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General equilibrium model with the entrepreneurial sector for the Russian economy

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Abstract

This paper proposes a general equilibrium model with the entrepreneurial sector for the Russian economy. The novelty of the model lies in several points. First, the model is a small open economy. Second, it includes the entrepreneurial sector. Third, the model reflects the main features of the Russian economy. Five experiments were conducted, for which steady states and transitions were computed. These experiments included: (1) an export price shock, (2) redistribution of government consumption between the corporate and entrepreneurial sectors, (3) relaxation of collateral requirements, (4) a credit rate subsidy for entrepreneurs, (5) VAT for entrepreneurs. The export price shock results in lower entrepreneurial output due to higher wages in the short run, but in the long run the positive effects of increased demand and assets lead to higher output. Increased government consumption of entrepreneurial goods leads to a reallocation of resources from the corporate sector to the entrepreneurial one. The relaxation of collateral requirements leads to a sharp increase in entrepreneurial investment and capital and a decline in the number of entrepreneurs, which means that they become bigger. The credit rate subsidy leads to an increase in capital in the entrepreneurial sector, and then in output. The cost of subsidies leads to a decrease in lump-sum transfers, but this does not lead to a significant change in household consumption. The introduction of a value-added tax on entrepreneurial goods leads to a redistribution of resources from the entrepreneurial sector to the corporate one, lower household consumption and higher GDP.

Keywords: general equilibrium, entrepreneurship, heterogeneous agents.
JEL classification: D58, E21, E62, H25.

1. Introduction

Small and medium-sized enterprises play an important role in the economy: they are a source of employment and economic growth, as well as one of the im-

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portant factors in adapting the economy to internal and external changes. Support of small and medium-sized enterprises is considered one of the priorities of government policy in Russia. Thus, in 2016, the Strategy for the Development of Small and Medium Entrepreneurship in the Russian Federation for the period up to 2030 was approved. In addition, the national project "Small and medium-sized enterprises and support for individual entrepreneurial initiatives" is being implemented as part of the execution of the Decree of the President of the Russian Federation No. 204, dated May 7, 2018. Therefore, the task of developing economic and mathematical tools to assess the consequences of economic policy and macroeconomic shocks on the dynamics of the main indicators of small and medium enterprises in Russia seems relevant.

General equilibrium models are a key tool for macroeconomic analysis in economic research. Examples of research on general equilibrium models for the Russian economy include Baluta et al. (2022), Elkina (2021), Mamedly and Norkina (2019), Zubarev and Nesterova (2019; 2022), Votinov and Lazaryan (2020). One area of research is the development of models with heterogeneous agents in the spirit of Quadrini (2000), in which agents decide whether to be entrepreneurs or hired workers. This model allows to quantify the impact of macroeconomic shocks and government policies on both the entrepreneurial sector and the overall macroeconomic equilibrium. Moreover, this class of models generates wealth distribution that is consistent with the empirical data due to additional incentives to save compared to the standard model with incomplete markets and idiosyncratic shocks, as shown in Cagetti and De Nardi (2006). First, households save more assets to accumulate the minimum capital needed to start a business. Second, entrepreneurs are exposed to more risks, so they save more out of a precautionary motive. Third, the higher cost of external financing also encourages entrepreneurs to save more.[1]

The purpose of this paper is to develop a general equilibrium model with the entrepreneurial sector for the Russian economy. The proposed model differs from the developed models in the spirit of Quadrini (2000) in the following aspects. First, it considers a small open economy, rather than a closed one, as in previous studies. Second, the model distinguishes several branches of the corporate sector: the exportable sector and the nontradable sector, as well as the oil and gas sector, which is defined in a simplified way. Third, entrepreneurs produce goods both for the domestic market and for the foreign market. Fourth, corporate firms bear the investment adjustment costs. We use this model to investigate the effects of economic policy on the entrepreneurial sector.

The present paper is close to a number of studies. Li (2002) estimates the effects of government credit subsidies to entrepreneurs. According to the conclusions of the paper, the existing credit assistance program has a strong positive impact on targeted entrepreneurs, but at the expense of other entrepreneurs, which leads to a decrease in entrepreneurial activity and output loss. Income subsidy programs and programs that target poor and capable entrepreneurs are more effective in stimulating entrepreneurial activity and increasing output. Kitao (2008) analyzes the channels through which fiscal policy affects key macroeconomic variables,

[1] For more details on general equilibrium models with the entrepreneurial sector, see Polbin and Shumilov (2020).

wealth distribution, and welfare based on a general equilibrium model with the entrepreneurial sector. According to the authors' quantitative results, capital tax cuts stimulate investment, but the effect varies depending on which type of capital is targeted by the reform. Morazzoni and Sy (2022) analyze the impact of the gender gap in access to credit on the entrepreneurial sector and input misallocation in the United States. According to the authors' quantitative estimates, the credit access gap explains most of the variation in capital allocation between firms run by men and women, and eliminating the gender imbalance leads to a 4% increase in output. The authors also analyze how lump-sum tax-financed support measures affect entrepreneurs by gender. Also, the present paper is close to the broad field of literature on entrepreneurship in Russia (Barinova et al., 2018; Barinova and Zemtsov, 2019; Chepurenko, 2012; Djankov et al., 2005; Obraztsova and Chepurenko, 2020; Zemtsov et al., 2020; Zemtsov et al., 2021). However, general equilibrium models regarding the entrepreneurial sector have not been previously developed for the Russian economy, as far as we know.

The article is organized as follows. Section 2 presents the model. Section 3 describes the calibration of the model parameters. Section 4 describes the policy experiments. Section 5 discusses the results. The last section concludes.

2. Model

The model is a small open economy. This implies that the interest rate and prices of imported and exported goods are exogenous. The model economy consists of households, which may be entrepreneurs or hired workers, the corporate sector, the intermediary sector, the government, and the oil and gas sector.

2.1. Trade structure

The trade structure of the model is shown in Fig. 1. There are two sectors of production of goods and services in the economy: the entrepreneurial sector and the corporate sector.

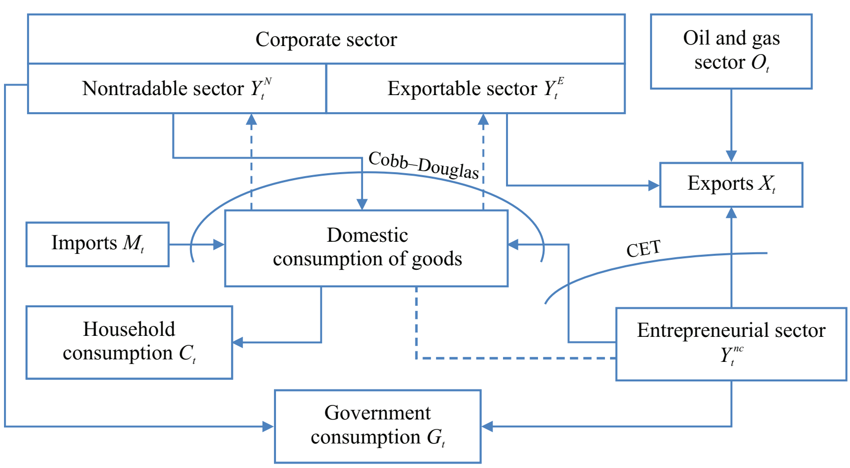

Fig. 1. Trade structure of the model.

Source: Compiled by the authors.

The corporate sector consists of larger firms and is characterized by diversified risk and anonymous operations. The corporate sector is divided into nontradable and exportable sectors. The nontradable sector produces goods Y_t^N, which are then consumed domestically. Government consumption of nontradable goods is exogenous and is denoted by G_t^c. The exportable sector produces goods Y_t^E.

The entrepreneurial sector consists of households that decided to become entrepreneurs in the previous period. They implement their own entrepreneurial project, the success of which depends on the decisions and entrepreneurial abilities of the owner, who is limited in borrowing depending on accumulated assets.

The entrepreneurial sector produces goods Y_t^{nc}, which are then exported or consumed domestically. Government consumption of entrepreneurial goods is exogenous and is denoted by G_t^{nc}. Goods between domestic consumption and exports are allocated based on a function with constant elasticity of transformation (CET):

$$Y_t^{nc} - G_t^{nc} = \left[(1-\alpha_e)^{\frac{1}{\rho}}(D_t^{nc})^{\frac{\rho-1}{\rho}} + (\alpha_e)^{\frac{1}{\rho}}(X_t^{nc})^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}}, \tag{1}$$

where D_t^{nc} is the consumption good produced by the entrepreneurial sector for the domestic market; X_t^{nc} is export of entrepreneurial goods; α_e is the export share parameter in CET function; ρ is the transformation parameter.

From the entrepreneur's profit maximization problem, we can derive the optimal ratio between exports X_t^{nc} and domestic sales D_t^{nc}:

$$\frac{X_t^{nc}}{D_t^{nc}} = \left(\frac{pd_t^{nc}}{p_t^e}\right)^{\rho} \times \frac{\alpha_e}{1-\alpha_e}, \tag{2}$$

where p_t^e is the price for exported goods (excluding goods of the oil and gas sector); pd_t^{nc} is the price for domestic consumption of goods produced in the entrepreneurial sector.

