is, a higher-than-expected actual inflation rate is typical of the period (based on the premise that economic agents' expectations are adaptive). This result is fully consistent with the economic processes that took place at that time, including sanctions, countersanctions, the Russian ruble's collapse in January–December 2014, the worsening geopolitical context, massive capital outflows, and the fall of energy prices. The situation reversed in February 2015, when the actual rate of inflation turned out be lower than expected as the situation stabilized, and the ex-post interest rate was much higher than the ex-ante interest rate.

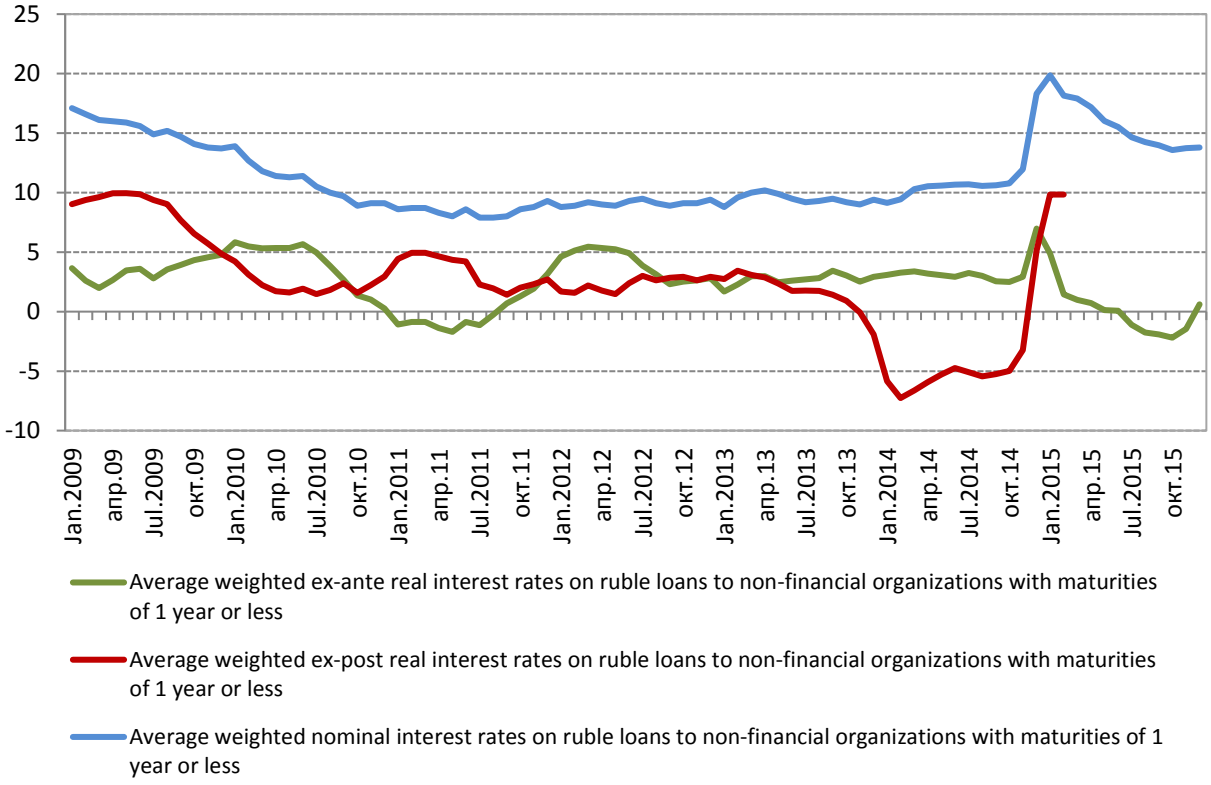


Figure 2. Average weighted ex-ante and ex-post nominal and real interest rates on ruble loans to non-financial organizations with maturities of 1 year or less (%)
Sources: Bank of Russia, own computation.

