

Elena Piskun <sup>1</sup>  
Vladimir Khokhlov  
Natalia Simchenko

## ECONOMIC DEVELOPMENT OF SEVASTOPOL AND ITS INFLUENCE ON THE POPULATION'S LIFE QUALITY

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**Abstract:** *An indispensable condition for setting strategy and programs of regional development, which stimulate solution of the tasks for increase of population's life quality, is a retrospective research of socio-economic performances for the purpose of determining the problem aspects and points of economic growth. Therewith, an assessment of economic development should be carried out within interrelation and interdependence of performances. In order to monitor modern economic state of Sevastopol and reveal its growth spurts, we need to uncover the current trends. The most true-to-life results were obtained using a system of simultaneous equations, which allows investigating the influence of external (exogenous) variables on endogenous ones that are integral and describing an economic state of the region. In the course of this study, we modelled economic processes depending on different levels of exogenous variables, which made it possible to reveal latent trends in the dynamic pattern of economic development of Sevastopol subject to irregular results of statistical conclusions.*

**Keywords:** *quality of life, economic development, region, city of Sevastopol, modeling of economic processes, exogenous and endogenous variables*

### 1. Introduction

The issues of life quality are considered at the global level. A lot of scholars note that the indicator of gross national product is not a sufficient measure of social and economic development – due to the objective limitations of its growth. It is necessary to take into account the existing tendencies and to determine which assets a certain region can pass to future generations. Thus, according to the report of the United Nations Economic and Social Council as a result of the research of Joseph E. Stiglitz, Chair, Amartya Sen, Chair Adviser, and Jean-Paul Fitouss, macro-economic statistics should be supplemented by more individualized indicators (which are

also more coordinated with the global system). Also, there are methods and methodologies of statistical observations that are adopted in each country, including the Russian Federation, which include a certain totality of the indicators characterizing the socio-economic state of the country and its regions. This will be the basis here for comparing the data and obtaining adequate assessments of development of the city of Sevastopol.

In July 2017, the Legislative Assembly of Sevastopol approved Development Strategy of the City until 2030. The document contains analysis of socio-economic situation herein, particularly examines the state of the housing sector, municipal economy, transport,

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<sup>1</sup> Corresponding author: Elena Piskun  
Email: [lenapiskun@mail.ru](mailto:lenapiskun@mail.ru)

structure of economy, investment, public finance and other areas of urban life. However, there is no analysis of the interaction between of different trends of urban life, measured by the main macroeconomic indicators. Such an analysis is possible on the basis of time series with a volume sufficient for correct computations. But the urban economic statistical data after return to the Russian Federation is insufficient, since it has been calculated since 2014. Therefore, to assess the current economic situation in Sevastopol and to discover priority lines of development hereof, we need to determine the trends of economic development in the Ukrainian period of its history. For this purpose, we can use a quite wide range of different approaches with econometric especially macroeconomic modeling as the most reliable ones. The methods of correlation-regression analysis are used very often, showing in particular the effect of a regional economic circulation on features of economic equilibrium (Antonyuk & Valentey, 2010); flexibility of GRP and individual industries of the region according to investments (Gorid'ko & Nizhegorodtsev, 2018). The class of optimization interregional inter-industry models enables not only analytical calculations, but also forecasting of regional industrial complex development within interrelation and interdependence (Granberg et al., 1989), opportunity of their innovation development (Granberg & Valentey, 2006). The methods of developmental level, adaptive and discriminant analysis (Nizhegorodtsev et al., 2017), expert and cluster analysis (Bakhtizin & Akinfeeva, 2010), non-linear dynamics (Daradeh et al., 2012) are applied also in assessing and forecasting the level of socio-economic development of the region and innovation capacity hereof. Wave and probability models contribute to the determination of the most suitable pathway of management responses for sustainable and crisis-free development of the economic system (Bogomolov et al., 2016; Theil, 1993). It can be stated that economic science has a

wide range of methods and models, but they sometimes impossible to be used.

The purpose of macroeconomic modeling of Sevastopol economy is to study the influence of external (exogenous) variables on endogenous ones that are integral and describing an economic state of the region. The relevance of this study consists in opportunity of this modeling to reveal latent trends in the dynamic pattern of processes subject to irregular results of statistical conclusions. In the course of this study, we modelled economic processes depending on the different levels of exogenous variables. An independent purpose of modelling is to get an assessment of performances of models under use.

## 2. Statistical study of quality of life and economic development of Sevastopol

According to the Strategy of socio-economic development of Sevastopol until 2030, GRP is to grow by 2.6 times, in industry – by 7.8 times, as compared to 2015 in real terms; GRP per one employee in the economy will grow by 2 times; wages will grow by 1.5 times in real terms; accessibility of accommodation will grow by 2 times; large growth of the share of own revenues of the city budget and non-budget sources in financing of projects and programs of development of Sevastopol is planned. These indicators could be achieved with joint efforts of entrepreneurial structures and government bodies.