Given the CET function, the aggregate price of entrepreneurial goods p_t^{nc} is given by:

$$p_t^{nc} = \left[(1-\alpha_e)(pd_t^{nc})^{1-\rho} + (\alpha_e)(p_t^e)^{1-\rho}\right]^{\frac{1}{1-\rho}}. \tag{3}$$

The consumption tax in the model is a counterpart to the value-added tax in Russia. The consumption tax is imposed on domestically produced goods and imported goods that are used for final consumption, but it is not imposed on investment goods, entrepreneurial goods, exported goods and government consumption goods. To reflect this, two Cobb–Douglas functions are introduced: one for consumption goods and one for investment goods.

Entrepreneurial goods for domestic consumption C_t^{nc}, nontradable consumption goods C_t^c and imported goods C_t^M are aggregated into homogeneous domestic consumption good C_t based on the Cobb–Douglas function:

$$C_t = \frac{(C_t^{nc})^{\omega_1}(C_t^c)^{\omega_2}(C_t^M)^{1-\omega_1-\omega_2}}{\omega_1^{\omega_1}\omega_2^{\omega_2}(1-\omega_1-\omega_2)^{1-\omega_1-\omega_2}}, \tag{4}$$

where ω_1 is the share of the entrepreneurial sector in the production function; ω_2 is the share of the corporate sector in the production function.

The objective is to minimize costs:

$$(1+\tau_t^{nc})pd_t^{nc}C_t^{nc}+(1+\tau_t^{C})p_t^{N}C_t^{c}+(1+\tau_t^{C})p_t^{M}C_t^{M}\rightarrow \min_{C_t^{nc},C_t^{c},C_t^{M}}, \quad s.t.(4) \tag{5}$$

where τ_t^{nc} is the tax on entrepreneurial goods; p_t^N is the price of corporate nontradable goods; and p_t^M is the price of imported goods. In the baseline scenario τ_t^{nc} is equal to zero since entrepreneurial goods are not subject to consumption tax. However, this tax allows us to analyze the macroeconomic effects of a hypothetical tax reform, if the entrepreneurial sector is subject to VAT. The price of consumption goods p_t^C is equal to $((1+\tau_t^{nc})pd_t^{nc})^{\omega_1}((1+\tau_t^{C})p_t^{N})^{\omega_2}((1+\tau_t^{C})p_t^{M})^{1-\omega_1-\omega_2}$.

From the problem of cost minimization, we can derive the demand for entrepreneurial consumption goods:

$$C_t^{nc}=\frac{\omega_1 p_t^C C_t}{(1+\tau_t^{nc})pd_t^{nc}}, \tag{6}$$

the demand for nontradable consumption goods:

$$C_t^{c}=\frac{\omega_2 p_t^C C_t}{(1+\tau_t^{C})p_t^{N}}, \tag{7}$$

and the demand for imported consumption goods:

$$C_t^{M}=\frac{(1-\omega_1-\omega_2) p_t^C C_t}{(1+\tau_t^{C})p_t^{M}}. \tag{8}$$

Entrepreneurial investment goods I_t^{nc}, nontradable investment goods I_t^c and imported investment goods I_t^M are aggregated into homogeneous domestic investment good I_t based on the Cobb–Douglas function:

$$I_t=\frac{(I_t^{nc})^{\omega_1}(I_t^{c})^{\omega_2}(I_t^{M})^{1-\omega_1-\omega_2}}{\omega_1^{\omega_1}\omega_2^{\omega_2}(1-\omega_1-\omega_2)^{1-\omega_1-\omega_2}}. \tag{9}$$

The price of investment goods is set as follows:

$$p_t^I=(pd_t^{nc})^{\omega_1}(p_t^{N})^{\omega_2}(p_t^{M})^{1-\omega_1-\omega_2}. \tag{10}$$

From the problem of cost minimization, we can derive the demand for entrepreneurial investment goods:

$$I_t^{nc}=\frac{\omega_1 p_t^I I_t}{pd_t^{nc}}, \tag{11}$$

the demand for nontradable investment goods:

$$I_t^{c}=\frac{\omega_2 p_t^I I_t}{p_t^{N}}, \tag{12}$$

and the demand for imported investment goods:

$$I_t^{M}=\frac{(1-\omega_1-\omega_2) p_t^I I_t}{p_t^{M}}. \tag{13}$$

2.2. Corporate sector

The production function of the nontradable sector is a Cobb–Douglas function:

$$Y_t^N = (K_t^N)^\alpha (A_t^N L_t^N)^{1-\alpha}, \tag{14}$$

where Y_t^N is the output of the nontradable sector; K_t^N is the capital stock in the nontradable sector; α is the output elasticity of capital; A_t^N is total factor productivity in the nontradable sector; L_t^N is labor input in the nontradable sector.

Corporate firms own capital, so they make decisions about the amount of capital and labor they hire based on the problem of maximizing market value:

$$\sum_{s=0}^{\infty}\left(\prod_{i=0}^{s}\frac{1}{1+r_{t+i}}\right)[(1-\tau_{t+s}^K)(p_{t+s}^N(K_{t+s}^N)^\alpha(A_{t+s}^N L_{t+s}^N)^{1-\alpha}-(1+\tau_{t+s}^{wf})w_{t+s}L_{t+s}^N)+ \\ +\tau_{t+s}^K\delta p_{t+s}^I K_{t+s}^N - p_{t+s}^I I_{t+s}^N], \tag{15}$$

where r_{t+i} is the interest rate in the $(t + i)$-th period; τ_{t+s}^K is the profit tax in the $(t + i)$-th period; τ_{t+s}^{wf} is the social contributions rate; w_{t+s} is the wage rate; δ is the depreciation rate for capital.

The capital stock of firms in the nontradable sector evolves according to:

$$K_{t+1}^N = (1-\delta)K_t^N + I_t^N\left(1-\frac{\psi}{2}\left(\frac{I_t^N}{I_{t-1}^N}-1\right)^2\right), \tag{16}$$

where ψ is the adjustment cost parameter. The quadratic term penalizes abrupt changes in capital, so firms will change investment gradually in response to shocks.

The problem of the exportable sector is set in a similar way. Firms make decisions about the amount of capital and labor inputs based on the problem of maximizing market value:

$$\sum_{s=0}^{\infty}\left(\prod_{i=0}^{s}\frac{1}{1+r_{t+i}}\right)[(1-\tau_{t+s}^K)(p_{t+s}^E(K_{t+s}^E)^\alpha(A_{t+s}^E L_{t+s}^E)^{1-\alpha}-(1+\tau_{t+s}^{wf})w_{t+s}L_{t+s}^E)+ \\ +\tau_{t+s}^K\delta p_{t+s}^I K_{t+s}^E - p_{t+s}^I I_{t+s}^E]. \tag{17}$$

The capital stock of firms in the exportable sector evolves according to:

$$K_{t+1}^E = (1-\delta)K_t^E + I_t^E\left(1-\frac{\psi}{2}\left(\frac{I_t^E}{I_{t-1}^E}-1\right)^2\right). \tag{18}$$

2.3. Households

The household's problem is a modification from Kitao (2008). The modification consists, first, in the correspondence of the tax structure with the Russian economy: entrepreneurs pay taxes on income or on income minus expenses, and households pay taxes on labor and consumption. Second, because of the differences in the trade structure of the models, the prices of goods are taken into account.

There is a continuum of infinitely living households of measure one. In the current period, agents choose their occupation in the next period, that is, whether they work for hire or run their own business. At the beginning of the period, each agent is randomly endowed with:

(1) labor productivity ϵ, which follows a Markov chain with a state vector $\mathcal{E} = \{\epsilon_1, ..., \epsilon_{N_\epsilon}\}$;

(2) entrepreneurial ability θ, which follows a Markov chain with a state vector $\Theta = \{\theta_1, ..., \theta_{N_\theta}\}$. This parameter shows how efficiently an agent can run the business.

After the shocks are realized, agents make decisions about how much to consume and how much to save. Moreover, because there is no uncertainty between the realization of ϵ and θ shocks in the current and next period, households can also immediately choose an occupation in the next period. Households maximize expected lifetime utility:

$$E_t\left\{\sum_{j=0}^{\infty} \beta^j u(c_{t+j})\right\}, \tag{19}$$

where E_t is the conditional expectation operator evaluated at period t; β is the subjective discount factor; $u(\cdot)$ is the utility function; j is the number of periods after period t. The household is subject to the budget constraint and the borrowing constraint, which depend on the occupation that the agent chose in the previous period.

The instantaneous utility function $u(c_t)$ is a constant relative risk aversion (CRRA) function:

$$u(c_t) = \frac{c_t^{1-\sigma}}{1-\sigma}, \tag{20}$$

where σ is the coefficient of relative risk aversion.

