The Impact of Investment Activity Parameters on Uneven Development of the Regions of Western Ukraine

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Abstract The research of the dynamics of impact of changes in investment activity parameters in Ukrainian regions and the level of their development asymmetry is relevant and in demand in current development stage. This chapter suggests the approach to evaluation of the impact of investment activity parameters on the level of development asymmetry of the regions of Western Ukraine. The dynamics of regional asymmetry in the period under research is analyzed based on the previously conducted estimation of the level of development asymmetry of Western Ukrainian regions by the parameters of sustainable development and levels of development harmonization and social tension. It was possible to obtain scientifically valid results due to the application of the methods of information analysis, indicative analysis, correlation-regression analysis, and estimation of the parameters of dynamic econometric models. Scientific novelty of the chapter lies in improvement of existing approaches to estimation, analysis, and prognosis of the impact of investment activity parameters on the regional asymmetry rates by the parameters of sustainable development and levels of harmonization and social tension.

Keywords Region · Development · Misbalances · Asymmetry · Level of sustainable development harmonization · Social tension · Model · Investment

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1 Introduction

In order to efficiently manage the investment component of socio-ecological-economic development, it is necessary to develop a set of instruments to estimate and analyze the level of socio-ecological-economic development, its unevenness, misbalances, and safety as well as to analyze the system of relations between the parameters of socio-ecological-economic development and parameters that characterize investment climate of the region and efficiency of its use.

Expansion of the problem of estimation and analysis of the level of regional development asymmetry to the problematics stipulates estimation of the level of socio-ecological-economic development of regions under research and of regions' development misbalances same as identification of factors that define the patterns of regions' development and impact the level of development misbalances.

As Pena [1] rightfully mentions, currently the development tendencies of Ukrainian regions stipulate the deepening of all types of regional misbalances in economic space. Such processes typically result in growing level of social tension, increasing labor migrations, deteriorating demographic situation, and finally reduction of development capacity of territorial systems and regions of Ukraine, where the misbalances of socio-ecological-economic development are substantial in a long-term period and of systemic nature. In other words, high rates of regional socio-ecological-economic development asymmetry observed in several reporting periods can be the basis for forming of preconditions for the emergence of economically backward and depressive territorial systems, systemic inefficient use of local resources, and exhaustion and degradation of some regions' capacities.

Domestic and foreign researchers use the concept of "asymmetry" in the process of forming of efficient mechanisms to overcome spatial disparities of regional development and to estimate their impact on the efficiency of the use of resources. According to Krasnonosov and Yermolenko [2], asymmetry helps adequate characterization of current development conditions of Ukrainian regions. They understand asymmetric as "territorially misbalanced development of the country, increasing gap between the economically strong and weakly developed regions with peculiar discrepancy of regional parameters."

We understand "asymmetry of regional development" in the framework of our research as the discrepancies in the level and dynamics of social, economic, and ecological development of some regions, which come as the result of the impact of various endogenous and exogenous factors with regard to the regions with their peculiar features.

It is obvious that positive aspects of the impact of asymmetry in some cases reduce to improvement of the use efficiency of local resources and forming of relevant competitive advantages of some regions. Meanwhile, as noted by Tyshchenko [3], the negative consequences of regional spatial asymmetry can exceed dozens of times the few positive economic and social effects caused by different levels of provision of territorial systems with main types of resources.

In our opinion, it is important to go beyond the objective estimation of the level of sustainable development of the regions under research in the process of forming of efficient mechanisms to manage regional socio-ecological-economic development and to determine and to analyze the level of harmonization of such development as well. We will consider the level of harmonization of a region's sustainable development as the balance that can be achieved only in case of creation of relevant conditions to align the goals of economic, ecological, and social development.

Currently, there are many scientific works devoted to the analysis of the impact of unbalanced development of regions on the nature of changes taking place in the relevant space. In particular, Doctor [4] argues that economic and political asymmetry as well as institutional, social, and economic deficits prevent the deepening of regionalism and international integration.

Petrakos [5] analyzes the spatial structure of Southeastern Europe with the view to estimate regional misbalances. The results of conducted analysis show that Southeastern Europe faces the increasing regional asymmetry, growing role of mega-cities and much lower rates of socio-economic development of peripheral regions.

