Bank of Russia

The Central Bank of the Russian Federation

The Effect of Financial Shock on Russian Short-term Equilibrium Interest Rates

Analytical note
Research and Forecasting Department
Bank of Russia

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Address 12 Neglinnaya Street, 107016 Moscow
Phone +7 (495) 771-91-00, +7 (495) 621-64-65 (fax)
Website www.cbr.ru

We estimate the impact of the Russia-specific shocks of 2014 on the short-term real equilibrium interest rate. We have used two approaches. The first approach is based on theoretical model calculations. The second rests on empirical estimates based on the results of IMF cross-country research on the sensitivity of the equilibrium interest rate to shifts in investment demand and supply (savings) curves.

Our estimates suggest that the 2014 financial shock that restricted external borrowing for Russian issuers triggered 0.6-1.4 pp growth of the short-term equilibrium interest rate. However, the economy adjusted to the financial shock in 2016-2017 thanks to the macroeconomic policy pursued: the CDS risk premium declined, investment resumed growth and the net investment position gradually decreased. As a result, the effect of the financial shock on the short-term equilibrium interest rate has almost entirely vanished.

Introduction

The Russian economy has been under international restrictions for three years; most of these were imposed in 2014 Q2-Q4. Restrictions not aimed at individuals can be split into two types:

1. Technological: a ban on Russian imports of dual-use goods, military technologies and sophisticated oil-field equipment.
2. Financial: external borrowing limitations (with more than 30-day maturity) on major, mostly state-controlled, Russian companies.

The effect of the imposed restrictions (and Russian retaliation measures) on the Russian economy is estimated in a number of ways. All estimates of the impact of borrowing caps are focused to some extent on GDP performance. In this paper, we have supplemented these estimates with an analysis of their impact on Russian equilibrium interest rates.

An insight into equilibrium interest rate movements is material for monetary policy. First, equilibrium interest rate movements affect estimates of the *effective* policy stance, which is often viewed as a deviation of the actual rate from the equilibrium. Second, equilibrium interest rate movements may point to a shift in the *medium-term* key rate benchmark.

When it comes to the equilibrium interest rate, the real equilibrium interest rate is usually implied. In this paper, the equilibrium rate means the interest rate that would settle in the economy if prices were flexible, that is the rate where the output is at its potential at any given time. Significantly, the paper estimates the real equilibrium interest rate's *deviation* in an economy under international restrictions from the equilibrium in an unrestricted economy.

To estimate the equilibrium interest rate, applied research often links it to potential economic growth rates. Such an approach to this notion (concept) is described in the preprint 'The equilibrium interest rate: a measurement for Russia' (Bank of Russia Working Paper Series, 2016, No. 13). Theoretically, the link is linear, but it is uneven and depends on additional ratios. It can be written as follows:

$$r = \sigma g - \ln \beta,$$

where r is the real rate, g is GDP growth, σ is the elasticity of intertemporal substitution, and β is the discount factor.

The link between the interest rate and potential growth rates is as follows. When income is likely to grow at a high pace (future income is higher than present income) loans enjoy greater demand due to consumption smoothing. In expectation of increased future income, economic agents may enhance consumption today through the use of credit. Accordingly, the higher GDP (income) growth, the higher the demand for loans to fund consumption and, consequently, the higher interest rates will be, in compensation for lenders' rejection of their own current consumption in favour of borrowers' increased consumption.

If potential growth slows as it becomes clear that the income growth rate is decelerating (that is, future income is posed to be lower than initially expected), economic agents adjust their behaviour; they start saving more to smooth consumption. The increase in the saving supply calls for a respective (higher) demand for credit. In the new environment this is possible only if interest rates are low.

The link between the interest rate and GDP growth depends on two factors:

1. The so-called elasticity of intertemporal substitution $1/\sigma$. This ratio reflects the sensitivity of consumption (GDP, income) to interest rate movements. The increase in the income growth rate may be accompanied by a considerable or moderate interest rate hike depending on the financial system's capability to transfer resources from lenders to borrowers. The higher the elasticity of substitution, the less responsive the interest rate is to changing income.

2. The discount factor β. Theoretically, $\ln \beta < 0$. This factor reflects how economic agents evaluate the future compared to the present. If the future is devalued (economic agents live for today), the discount factor falls considerably below 1 (the logarithm is positive) for any income and growth pace. Thus, such 'impatient' agents translate any growth in potential GDP into a higher interest rate in the economy. The second item reflects this increase.