The problem of the hired worker is given by:

$$V^W(a, \varepsilon, \theta) = \max_{c, a', i, j'} \{u(c) + i\beta EV^W(a', \epsilon', \theta') + (1-i)\beta EV^E(a', \epsilon', \theta', j')\} \tag{21}$$

subject to

$$p^c c + a' = Tr + (1-\tau^{wh})\epsilon w + (1+r)a, \tag{22}$$

$$a' \geq 0,\ \ c \geq 0,\ \ i \in \{0,1\}, j \in \{0,1\},$$

where $V^W(a, \varepsilon, \theta)$ is the value function of a hired worker, which depends on the stock of assets in the current period a, labor productivity ϵ and entrepreneurial ability θ; $V^E(a', \epsilon', \theta', j')$ is the value function of an entrepreneur, which also depends on the choice of tax regime j: "income" ($j = 0$) or "income minus expenses" (j=1); i is a binary variable that is zero if the household will be an entrepreneur in the next period, and one if a hired worker, $a', \epsilon', \theta', j'$ are the corresponding variables in the next period; Tr is lump-sum transfers (or lump-sum taxes if transfers are negative); τ^{wh} is payroll tax rate.

The production function of the entrepreneur is defined as:

$$y = f(k, n, \theta) = \theta k^{v_1} n^{v_2}, \tag{23}$$

where k is the capital invested in the entrepreneurial project; n is labor input; θ is the entrepreneurial ability of the household; v_1 and v_2 are the output elasticities of capital and labor, respectively.

As in (Kitao, 2008), it is assumed that the ratio of output elasticities of capital and labor is the same as in the corporate sector. Given this assumption, the production function is defined as:

$$y = \theta(k^{\alpha} n^{1-\alpha})^{v}, \tag{24}$$

where α is the output elasticity of capital in the corporate sector, and $v = v_1 + v_2 \in (0,1)$.

The problem of the entrepreneur is given by:

$$V^E(a,\epsilon,\theta,j) = \max_{c,a',i,j'} \{u(c) + i\beta EV^W(a',\epsilon',\theta') + (1-i)\beta EV^E(a',\epsilon',\theta',j')\} \tag{25}$$

subject to

$$p^c c + a' = Tr + \pi^E(a,\epsilon,\theta,j), \tag{26}$$
$$a' \geq 0,\ c \geq 0,\ i \in \{0,1\}, j \in \{0,1\},$$

where π^E is entrepreneurial profit; j is a binary variable reflecting the entrepreneur's choice regarding the object of taxation.

It is assumed that at the end of each period the household that chose to be an entrepreneur in the next period also chooses the object of taxation I, which can be "income" ($j = 0$) or "income minus expenses" ($j = 1$). Thus, the profit of the entrepreneur is set as:

$$\pi^E(a,\epsilon,\theta,j) = \max_{k,n}\{p_t^{nc} f(k,n,\theta) + p^I(1-\delta)k - p^I(1+\tilde{r})\left(k - \frac{a}{p^I}\right) - (1+\tau^{wf})w \times \max\{n-\epsilon,0\} - T(I,j)\}, \tag{27}$$

where the taxes $T(I,j)$ paid by an entrepreneur with object of taxation I are set as:

$$T(I,j) = \begin{cases} \tau_t^{nc,r} p_t^{nc} f(k,n,\theta), \text{ if } j = 0, \\ \max\left\{0.01 \times p_t^{nc} f(k,n,\theta),\ \tau_t^{nc,\pi}\left(p_t^{nc} f(k,n,\theta) - p^I \delta k - p^I \tilde{r}\left(k - \frac{a}{p^I}\right) - (1+\tau^{wf})w \max\{n-\epsilon,0\}\right)\right\}, \text{ if } j = 1, \end{cases} \tag{28}$$

entrepreneurial capital is limited:

$$k \leq (1+d)\frac{a}{p^I}, \tag{29}$$

and interest rate on capital is given by:

$$\tilde{r} = \begin{cases} r, \text{ if } k \leq \frac{a}{p^I}, \\ r_d = r + \phi, \text{ if } k > \frac{a}{p^I}, \end{cases} \tag{30}$$

where k and n are the capital and labor inputs that the entrepreneur invests in his project; $\tau_t^{nc,\pi}$ is the tax rate on profits; $\tau_t^{nc,r}$ is tax rate on revenue; d is the maximum leverage ratio; r_d is the borrowing rate for entrepreneurs; ϕ is the credit spread.

2.4. Intermediary sector

The intermediary sector is defined in the same way as in Kitao (2008). The intermediary sector consists of banks that collect deposits from households and make loans to firms from the corporate and entrepreneurial sectors. Hired workers face borrowing constraints, so they cannot have negative assets.

Banks lend to the corporate sector at the risk-free rate r. The entrepreneurial sector borrows at the rate $r_d = r + \phi$, where r is the risk-free deposit rate, and ϕ is the fixed cost per unit of borrowed funds. It is assumed that the cost ϕ is wasted, so it does not contribute to the overall equilibrium.

Entrepreneurs can borrow only up to a limit, which is an increasing function of household assets. Entrepreneurial ability θ is not observed by banks, so it does not affect the borrowing limit. It is assumed that the limit on assets for entrepreneurs is given by $(1 + d)a/p^I$, where a is household assets, and d is the maximum leverage ratio.

2.5. Oil and gas sector

The production in the oil and gas sector is exogenous and is denoted by O_t. The entire volume of extracted oil and gas is exported at exogenous price p_t^O. The oil and gas sector pays the extraction tax $\tau_t^O p_t^O O_t$.

The production function of the oil and gas sector is the Leontief function:

$$Y_t^O = \min\{\phi_1 L_t^O; \phi_2 K_t^O\}, \tag{31}$$

where Y_t^O is the output of the oil and gas sector; ϕ_1 and ϕ_2 are the exogenous production parameters; L_t^O is labor input in the oil and gas sector; K_t^O is capital input in the oil and gas sector.

The optimal factor inputs are given by:

$$L_t^O = \frac{1}{\phi_1} Y_t^O, \tag{32}$$

$$K_t^O = \frac{1}{\phi_2} Y_t^O. \tag{33}$$

2.6. Government

The government spends on goods of the corporate nontradable and entrepreneurial sectors, transfers to households, and interest on the government debt.

Government revenues consist of:

- consumption tax, which is imposed on goods of the nontradable sector and imported goods;
- income tax, which is paid by hired workers;
- social contributions on employees, which are paid by the entrepreneurial, corporate and oil and gas sectors;
- profit tax, which is imposed on corporate firms;
- taxes, which are imposed on entrepreneurs;
- extraction tax.

The budget constraint of the government is given by:

$$p_t^{nc}G_t^{nc} + p_t^N G_t^c + Tr_t + (1+r_t)B_t = B_{t+1} + \tau_t^C p_t^N C_t^c + \tau_t^{nc} pd_t^{nc} C_t^{nc} +$$
$$+ \tau_t^C p_t^M C_t^M + w_t(\tau_t^{wf} + \tau_t^{wh}) \times (L_t^{nc} + L_t^c + L_t^O) + \tau_t^O p_t^O O_t + T_t^{nc,r} + T_t^{nc,\pi} +$$
$$+ \tau_t^K (p_t^E (K_t^E)^\alpha (A_t^E L_t^E)^{1-\alpha} - (1+\tau_t^{wf}) w_t L_t^E) - \tau_t^K \delta p_t^I K_t^E +$$
$$+ \tau_t^K (p_t^N (K_t^N)^\alpha (A_t^N L_t^N)^{1-\alpha} - (1+\tau_t^{wf}) w_t L_t^N) - \tau_t^K \delta p_t^I K_t^N, \tag{34}$$

where $T_t^{nc,r}$ are tax revenues from entrepreneurs who chose the "income" regime; $T_t^{nc,\pi}$ are tax revenues from entrepreneurs who chose the "income minus expenses" regime; B_t is public debt in the t-th period.

The dynamics of lump-sum transfers are given by:

$$Tr_t - Tr_{ss} = \rho_{Tr}(Tr_{t-1} - Tr_{ss}) - \gamma_{Tr}\left(\frac{B_{t-1}}{GDP_t} - debt\_GDP\_ratio\right), \tag{35}$$

where Tr_{ss} is the lump-sum transfers in the steady state (in scenarios where the steady state changes, the tax from the new steady state was taken as Tr_{ss}); ρ_{Tr} is the autoregression parameter for lump-sum transfers; γ_{Tr} is parameter of sensitivity of lump-sum transfers to the deviation of the debt-to-GDP ratio from the steady state ratio; *debt_GDP_ratio* is debt-GDP-ratio in the steady state.

2.7. Stationary competitive equilibrium

The state vector of each agent at the beginning of each period is given by $s = (a, \epsilon, \theta, \xi)$, where a is assets; ϵ is labor productivity; θ is entrepreneurial ability; $\xi \in \{W, E_1, E_2\}$ is occupation (hired worker or entrepreneur with one of two possible tax regimes). Let $a \in A = R_+$, $\epsilon \in \mathcal{E}$, $\theta \in \Theta$, $\xi \in \Xi$. Then the state space is defined as $S = A \times \mathcal{E} \times \Theta \times \Xi$.