There is also the range of approaches to estimation of regional asymmetries and development misbalances. For example, they are calculated by the Herfindahl coefficient and quintile coefficient [6], regional asymmetry coefficient (AS) [7], decile coefficient [8], standard variation level [9], and Euclidean distance [10]. The level of misbalances is advisable to be calculated by the methods of ranging using the Lorenz curve and Gini coefficient, Theil index, scaling methods, average deviation, and standard variation as outlined in refs. [11–15].

It is worth mentioning that possible options of solving the tasks of estimation and analysis of misbalances and asymmetries of regional socio-ecological-economic development are actively examined by both domestic and foreign researchers. Western methods of estimation of development misbalances in some groups of countries and regions usually stipulate: development of rankings (complex estimations) of international and regional development, use of the methodics of research of income inequality (Lorenz curve, Gini coefficient), and use of indicators that show the dispersion, standard deviation, variation coefficient, etc. [16–18].

Maslyhina [19] provides classification of parameters and methods of quantitative evaluation of spatial development misbalances. In particular, she outlines the parameters of the scope of inequality (Williamson's coefficient of variation, Klotsvog-Mahomedov coefficient, Gini Index, Hoover Index, Theil Index, Atkinson Index, Kolm Index, Moran's and Geary's Spatial Correlation Indices, etc.), parameters and methods that characterize the structure of inequalities (Local Spatial Autocorrelation Index (Getis-Ord Index), asymmetry and kurtosis coefficients, cluster analysis, Theil and Atkinson Indices), as well as methods showing the dynamics of inequalities (dispersion parameters, Gini Index, Hoover Index, Theil Index, Atkinson Index, Kolm Index, decile coefficient, convergence analysis, etc.).

In Ukraine, the processes of estimation of regional development are regulated by the Resolution of the Cabinet of Ministers of Ukraine "On Approval of Estimation of Interregional and Intraregional Differentiation of the Region's Socio-Economic

Development" [20], which outlines the procedures of estimation and analysis of socio-economic situation, level, and quality of life in order to find interregional and intraregional asymmetries and inequalities of socio-economic development.

Moreover, some issues of estimation of the level, misbalances, and asymmetries of regional development are regulated by 2020 State Regional Development Strategy of Ukraine 2020 [21] and the Law of Ukraine "On the Foundations of State Regional Policy" [22].

The issues of estimation of investment component of socio-ecological-economic development of a region and its modeling are covered in ref. [23]. Hasnah [24] suggests the scheme of analysis of the impact of key economic growth factors on the GDP rates of regions in Malaysia based on econometric methods and models. Capital investment and foreign investment volumes and number of employed were selected among the factors of economic growth [24]. The suggested scheme of analysis contributes to quantitative estimation and ranging by impact of economic growth factors on the result indicators of the regions' economy and inequalities of regional development.

Sîrbu [25] estimates the impact of foreign investment on aligning of development indicators of Romanian regions.

This chapter aims to show the results of conducted research directed at development of theoretical basis and scientific methodical foundations of increasing the efficiency of management of regional socio-ecological-economic development based on economic-mathematical modeling of the processes of asymmetry estimation and analysis and estimation of lag effect of impact of regional development investment component on its asymmetry.

2 Materials and Methods

The suggested [10] scheme of estimation of the level and degree of harmonization of Western Ukrainian regions' sustainable development lies in improvements in terms of accounting of possible multicollinearity and modification considering the available statistical information and based on the approach that stipulates the calculation of sustainable development rate outlined in ref. [26]. Sustainable development parameter I_{sd} is calculated based on the rates of economic (I_{ec}), ecological (I_e), and social development (I_s). In order to determine the weight of each of these parameters, we suggest calculation of actual shares of pairwise correlation coefficients based on estimation of the nature of interrelations between the relevant economic, social, and ecological parameters and the parameter of social tension calculated for each of regions under research for 2000–2017.