Another link between the interest rate and GDP growth sees GDP as a product rather than the total expenses/income in the economy. This correlation calls for equalisation of the return on financial assets (interest rate) and real assets (capital).

$$r = MPK + (\Delta Pcapital - \Delta P\text{gdp}) - \text{amortisation rate},$$

where MPK is the marginal product of capital (faster technological advances and an increasing labour force brings the interest rate up whereas a slowdown decreases the interest rate). However, this correlation also requires adjustments. The relationship is not one-to-one. Particularly, adjustments should be made for the relative price of investment goods ($\Delta Pcapital - \Delta P\text{gdp}$). Its reduction favours real rather than financial investment and raises the interest rate. The increase in the amortisation rate reduces gains from physical capital investment (because of resale complications).

The ratio of GDP growth to interest rate growth is also valuable in estimating the stability of the economic equilibrium, that is, an estimate of the non-explosive nature of debt increase in the economy. For this purpose, the real interest rate reading should exceed GDP growth ($r > g$). This is the so-called 'modified golden rule'. Debt growth is

$$d_t - d_{t-1} = \frac{r_t}{1+g_t} d_{t-1} - \frac{g_t}{1+g_t} d_{t-1} - p_t,$$

where d is real debt, r is the real interest rate, g is GDP growth and p is inflation.

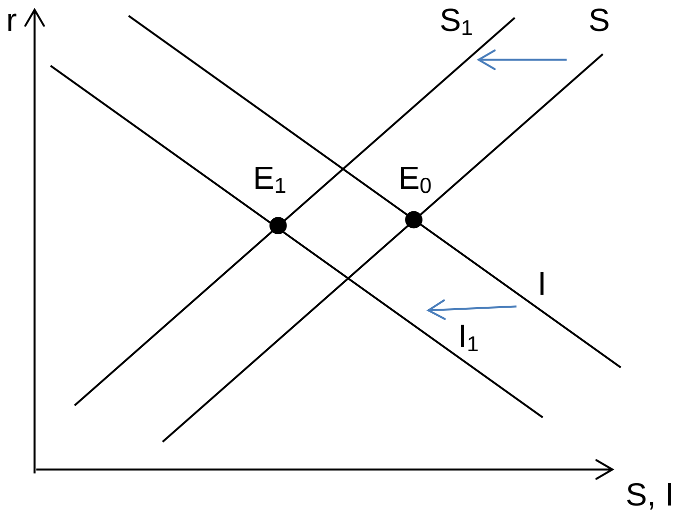
The rule says that when GDP (income) growth surpasses real interest rates ($r < g$), economic agents may borrow easily. They accumulate debt at low rates and, importantly, may borrow to pay interest on loans ('a snowball effect') but this fails to increase the debt-to-income ratio as the debt is diluted faster than capitalised interest accumulates. The equilibrium is possible if $r < g$, but it is ineffective as economic agents may always take advantage of new opportunities to accumulate debt. As a result, the equilibrium shifts to $r > g$ sooner or later. When $r > g$, such conduct proves impossible, debt will snowball and, thus, for the equilibrium to be stable, the condition $r > g$ calls for a debt finiteness (not higher than a certain value in terms of income). If $r > g$, financial bubbles may arise.

In effect, such estimates prove to be very uncertain, as shown by studies of correlation estimates between the equilibrium rate and the potential economic growth rate (have large confidence intervals). This point should be taken into account in practical application of the estimates (e.g. monetary policy advice).

It should be also borne in mind that external borrowing complexities may have a mixed effect on real equilibrium interest rates. They impact both investment supply and demand. On the one hand, restricted access to new external borrowing reduces accessible financial resources at home, thus decreasing the supply of financial resources available for investment. Furthermore, rising risks related to restrictions, along with economic uncertainty, may curtail the inflow of non-resident funds to the industries and sectors unaffected by international sanctions. Both these factors shift the savings curve S leftwards and upwards (Figure 1). If the investment demand curve remains unchanged, this should increase the equilibrium rate and reduce the equilibrium investment volume.

On the other hand, a decrease in companies' demand for investment shifts the I curve leftwards and downwards. This leads to a drop in the equilibrium value of the interest rate and investment volume. The decline in demand may be caused by heightened uncertainty, the emergence of free production capacities following GDP contraction, reduced accessibility of technologies (and, consequently, lower effectiveness of investment projects), changes in the relative prices of investment goods,[1] etc.