The stationary equilibrium in the given economy is value functions, decision rules $\{\xi_{t+1}, c_t, a_{t+1}, k_t, n_t\}_{t=0}^{\infty}$, prices $\{w, p^{nc}\}$, distribution of workers and entrepreneurs, tax structure, intermediaries and distribution of agents in the state space S, defined as $\Phi(s)$, $s \in S$, such that:

(1) The allocations $\{\xi_{t+1}, c_t, a_{t+1}, k_t, n_t\}_{t=0}^{\infty}$ solve the maximization problem for a household for given prices and lump-sum transfers (taxes).
(2) Factor prices satisfy the conditions for maximizing firm value in the corporate sector.
(3) The government budget satisfies the budget constraint and the lump-sum transfer dynamics equation.
(4) Banks in the intermediary sector receive deposits from households at the risk-free rate r and lend to the corporate sector at the risk-free rate r and the entrepreneurial sector at the rate $r + \phi$, where ϕ is the credit spread.
(5) The goods market clears.
(6) The capital market clears.
(7) The labor market clears.
(8) The distribution of Φ is time-invariant.

3. Calibration

The values of the parameters, their descriptions and sources are presented in Table 1. The calibrated parameters in the model can be divided into three groups. The first group of parameters was calibrated based on the values commonly used in the literature. The second group was calibrated based on statistical data. The third group was calibrated to fit certain characteristics of the Russian economy.

The parameters σ, r, α were calibrated based on commonly used values in the literature. The elasticity of marginal utility of consumption σ generally takes values from 1 to 2. For example, σ equals 1 in Krueger et al. (2016), and σ equals 2 in Benhabib et al. (2019), Heer and Trede (2003), Lehmus (2011), Nishiyama and Smetters (2005), Quadrini (2000). In the present paper, the parameter σ equals 2, as this value occurs most frequently. In the above papers, the parameter α ranged from 0.33 to 0.36. In our paper, this parameter equals 0.35. The interest rate was set at 3%.

Table 1
Parameters of the model.

Parameter	Description	Source
$\sigma = 2$	Elasticity of marginal utility of consumption	
$\beta = 0.90$	Subjective discount factor	
$r = 3\%$	Interest rate	
$\omega_1 = 0.25$	Share of the entrepreneurial sector in the production function	Calculations based on GDP by expenditure data
$\omega_2 = 0.48$	Share of the nontradable sector in the production function	Calculations based on national accounts data
$A^N = A^E = 0.55$	Total factor productivity in the nontradable and exportable sectors	The parameters are calibrated so that aggregate GDP equals 1
$\alpha = 0.35$	Output elasticity of capital	
$\delta = 0.11$	Capital depreciation rate	
$\psi = 1.20$	Investment adjustment cost parameter	Polbin (2014)
$\gamma_G = 0.18$	Share of government spending in GDP	National accounts data
$\rho_{Tr} = 0.70$, $\gamma_{Tr} = 0.05$	Parameters for the equation for lump-sum transfers	
$debt\_GDP\_ratio = 0$	Debt-GDP ratio	
$\alpha_e = 0.1428$	Parameter of the share of exports in the CET function in the entrepreneurial sector	
$\rho = -0.15$	Parameter transformation in the CET function in the entrepreneurial sector	Turdyeva (2020)
$\mathcal{E} = \{\epsilon_1, \ldots, \epsilon_{N_\epsilon}\}$, P_ϵ	State vector and transition matrix for household labor productivity	
$\Theta = \{0; \theta_1\} = \{0, 1.05\}$, P_θ	State vector and transition matrix for entrepreneurial ability	
$v = 0.9$	Parameter of the production function in the entrepreneurial sector	
$d = 0.5$	Maximum leverage ratio	Kitao (2008)
$\phi = 0.028$	Credit spread	Bank of Russia[a)]; data on the zero-coupon yield curve from the Moscow Exchange[b)]

[a)] https://www.cbr.ru/statistics/bank_sector/int_rat/ (in Russian).
[b)] https://www.moex.com/ru/marketdata/indices/state/g-curve/archive/ (in Russian).
Source: Compiled by the authors.

The discount factor is formulated in real terms since the model is of the neoclassical type. A value of 0.9 was chosen, which gives the closest value for consumption-GDP ratio. The calibration of its value is consistent with the foreign practice of calibrating this parameter in models of the corresponding class (see, for example Cagetti and De Nardi, 2009). However, we were unable to achieve an exact match between consumption-GDP ratio in the model and the same ratio in the actual data within a reasonable variation of the discount factor. The consumption-GDP ratio is influenced by many other factors: risk aversion, parameters of the stochastic income process, the tax system, the level of government spending, macroeconomic uncertainty, etc. We leave the task of calibrating the model more accurately to reproduce this ratio for further research.

The maximum leverage ratio d was taken from Kitao (2008) since no suitable data or empirical work could be found for the Russian economy. The credit spread ϕ was calculated as the difference between the weighted average interest rate on loans to small and medium-sized enterprises (SME) for a period of 1 year and the yield on federal loan bonds with a maturity of up to 1 year.

The parameters δ, A^N and A^E were chosen so that $GDP = 1$, as in Fernández-Villaverde et al. (2016) and the components of GDP were the same proportion of GDP as in national accounts data. In 2011–2019, the share of exports in GDP was approximately 28%. According to the data of the Bank of Russia,[2] the share of oil and gas exports averaged about 14% in 2011–2019. That is, the share of exports other than oil and gas was about 14% of GDP. As for the SME sector, data from the Federal Customs Service are only available over the 2020–2021 period, according to which the share of the SME sector in total exports was 12.56% and 11.61%, respectively. According to Rosstat,[3] the share of the SME sector in 2017–2021 was 20–22%. Thus, the share of SME exports in GDP was about 3%, and the share of goods produced by the entrepreneurial sector for the domestic market was about 18%. So, the output of the non-tradable sector $Y^N = 1 - 0.28 - (0.21 - 0.03) = 0.54$, and in the exportable sector $Y^E = 0.14 - 0.03 = 0.11$.

The share of investment in fixed capital (gross fixed capital formation) was approximately 21%, according to data on GDP by expenditure. According to data on fixed capital investment (excluding small businesses),[4] as well as data on total investment, the share of export-oriented investment of the oil and gas sector was approximately 12% between 2017 and 2020.[5] As for small- and medium-sized businesses, the share of this sector's investment in total investment in fixed capital was approximately 8%, according to Rosstat data.[6] Thus, the share of investment in the corporate sector $\overline{I}^c = 0.21 \times (1 - 0.12 - 0.08) = 0.168$.

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2 https://www.cbr.ru/statistics/macro_itm/svs/ (in Russian).

3 https://www.fedstat.ru/indicator/59206 (in Russian).

4 https://www.fedstat.ru/indicator/58991 (in Russian).

5 The Federal State Statistics Service has developed a methodology for estimating the oil and gas sector in the Russian economy (see https://rosstat.gov.ru/folder/74099/document/122836, in Russian). According to the theses of the report, the share of the primary subsector is 72%, and the secondary subsector is 28%. In the data on the secondary sector, most indicators are not presented, so the total volume of investment and wage bill was calculated based on the volume of the primary sector and its share from the Rosstat calculations and then multiplied by the share of oil and gas exports.

6 https://rosstat.gov.ru/folder/210/document/13223 (in Russian).

The depreciation rate δ was calibrated so that the share of corporate sector investment in GDP equals 0.168. Since production function in both sectors is Cobb–Douglas function, the optimal capital stock in the corporate sector is given by:

$$K^N = \frac{\alpha Y^N}{R^K} = \frac{\alpha Y^N}{r/(1-\tau^K)+\delta}, \tag{36}$$

$$K^E = \frac{\alpha Y^E}{R^E} = \frac{\alpha Y^E}{r/(1-\tau^K)+\delta}. \tag{37}$$

The law of motion of capital in the steady state is defined as:

$$\delta(K^E + K^N) = \overline{I}^c. \tag{38}$$

Given (36–38), we get:

$$\delta\left(\frac{\alpha(Y^E+Y^N)}{R^K}\right) = \delta\left(\frac{\alpha(Y^E+Y^N)}{r/(1-\tau^K)+\delta}\right) = \overline{I}^c, \tag{39}$$

from where we can express δ:

$$\delta = \frac{\overline{I}^c \times r}{(1-\tau^K)(\alpha(Y^E+Y^N)-\overline{I}^c)}. \tag{40}$$

Substituting the above calculated values of Y^E and Y^N by exogenous parameters α, r, τ_K, $\overline{I}^c$, we can calculate the parameter δ. Given δ, we can calculate the values of K^N and K^E.