4.3 SVAR model specifications

In a manner similar to that described in some empirical literature on the interest rate channel effectiveness we evaluate the extent to which real and nominal interest rate shocks can impact the real economy's key indicators using a structural vector autoregression model given by

$$CY_t = b_0 + A(L)Y_{t-1} + B(L)X_t + E_t, \quad (2)$$

where *Y* is the vector of variables, *C* is the matrix with zeros on the main diagonal, *A(L), B(L)* is the matrix lag polynomials of order p-1 and p, respectively, E_t is the vector of structural shocks. Note that, despite the fact that all the time series are first-order integrated, a VAR model can be constructed in levels, and impulse responses obtained using this model will be substantiated at short horizons [34].

We will now consider various options for identifying SVAR-model structural shocks for a particular macroeconomic indicator which is tested for interest-rate sensitivity. Let u_t be reduced-form residuals in equation (2). The residuals can then be associated with structural shocks of various variables through structural models (3)-(4).

A structural model for the industrial production index (ipp_baz, Jan. 2009=100%) (the index of core industrial branches output (baz_otr_baz, Jan. 2009=100%), fixed investment (inv_baz, Jan. 2009=100%) in alternative setups) can be written as

$$\begin{pmatrix} \alpha_{11} & 0 & 0 \\ \alpha_{21} & \alpha_{22} & 0 \\ \alpha_{31} & \alpha_{32} & \alpha_{33} \end{pmatrix} \begin{pmatrix} u_t^{cpi} \\ u_t^{ir} \\ u_t^{ipp} \end{pmatrix} = \begin{pmatrix} \varepsilon_t^{cpi} \\ \varepsilon_t^{ir} \\ \varepsilon_t^{ipp} \end{pmatrix} \quad (3)$$

The first two equations of system (3) show that during the first period inflation is an exogenous variable and the (real or nominal) interest rate on loans responds only to the inflationary shock. The third equation of the system describes the impact of shocks of inflation and of the corporate loan interest rate on the industrial production index (the index of core economic activities' product and service output, fixed investment). Note that the reason for using the indicator for inflation accumulated over the previous 12 months in the system is because Bank of Russia's interest-rate decisions depend on the extent to which the indicator deviates from the target level.

The reason why the ruble-dollar nominal exchange rate as well as the ruble's real effective exchange rate are used instead of using the CPI as most exogenous variables of the system within the scope of alternative specifications is because we think that the interest rate policy in the Russian environment is governed by not only inflationary processes but also the exchange rate which affects the financial stability.

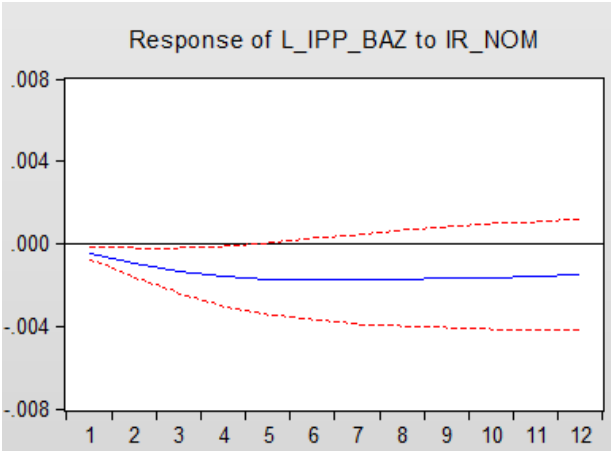
The first two equations of system (4) show that during the first period real personal cash incomes and the (real or nominal) interest rate on retail loans are exogenous variables. The third equation of the system describes the impact of shocks of real personal cash incomes and of the credit interest rate on the retail trade turnover dynamics (rozn_oborot_baz, Jan. 2009=100%).

$$\begin{pmatrix} \alpha_{11} & 0 & 0 \\ 0 & \alpha_{22} & 0 \\ \alpha_{31} & \alpha_{32} & \alpha_{33} \end{pmatrix} \begin{pmatrix} u_t^{real\_inc} \\ u_t^{ir} \\ u_t^{oborot\_rozn} \end{pmatrix} = \begin{pmatrix} \varepsilon_t^{real\_inc} \\ \varepsilon_t^{ir} \\ \varepsilon_t^{oborot\_rozn} \end{pmatrix} \quad (4)$$

Note that in this research the effectiveness of the final stage of the interest rate channel of monetary transmission refers to a significantly negative response of a variable describing the state of the real economy (the industrial production index, the index of core economic activities' product and service output, fixed investment, retail trade turnover) to a positive shock of the interest rate.