According to the adopted Strategy, its implementation is aimed at increase of population's life quality and region's transition from the category of recipients into the category of donors by means of dynamics development of various spheres and entrepreneurship. Also, the Chamber of Control and Accounts of Sevastopol (Official web-site of the Chamber of Control and Accounts of Sevastopol) states that comparative analysis of forecasts and factual

data for 2015-2017 shows the necessity for increasing the quality of forecasting and, therefore, for correction of the target indicators.

GRP per capita in 2014-2015 was the lowest in Russia (RUB 78,000 and RUB 92,900, accordingly), which is lower by 4.8 times that the average indicator for Russia. The share of the region's GRP in the Russian GRP is 0.1% (Federal State Statistics Service).

According to a lot of indicator Sevastopol occupies weak positions (Figure 1) in the comparative analysis of the Russian regions – so the region's competitiveness is low.

However, evaluating the dynamics of certain socio-economic indicators of Sevastopol, it is necessary to note their sustainable growth (Table 1), which is ensured by successful activities of entrepreneurial structures and the actions of public authorities on support for their functioning.

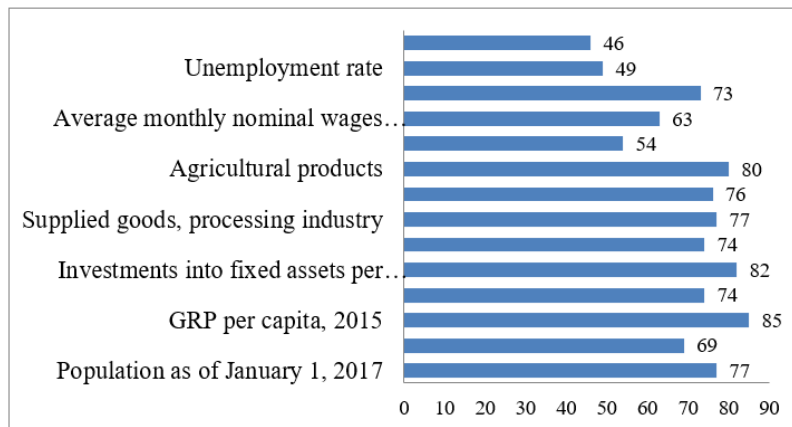
Sevastopol is a region with favorable climate for living, good geo-political position, and rich history. Under the condition of cancelling of sanctions and successful development of entrepreneurship, this will give Sevastopol advantages in formation of GRP by means of transportation of civil and military cargos, development of tourism, wine industry, and

ship building.

As for the structure of Sevastopol's economy, the following spheres, which could be unified into inter-sectorial complexes, could be noted:

- 1) industrial production, connected to service maintenance of ships of the Russian Black Sea Fleet; manufacture of specialized marine facilities; instrument engineering and electric energy; transport and logistics, including sea port and highways;
- 2) tourist sphere, hotel and restaurant business; trade; wine industry; food industry; fishing.

Several cluster structure have already been created in Sevastopol. The innovational IT cluster (technological park IT Crimea) is a platform for developing startups in the sphere of digital technologies. The Simple startup was presented within the strategy of import substitution in September 2018; it will ensure organization of automation of business processes of medium business and implementation of the city project "Smart city". An experimental wine industry cluster "Sevastopol" is based on unification of efforts of winegrowers and winemakers of the region.



Source: Compiled by the authors based on Federal State Statistics Service

**Figure 1.** Sevastopol's position in the RF according to the main socio-economic indicators.

**Table 1.** Dynamics of certain socio-economic indicators of Sevastopol, 2015-2017

Socio-economic indicators	2015	2016	Growth rate in 2016/2015, %	2017	Growth rate in, 2017/2016, %
Index of industrial production, (%)	91.6	111.57	121.8	99.52	89.2
Index of consumer prices (%)	121	128.9	106.5	136	105.5
Monthly average nominal accrued wages, RUB	24,186.6	26,865.9	111.1	27,456	102.2
Organizations' turnover in economic activities "Construction", RUB million	2,880.6	5,556.7	192.9	11,139.5	200.5
Organizations' turnover in economic activities "Transport and communications, RUB million	2,045.6	4,283.4	209.4	5,684.2	132.7
Organizations' turnover in economic activities "Agriculture", RUB million	376.6	785.7	208.6	797.5	101.5
Retail trade turnover, RUB million	40,972.2	49,453.5	120.7	77,053.7	155.8

It will ensure control of products' quality, rejection of counterfeit raw materials, implementation of "wine culture", and organization of "wine tourism". The Balaklava cluster is aimed at development of military and historical tourism and the Balaklava marine. Sevastopol instrument engineering cluster is to unify the companies of Sevastopol on production of competitive high-precision and hi-tech tools, robots, and microelectronics and to stimulate the promotion of digital technologies. The ship-repairing cluster is to ensure restoration and development of the Sevastopol traditional sphere. Functioning of the above clusters will allow creating a large number of additional jobs and replenishing the city budget.