The values of total factor productivities A^N and A^E in both sectors were calibrated so that Y^N and Y^E were equal to 0.54 and 0.11, respectively. Thus, there are four equations with four unknowns A^E, A^N, L^E, L^N:

$$(K^E)^\alpha \times (A^E L^E)^{1-\alpha} = Y^E, \tag{41}$$

$$(K^N)^\alpha \times (A^N L^N)^{1-\alpha} = Y^N, \tag{42}$$

$$\left(\frac{K^N}{L^N}\right)^\alpha (A^N)^{1-\alpha} = \left(\frac{K^E}{L^E}\right)^\alpha (A^E)^{1-\alpha}, \tag{43}$$

$$L^E + L^N + L^{nc} + L^O = \overline{L} = 1. \tag{44}$$

The wage bill in the oil and gas sector was approximately 5% of the total wage bill in 2017–2021.[7] Employment in the SME sector was approximately 22% of the total employment according to the data presented in Zemtsov et al. (2021). For a more accurate calibration, the wage bill data should have been used as well, but it would not include the entrepreneurs themselves, as they are not necessarily paid for their labor contributions.

[7] https://www.fedstat.ru/indicator/57849 (in Russian).

The share of the entrepreneurial sector ω_1 and the share of the nontradable sector ω_2 in the Cobb–Douglas function can be calibrated based on the equations:

$$\omega_1 = \frac{pd^{nc} D^{nc}}{p^d Y^d}, \tag{45}$$

$$\omega_1 = \frac{p^N (Y^N - G^c)}{p^d Y^d} = \frac{p^d Y^d - pd^{nc} D^{nc} - p^M M}{p^d Y^d}. \tag{46}$$

The share of imports in GDP was approximately 21% according to national accounts data. As mentioned above, the share of goods produced by the entrepreneurial sector for the domestic market accounted for 17–18% of GDP. Domestic consumption output can be calculated as the sum of household final consumption and gross fixed capital formation. According to the national accounts data, its share in GDP was 0.73. Thus, the parameters ω_1 and ω_2 were calibrated at 0.25 and 0.48, respectively.

In Polbin (2014), a structural model for the Russian economy was estimated using Bayesian econometric methods. In this paper, a similar equation for the dynamics of capital stock was assumed, and the posterior mean for the parameter of the costs of capital setup turned out to be 4.65. Considering that the model in Polbin (2014) was estimated quarterly, the parameter ψ is set to 1.2 in the present paper.

The transformation parameter in the CET function ρ was calibrated at –0.15 according to Turdyeva (2020), which quantified the impact of terms-of-trade shocks on the Russian economy using a computable general equilibrium model. From the optimal ratio between exports X_t^{nc} and domestic sales D_t^{nc} in (2) we can express the parameter of the export share in the CET function:

$$\alpha_e = \frac{1}{\left(\frac{pd_t^{nc}}{p_t^e}\right)^{\rho} \frac{D_t^{nc}}{X_t^{nc}} + 1}. \tag{47}$$

We know from available data that the share of exports of SMEs in GDP was approximately 3%, and the share of SMEs in GDP was 20–22%. Given this data and the calibrated parameter ρ, the parameter α_e is approximately equal to 0.1428.

The share of government final consumption expenditures in GDP in 2011–2021 was stable, averaging around 18%. The exception was 2020, in which the share of government spending rose to 20%. Thus, government consumption in the model is set as a fixed share of nominal GDP:

$$p^N G^c = \gamma_{G^c} GDP, \tag{48}$$

$$p^{nc} G^{nc} = \gamma_{G^{nc}} GDP, \tag{49}$$

where $\gamma_{G^{nc}} + \gamma_{G^c} = \gamma_G = 0.18$.

The target debt-to-GDP ratio was assumed to be 0. The autoregression coefficient for lump-sum transfers was calibrated at 0.7, and the sensitivity coefficient at 0.05. It is impossible to estimate the value of the parameters from the data due to the short time series and frequent changes in budget rules in Russia, so the parameters were calibrated based on partial equilibrium so that the model would

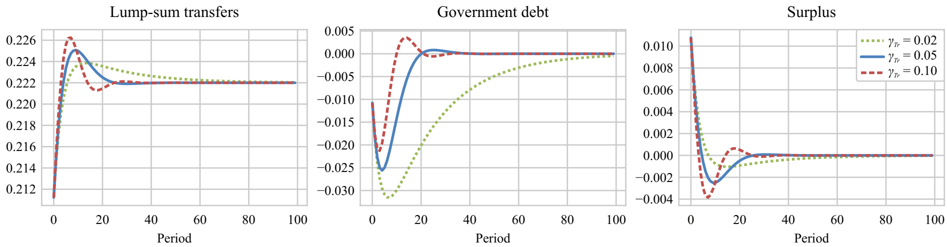

Fig. 2. Lump sum transfers, government debt, and budget surplus at different values of the rule parameters for transfers.

Source: Authors' calculations.

generate satisfactory transition paths. For example, Fig. 2 shows the dynamics of fluctuations of transfers, public debt, and budget surplus in partial equilibrium after a 20% permanent increase in oil prices. For higher values of the parameter γ_{Tr}, the model generates periodic fluctuations. With the chosen parameters, the transitions of the fiscal sector indicators turn out to be reasonable. With a lower value, the national debt converges to its steady state in about 100 years.

As in Quadrini (2000), Cagetti and De Nardi (2006), and Kitao (2008), it is assumed that the exogenous processes for labor productivity and entrepreneurial ability evolve independently.

It is assumed that the process of income generation is described by a first order autoregression, which is then approximated by a discrete process based on the method proposed in Rouwenhorst (1995). The autoregressive coefficient was assumed to be 0.93 and the variance of the shocks to be 0.08, as estimated in Martyanova and Polbin (2022). Applying the procedure from Rouwenhorst (1995) with these parameters, the transition matrix and state vector were obtained. The vector of states was normalized so that in the stationary state the average labor productivity equals unity. Thus, the transition matrix and the state vector are set as follows:

$$\mathcal{E} = \{\epsilon_1, ..., \epsilon_{N_\epsilon}\} = \{0.254, 0.754, 2.238\}, \tag{50}$$

$$P_\epsilon = \begin{bmatrix} 0.931 & 0.068 & 0.001 \\ 0.034 & 0.932 & 0.034 \\ 0.001 & 0.068 & 0.931 \end{bmatrix}. \tag{51}$$

In papers that use general equilibrium models with the entrepreneurial sector, the transition matrix and the state vector for entrepreneurial ability are calibrated to reflect given moments of the distribution, since there are no suitable microdata or estimates. For example, in Kitao (2008) entrepreneurial abilities were approximated with a four-point discrete Markov chain. A number of simplifying assumptions were made, so only six parameters needed to be calibrated. Parameters were calibrated so that the model reflected seven moments in equilibrium, namely the share of entrepreneurs in the economy, the share of income received by entrepreneurs, the average exit rate of entrepreneurs, the exit rate of new entrepreneurs with a one-period tenure, the share of capital in the entrepreneurial sector, the share of assets owned by entrepreneurs, and the ratio of median assets of entrepreneurs to workers. However, not all these indicators are available from statistical data for

Table 2
Calibration targets and results.

Description	Model, %	Data, %	Data source
Share of household consumption in GDP	60	≈ 50	GDP by expenditure data
Share of entrepreneurs in the total employed population	10	5	RBC citing Sberbank[a)]; Rosstat
Share of entrepreneurs' income	23.6	20–22	Rosstat
Exit rate for entrepreneurs	18.8	15	Rosstat

[a)] https://www.rbc.ru/economics/30/04/2019/5cc729d69a7947b3c4f18ab5 (in Russian).
Source: Compiled by the authors.

Russia. Therefore, two states were assumed for the entrepreneurial ability process, as in Cagetti and De Nardi (2006), Bassetto et al. (2015). Furthermore, as argued in these studies, a Markov chain with two states allows reproducing distributional moments corresponding to real data in a reasonable computation time.

Thus, an agent's entrepreneurial ability can take two values: zero and some positive number θ_1. The transition matrix is of dimension 2 × 2, and the sum of the elements in each row must equal one.

$$P^{\theta} = \begin{pmatrix} p_{11}^{\theta} & p_{12}^{\theta} \\ p_{21}^{\theta} & p_{22}^{\theta} \end{pmatrix}, \tag{52}$$

That is, two more elements must be calibrated for the transition matrix. Thus, four parameters, namely the subjective discounting factor β, the parameter of the production function in the entrepreneurial sector v, entrepreneurial ability θ_1, the transition matrix elements p_{11}^{θ} and p_{22}^{θ}, were calibrated so that the model reproduces the actual data from the Russian economy presented in Table 2.

The transition matrix element p_{22}^{θ} strongly affects the exit rate from entrepreneurship, as it determines the loss of entrepreneurial ability. According to Rosstat,[8] the official liquidation rate for organizations ranged from 9.8% to 17.2% in 2017–2022 with an average of 13.9%. Taking into account rounding, this parameter was calibrated at 15%. In Kitao (2008), and Cagetti and De Nardi (2006), which calibrated general equilibrium models with the entrepreneurial sector for the U.S. economy, the entrepreneurial exit rate was 20%. The lower value compared to the U.S. data is also consistent with Sberbank's data[9] on the higher survival rate of small and medium-sized enterprises in Russia compared to the US.