4.4 Evaluation results

The evaluation results for the impulse response functions of model (3) are shown in Figure 2. The industrial production index response to a shock of the nominal interest rate on corporate loans has turned out to be negative and insignificant. The real interest rate shocks had no significant affect on the industrial production dynamics (Fig. 3). This can be explained, on the one hand, by a relatively short sample period and, on the other hand, by the fact that the indicator has a weak sensitivity to the Bank of Russia's interest-rate policy. In addition, there is a significant negative response of the index of core economic activities' product and service output after four months following a shock of the nominal interest rate on corporate loans, as well as a fixed investment negative response after five months following the ex-ante real interest rates' shocks (Figs. 4, 5). The obtained results show that the final stage of the interest rate channel is partially efficient in the Russian environment. The economy shrinks marginally as credit interest rates increase. Furthermore, economic agents rely predominantly on adaptive forecasting for inflation in their decision-making on how much fixed investment to undertake.



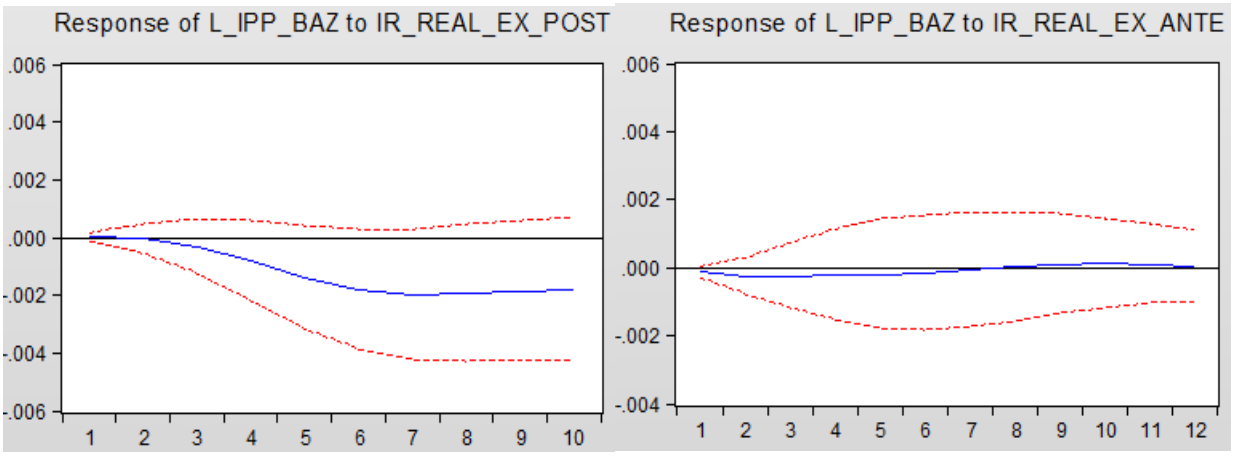


Figure 3. Industrial production index impulse response functions for shocks of corporate loan interest rates

Source: own computation.