The Government of Sevastopol will oversee the implementation of the top-priority projects that ensure the increase of comfort, life quality of city population and city guests, growth of the region's self-sufficiency, and unification of the efforts of companies of various spheres for increasing the level of socio-economic development: "Formation of comfortable city environment", "Smart city", "Civil development of the Balaklava Bay of

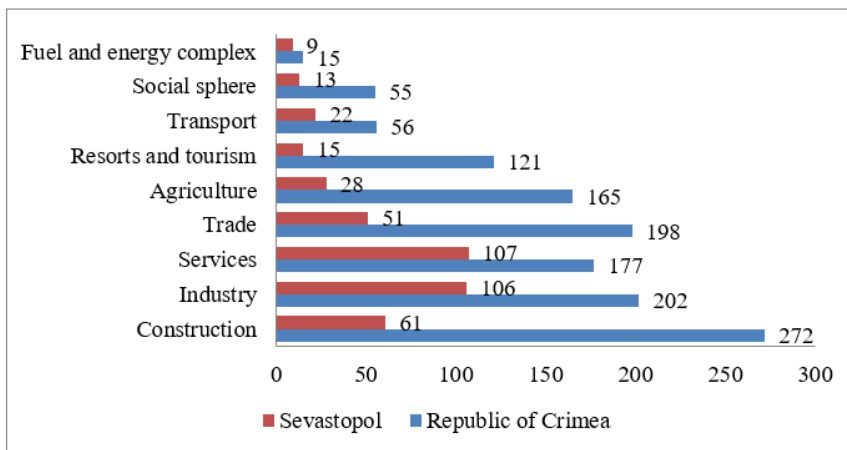
Sevastopol as an international tourism center", "Terroir Sevastopol", "EnergyNet"; and city project: "Sevastopol eco-tourism", "New wine-growing economy in Sevastopol", "Complex development of the territory of the 7th kilometer of the Balaklava highway of Sevastopol", "Large Sevastopol trail", "War-historical park at Fedyukhino hills", and industrial park "Heraclides"<sup>6</sup>.

According to the Expert rating agency, Sevastopol was ranked 71st in Russia in 2017 as to investment potential, with the share in the total Russian potential of 0.421%. As compared to 2016, Sevastopol lost one position. The ranks of the components of investment potential in 2017: labor – 74, consumer – 75, production – 80, financial – 77, institutional – 79, innovational – 65, infrastructural – 24, natural and resource – 66, and tourist – 37. According to investment risk of Russian regions, Sevastopol was ranked 65th among 85 regions in 2017; the ranks of the components of investment risk in 2017: social – 71, economic – 53, financial – 71, criminal – 18, ecological – 2, and managerial – 74. Experts see the region as the one with small potential with moderate risk (3B2).

This is primarily due to the sanctions, as large investors are not interested in development of business in Sevastopol. According to the data, the tourist and infrastructural ranks have the largest values. Infrastructural objects are developed with the help of assets from the federal budget.

It is possible to observe activity in implementation of the investment projects in various spheres of economy by subjects of small and medium business, which are the residents of the free economic area (93.9 % of them are involved with investment projects) (Figure 2). The main direction is capital investments, which total volume for 2015-2017 equaled RUB 44.8 billion (Sevastopol – RUB 3.79 billion).

Region’s competitiveness consists of a lot of production factors. According to *RIARating* (Official web-site of the media group “Russia today”), Sevastopol was ranked 66<sup>th</sup> in 2017 as to socio-economic development (criteria: scale and effectiveness of economy, budget and social spheres); 23<sup>rd</sup> as to life quality (29<sup>th</sup> in 2016); 39<sup>th</sup> as to innovativeness; 77<sup>th</sup> as to innovational development. As to effectiveness of management in the subjects of the RF in 2017 (Official web-site of the Agency of political and economic communications), which takes into account three blocks of indicators, the region was assigned the following ranks: political and managerial block – 66<sup>th</sup>, social block – 73<sup>rd</sup>, and financial & economic block – 67<sup>th</sup>.



Source: compiled by the authors based on the Crimean Statistics Service

Figure 2. Investment projects that are implemented by the subjects of small and medium business in Sevastopol and the Republic of Crimea

Sustainable development of cities, built on the basis of consideration of historical peculiarities and the influence of modern tendencies, ensures growth of population's quality of life. Accordingly, the formula of success of socio-economic implementation of the state as a public institute at the level of a separate city consists in establishing a direct dependence between the current interests of its residents and the city's resources base.