Figure 1. Investment demand and saving supply movements



The resulting change in the real equilibrium interest rate is ambiguous, as it depends on the shift of the investment demand (I) and saving supply (S) curve. At the same time, investments in the economy are clearly shrinking. We applied two approaches to estimate the effect of external financing restrictions on equilibrium interest rates: calibrated theoretical model calculations and IMF research-based empirical estimates.

[1] The ruble's depreciation led to a more considerable growth in the cost of imported machinery, equipment and materials in ruble terms compared with the increase in prices of domestic intermediate and investment goods and ex-factory prices.

Financial market indicators allow us to estimate short-term equilibrium rate movements through changes in risk premiums. Thus, in the period between late 2014 and early 2015, the Russian risk premium (5-year CDS premium) rose by 4.7 pp while risk premiums of other emerging markets hardly changed. At the same time, the risk premium is highly volatile, complicating its use in estimates of short-term equilibrium rate movements.

Empirical calculation results

We used the findings of an IMF study[2] to estimate equilibrium interest rate movements. It assesses the effect of investment and saving curve shifts on the equilibrium interest rate and investment/savings. In its research the IMF estimated the following system of simultaneous equations on global economic data from 1980 to 2013:

$$
\begin{aligned}
s_t &= a_0 + a_1 r_t + a_2 n_t + \varepsilon_t \\
i_t &= b_0 + b_1 r_t + b_2 p_t + \xi_t \\
s_t &= i_t
\end{aligned}
$$

where *S* denotes saving as a per cent of GDP, *i* is investment as a per cent of GDP, *r* represents the real interest rate, *n* is advanced economy social expenditure as a per cent of GDP[3] and *p* stands for the relative price of investment calculated as the change from investment deflator to GDP deflator.

The research did not consider restrictions on external borrowing in any economy; thus, we estimated their effect through the shift in saving and investment curves and their impact on the equilibrium interest rate. We assumed that the saving curve shift equalled contraction in foreign debt (forced deleveraging) while the shift in the investment demand curve equalled the change in the relative price[4] of investment.[5]

Significantly, the imposition of international constraints or bans on raising capital in foreign markets for Russian companies coincided with a major drop in oil prices. Shrinking oil and gas export revenues could also have a negative effect on domestic saving. However, as the exchange rate rapidly adjusted to the changes in the balance of payments, imports contracted considerably. Its scale was comparable with the drop in export costs and, thus, the effect of the oil price downturn on funds available for investment proved to be neutral. Moreover, the ruble's depreciation increased costs of investment equipment and materials. Our estimates suggest that, adjusted for commodity prices, the ruble would have depreciated by only 25-35% compared with the actual 56.5% weakening (after the ruble appreciation in 2015 Q2). However, we calculated the effect of the actual ruble weakening on investment demand as an upper bound estimate.

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[2] Recovery Strengthens, Remains Uneven // WEO. Chapter 3. 2014. April.

[3] Given that increased social expenditure allows households to save less, all else being equal.

[4] We calculated the change in the relative price of investment through the relative change in fixed capital investment deflator and GDP deflator.

[5] Interestingly, in the IMF study the effect of the change in the relative price of investment has a positive sign, which is counter-intuitive at first approximation. The increase in the relative cost of investment goods reduces return on investments, lowering demand for investments (the quantity of purchased equipment) at a given interest rate (a leftward shift in the investment demand curve). On the other hand, the increase in the investment cost implies that the purchase of one equipment item will require a larger nominal loan at a given interest rate (a rightward shift in the investment curve). The shift in the demand curve depends on which factor is of higher importance for the investment demand. The IMF study revealed that the elasticity of investment demand to the relative price of investment goods proved positive for the global economy in the period since 1980. That is, price increases shift the investment demand curve to the right, raising the equilibrium interest rate, all else being equal.