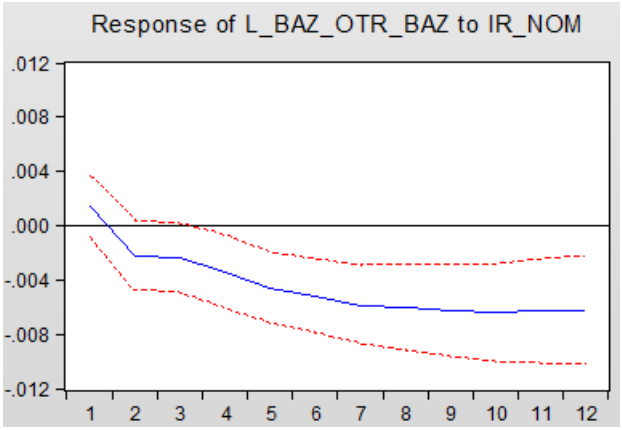


Figure 4. Impulse response function of the index of core economic activities' product and service output for a shock of the nominal interest rate on corporate loans

Source: own computation.

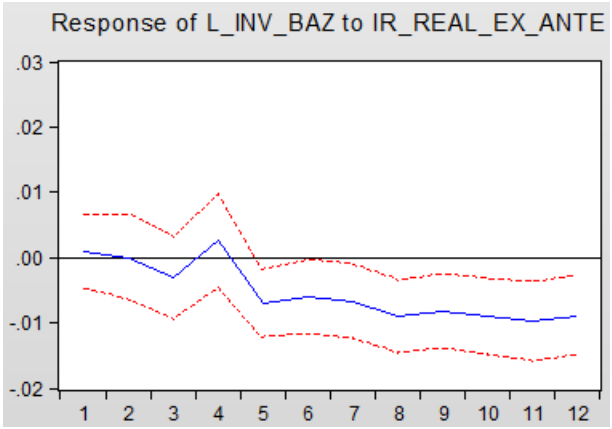


Figure 5. Fixed investment impulse response function for a shock of the ex-ante real interest rate on corporate loans

Source: own computation.

Note that all the models in question show that ex-ante nominal and real interest rates have a stable significant effect on inflation. The interest rate positive shock leads to a considerable decline in the inflation rate after five to six months following the shock (Fig. 6). The significance of inflation response to the ex-ante real interest rate positive shock and the insignificance of a similar response to the ex-post real interest rate shock may suggest that economic agents consistently make errors when relying on adaptive forecasting for future inflation. In general, this result indicates that the Bank of Russia applied the interest rate as an inflation management tool during the post-crisis period despite the fact that the interest rate band formation was not completed until September 2013.

