

# Entropy approach for managing the socio-economic development of the region

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**Abstract.** The article is focused on actual theories and approaches for managing the socio-economic development of the region. And also strengths and weaknesses of the actual theories and approaches of regional development are shown. The article studies the specifics of regional development in Europe, the USA, the Russian Federation and the countries of Central Asia. Entropy approach to study the economic phenomena and processes is offered as an integrated one. It is shown that all actual approaches to regional development can be explained under the entropy approach as special cases. Opportunities for practical application of entropy approach for managing the socio-economic development of the region are shown. As well as the strengths and weaknesses of the entropy approach and the opportunities for its further development are pointed out

## 1 Introduction

In the age of the economic globalization, the management of the socio-economic development of a region or territory becomes even more pressing because, in addition to meeting social objectives, they are aimed to preserve the integrity and identity of the country, region and territory. Anymore, there are many theories and approaches to regional development [1] and their contradictions and divergence are obvious. Therefore, there is a basic urge to develop an integrated theory of regional development. Attempts to develop an integrated theory of regional development are already underway, as an example, the article by E. Medeiros [2], wherein he tried to develop a “theory of everything” for regional development, which would summarize all actual approaches for managing the socio-economic development of the region.

## 2 Materials and Methods

### 2.1 Actual management theories of socio-economic development of the region

All theories of regional development can be formed into two large groups: economic-centric and semi-economic. Economic-centric theories of socio-economic development of the region give priority to endogenous economic factors of development of the region (Table 1).

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**Table 1.** Economic-centric theories of socio-economic development of the region

<b>Theoretical paradigm</b>	<b>Research objectives (problems)</b>	<b>Reasons/Development factors</b>
Theory of firm/production location	Optimal location alternatives for production facilities	Regional development depends significantly on firms / transport costs in the region
Traditional neoclassical theory	Finding out endogenous and exogenous factors of economic development of the region	Regional development is mainly influenced by factors related to productive capacity, including free trade between regions, perfect competition and information, exogenously determined technological progress and balanced growth path leading to approach of growth rates between regions / security and productivity (“Borts and Stein model” and “theory of factor price alignment”)
Keynesian theory	Finding out the exogenous factors of economic development of the region	Regional development is largely driven by demand / production of goods and services (“export base theory” and “input-output theory”)
Theory of functional development	Finding out the regional development management tools	Regional development can be achieved by using selected regional resources to create generative growth. Thus, it is possible to relocate the region to higher steps of development around a core function closely linked to the investment / funds from leading regions, reduced imports of goods and services and reinvestment at the local level
Stadial theory	Finding out the steps of economic development and its impact on progress rates of this development	Regional development gets through five steps: (1) traditional, (2) opportunity for rise, (3) rise, (4) maturity and (5) mass consumption / technology, investment flows, physical infrastructure, and skilled labor
Non-equilibrium theory	Finding out the dynamic development factors of the region	Regional development is created by unbalanced forces / production structure, technology, infrastructure, market dynamics (“dynamic Schumpeter disbalance”, “regional life cycle theory” and “product life cycle theory”)
Cumulative growth theory	Explanation for unbalanced regional growth	The main driver of economic growth is accumulated growth experience and base effect
Regional growth theory	Determination of the economic quantity and economy structure of the region	Progress of economic growth depends on balanced and optimal structure of the region’s economy

Neoclassical endogenous growth theory	Finding out mainly endogenous factors of economic development of the region	Regional development depends not only on long-term regional growth through capital and labor accumulation, but also on endogenous economic factors / human capital, Research and Development (effort), innovation, extension and technology
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Source: made up on basis of [1, P.125; 2, P.5; 3]

Economic-centric growth theory attempts to explain the growth and development of the region’s economy just by economic conditions and factors: location of economic activity, trade balance, resource availability, capital, structure of economy, etc. Advantages of economic-centric theory includes:

- simplicity and comprehensibility for most economists;
- econometric data and calculations;
- open and easily explained causal relationships.