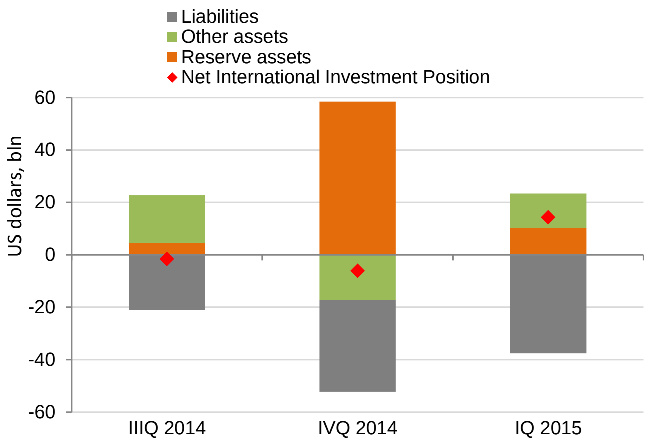
We used the IMF's ratios of the equilibrium rate's sensitivity to shifts in saving and investment curves to obtain the following results:

1. The real equilibrium interest rate rose by 0.9 pp by the end of the first quarter of 2015.
2. External assets (net positive international investment position) helped mitigate the effect of financial restrictions on the equilibrium interest rate. The shrinkage of external assets outstripped external liabilities,[6] serving as a buffer for the Russian economy. Without them, the real equilibrium interest rate would have grown by 9 pp against the 2014 Q2 reading.

3. The Bank of Russia's moves played a considerable role in mitigating the effect of external borrowing restrictions on equilibrium interest rates (Figure 3). It was the Bank of Russia's FX liquidity provision (particularly, FX repos) that largely reduced the effect of the financial channel of international restrictions on the short-term real equilibrium interest rate, especially in the fourth quarter of 2014.

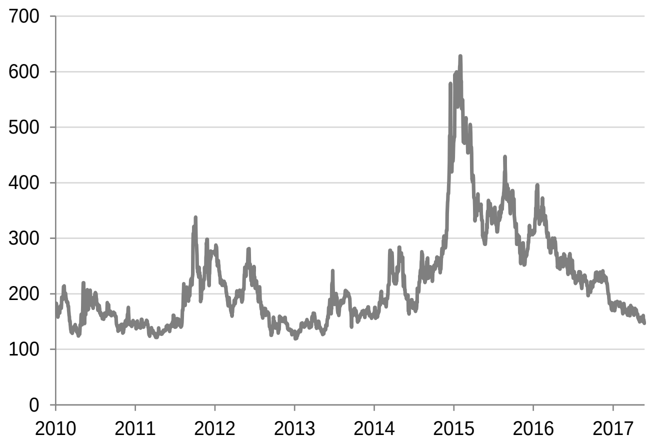
4. The surge in the equilibrium interest rate proved temporary. Despite ongoing restrictions on external borrowing, we may conclude that the economy has almost completely adapted to the financial shock. Thus, the net international position has declined progressively since early 2016 due to greater growth in external liabilities than in assets. This points to the growing accessibility of external financing. Furthermore, the policy of the Bank of Russia and the Ministry of Finance restored investor confidence, as confirmed by the decline in the Russian CDS risk premium throughout 2016 and its return to the 2013 H2 readings in early 2017.

Figure 3. Key net international investment position components, $ bln



Source: Bank of Russia, R&F Department calculations.

Figure 4. Russian CDS (Russia CDS USD SR 5Y Corp)



Source: Bloomberg Finance L.P.

Model calculation results

In order to estimate the likely effects of international financial restrictions on the Russian economy, we consider a simplified three-period model.[7] It implies that, in the first period, economic agents learn that they should completely redeem their debt in the second period, and

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[6] Adjusted for revaluation.
[7] Our calibration suggests that one period corresponds to one year.

reach a specific capital value by the third period.[8] We have compared the results obtained in this model with those of the model where the debt is refinanced in full. Thus, we find the effect of forced deleveraging (external debt reduction), which is identical to the effect of external finance restriction in the model. The indicators were calibrated based on Russian specificities. For example, the debt-to-output ratio roughly equals the ratio between net private external debt to the Russian GDP before the imposition of financial restrictions.

The initial calculation was based on a relatively stiff assumption that the productive capital should return to the initial level in the third period of time. Figure 5 features the respective results. The main effect on the interest rate falls on the third period (that is, the third year). The need to fully repay debt reduces the economy's capital stock and, in order to replenish it to the initial level in the third period, conditions must be established to promptly shift consumption towards investment. To do so, a strong rate increase is needed to make saving more attractive. Figure 6 features the results, where the ultimate capital stock ranges between 90% and 100% of the initial value. The model provides for a return to the stationary level in the future. The weakening of the assumption of the level to which capital should return in the third period is entirely logical. Indeed, as long as, for example, a ban or stiff restrictions on certain technology imports are effective or a long-term equilibrium oil price persistently lowers, the potential output and, consequently, the required capital fall compared with the initial level.