The second value of the transition matrix p_{11}^{θ} was calibrated so that the model reproduces the share of entrepreneurs in the total employed population. Thus, the transition matrix for entrepreneurial ability looks as follows:

$$P^{\theta} = \begin{pmatrix} 0.975 & 0.025 \\ 0.150 & 0.850 \end{pmatrix}. \tag{53}$$

The entrepreneurial ability parameter θ_1 was calibrated so that in the baseline steady state the price of entrepreneurial goods approximately equals 1.

[8] https://rosstat.gov.ru/statistics/instituteconomics (in Russian).
[9] https://www.sberbank.com/common/img/uploaded/files/pdf/analytics/ust_bz.pdf (in Russian).

Table 3
Tax rates in the baseline scenario.

Variable values	Variable description
$\tau^c = 0.2$	Consumption tax
$\tau^{wh} = 0.13$	Payroll tax
$\tau^{wf} = 0.3$	Social security contribution rate
$\tau^{nc,r} = 0.06$	Income tax rate for entrepreneurs who have chosen the "Income" regime ($j = 0$)
$\tau^{nc,\pi} = 0.15$	Income tax rate for entrepreneurs who have chosen the "Income minus expenses" regime ($j = 1$)
$\tau_t^K = 0.2$	Profit tax for corporate firms
$\tau_t^O = 0.55$	The average tax burden on oil and gas exports

Source: Compiled by the authors.

4. Policy experiments

In the baseline scenario, all exogenous prices are set at 1, and tax rates are set at the same level as the corresponding rates in the Russian economy (see Table 3).

Scenario 1: export price shock. In the first scenario, oil prices increase by 20% and prices of export goods increase by 10%. This scenario can be interpreted as an increase in global business activity, which leads to an increase in demand for both oil and other exports.

Scenario 2: redistribution of government expenditures between the corporate and entrepreneurial sectors. As mentioned above, the share of government consumption in GDP is stable at around 18%. The baseline version of the model assumed that the government does not buy entrepreneurial goods, i.e., $\gamma_{G_{nc}} = 0$, $\gamma_{G_c} = 0.18$. The experiment 2 consisted of redistributing government spending between the corporate and entrepreneurial sectors: $\gamma_{G_{nc}} = 0.03$, $\gamma_{G_c} = 0.15$.

Scenario 3: relaxation of collateral requirements. This scenario consists of relaxing the credit constraint (29) for entrepreneurs, namely increasing the parameter d from 0.5 to 0.75. It is important to note that the model does not consider the possibility of default for entrepreneurs. An example of such a policy is the National Guarantee System, created to make access to credit for small and medium-sized enterprises easier.[10] Members of the system (guarantee organizations) provide sureties and guarantees on liabilities for the self-employed and organizations from the Unified Register of SMEs.

Scenario 4: credit rate subsidy for entrepreneurs. This experiment consists of reducing the parameter ϕ by 0.01, that is, loans for entrepreneurs become cheaper. The government bears the costs of credit subsidies, which is reflected in its budget constraint. The cost is equal to the sum of entrepreneurial loans multiplied by 0.01.

Scenario 5: VAT for entrepreneurs. In this scenario, entrepreneurial goods are taxed at a rate $\tau^{nc} = 0.2$, which is equivalent to imposing a value-added tax on consumption goods of the entrepreneurial sector.

5. Results

Stationary equilibria were computed for all scenarios. The results are presented in Table 4, which shows the indices of changes in indicators compared to

[10] https://www.cbr.ru/develop/msp/ (in Russian).

Table 4
Steady states (%).

Variable	(1)	(2)	(3)	(4)	(5)
Lump-sum transfer	14.1	0.8	–0.2	–0.7	15.2
Price of entrepreneurial goods for the domestic market	9.6	1.8	–1.6	–0.7	–0.6
Price of entrepreneurial goods	9.7	1.5	–1.4	–0.6	–0.5
Household consumption	4.6	1.0	–0.2	0.0	–1.8
Entrepreneurial output	1.9	11.5	1.4	0.7	–10.1
Entrepreneurial labor	0.0	11.0	–0.1	0.1	–8.4
Entrepreneurial capital	3.9	11.4	4.6	2.7	–10.4
Number of entrepreneurs	2.5	0.5	–0.1	0.0	–1.8
Entrepreneurial taxes	11.8	13.2	0.0	0.1	–10.5
Entrepreneurial output for the domestic market	1.9	–1.0	1.4	0.7	–10.1
Exports of the entrepreneurial sector	2.0	–1.3	1.7	0.8	–10.0
Output in exportable sector	–5.6	–2.0	5.6	0.8	27.2
Output in nontradable sector	1.9	–5.2	–0.1	0.0	2.1
Capital in exportable sector	–3.0	–2.5	6.0	1.0	27.3
Capital in nontradable sector	4.6	–5.6	0.3	0.2	2.3
Labor in exportable sector	–6.9	–1.8	5.4	0.7	27.1
Labor in nontradable sector	0.5	–4.9	–0.3	–0.1	2.0
Price of investment goods on the domestic market	7.1	0.4	–0.4	–0.2	–0.1
Price of consumption goods on the domestic market	7.1	0.4	–0.4	–0.2	4.5
Wage rate	11.6	–0.2	0.2	0.1	0.1
GDP	12.8	0.5	0.1	0.0	2.3

Source: Authors' calculations.

the steady state in the baseline scenario. Figs. 3, 4, 6, 7 and 8 show the transitions from the baseline scenario to the new steady states for scenarios 1–5. The years after reform are on the horizontal axis, and the relative value of each indicator to its pre-reform level is on the vertical axis. Only in the graph for the public debt is the absolute value because the target value of the debt in the steady state was assumed to be zero. Note that the graphs for taxes for the entrepreneurial sector depict taxes paid by entrepreneurs under the "income" and "income minus expenses" regimes, which do not include social insurance contributions.

Scenario 1: export price shock. In the first scenario, the entrepreneurial sector is influenced by three effects: the negative effect of the higher wage rate, the positive effect of an increase in lump-sum transfers and assets, and the positive effect of an increase in demand.

As can be seen in Fig. 3, the increase in wages leads to a decrease in entrepreneurial output by about 1% in the short run. In the long run, however, the positive effects exceed the negative effect, but output increases by only 2%. The number of entrepreneurs increases by about 2.5%. The price of entrepreneurial goods increases immediately after the reform and then decreases to a level that exceeds the initial level by 9.7%. This is explained by the fact that the nontradable sector is bearing the adjustment costs of investment, which does not allow it to increase production quickly in order to meet the increased demand in the domestic market.

Lump-sum transfers increase by about 14%, leading to an increase in household consumption. Output of the exportable sector declines by 5.6%, while output of the nontradable sector increases by about 2%. The domestic price for both consumption and investment increases by about 7%, following an increase in export prices. The wage rate increases by about 12%.

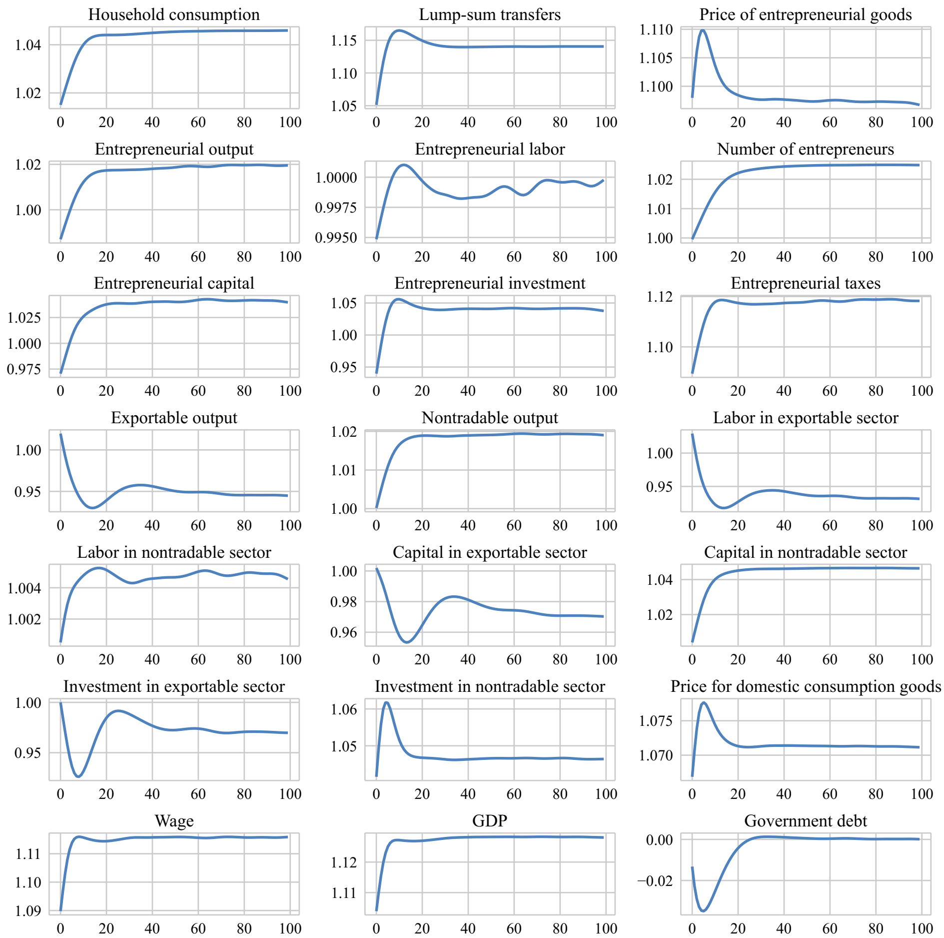

Fig. 3. Transitions for experiment 1 (export price shock).