Its weaknesses:

- limitations of the conditions and factors of regional development considered;
- failure to explain several regional development phenomena and imbalances.

Semi-economic theory of socio-economic development of the region attempts to link economic development with various non-economic factors (Table 2).

**Table 2.** Semi-economic theories of socio-economic development of the region

<b>Theoretical paradigm</b>	<b>Research objectives (problems)</b>	<b>Reasons/Development factors</b>
Innovation diffusion theory	Addressing the emergence and diffusion of innovation	Development and introduction of innovation, process of its diffusion in the region are discussed as the main factor of development of the region
Core-periphery theory	Finding out the impact of territorial heterogeneity on economic development	Regional development is inherently uneven, as it implies under the advanced (leading) regions and less-developed (lagging) regions / resource endowments (“cumulative causation theory”, “pole/growth center theory” and “central location theory”).
Development axis theory	Determination of transport routes connecting the most important industrial centers	Transport connectivity of the region and transport costs are the main drivers of development
Infrastructure theory	Determining the required level of infrastructure development	The development of the region is defined by sophistication of all types of infrastructure: market, logistics, energy, transport, etc.
New Economic Geography Theory / Agglomeration Theory	Finding out the impact of migration processes on economic development	Regional development depends on a balance between centripetal (agglomerate) and centrifugal (diffusive) forces determining the degree and form of regional concentration of economic activity

Complex theory	Connecting the unified theory and approach of location and regional problems of economy	The rate and quality of economic growth are determined by a combination of factors, both economic and non-economic: institutional, behavioural, etc.
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Source: made up on basis of [1, P. 125; 2, P. 5; 3]

Advantages of semi-economic theories of regional development:

- finding out the full range of factors affecting the growth and development of the region's economy;
- finding out and substantiation of non-linearity of relationships in the region's economy;
- attempts to explain phenomena and inconsistencies of economic-centric theory.

Its weaknesses:

- arbitrariness in non-economic factors option affecting the economic development of the region;
- imbalance and contradiction of these theories.

## 2.2 Main approaches to the management of socio-economic development of the region

Theory generalization of economic development of the region allowed to find out the main approaches to the management of socio-economic development of the region (Table 3).

**Table 3.** Synthesis of actual approaches and models of socio-economic development of the region

Approach	Approach content	Development models in the approach
Infrastructural development	The first thing we have to do for the economic development of the region is to create the infrastructure base	Infrastructure Telecommunications Socio-cultural services Productive capital Accessibility features
Balanced development	The main condition for the growth of the region's economy is a balanced growth and development of industries and areas of the economy	Urban polycentrism Territorial cohesion Policy integration Spatial planning Spatial connectivity Cluster development
Inclusive development / Community development	To develop the region under globalization, the high priority is not to lose local advantages, but to try to develop them	Smart Specialization / Using Comparative Advantages Balanced bottom-up / top-down approach Collaborative approaches Community led enterprise Endogenous assets
Knowledge-based development	Under the formation of an innovative economy, the most important resource for the development of the region is knowledge-based assets	Human capital assets Innovation Entrepreneurship Business environment Intellectual capital

Institutional development	First of all, for the economic development of the region, it is necessary to create institutional assumptions, i.e. “rules of the game”	Administrative capacity Institutional capacity / density and change Social capital Territorial cooperation Leadership
Sustainable development	The main condition for the development of the region’s economy is balanced development of economic, social and environmental components	Closed-loop economy Social environmental consciousness Environmental protection Global governance sustainability Sustainability of global spatial planning

Source: made up on basis of [2, P. 14]

Indeed, the diversity of approaches to managing the socio-economic development of the region cannot be fully reduced to the above approaches. But anymore these approaches and models are most often used in regional development practices. The strengths and weaknesses of actual approaches to managing the socio-economic development of the region are shown in Table 4.