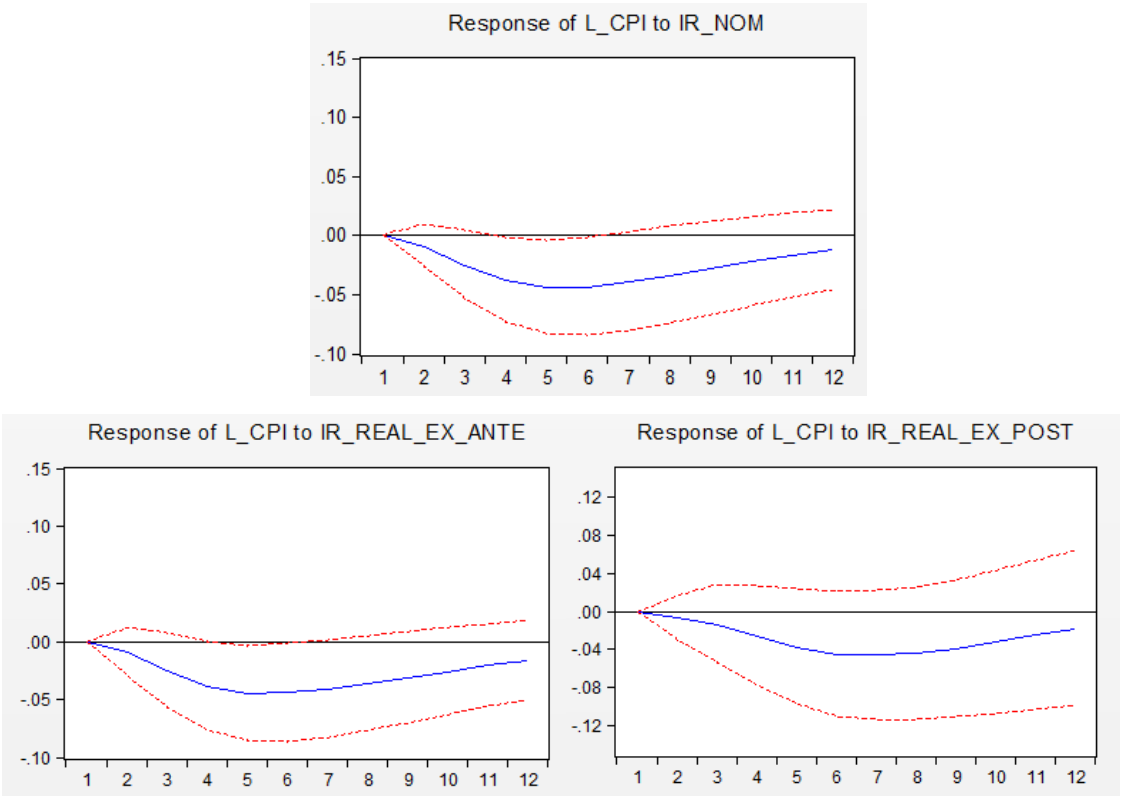


Figure 6. Inflation impulse response function for shocks of nominal and real interest rates on corporate loans

Source: own computation.

We will now examine the impulse response function graphs by evaluating system (4) in which the retail trade turnover describing the consumer behavior is the most endogenous variable in the system (Fig. 7). There is a considerable decline in the retail trade turnover within the first and second months following the nominal interest rate positive shock on retail loans. However, no significant impact of real interest rate shocks on the retail trade turnover dynamics has been detected, which indicates that economic agents' retail purchase decisions rely on actual nominal

interest rates because inflation is highly volatile and sensitive to the exchange rate pass-through effect.

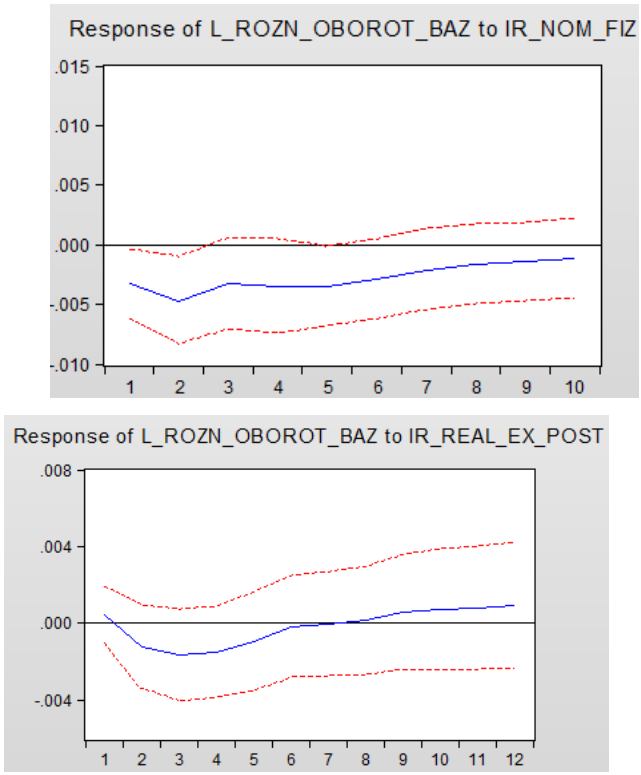


Figure 7. Retail trade turnover impulse response function for shocks of nominal and real interest rates on retail loans

Source: own computation.

Note also the significance of retail trade turnover positive response after three months following a positive shock of real personal cash incomes (Fig. 8).