Source: Authors' calculations.

Scenario 2: redistribution of government consumption between the corporate and entrepreneurial sectors. In the baseline scenario, government consumption of entrepreneurial goods is 0% of GDP, and in the scenario 2 it is 3% of GDP. As can be seen in Fig. 4, the subsidy to entrepreneurs leads to an increase in output, capital, and labor in the entrepreneurial sector of 10% or more. At the same time, the number of entrepreneurs increases by only 0.5% compared to the baseline scenario, i.e., entrepreneurs grow in number on average.

Household consumption increases by 1% in the long run. GDP decreases after the reform, while in the long run it increases insignificantly by about 0.5%. This can be explained by the fact that in the transition period there is a gradual reallocation of resources from the corporate sector to the entrepreneurial sector. Wages decrease immediately after the reform, and then increase to the level of the new steady state, which is lower than the initial one.

Scenario 3: relaxation of collateral requirements. As can be seen in Fig. 6, a decrease in the maximum leverage d leads to a sharp increase in investment and capital in the entrepreneurial sector. An increase in capital leads to an increase in output. It is important to note that the total number of entrepreneurs in the model

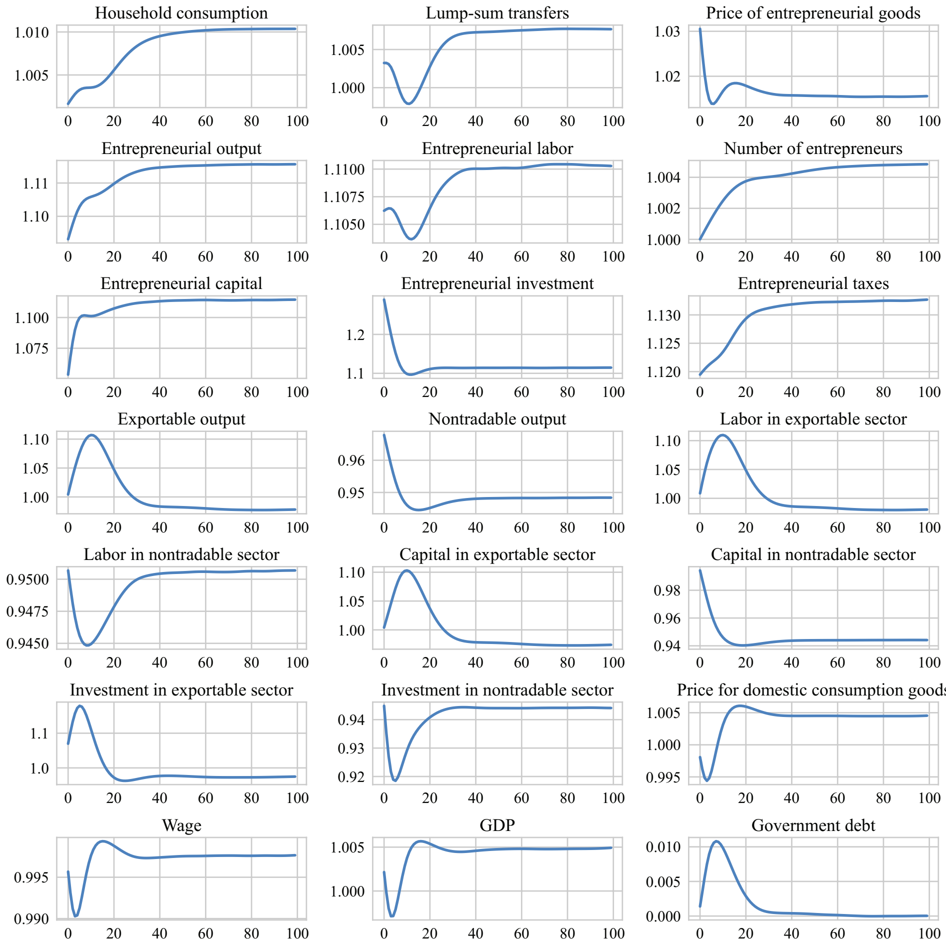

Fig. 4. Transitions for experiment 2 (redistribution of government expenditures).

Source: Authors' calculations.

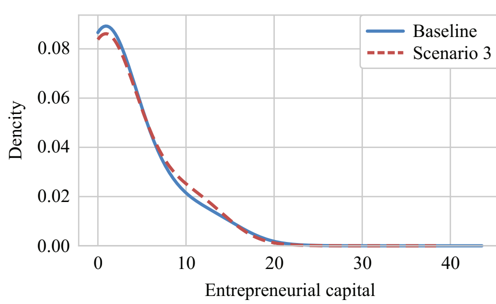

Fig. 5. Distribution density of entrepreneurial capital.

Source: Authors' calculations.

economy declines in the long run. This is due to a decrease in the price of entrepreneurial goods, caused by a sharp increase in supply from the entrepreneurial sector. As can be seen in Fig. 5, the reform causes the "hump" of the distribution to become lower and the right tail of the distribution to become thicker. Thus, the share of entrepreneurs with more capital increases.

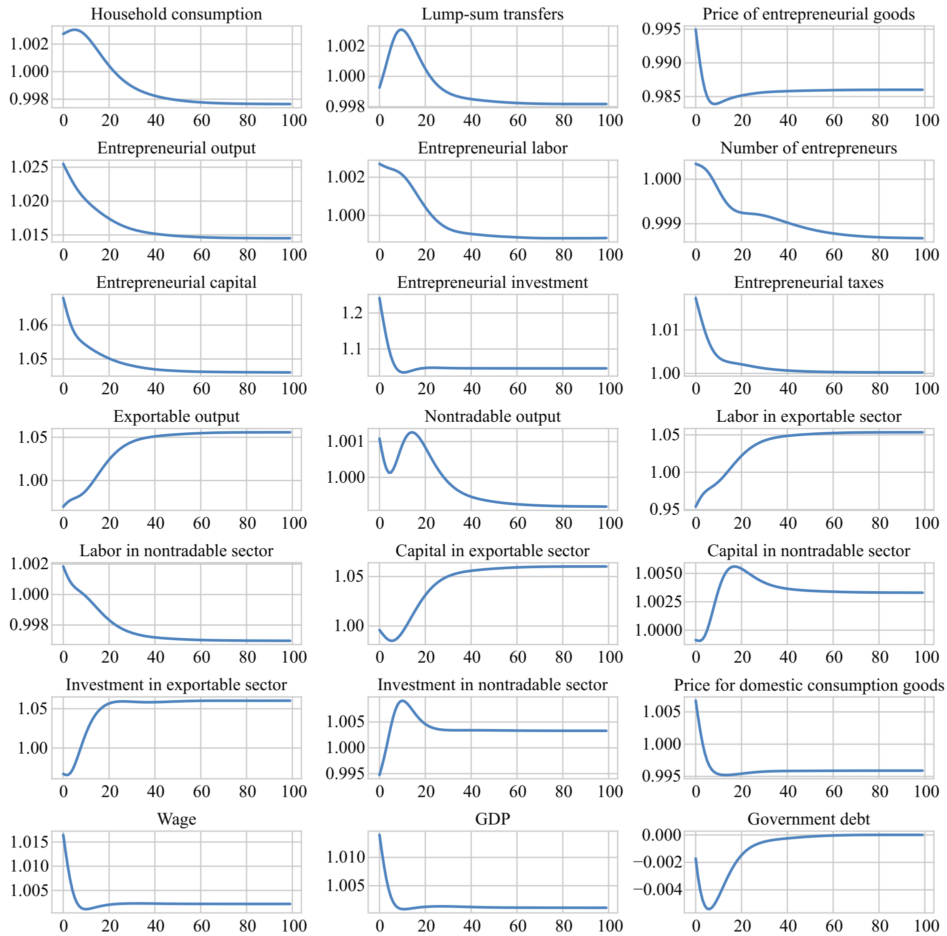

Fig. 6. Transitions for experiment 3 (relaxation of collateral requirements).

Source: Authors' calculations.

GDP increases sharply immediately after the reform because of the increased demand for investment from entrepreneurs, but in the new steady state it is slightly higher than the initial value, by 0.1%. The reform leads to a slight increase in household consumption in the short run, but in the long run consumption is lower by 0.2%. This is explained by a decrease in lump-sum transfers. It is important to note that, according to the construction of the model, it is impossible to consider the possibility of default, so the results of this experiment should be interpreted carefully.