The effect to be reached in the third period is very sensitive to assumptions about the level of capital to be reached by the end of this period. Moreover, in the second period of time, the effect ranges between 0.55 and 1.36 pp when capital changes its level from 90% to 100% of the initial reading. We have used it to gauge the effect of financial restrictions on interest rates, as we are primarily interested in the impact of the forced deleveraging on the equilibrium rate.

Figure 5. Rate hike after debt redemption in the scenario where capital returns to the initial reading, pp

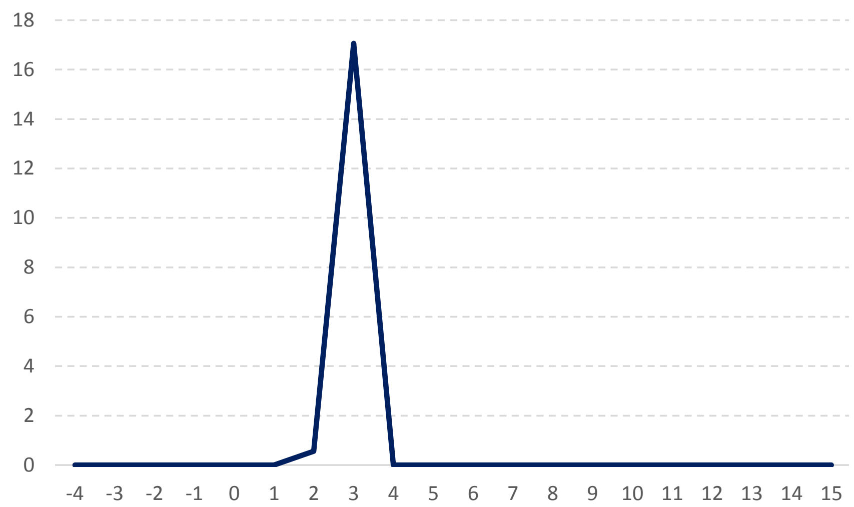
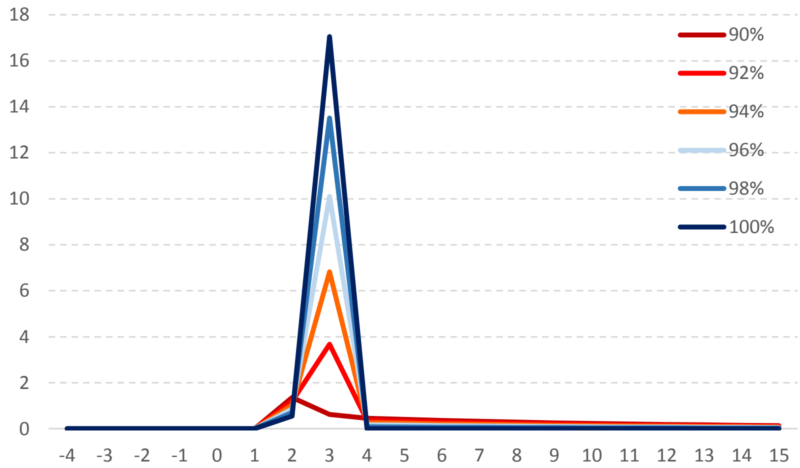


Figure 6. Rate hike after debt redemption depending on the capital level in the third period, pp

[8] For model details please refer to the Appendix.



The theoretical model calculations are overall in line with the empirical estimates. The use of forced deleveraging to restore the initial capital reading and non-use of accumulated external assets to set off the closed funding channels would cause interest rates to jump (by 17 pp, according to model estimates). The empirical estimates that do not cap the capital level to be reached in the economy suggest that rates could increase by roughly 9 pp during the course of the year.

The estimated effect of financial restrictions on the short-term real equilibrium interest rate declined considerably, if we assume that economic agents have failed to completely restore the initial capital level and take the net positive international investment position into account. The latter permitted the use of a part of external assets to offset the closure of the external debt financing channel. The resulting effect was 0.6-1.4 pp according to model estimates and 0.9 pp according to empirical estimates.

Conclusion

Both calculations suggest that the imposed restrictions on raising new external financing by Russian companies increased short-term real equilibrium interest rates by roughly 1 pp. This increase is quite substantial and suggests that the Bank of Russia’s moderately tight monetary policy of 2014-2016 was justified.

