Impact of Capital Expenditures on Final Consumption and Productivity of the Region's Economy

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Abstract: The reproduction model is intended to address the problem of material provision of state programs or other needs. It allows estimating necessary changes of output, gross product, the maximum possible volume of final consumption of different sectors of economy, as well as estimation of actual and equal productivity. One way to manage reproduction is to change the cost structure and final consumption. This means that a certain amount of productive resources is available. In the case of a shortage of production resources, the process of changing the control parameters in parallel with reproduction starts a slow process of forming additional production capacity. The capital formation process can be stimulated by an increase in the share of final consumption in output, which in turn can be achieved by stimulating the corresponding final demand. Balanced funding helps to maintain final consumption. On the other hand, starting at a certain level of the latter, equilibrium mode productivity begins to exceed its achieved level.

1 INTRODUCTION

The management of the structure of the reproductive system of the region allows to significantly increase its productivity, which can be defined as the ratio of gross value added (GRP) W to the gross volume of intermediate costs Z:

$$\pi = W / Z .$$

Denote V - gross output, then the coefficient of intermediate consumption is equal a = Z/V, gross output V = W + Z, hence π = 1/a - 1. If purposeful restructuring of the technological core of the reproduction system is aimed at increasing its productivity, its transition to the equilibrium structure can ensure the stability of the economic system.

Let the volume of output of the i-th branch V_i of the multisectoral economic system having n branches forms a vector $\mathbf{V}$. The change of prices and volumes of output is defined by vectors of price indices p and output indices v. $[X_{ij}]$ - the matrix of volumes of resources spent during reproduction , $i, j = 1,..,n$. Here j is the number of the industry engaged in the production of resource i, $\mathbf{X}$ - the vector of direct costs,

$$X_i = \sum_{j=1}^{n} X_{ij} .$$

Unit cost coefficients (material intensities) are calculated using the formula

$$a_{ij} = X_{ij} / V_j \qquad (1)$$

and form a matrix of unit costs $\mathbf{A} = [a_{ij}]$, having spectrum S. Matrix A defines the structure and state of the technological core of the reproduction system (Leontief, 1990). We assume that output costs, including fund formation, final consumption, net exports, are linearly dependent on output and prices.

$$X_i = \sum_{j=1}^{n} a_{ij} V_j \qquad (2)$$

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2 LOCAL EQUILIBRIUM REPRODUCTION MODE MODEL

The article considers locally stable mode of reproduction of technological core of economy. The local nature of management is that the industry's output is increased by its own added value. Equilibrium output and price indices are the eigenvectors of the technology matrix and the transposed technology matrix respectively. To calculate the eigenvector and frobenius eigenvalue of the positive shura matrix **A (**Ashmanov, 1984; Poljak, 2019) it is convenient to use its stability in the construction of a convergent iteration procedure (Gusev, 2021):

$$\mathbf{x}^0 = (1,1,\ldots,1),$$

$$\mathbf{y}_k = \mathbf{A}\cdot\mathbf{x}_k \qquad (3)$$

$$\mathbf{x}_{k+1} = \mathbf{y}^k \frac{\|\mathbf{x}^k\|}{\|\mathbf{y}^k\|}, k = 0,1,2,.. \qquad (4)$$

If interpreted x^k , as a vector of output indices or prices for a moment *k*, the process (3), (4) simulates an uncontrollable process of approaching a locally stable equilibrium reproduction mode for the technological core of the economy. Thus, the output of industries and prices change proportionally to intermediate costs, that is, locally, depending on the available funds of industries. Eigenvalue of matrix **A**, calculated as a limit value:

$$a^* = \lim_{k\to\infty} \frac{\|\mathbf{y}^k\|}{\|\mathbf{x}^k\|}$$

is the largest of all its own numbers (Poljak, 2019). This value determines the local equilibrium productivity $\pi^* = 1/a^* - 1$. It is obviously less than the productivity obtained as a result of optimization processes (Gusev, 2022).

Deformation (1) of matrix **A** as a result of change in final consumption results in change in local equilibrium productivity π^*.