Scenario 4: credit rate subsidy for entrepreneurs. As can be seen in Fig. 7, investment in the entrepreneurial sector rises to 10% immediately after the reform, as entrepreneurs need to build up the necessary amount of capital. Then investment gradually declines to the level necessary to maintain capital at the level of the long-run steady state. At the same time, the amount of labor increases slightly by 0.1%. The prices of entrepreneurial goods fall due to lower production costs. Entrepreneurial taxes increase by 0.5% immediately after the reform, and then decrease to a level that exceeds the initial level by 0.1%. This is explained by the fact that, on the one hand, the output of the entrepreneurial sector and the number of entrepreneurs increased, while production costs decrease, which increases the tax

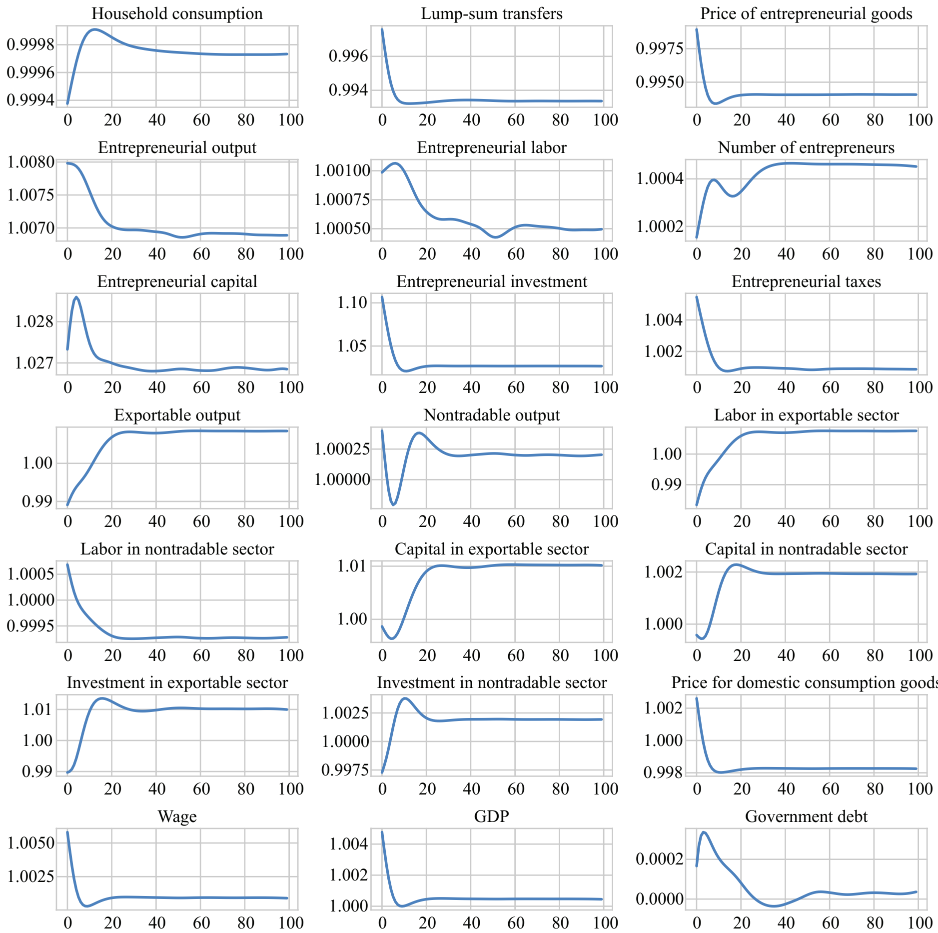

Fig. 7. Transitions for experiment 4 (credit rate subsidy for entrepreneurs).

Source: Authors' calculations.

base. On the other hand, the price of entrepreneurial goods has declined monotonically throughout the transition, reducing entrepreneurial income.

Lump-sum transfers decrease because of the additional costs of financing subsidies. Household aggregate consumption changed insignificantly: immediately after the reform, consumption declined by 0.06%, and in the long run it is lower than the value in the initial steady state by about 0.02%.

Scenario 5: VAT for entrepreneurs. The introduction of a tax on entrepreneurial goods used for final consumption leads to a 10% decrease in the entrepreneurial output. As can be seen in Fig. 8, the price of entrepreneurial goods decreases immediately after the reform, but then increases to a level that is 0.5% lower than the value in the initial steady state. The number of entrepreneurs declines by 1.8%.

Household consumption declines by 1.8% despite a 15.2% increase in lump-sum transfers. This can be explained, among other things, by the fact that the price of final consumption goods in the domestic market is increasing by 4.5%. The output of the corporate sector increases. Thus, output in the nontradable sector increases by about 2%, while output of the exportable sector increases by 27.2%. As a result, GDP increases by 2.3%, despite a decline in the entrepreneurial output.

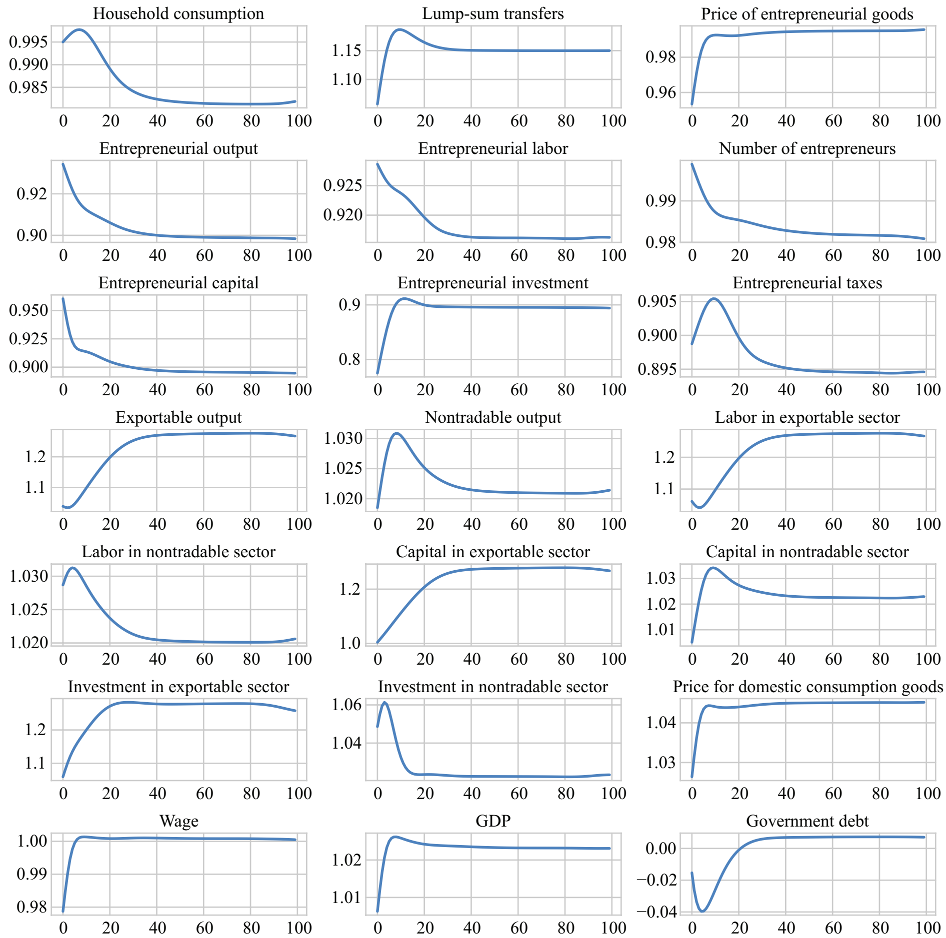

Fig. 8. Transitions for experiment 5 (VAT for entrepreneurs).

Source: Authors' calculations.

6. Conclusions

The following conclusions can be drawn from the results of our study. This paper proposes a modification of the general equilibrium model with the entrepreneurial sector in the spirit of Quadrini (2000), supplemented by the oil and gas sector. The model parameters were calibrated to fit the Russian economy as much as possible.

Five scenarios were analyzed: (1) an export price shock, (2) redistribution of government consumption between the corporate and entrepreneurial sectors, (3) relaxation of collateral requirements, (4) a credit rate subsidy for entrepreneurs, (5) VAT for entrepreneurs. Steady states were computed for the baseline scenario and scenarios 1–5. The transition dynamics from the baseline steady state to each of the five proposed scenarios were computed.

In the short run, a wage rate increase after the export price shock leads to lower output in the entrepreneurial sector. However, in the long run, the positive effects of increased demand and assets exceeded this negative effect, leading to increased output in the entrepreneurial sector. The redistribution of government consumption between the corporate and entrepreneurial sectors leads to reallocation of resources from the corporate sector to the entrepreneurial sector. The relaxation of collateral requirements leads to a sharp increase in entrepreneurial investment and capital and a decline in the number of entrepreneurs, which means that entrepreneurs become bigger. The credit rate subsidy leads to an increase in capital in the entrepreneurial sector, and then in output. The cost of subsidies leads to a decrease in lump-sum transfers, but this does not lead to a significant change in household consumption. The introduction of a value-added tax on entrepreneurial goods leads to a redistribution of resources from the entrepreneurial sector to the corporate sector, reducing household consumption and increasing GDP.

Acknowledgements

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