A complex foreign economic situation predetermines the necessity for taking the

cities of the military and strategic purpose to the innovational path of development. Sevastopol is one of such cities. Its innovativeness could be increased by means of cooperation of industrial companies in the sphere of development of new products (Nguyen et al, 2018) and implementation of new digital technologies, which allow improving quality of life (Bravi et al., 2018).

Based on studying the current legislative basis and specialized literature of the Russian and foreign authors it is determined that there

is no unified approach to defining the notion „city's innovational development“. Therefore, it is offered to consider the analyzed category as a logical synthesis of the definitions „city development“ and „innovational development“. Innovational development of Sevastopol shall be treated as a totality of managerial local processes in various sectors and spheres of activities, aimed at qualitative and quantitative transformation of the results of city's economic life and achievement of the set goals through implementation and further application of the innovational technologies.

It should be noted that transition of specific territories of the Russian Federation to the innovational model of economy is performed within the corresponding concept of the state on implementation of innovations – in particular, together with the priorities of the Strategy of socio-economic life of Sevastopol until 2030. Thus, the basic principles of innovational development are as follows:

- correspondence of city's interests to the interests of the state for formation of a favorable investment climate;
- complex character of measures (coverage of all spheres of socio-economic life of the city);
- ecological environment (innovations should not form (or stimulate) dangerous environment for residents);
- optimal usage of resources (innovational development should be aimed at increasing the population's living standards, simplifying the processes of production, and bringing expenditures down to the minimum, instead of depleting the Sevastopol's resource base);
- possibility for residents' participation in stimulation of full implementation of the city's innovational life (it is necessary to develop an effective social policy).

For diagnosing the problems and perspectives of Sevastopol's innovational development, we determined the key external and internal factors of influence on the city's investment and technological environment. The main external factors include presence of complex economic interrelations of the region; orientation at import substitution; reduction of concentration of foreign capital; remoteness of the territory. The important internal factors include personnel provision, level of qualification of the population, level of development of the corresponding infrastructure, level of activity of small and medium business, and demographic and migration waves. All this forms the innovational potential of the territory.

The main problems as of now are the problem of effectiveness of usage of the existing resources in combination with their optimality; difficulties in the process of creation of a favorable innovational and investment environment of Sevastopol. The first problem could be explained by large influence of the above factors and by absence of a working mechanism of opposing them. The second problem comes from the first one: impossibility of achievement of effectiveness of resources' usage in the short-term hinders the adequate formation of the investment and innovational environment.

Sevastopol starts becoming a part of digital economy of the Russian Federation, but this sphere is limited in its opportunities – purchase of new products of technological progress and necessary software, as well as usage of expensive technologies, which slows down the region's adaptation to the information breakthrough.

This problem should be solved in the sphere of good interaction during implementation of the projects of social, cultural, education, and economic character. According to this, based on the factors of influence on promotion of Sevastopol as an integrated and relatively independent entity, various normative and legal acts – in particular the programs and the Strategy of development of the region – have



the system of conditions that stimulates the powerful innovational development:

- actualization of city’s interests in the mid-term and long-term periods;
- high social activity;
- development and adoption of the corresponding laws;
- active investment support for projects;
- introduction of subsidies and special regimes of taxation for the parties which activities are aimed at implementation of innovational projects.

In the conditions of development of digital economy and provision of economic growth, the role of innovations is constantly growing. The main indicator of their state is expenditures for innovational activities (Table 2).

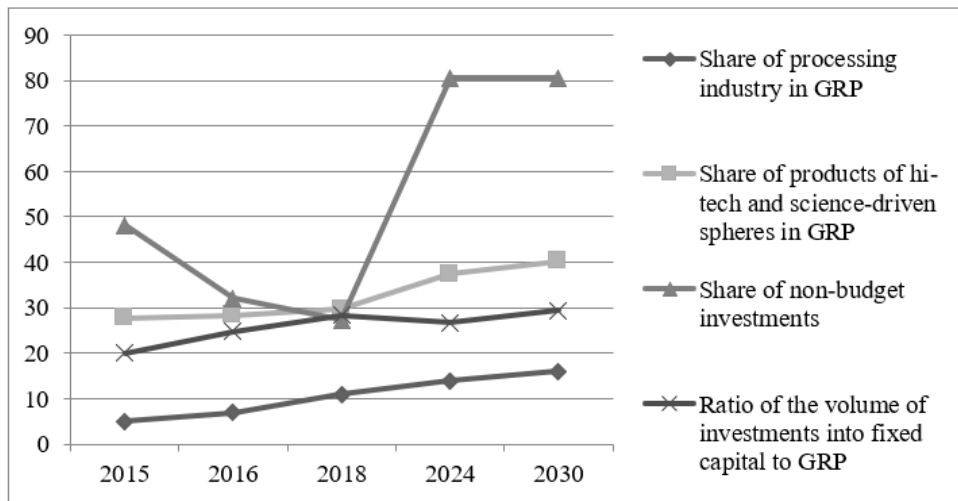
It is possible to observe growth of investments into innovational activities from organizations of the entrepreneurial sector, budgets of all levels, and educational organizations of higher education; however, investments into innovational activities from scientific organizations and organizations of the public sector decrease. The share of organizations that invested into innovations in 2017 was 3.2% (8.5% in Russia). The share of innovational goods, works, and services in the total volume of supplied goods, works, and services constituted 15.9% in 2016 and 6.3% in 2017 (8.4% and 6.7 % in Russia, accordingly). Innovational activities in Sevastopol develop with insufficient intensity and cannot ensure rapid economic development and growth of population’s life quality.