The consistency of the Bank of Russia’s policy during that period, among other things, reduced the risk premium from its peak value of almost 600 bp in late 2014 to 250-300 bp by late 2015, despite persistently falling oil prices. Later, the recovery of oil prices in 2016 alongside the moderately tight monetary policy led to further reduction in the risk premium to the readings registered before the shock. As a result, the effect of the rise in the equilibrium interest rate, triggered by the financial shock, was largely offset and has almost completely vanished.

Appendix

No-financial-restriction model

We consider a simple three-period model of a small open economy where agents maximise their utility.

$$U = lnC_1 + \beta lnC_2 + \beta^2 lnC_3,$$

Given the restrictions:

$$C_1 + K_1 + D_1 < (1 + r)D_0 + (1 - \delta)K_0 + AK_1^a$$
$$C_2 + K_2 + D_2 < (1 + r)D_1 + (1 - \delta)K_1 + AK_2^a$$
$$C_3 + K_3 + D_3 < (1 + r)D_2 + (1 - \delta)K_2 + AK_3^a,$$

where C_t is consumption in the period of time t,

K_t is capital in the period of time t,

D_t is debt in the period of time t.

The first order conditions will be written as follows:

$$\frac{\partial L}{\partial C_1} = \frac{1}{C_1} - \lambda_1 = 0$$
$$\frac{\partial L}{\partial C_2} = \frac{\beta}{C_2} - \lambda_2 = 0$$
$$\frac{\partial L}{\partial C_3} = \frac{\beta^2}{C_3} - \lambda_3 = 0$$
$$\frac{\partial L}{\partial K_1} = \lambda_1 \frac{aA}{K_1^{1-a}} - \lambda_1 + (1 - \delta)\lambda_2 = 0$$
$$\frac{\partial L}{\partial K_2} = \lambda_2 \frac{aA}{K_2^{1-a}} - \lambda_2 + (1 - \delta)\lambda_3 = 0$$
$$\frac{\partial L}{\partial D_1} = -\lambda_1 + \lambda_2(1 + r) = 0$$
$$\frac{\partial L}{\partial D_2} = -\lambda_2 + \lambda_3(1 + r) = 0.$$

Let us assume that

$$\beta(1 + r) = 1.$$

The initial and the ultimate states are as follows:

$$K_0 = \left(\frac{aA}{1 - (1 - \delta)\beta}\right)^{\frac{1}{1-a}}$$
$$D_0 = D'$$
$$C_0 = rD_0 + AK_0^a - \delta K_0.$$

It is clear that:

$$K_t = K_0$$
$$D_t = D_0$$
$$C_t = C_0$$

for any t.

Financial restriction model

Similar to the basic model, economic agents maximise their utility:

$$U = lnC_1 + \beta lnC_2 + \beta^2 lnC_3,$$

Given the restrictions:

$$C_1 + K_1 + D_1 < (1+r)D_0 + (1-\delta)K_0 + AK_1^a$$

$$C_2 + K_2 < (1+r)D_1 + (1-\delta)K_1 + AK_2^a$$

$$C_3 + K_3 < (1-\delta)K_2 + AK_3^a$$

$$K_3 = \left(\frac{aA}{1-(1-\delta)\beta}\right)^{\frac{1}{1-a}}.$$

The first order conditions will be written as follows:

$$\frac{\partial L}{\partial C_1} = \frac{1}{C_1} - \lambda_1 = 0$$

$$\frac{\partial L}{\partial C_2} = \frac{\beta}{C_2} - \lambda_2 = 0$$

$$\frac{\partial L}{\partial C_3} = \frac{\beta^2}{C_3} - \lambda_3 = 0$$

$$\frac{\partial L}{\partial K_1} = \lambda_1 \frac{aA}{K_1^{1-a}} - \lambda_1 + (1-\delta)\lambda_2 = 0$$

$$\frac{\partial L}{\partial K_2} = \lambda_2 \frac{aA}{K_2^{1-a}} - \lambda_2 + (1-\delta)\lambda_3 = 0$$

$$\frac{\partial L}{\partial D_1} = -\lambda_1 + \lambda_2(1+r) = 0.$$

Calculating rates in the model

The model contains no rates; thus, we calculate them as follows:

$$R_t = \frac{1}{\beta}\frac{C_{t+1}}{C_t}.$$

Calibration

Parameter	Value
D_0/AK_0^a	-0.3
a	0.33
δ	0.1
A	1
β	0.96

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Research and Forecasting Department
Yulia Ushakova
Dmitry Chernyadyev

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