3 BALANCE-SHEET MODEL OF FINAL CONSUMPTION IMPACT ON REPRODUCTION

Let $\mathbf{C}$ - the vector of final consumption, $\mathbf{R}$ - the vector of accumulation (including fund formation and net exports). The equation of balance is like

$$\mathbf{V} = \mathbf{X} + \mathbf{C} + \mathbf{R},$$

Let $\mathbf{V}_c$ - a vector of output that takes into account the provision of growth of final consumption by volume c. It is necessary to calculate the vector of balanced output as a function of the cost of additional consumption. The increase in the output vector $\Delta\mathbf{V}_c = \mathbf{V}_c - \mathbf{V}_0$ under the additional fund formation of Rc is due to the growth of the final consumption equation:

$$\Delta\mathbf{V}_c = \mathbf{B}(\Delta\mathbf{C} + \mathbf{R}_c / f_0),$$

where the $\mathbf{B} = (\mathbf{E} - \mathbf{A})^{-1}$ - matrix of total costs (Leontief, 1990), f_0 is the ratio of investment productivity, which means the volume of production capacity per unit value. $\mathbf{R}_c / f_0$ - costs of capacity building.

End-use growth has a pattern $\mathbf{d} = \mathbf{C_0}/\|\mathbf{C_0}\|$:

$$\Delta\mathbf{C} = \mathbf{d}c,$$

where $\mathbf{C_0}$ is the initial final consumption of the sector in question.

Let *eps* - the ratio of reserve of production, labor and material resources, then restrictions on output without taking into account the growth of capacities have the form

$$\mathbf{V}_c \le \mathbf{V}_0 \cdot (1 + eps).$$

Given the availability of reserve resources, capacity shortfalls offset by additional output are

$$\begin{aligned}\mathbf{R}c &= \max(0, \mathbf{V}_c - \mathbf{V}_0 \cdot (1 + eps)) \\ &= \max(0, \Delta\mathbf{V}_c - eps \cdot \mathbf{V}_0)\end{aligned}. \qquad (5)$$

We shall introduce the reserve volume $\mathbf{R} = \mathbf{R}c^* q$ adjusted in accordance with the social orientation of economic policy, where the multiplier q is selected so that the dependence of the growth of final consumption on the planned growth of final consumption with was monotonous, which is required. Then we shall

$$\Delta\mathbf{V}_C = \min(\mathbf{B}(\Delta\mathbf{C} + \mathbf{R} / fo), \mathbf{R} + \mathbf{V}_0 \cdot eps). \qquad (6)$$

In the solution of the system of equations (5), (6), it is assumed that the deficit is covered by the internal product generated in the reproduction cycle over the corresponding period of time. The initial approximation **R** can be calculated using the formula

$$\mathbf{R}c = \max(0, \mathbf{B}\Delta\mathbf{C} - eps \cdot \mathbf{V}_0) / (1 + eps).$$

The value added vector (domestic product) due to change in final demand is equal to

$$\mathbf{W}_c = \mathbf{V}_c - \mathbf{X}_c = \mathbf{V}_c - \mathbf{A}\mathbf{V}_c.$$

The corresponding final consumption growth vector is equal to

$$\Delta\mathbf{C} = \mathbf{W}_c - \mathbf{R}_c / fo$$

As a result of the increase in final consumption, and due to the piecemeal linear dependence of parameters on the initial output $\mathbf{V}_0$, there is a change in the intermediate costs ΔX_{ij} of product i in industry j, caused by a change in output corresponding to the growth of the final consumption vector . The unit cost matrix coefficients then change as follows:

$$a_{ij}^* = (X_{0ij} + \Delta X_{ij})/V_i = (X_{0ij} + a_{ij} \cdot \Delta C_j)/V \quad (8)$$

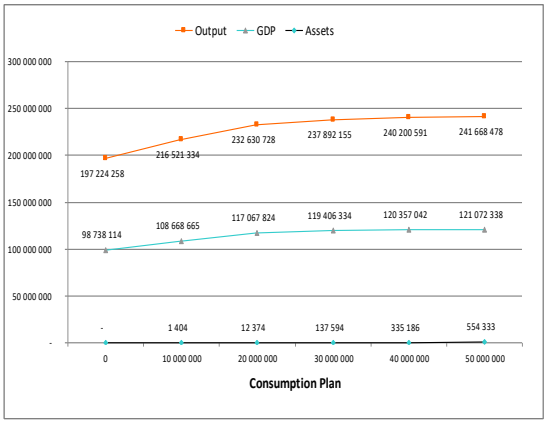
Transformation of matrix A as a result of change of final consumption leads to change of productivity π as well as its own values and, therefore, this transformation can be called deformation of technological core. Such a distortion can occur both locally funded and centrally funded.