**Table 2.** Expenditures for innovational activities in Sevastopol in 2014-2016

Indicator	2014	2015	2016	2016/2015, %
	RUB thousand			
Assets of budgets of all levels	227,567.3	560,157.7	609,272.7	8.77
Own assets of scientific organizations	4,833.2	4,898.1	4,061.3	-17.08
Assets of non-budget funds	4,191.9	1,315	1,400	6.46
Assets of organizations of the entrepreneurial sector	14,063.8	22,842.5	24,099.6	5.50
Assets of educational organizations of higher education	913.3	298.4	3184	967.02
Assets of foreign sources	5,395.6	2,742.8	-	-
Assets of organizations of the public sector	10,422.9	57,919.3	11129.1	-80.79
Total expenditures	267,388	650,173.8	653,146.7	0.46

Activation of the process of growth own tax revenues is possible by means of increase of the spheres of activities with high added value, including hi-tech and science-driven spheres and growth of investments of the corporate sector, which is declared in the Strategy of socio-economic development of Sevastopol until 203 (Figure 3).

Achievement of high indicators of development of the Sevastopol’s economy is hindered by sanctions. However, it could be stimulated by the created innovational infrastructure of provision of business, free economic area, and creation of industrial clusters that use technological innovations.



**Figure 3.** Forecast of the indicators of the Sevastopol's economy until 2030.

Organizational and structural transformations in Sevastopol and the changes of property relations will lead to economic integration, which will stimulate the increase of competitiveness, achievement of synergetic effect of structural elements, preservation of strategic sustainability of the companies, increase of the market share, formation of new possibilities for growth, and quick development of the region's internal development, which would ensure growth of populations life quality.

### 3. Research methods

Review of the time series of regional macroeconomic indicators now provides some data to make practical conclusions. It can be argued that the very prior method is widely used in the daily work of regional think tanks without loss of generality. However, examination of total values of indicators related to different time periods can reveal only trends of growth, decline or temporal stability that can no way describe a truly state of the economic system point at recommendations for practical steps and particular acts.

It's impossible to get full and sufficient information and moreover, to draw up a

program of regional efforts contributing to dynamic development of the local economy without analysis of interdependencies between the indicators of regional development.

In this paper, we offer to use a system of simultaneous equations as a tool of research. It's a quite widely used research technique in the world practice characterized by a big number of models developed in factor analysis (Hausman, 1978), assessment of economic relations (Sargan, 2014), macroeconomics (Ray, 2013), economic forecasts (Theil, 1998; Zellner & Theil, 1992), stochastic attractors and economic disturbances (Wu D-M, 2003), national (Klein, 1996), regional and inter-industry economy (Ray, 1999), financial time series (Mills & Markellos, 2008), economies of different countries and regions (Mukherjee et al., 1998; Wooldridge, 2013).

It has a number of distinguishing features from other econometric methods, and regression analysis and dynamic regression in particular. An endogenous variable is in the left explanatory part of each equation of a simultaneous system, and in the right one there can be both exogenous variables determining the state of economic system and endogenous ones.



When composing a system of simultaneous equations, one may deal with the problem of model identifiability. For this, the number of equations in the system should be equal to the number of endogenous variables, and the identifiability criterion should be fulfilled; according hereto, the number of exogenous variables in each equation shouldn't exceed the number of endogenous variables increased by one. The equations themselves express either some statistical relations, and the corresponding equations contain stochastic constituents; or some functional dependencies that can be considered as some restrictions to ratios between variables.

#### 4. Results

The article is based on a well-proven model that appropriately presents the ratio between the main regional macroeconomic indicators (Theil, P. 68). However, it is short of important macroeconomic indicators, such as capital stock and imported goods.