Similar to [10, 26], the level of sustainable development harmonization is considered as the angle between the vector I_{sd}:

$$I_{\text{sd}} = \frac{I_{\text{ec}}}{3} + \frac{I_e}{3} + \frac{I_s}{3}, \tag{1}$$

And "ideal" vector equidistant from each of coordinates I_{ec}, I_e, I_s:

$$1 = \frac{I_{ec}}{3} + \frac{I_e}{3} + \frac{I_s}{3}, \tag{2}$$

The angle is measured in degrees and determined by the ratio:

$$\alpha = \frac{I_{ec} + I_e + I_s}{\sqrt{3} * \sqrt{{I_{ec}}^2 + {I_e}^2 + {I_s}^2}}, \tag{3}$$

Equidistance I_{sd} from each of coordinates I_{ec}, I_e, I_s corresponds to the most harmonious socio-economic development. Approaching of this rate to one of the coordinates indicates actual priorities of the region's development by the relevant dimension with comparatively lacking investment in development by two other directions [26]. Index I_{sd} and the level of harmonization of sustainable development is calculated through its components I_{ec}, I_e, I_s. In particular, in order to calculate the value of economic development parameter (I_{ec}), the following formula is suggested:

$$I_{ec} = k_{stii} * I_{ii} + k_{strt} * I_{rt} + k_{stki} * I_{ki} + k_{strz} * I_{rz} + k_{stek} * I_{ek} + k_{stGRP} * I_{GRP}, \tag{4}$$

where I_{ii}, I_{rz} are the values of economic dimension parameters, including the volumes of foreign direct investment, companies' retail turnover, capital investment, average monthly wages, net exports, and Gross Regional Product per capita.

k_{stii}, k_{strt}, k_{stki}, k_{strz}, k_{stek}, k_{stGRP} are actual shares of pairwise correlation coefficients based on estimation of the nature of interrelations between the relevant economic parameters and social tension parameter.

In order to calculate the value of ecological development parameter (I_e):

$$I_e = k_{stsdz} * I_{sdz} + k_{stpdz} * I_{pdz} + k_{stuv} * I_{uv} + k_{stvu} * I_{vu} + k_{stvo} * I_{vo}, \tag{5}$$

where I_{sdz}, I_{pdz} are the values of ecological dimension parameters, namely the volumes of air pollutants emissions from stationary polluting sources, volumes of air pollutants emissions from mobile polluting sources, wastes generation and management, cost of protection, and rational use of natural resources.k_{stsdz}, k_{stpdz}, k_{stuv}, k_{stvu}, k_{stvo} are the actual shares of pairwise correlation coefficients based on estimation of the nature of interrelations between the relevant ecological parameters and social tension parameter.

The value of social development parameter (I_s) was calculated according to the following formula:

$$I_s = k_{stpz} * I_{pz} + k_{stll} * I_{ll} + k_{stzz} * I_{zz} + k_{stdz} * I_{dz} + k_{stsr} * I_{sr} + k_{stps} * I_{ps}, \tag{6}$$

where I_{pz}, I_{ll}, I_{zz}, I_{dz} are the values of social dimension parameters, namely the number of outpatient clinics, number of hospital beds per 10 thousand persons, number of general education and pre-school education establishments, rate of average monthly total resources per one household, total amount of assigned subsidies.

k_{stpz}, k_{stll}, k_{stzz}, k_{stdz}, k_{stsr}, k_{stps} are the actual shares of pairwise correlation coefficients based on the estimation of the nature of interrelations between the relevant social parameters and social tension parameter [10].

3 Results and Discussion

The value of social tension parameter (I_{st}) was calculated based on the method of Povstyn [27]. In order to calculate the parameter of social tension, the information across the following parameters was used: dropout rate, number of people suffering injuries, number of discharged persons, number of registered crimes, volumes of air pollutants emissions from mobile polluting sources, volumes of air pollutants emissions from stationary polluting sources, number of deaths per 1000 persons of actual population, number of persons with mental health and behavior disorders, number of entities registered in EDRPOU, fixed investment rates, number of arriving persons, number of employed, average monthly wages, amount of housing space available for population, number of health facilities, number of births per 1000 persons of actual population, average monthly total resources per one household.

In order to determine the degree of development asymmetry of the examined regions, we used the Williamson's weighted coefficient of variation in our research [6].

Conducted calculations brought us to conclusions that the acceptable situation in terms of the level of sustainable development and its harmonization was observed in Ivano-Frankivsk, Lviv, Transcarpathian, Chernivtsi, and Ternopil regions depending on the report period (Tables 1 and 2). "Ideal" vector could be observed only in Transcarpathian region in 2000, when the level of sustainable development harmonization reached its maximum value. In time, the level of sustainable development deteriorates along with its harmonization level, which can be explained by both systemic determined and stochastic impact of endogenous and exogenous factors.

The ranging of the impact of factors on the level of economic, social, ecological, and sustainable development of Western Ukrainian regions [10] shows that capital investment is one of the determining rates that directly or indirectly influences the major directions of regional development.