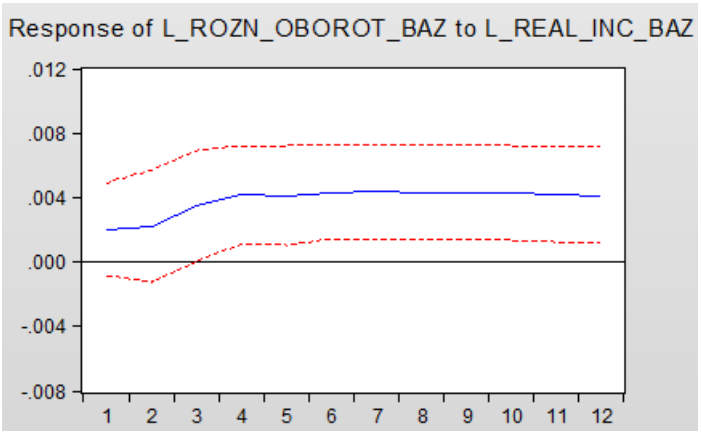


Figure 8. Retail trade turnover impulse response function for a shock of the indicator for real personal cash incomes

Source: own computation.

In general, our calculations show that the final stage of the interest rate channel has been found to be partially efficient. A significant negative response to a positive shock of the nominal interest rate on loans has been detected for the industrial production index, the index of core economic activities' product and service output, the retail trade turnover. Moreover, economic agents relying on adaptive forecasts for inflation cut their fixed investment spending in response to increase in the real interest rate on loans. In addition, a positive shock of the ex-ante nominal and real interest rates on corporate loans contributes to a decline in inflation after five to six months following the shock, thus indicating that inflationary processes can be influenced by the interest rate policy in the Russian environment. Note that, because of the adaptive nature of inflation expectations, economic agents' decisions basically relied on the nominal and real ex-ante interest rate on loans during the period under review. The absence of any significant effect of the ex-post interest rate on the macroeconomic indicators in question gives evidence of the adaptive nature of inflation expectations in the Russian environment and of high probability of prediction errors for real interest rates during inflationary upsurges.

Note that the results obtained differ largely from the findings of the interest rate channel research using the data gathered prior to the global financial crisis [1], [33], when the effect of interest rates on the real economy indicators was found to be insignificant. This fact gives evidence that the Bank of Russia gradually shifted its focus toward inflation-targeting regime and toward applying the interest rate as a primary monetary policy tool. In addition, the positive results of the research of interest rate channel's first and second stages using the Russian data gathered after the global financial crisis [23], [24] lead to the conclusion that the interest rate channel is partially efficient in general.

5. Conclusions

The effect of interest rates on economic growth appear to be mixed and can be transmitted through a host of channels which are reduced to households' decisions on how much to consume and to firms' decisions on how much to invest. In this research, the analysis of international relatively tight monetary policies shows that high nominal and real interest rates may not dampen economic growth amid low inflation expectations, economy's attractiveness to foreign investors, the technology transfer effect, accumulation of domestic savings. In this context, even through the central bank's monetary policy is moderately tight, the effectiveness of the above listed channels in Russia may serve as a precondition for boosting economic growth rates in the medium term as

the economic situation stabilizes, the risk premium declines, the inflation rate gets closer to the target rate.

The econometric evaluation of the interest rate channel using the Russian data shows that the rise of actually realized (ex-post) real interest rates has no significant effect on the dynamics of output and of its components. Therefore, efforts at stimulating economic growth through an easy monetary policy would rather ramp up inflation than have the desired effect on the real economy. The review of international practices shows that both nominal and, to a greater extent, real interest rates are relatively low in Russia and therefore do not inhibit economic growth.

In general, the current moderately tight monetary policy of the Bank of Russia appears to be reasonable enough amid a highly volatile exchange rate, as well as economic agents' high inflation expectations, and therefore they do not hamper economic growth. Having achieved a substantial progress in enhancing the effectiveness of the interest rate channel of monetary policy transmission mechanism as a result of switching to an inflation-targeting regime and of completing the interest rate band formation, the Bank of Russia would be able to raise the confidence of economic agents and to enhance the effectiveness of the interest rate policy by continuing the regime and improving its monetary policy tools.

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