4 CALCULATION RESULTS FOR REPRODUCTION MODELS

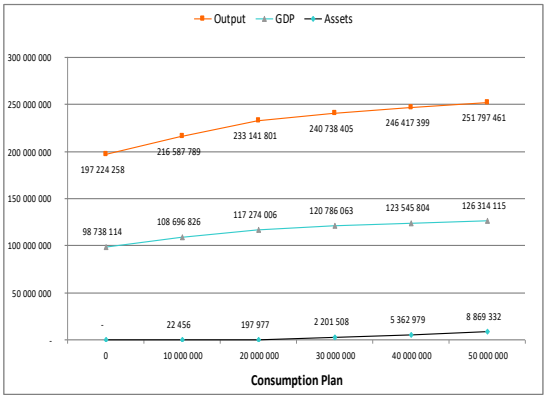
The Tables of Supply and Use of Goods and Services of the Russian Federation for the year 2020 were used to demonstrate the modelled approach and to obtain qualitative conclusions for the regional economy. This table, as well as the Rosstat tables of previous years, contains the same number of industries and types of products, and it can be distinguished symmetric subtface. To calculate the unit expenditure matrix A, this part of the table was used, corresponding to the intermediate consumption of industries, and in addition, a row containing the industry output vector. The statistical data allow estimating the share of unladen production industries about 25%, and the average ratio of fund productivity fo about 0.5.

The values of output V , GRP W , fund formation R, final consumption C, productivity π for declared final consumption c (in table (Tablicy, 2020) for total final consumption expenditures) were calculated. The following results (fig. 1, 2, 3) were obtained for two modes: A - limited funding generation ($q = eps^3$).and B - excess funding ($q = eps$)

All volume indicators are measured in mln. rubles.

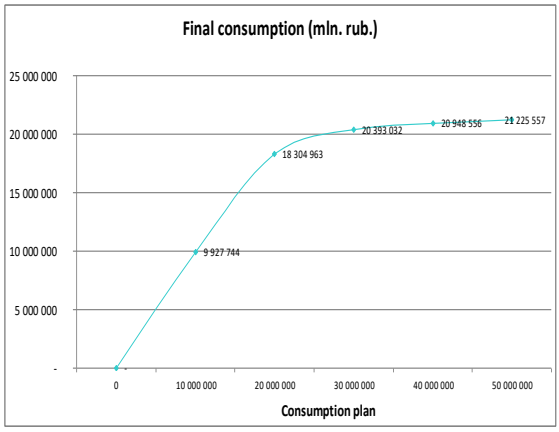


A

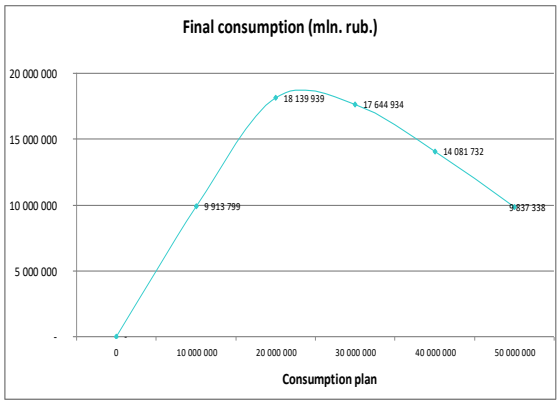


B

Figure 1: Dependence of macro indicators on planned consumption of sector «final consumption expenditure».