With this regard, we have analyzed the impact of capital investment on the rates of asymmetry of regional socio-ecological-economic development by the parameters of sustainable development, level of sustainable development harmonization, and social tension rate.

Calculated rates of regional asymmetry of Western Ukrainian regions by the Williamson's weighted coefficient of variation by the parameters of sustainable

Table 1 Level of sustainable development of Western Ukrainian regions in 2000–2017

Year	Ivano-Frankivsk	Lviv	Transcarpathian	Chernivtsi	Ternopil
2000	0.960289197	0.954137542	0.894341548	0.666708251	0.980512206
2001	0.957419358	0.883027081	0.945166503	0.626825825	0.836784075
2002	0.858659327	0.719969015	0.809497596	0.597003656	0.765589707
2003	0.807784758	0.785434344	0.746528087	0.551406506	0.805041321
2004	0.845944232	0.745127055	0.650187864	0.506693411	0.857505606
2005	0.486893314	0.610448044	0.550120163	0.425140438	0.76646922
2006	0.387110608	0.631517475	0.285846391	0.357233025	0.62814557
2007	0.346443282	0.570333864	0.245957302	0.185672142	0.452815119
2008	0.293934581	0.429238861	0.366234926	0.239635155	0.402546797
2009	0.493809913	0.512094391	0.365716397	0.23740418	0.377056705
2010	0.358357921	0.442894531	0.195381301	0.455551841	0.317030196
2011	0.136834766	0.285031801	0.124548287	0.424356542	0.206832534
2012	0.045412465	0.0684898	0.161585498	0.354972273	0.218628256
2013	0.055536105	0.00207165	0.155987188	0.333333333	0.090408783
2014	0.25948236	0.179671184	0.405205863	0.366517255	0.107803415
2015	0.439431947	0.530264419	0.45407231	0.449895842	0.18900308
2016	0.419827431	0.484775992	0.48499664	0.431612412	0.141371814
2017	0.480532206	0.491104462	0.49423618	0.455385664	0.204195835

Table 2 Level of sustainable development harmonization of the regions of Western Ukraine in 2000–2017

Year	Ivano-Frankivsk	Lviv	Transcarpathian	Chernivtsi	Ternopil
2000	0.058415384	0.067872484	0	0.6153915	0.02810026
2001	0.007892475	0.109566212	0.083781888	0.61528111	0.165625722
2002	0.07733212	0.310226927	0.018631415	0.61550889	0.210115728
2003	0.143920234	0.12951701	0.070627494	0.61550466	0.013099467
2004	0.050662567	0.105704055	0.080227051	0.61514675	0.08294542
2005	0.500868697	0.139746115	0.086234291	0.61505878	0.212353013
2006	0.576147233	0.178101207	0.110853906	0.6159485	0.094829489
2007	0.581366845	0.17380721	0.615891699	0.81632525	0.196137928
2008	0.255221466	0.364545158	0.037106174	0.615459	0.047535289
2009	0.439589702	0.397971725	0.246499531	0.61650205	0.047157002
2010	0.442988771	0.43087748	0.081762399	0.44891725	0.211944711
2011	0.60186673	0.499856344	0.090419316	0.591875	0.376969546
2012	0.755483422	0.627447078	0.349812273	0.84545386	0.35457038
2013	0.955316618	0.955316618	0.955316618	0.95531662	0.955316618
2014	0.768031934	0.338239863	0.313274705	0.77273781	0.618796832
2015	0.700673633	0.465783175	0.303246528	0.46879612	0.561950615
2016	0.77451354	0.649422524	0.522388822	0.69118592	0.60223431
2017	0.796549532	0.632144237	0.543795556	0.71446223	0.65323665

Table 3 Level of regional asymmetry of Western Ukrainian regions by the Williamson's weighted coefficient of variation by the parameters of sustainable development