For a fuller description of the developmental trends of the regional economy, we suggest a model regarding examination of the following endogenous variables:

C is consumption;

Y is an income;

I is investments;

K is stock capital;

W is salary;

Im is imported product;

E is gross regional product;

as well as of exogenous variables:

T is taxes;

G is government expenditures;

L is personnel.

The above-stated variables are related between each other with the following assumptions: consumption depends on the regional income, imported product and is

determined by a regional salary. The value of the imported product is specified by the level of income and amount of salary. Salary has a linear relationship with a regional product manufactured. Both internal and external investments within the region are governed by income and stock capital. The volume of the domestic product is defined by available working-age population and depends positively on investments. These dependencies are stochastic, i.e. they are determined within the accuracy of some errors and designated in equations as  $\varepsilon$ . The functional dependencies between the variables are determined by the following statements: income equals consumption plus investment minus imported product plus government expenditures minus taxes and plus stock capital; then, the gross regional product is equal to income plus taxes and minus government expenditures.

Thus, the system of simultaneous equations is written as (1):

$$\begin{cases} C = \alpha_0 + \alpha_1 Y + \alpha_2 \text{Im} + \alpha_3 W + \varepsilon_1; \\ \text{Im} = \beta_0 + \beta_1 Y + \beta_2 W + \varepsilon_2; \\ W = \gamma_0 + \gamma_1 E + \varepsilon_3; \\ I = \delta_0 + \delta_1 Y + \delta_2 K + \varepsilon_4; \\ E = \zeta_0 + \zeta_1 L + \zeta_2 I + \varepsilon_5; \\ Y = C + I - \text{Im} + G - T + K; \\ E = Y + T - G. \end{cases} \quad (1)$$

This system has no any particular equation for stock capital, however this endogenous variable participates in two equations of the system to meet a condition of identifiability; another equation for gross regional product is added as the seventh equation (according to number of endogenous variables).

Estimates of the unknown parameters are obtained with two-step least square method, and are as follows:

$$\begin{pmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_0 \end{pmatrix} = \begin{bmatrix} \begin{pmatrix} Y^T \\ Im^T \\ W^T \end{pmatrix} X(X^T X)^{-1} X^T (Y Im W) & \begin{pmatrix} Y^T \\ Im^T \\ W^T \end{pmatrix} \cdot I \\ I^T (Y Im W) & I^T I \end{bmatrix}^{-1} \begin{pmatrix} \begin{pmatrix} Y^T \\ Im^T \\ W^T \end{pmatrix} X(X^T X)^{-1} X^T \\ I^T C \end{pmatrix};$$

$$\begin{pmatrix} \beta_1 \\ \beta_2 \\ \beta_0 \end{pmatrix} = \begin{bmatrix} \begin{pmatrix} Y^T \\ W^T \end{pmatrix} X(X^T X)^{-1} X^T (Y W) & \begin{pmatrix} Y^T \\ W^T \end{pmatrix} I \\ I^T (Y W) & I^T I \end{bmatrix}^{-1} \begin{pmatrix} \begin{pmatrix} Y^T \\ W^T \end{pmatrix} X(X^T X)^{-1} X^T Im \\ I^T Im \end{pmatrix};$$

$$\begin{pmatrix} \gamma_1 \\ \gamma_0 \end{pmatrix} = \begin{bmatrix} E^T X(X^T X)^{-1} X^T E & E^T I \\ I^T E & I^T I \end{bmatrix}^{-1} \begin{pmatrix} E^T X(X^T X)^{-1} X^T W \\ I^T W \end{pmatrix};$$

$$\begin{pmatrix} \delta_1 \\ \delta_2 \\ \delta_0 \end{pmatrix} = \begin{bmatrix} \begin{pmatrix} Y^T \\ K^T \end{pmatrix} X(X^T X)^{-1} X^T (Y K) & \begin{pmatrix} Y^T \\ K^T \end{pmatrix} I \\ I^T (Y K) & I^T I \end{bmatrix}^{-1} \begin{pmatrix} \begin{pmatrix} Y^T \\ K^T \end{pmatrix} X(X^T X)^{-1} X^T I \\ I^T I \end{pmatrix};$$

$$\begin{pmatrix} \zeta_2 \\ \zeta_0 \\ \zeta_1 \end{pmatrix} = \begin{bmatrix} I^T X(X^T X)^{-1} X^T I & I^T (I L) \\ \begin{pmatrix} I^T \\ L^T \end{pmatrix} I & \begin{pmatrix} I^T \\ L^T \end{pmatrix} (I L) \end{bmatrix}^{-1} \begin{pmatrix} I^T X(X^T X)^{-1} X^T E \\ \begin{pmatrix} I^T \\ L^T \end{pmatrix} E \end{pmatrix}.$$

where **1** is a matrix column consisting of units;

**X** is a matrix of observations for exogenous variables:  $X = (1 T G L)$ .

To estimate the unknown parameters of the

equations, we applied statistical data of the State Statistics Service of Ukraine. The initial data presented in Table 3 are value indicators (except for the labor resources indicator) over 2004-2013.