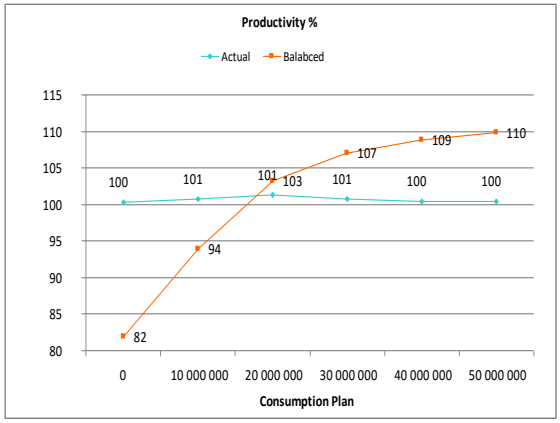
A



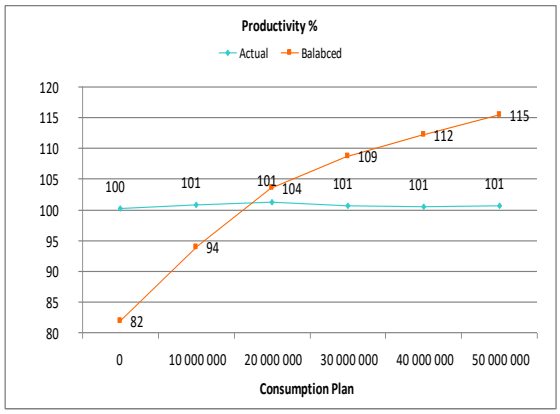
B

Figure 2: Dependence of current final consumption on planned consumption of sector «final consumption expenditure».

The resulting output grows with added consumption nonlinearly, as it takes into account the build-up of fixed assets. If it is large enough, additional constraints on labour must be taken into account. When there is excess funding, final consumption decreases because there is a shortfall in funds. But gross value added increases.



A



B

Figure 3: Dependence of current and equilibrium productivity on planned consumption of the sector «final consumption expenditure»

Equilibrium productivity is calculated by procedures of search of local equilibrium and recalculation of technological matrix (8). Graphs of actual and equilibrium productivity intersect with the volume of final consumption 17 trillion. rub. at the level of 101%. This consumption is a point of bifurcation, with the property that the equilibrium economy is inferior to the uncontrolled economy in terms of productivity, and higher in terms of final consumption. In addition, in excess fund formation, equilibrium productivity is slightly higher than in limited fund formation.

In this case, for sufficient final consumption, actual productivity increases to an amount comparable to that achieved with optimal consolidated management (Gusev, 2022). But equilibrium productivity is much lower than for final consumption expenditure.

4 CONCLUSIONS

The main conclusion is that the multisectoral economy of the region, which has no institutional system of coordination of participants, tends to a state of local equilibrium with minimal equilibrium productivity of the system of reproduction.

The developed model showed a number of reproduction process features associated with the burden of the economic system by the output of end-use products:

Final consumption growth less than or equal to planned volume.

An increase in final consumption, with its corresponding structure, leads to an increase in equilibrium productivity that is achievable in a local control situation. This increase in equilibrium productivity (as opposed to the optimization model of consolidated management) is irreversible, as it is due to a change in the technological structure of reproduction.

When the final consumption threshold is exceeded, the economy achieves a stable state, where local control allows to ensure a value of equilibrium productivity greater than its initial value. That is, after overcoming the specified threshold of final consumption, the local equilibrium economy sustains it.

The maximum possible increase in final consumption is directly dependent on the reserve ratio eps.

Given the local nature of reproduction management, the Russian economy has minimal efficiency, but is stable and uneven income. If each industry, in cooperation with others, only manages its own resource for investment, then the economy is in balance with minimal productivity. The growth rate of such an economy depends on final consumption. The trap is the inability to break the poverty line with low end consumption. A centralized reserve is needed to increase economic productivity.

The obtained results testify to the prospect of development of institutes of management of development of technological infrastructure of the Russian economy (Gusev, 2022a; Gusev, 2007; Antipov, 2019). The models can be used to refine the programs of medium-term development of the Russian economy, including the project of basic unconditional income (Bobkov, 2021), as well as to solve the problems of material provision of CBO. The obtained solutions represent the framework values of economic indicators within a given technological base.

The formulation of economic development plans along with their sustainability (Chen, 2024) should take into account the impact of household final consumption on the external environment (Nágela, 2020) as well as be consistent with natural resource management policies (Smith, 2021).

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