Year	Ivano-Frankivsk	Lviv	Transcarpathian	Chernivtsi	Ternopil
2000	0.132920885	0.181855355	0.124958665	0.107322	0.119552298
2001	0.131937203	0.180279575	0.124337382	0.106646	0.118719636
2002	0.149746482	0.204400513	0.141476849	0.121157	0.134803875
2003	0.130990606	0.178651406	0.123803936	0.10596	0.11774645
2004	0.166814779	0.227434662	0.157818539	0.134936	0.149760362
2005	0.201317467	0.274343405	0.190548995	0.162814	0.180444577
2006	0.224978687	0.306458396	0.213048144	0.181927	0.201315776
2007	0.354342097	0.482465752	0.335745682	0.286597	0.316515432
2008	0.240931157	0.327829255	0.228407502	0.194872	0.214765485
2009	0.245514714	0.333796565	0.232954119	0.198643	0.218441242
2010	0.133811565	0.18183606	0.12705559	0.108299	0.118833253
2011	0.390284191	0.53001869	0.371087016	0.315958	0.345945401
2012	0.684977838	0.929426454	0.652075402	0.554776	0.606057082
2013	0.876339943	1.188301667	0.834964547	0.710071	0.773781501
2014	0.416712596	0.564737887	0.397390296	0.337854	0.367220958
2015	0.279281255	0.378374803	0.266569119	0.226576	0.245677342
2016	0.31673278	0.42884129	0.30228981	0.256964	0.27809529
2017	0.29663547	0.44325697	0.33648795	0.284653	0.25647894

development, level of sustainable development harmonization and social tension rate are outlined in Tables 3, 4, and 5.

We hypothesize that the impact of capital investment volumes on the rates of regional socio-ecological-economic development asymmetry is not only of immediate but also lag nature. The hypothesis was verified by the results of correlation-regression analysis between the actual values of dependent variable (asymmetry level) and lag values of factor variable (volumes of capital investment), as well as by the results of application of Alt-Tinbergen's method to determine the maximum lag length.

In order to build the distribution-lag models and to calculate the predicted values of asymmetry under the impact of capital investment for 2018–2020 for the regions of Western Ukraine, we used the following conventional values:

Y_t—level of regional asymmetry

x_t—volumes of capital investment in the current time period

$x_{t-1}, x_{t-2}, x_{t-3}$ x_t— volumes of capital investment in time period $t-1$ $t-2$, $t-3$ (lag variables)

The dynamic econometric models of analysis and prognosis of asymmetry level estimated by the method of Almon by the parameters of sustainable development and the predicted values of asymmetry rate for 2018–2020 are outlined below:

Ivano-Frankivsk region:

Table 4 Level of regional asymmetry of Western Ukrainian regions by the Williamson's weighted coefficient of variation by the parameters of the level of harmonization

Year	Ivano-Frankivsk	Lviv	Transcarpathian	Chernivtsi	Ternopil
2000	1.475004034	2.018022846	1.386648422	1.190934419	1.326654747
2001	1.073822144	1.4672753	1.011968046	0.867976943	0.966245843
2002	0.837194673	1.142751523	0.790961245	0.677355871	0.753654338
2003	1.08480266	1.47950701	1.025286036	0.877512217	0.975120783
2004	1.125296319	1.5342249	1.064609635	0.910248514	1.010250918
2005	0.658141641	0.896876071	0.622937642	0.532265892	0.58990455
2006	0.719367037	0.979897568	0.681219248	0.581709014	0.643705122
2007	0.517042399	0.703995522	0.489907223	0.418190879	0.46184718
2008	0.80033086	1.088991034	0.758729485	0.647329758	0.713413107
2009	0.538084352	0.731568002	0.51055582	0.435357504	0.478748553
2010	0.45514954	0.618501093	0.432169622	0.368370398	0.404201988
2011	0.429390708	0.583126619	0.408269975	0.347616864	0.380609167
2012	0.340691876	0.462274871	0.324326977	0.275932439	0.301438546
2013	0.165786045	0.224802984	0.157958645	0.134331201	0.146384033
2014	0.351260447	0.476035724	0.334973059	0.284788194	0.309542354
2015	0.256132369	0.347012314	0.244473909	0.207795858	0.225313796
2016	0.128289297	0.173697675	0.122439323	0.104080746	0.112639586
2017	0.154697853	0.219864317	0.143267981	0.119846254	0.136477893

Table 5 Level of regional asymmetry of Western Ukrainian regions by the Williamson's weighted coefficient of variation by social tension rate