**Table 3.** Initial data for model parameter estimation

	C	Y	I	Im	W	E	K	I	T	G	L
C	21596	50307	1513	15611	9491	44771	40002	461.7	6461	11998	2608980
Y		123160	3789	32897	23255	11037	94708	1091	15564	28354	6203540
I			183.4	1007	720.2	3426	2794	33.0	489	853	192300
Im				14943	6144	29015	28712	331.9	4722	9603	1885330
W					4490	20859	18001	207.5	2973	5368	1177030
E						99105	84672	974.8	14046	25310	5554470
K							75502	868	12529	22565	4917400
I								10	143.6	259.5	56700
T									2231	3750	821640
G										6794	470710
L											32367000

The table is symmetrical, so below-diagonal part isn't specified.

At the intersection of a row and column

corresponding to the indicators there is a value equal to the sum of indicators' production:

$$a_{ij} = \sum_{t=2004}^{t=2013} P i_t \cdot P j_t;$$

where  $a_{ij}$  is the table element; measurement unit of all elements of table (except the last) is (million UAH)<sup>2</sup> divided by 1000; measurement unit of the last column elements is (million UAH per thousand people) divided by 1000.

$P i_t$  and  $P j_t$  are values of indicators in the year  $t$ .

Model with estimated parameters:

$$\begin{cases} C = 194,69 - 1,96Y + 10,31Im - 13,35W + \varepsilon_1; \\ Im = -16,78 + 0,22Y + 1,27W + \varepsilon_2; \\ W = 20,40 + 0,004E + \varepsilon_3; \\ I = 1,47 + 0,08Y - 0,08K + \varepsilon_4; \\ E = 8,63 + 0,02L - 1,74I + \varepsilon_5. \end{cases} \quad (2)$$

Model with estimated parameters:

In the model (2), there are five of the seven equations occurring in the system of equations (1), since we need to estimate unknown coefficients only in the first five equations hereof. The last two equations (1) are identities without unknown coefficients.

The main features revealed on the back of the model research: consumption is mostly determined by some invariable, which can be interpreted as an undocumented income of the population. Whatever the economic situation is, consumption will fluctuate with the respect to this invariable. Also, a regional consumption is determined by an imported product. This observation is explained by the fact that Sevastopol hasn't efficient production matrix. Investments are also governed by invariable not depending on the economic situation and are made despite stock capital (a negative sign of K).

The final model had given a quite reliable description of economic processes across the country. The working-age population gained income beyond production and services, with

official statistical reports or received a salary off the books. Investments, as the main mechanism of regional economic development, take place, but their limited nature can't evidence positive trends in the development of the Sevastopol region.

Another important issue in analysis of economic state of Sevastopol in the Ukrainian period is a discovery of a direct dependency between endogenous and exogenous variables. To do this, let's express the endogenous variables in terms of exogenous ones in an explicit form.

The initial system of equations (1) can be written in a structural form:

$$B Y + \Gamma X = E, \quad (3)$$

where **Y** and **G** are matrices of coefficients under endogenous and exogenous variables respectively,

**Y** is a value matrix of endogenous variables,

**X** is a value matrix of exogenous variables,

**E** is a random departure matrix:

$$Y = \begin{pmatrix} C \\ Y \\ I \\ K \\ W \\ Im \\ K \end{pmatrix}; \quad X = \begin{pmatrix} I \\ T \\ G \\ L \end{pmatrix}; \quad E = \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \varepsilon_4 \\ \varepsilon_5 \end{pmatrix}.$$

Solving equation (3) concerning **Y**-matrix, let's express the endogenous variables in terms exogenous **X**:

$$Y = \Pi X + \Xi. \quad (4)$$

Equation (4) is called a reduced form of simultaneous equation system, where:

$$\Pi = -B^{-1} \Gamma$$

- coefficient matrix of reduced form;

$$\Xi = B^{-1} E$$

- reduced random departures.

Making all the necessary computations, we get the following dependence of each endogenous variable on exogenous ones:

$$\begin{cases} C = 17,89 - 0,26T + 0,26G + 0,005L + \zeta_1; \\ Y = 4,94 - 0,84T + 0,84G + 0,02L + \zeta_2; \\ I = 2,27 - 0,09T + 0,09G + 0,0001L + \zeta_3; \\ K = -5,35 + 0,32T - 0,32G + 0,02L + \zeta_4; \\ W = 20,46 - 0,003T + 0,003G + 0,0001L + \zeta_5; \\ Im = 10,17 - 0,19T + 0,19G + 0,004L + \zeta_6; \\ E = 4,64 - 0,16T + 0,16G + 0,02L + \zeta_7. \end{cases} \quad (5)$$

Since we consider seven endogenous variables, the model (5) contains seven equations.