Year	Ivano-Frankivsk	Lviv	Transcarpathian	Chernivtsi	Ternopil
2000	0.574812015	0.78642753	0.540379657	0.46411	0.517000002
2001	0.328405634	0.448734902	0.309488875	0.265452	0.295505713
2002	0.545213643	0.744204116	0.515104641	0.44112	0.490808937
2003	0.743002729	1.01334352	0.70223862	0.601025	0.667879449
2004	−1.89350596	−2.58159913	−1.79139011	−1.53165	−1.69992215
2005	−0.90840252	−1.237916635	−0.85981207	−0.73466	−0.81421802
2006	−0.49677901	−0.676695652	−0.47043499	−0.40172	−0.44452856
2007	−0.52317449	−0.712344866	−0.49571749	−0.42315	−0.46732466
2008	−0.35353619	−0.481048227	−0.3351593	−0.28595	−0.31514136
2009	−0.39674875	−0.53941113	−0.37645098	−0.321	−0.35299835
2010	−0.34533613	−0.469276043	−0.32790055	−0.27949	−0.30668064
2011	−0.37092522	−0.503728574	−0.35268027	−0.30029	−0.32878573
2012	−0.27622781	−0.374805458	−0.2629594	−0.22372	−0.2444018
2013	−0.2826467	−0.383263998	−0.26930186	−0.22902	−0.24956844
2014	−0.25062681	−0.339654848	−0.23900564	−0.2032	−0.22086065
2015	−0.40391674	−0.547232992	−0.38553153	−0.32769	−0.35531633
2016	−0.40202959	−0.544329155	−0.38369709	−0.32617	−0.35298694
2017	−0.38301564	−0.523614779	−0.37685412	−0.31425	−0.33147856

$$Y_t = 0.044 + 0.189x_t + 0.086x_{t-1} \qquad R^2 = 0.753$$
$$Y_{2018} = 0.526 \qquad Y_{2019} = 0.583 \qquad Y_{2020} = 0.603$$

Lviv region:

$$Y_t = 0.154 + 0.53x_t - 0., 145x_{t-1} \qquad R^2 = 0.723$$
$$Y_{2018} = 0.852 \qquad Y_{2019} = 0.892 \qquad Y_{2020} = 0.885$$

Transcarpathian region:

$$Y_t = -0.008 + 0.31x_t + 0.11x_{t-1} \qquad R^2 = 0.725$$
$$Y_{2018} = 0.355 \qquad Y_{2019} = 0.412 \qquad Y_{2020} = 0.442$$

Chernivtsi region:

$$Y_t = 0.12 + 0.047x_t + 0.115x_{t-1} \qquad R^2 = 0.88$$
$$Y_{2018} = 0.228 \qquad Y_{2019} = 0.229 \qquad Y_{2020} = 0.25$$

Ternopil region:

$$Y_t = -0.074 + 0.15x_t + 0.26x_{t-1} \qquad R^2 = 0.827$$
$$Y_{2018} = 0.323 \qquad Y_{2019} = 0.343 \qquad Y_{2020} = 0.404$$

The calculated predicted values of the level of asymmetry under the impact of capital investment show that asymmetry will grow in Ivano-Frankivsk, Transcarpathian, Chernivtsi, and Ternopil regions by the parameters of sustainable development, i.e., the tendency toward the deterioration of the development of regions is expected. Only in Lviv region, the level of asymmetry will remain around its current level.

The dynamic econometric models of analysis and prognosis of asymmetry level estimated by the method of Almon by the parameters of harmonization level and the predicted values of asymmetry rate for 2018–2020 are outlined below:

Ivano-Frankivsk region:

$$Y_t = 1.13 - 0.021x_t - 0.16x_{t-1} - 0.13x_{t-2} - 0.126x_{t-3} \qquad R^2 = 0.839$$
$$Y_{2018} = 0.136 \qquad Y_{2019} = 0.067 \qquad Y_{2020} = -0.05$$

Lviv region:

$$Y_t = 1.3 - 0.3x_t - 0.05x_{t-1} - 0.07x_{t-2} - 0.36x_{t-3} \qquad R^2 = 0.77$$
$$Y_{2018} = 0.283 \qquad Y_{2019} = 0.122 \qquad Y_{2020} = 0.066$$

Transcarpathian region:

$$Y_t = 1.13 - 0.57x_t - 0.17x_{t-1} - 0.018x_{t-2} - 0.125x_{t-3} \qquad R^2 = 0.753$$
$$Y_{2018} = 0.393 \qquad Y_{2019} = 0.278 \qquad Y_{2020} = 0.22$$

Chernivtsi region:

$$Y_t = 0.574 - 0.41x_t - 0.027x_{t-1} + 0.14x_{t-2} + 0.09x_{t-3} \qquad R^2 = 0.801$$
$$Y_{2018} = 0.444 \qquad Y_{2019} = 0.389 \qquad Y_{2020} = 0.349$$

Ternopil region:

$$Y_t = 1.25 - 0.51x_t - 0.07x_{t-1} - 0.014x_{t-2} - 0.337x_{t-3} \qquad R^2 = 0.814$$
$$Y_{2018} = 0.409 \qquad Y_{2019}0.302 \qquad Y_{2020} = 0.195$$

We can observe that the level of asymmetry of regional development falls under the impact of the change of capital investment volumes by the parameter of harmonization level, i.e., the tendency is positive from the viewpoint of investment influence on the rate of harmonization of regional socio-economic-ecological development in all regions of Western Ukraine. In other words, current tendencies of fixed investments will promote the harmonization of development of Western Ukrainian regions. However, based on the results of prognosis of asymmetry level by sustainable development parameters, we can conclude that general development tendency does not contribute to achievement by the regions under research of the development parameters close to the sustainable development parameters, i.e., the misbalances tend to grow.

The dynamic econometric models of analysis and prognosis of asymmetry level estimated by the method of S. Almon by the parameter of social tension and the predicted values of asymmetry rate for 2018–2020 are outlined below:

Ivano-Frankivsk region:

$$Y_t = -0.138 + 0.026x_t - 0.22x_{t-1} \qquad R^2 = 0.828$$
$$Y_{2018} = -0.393 \qquad Y_{2019} = -0.502 \qquad Y_{2020} = -0.516$$

Lviv region:

$$Y_t = -0.368 + 0.112x_t - 0.21x_{t-1} \qquad R^2 = 0.808$$
$$Y_{2018} = -0.457 \qquad Y_{2019} = -0.513 \qquad Y_{2020} - 0.545$$

Transcarpathian region:

$$Y_t = 0.25 + 0.27x_t - 1.016x_{t-1} \qquad R^2 = 0.733$$
$$Y_{2018} = -0.388 \qquad = -0.341 \qquad Y_{2020} = -0.518$$

Chernivtsi region:

$$Y_t = 0.2 + 0.044x_t - 0.62x_{t-1} \qquad R^2 = 0.839$$
$$Y_{2018} = -0.189 \qquad Y_{2019} = -0.152 \qquad Y_{2020} = -0.238$$

Ternopil region:

$$Y_t = 0.24 + 0.12x_t - 0.75x_{t-1} \qquad R^2 = 0.825$$
$$Y_{2018} = -0.354 \qquad Y_{2019} = -0.342 \qquad Y_{2020} = -0.418$$

The calculated predicted values of the level of asymmetry under the impact of capital investment show that asymmetry will diminish in Ivano-Frankivsk and Lviv regions by the parameter of social tension. In Transcarpathian, Chernivtsi, and Ternopil regions, the steady tendency of the change of the level of regional development asymmetry by the parameter of social tension is absent, which is caused by the change of the volumes of capital investment into the economy of abovementioned regions.

4 Conclusions

The conducted analysis of the results of application of existing methodics to estimate the level of misbalances and asymmetry of socio-ecological-economic development of a region as well as the predicted values of the level of asymmetry of regional development under the impact of the change of capital investment volumes calculated based on the developed dynamic econometric models and statistical data of the regions of Western Ukraine show that the asymmetries of regional development by the parameters of sustainable development are expected to grow under the current tendencies toward the practical realization of investment policy, i.e., the misbalances will aggravate in future. However, improvement of the situation is expected by the parameters of harmonization of sustainable development and the results of prognosis of asymmetry level by the parameter of social tension show the positive trend to the reduction of development of misbalances in Ivano-Franskivska and Lviv regions, which is the positive phenomenon, and the absence of the tendency toward the change of development of misbalances by the parameter in the rest regions of Western Ukraine. Existing unequivocal positive tendencies toward the reduction of development misbalances in two industrial-agricultural regions of Western Ukraine (Ivano-Frankivsk and Lviv regions) and the absence of negative tendencies of the parameter in the rest of regions under research, which are agricultural-industrial by their nature, testify to the fact that growing volumes of capital investment create preconditions in the long-term perspective to conduct systemic transformations directed at reduction of misbalances of regional development by the parameters of sustainable development, as far as the level of development asymmetry by the parameter of development harmonization is being secured currently.

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