The revealed dependences of macroeconomic indicators on exogenous variables lead to the following conclusions.

An absolute term, i.e. some quantity not related to economic levers, is fundamental and prevailing in all dependencies. It's the only one to determine salary *W*. The latter is not actually influenced by taxes, government expenditures and procurements. The reduced form for *W* isn't totally different from initial equation: absolute term value didn't change, coefficients of the other variables don't contrast with naught ones. This suggests that the amount of salary was determined by the most minimum-allowable level of requests for personnel reproduction, and was scarcely associated with deliverables (almost zero value of the coefficient under *E* in structural form).

Investments *I* also didn't depend on economic levers, i.e., they were determined by non-economic reasons. This one of the most meaningful elements of economic system development remained beyond formation of financial flows. And if we consider a reduced equation for *I* together with another indicator closely related to investments (stock capital *K*), then *K* have opposite trends (in the

equation for *K*, all coefficients have opposite signs compared to *I*). These two incompatible trends revealed point at absent economic development of Sevastopol until 2013.

The volume of imported product was also determined by some invariable. In the initial equation (2), estimate of absolute term has a negative sign, which exhibits contradictory tendencies of the formation of imported products; but it is positive in the equation of dependence on non-system factors (5). Taxes restrain the increase in output from other regions, and the number of the working-age population had insignificant effect on imported goods and services of other economic entities.

Describing an exogenous factor (personnel) in general, it should be noted that it appeared to be small for Sevastopol in the Ukrainian period. The highest coefficient is 0.017 under *L*-variable occurred in the equation for regional income, and the lowest is 0.0001 for investments and salary, i.e. there was no competition in the labor market.

Other exogenous factors (taxes and government expenditures) have coefficients of the same absolute value, but of opposite sign for each macroeconomic indicator. Government expenditures (pensions, subsidies, procurements and orders) stimulate regional development, but insufficiently (coefficients under *G* are much lower than the values of absolute terms). Levied taxes had a negative impact on almost all macroeconomic indicators, which points at onerous role of the tax burden. Therewith, taxes had a negative effect to a greater extent (fourfold) on regional income than on consumption.

## 5. Conclusion

Comparing Sevastopol with other regions of the RF as to the main economic indicators that directly influence the population's life quality, one may assign it to the category of depressive regions, as Sevastopol's GRP per capita is the lowest in Russia; the following indicators are very low: investments into

fixed capital per capita, supplied goods in the sphere of minerals extraction, processing production, production and distribution of electric energy, gas, and water, and agricultural products. However, based on the assessment of these indicators in their dynamics, it is possible to see their constant growth – which confirms efficiency of the measures that are performed by the government for reducing the gap between Sevastopol and other territories of Russia and accelerating entrepreneurial activities. On the whole, estimates of the rating agencies as to scales of economy, institutes, and human, financial, investment, and natural capitals are not high; however, it is necessary to take into account that the studied region has been in Russia only for a short period now, and it is a municipal entity. The region's prospering is possible in case of successful implementation of the Strategy of development of the city and the projects that are supported by municipal authorities.

If we rely on the statistical data of the Ukrainian period, then reduced structural equations highlight the following practical measures for Sevastopol: tax cuts would have a significant effect on regional revenues, which evidences an obvious appropriateness

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of such a measure; efforts should be made to establish an investment foundation, the lack hereof makes a regional development impossible; it was inexpedient to restrict imports out of Sevastopol region, pursuing the purpose of local manufacturers encouragement.

These recommendations are relevant to modern Sevastopol already belonging to Russia.

## 6. Directions for future research

Similar macroeconomic modeling of the Sevastopol region on the back of Russian statistical data is possible provided that an econometric method will be developed. It enables evolving models in accordance with small statistical data, and we see the prospects for further research herein.

Determining the interconnected and mutually dependence indicators of economic growth will stimulate the development of effective measures for increasing the life quality of Sevastopol region's population.

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**Elena Piskun**

Sevastopol State University,  
Sevastopol,  
Russia  
[lenapiskun@mail.ru](mailto:lenapiskun@mail.ru)

**Vladimir Khokhlov**

Sevastopol State  
University,  
Sevastopol,  
Russia  
[khokhlov\\_vv57@mail.ru](mailto:khokhlov_vv57@mail.ru)

**Natalia Simchenko**

V.I. Vernadsky Crimean  
Federal University,  
Simferopol,  
Russia  
[natalysimchenko@yandex.ru](mailto:natalysimchenko@yandex.ru)

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