**Table 4.** The strengths and weaknesses of actual approaches to managing the socio-economic development of the region

Approach	Strengths	Weaknesses
Infrastructural development	It is logical to start with the material and technical base of economic development	Good infrastructure does not guarantee successful development
Balanced development	It avoids distortions in the development of the region	It is inapplicable under the catching-up development because distortions are unavoidable
Inclusive development / Community development	Caring for local resources and communities	If there are no comparative strengths in the region, it is not applicable
Knowledge-based development	It allows the development of the region even at a high base	It is inapplicable under the catching-up development, because there is no required scientific and technical base
Institutional development	Starting with the basic economic conditions of development	Not applicable at a very low initial income level of the population, because the development of the institutional environment takes place only in a co-evolution with the development of the economy
Sustainable development	Environmental accounting and social management	When catching-up development is weak, because insufficient economic resources to solve all problems simultaneously, you need to choose priorities

Source: by author based on research

As shown in Table 4, each of the approaches to the socio-economic development of the region has its own strengths and weaknesses, depending on the type of region to which these approaches are applied. Some of the current approaches are weak in catching-up development regions.

## 2.3 Regional specificity

While there are generally accepted approaches to the management of socio-economic development of the regions' economies, it should be noted as part of management impacts for development of socio-economic system of regions must be considered the specifics of regional development in the various macroregions of the planet Earth.

Generalization of the planetary experience of regional development was made in a monograph [4]. The features of regional policy in different countries by type and level of development, the experience of which for various reasons is interesting for Russia are focused on this summary activity. Special priority should be given to such issues as the motives of regional policy, its legislative and organizational support, tools. Interaction of regional policy and other components of state regulation of economy, including inter-budgetary relations, regional (territorial) planning, various directions of sectoral policy was studied.

Today, the specifics of regional development of European countries are described in more details since actual regional economy as a science originated in Europe. For example, the paper [5] shows a method for disaggregating national trade data in Europe at the regional level. This makes it possible to develop trade indicators at the regional level, including the identified export strengths. Identification of industries in which the region performs a powerful line of business does double service in the development of industrial and regional policies. First, the identification of successful structures at the industry and regional levels helps to better get micro- and meso-competitiveness, as well as the scope and cases of political interference. Secondly, knowledge of the spatial distribution of competitive industries and the required location factors is necessary for a differentiated view of future economic development and choice of policy instruments.

The article [6] studies the influence to form the Single European Market on local development. The main research issue was whether some parts of Europe have improved their position in the internal trade of the EU through better use of their comparative advantages (productivity, factor endowment...) and scale economy.

The paper [7] reviews and provides examples of how local development in areas or regions of advanced industrial countries and countries in transition is addressing the negative impacts of globalization. Employment is the central determinant of socio-economic well-being, so regions seek for effective local development strategies aimed at promoting economic growth and employment growth by process of combining a number of elements from many different local individuals and based on local resources, need and characteristics.

The specifics of regional development in the United States of America are also detailed. For example, article [8] provides an empirical study related and absolute specialized in US regions. Analyzing local agglomerations in time, the authors of the article found that the growth of absolute specialization is positively related to salary, while the change in relative concentration has no significant relation to the dynamics of salary.

The authors of this article [9] made an empirical study of how the concentration of employment in industries and professions in US regions has changed over time and how regional specialization has developed. Results show that indices of industrial concentration and specialization have decreased, while indices of concentration of occupation and specialization have increased.

Specifics of regional development in the Russian Federation described in the paper [10]. The study shows the function of federal policy of regional development as a key tool for implementation aimed at improving the spatial structure of the Russian economy. Assessments of the economic differentiation of the Russian regions and justifications for maintaining the significance of «balancing policy» as one of the priorities of spatial structure regulation of the Russian economy are given; the system of institutions and tools of modern policy of regional development, as well as its legal bases is studied.

The articles [11, 12, 13] found out and generalized the factors of regional development of Russia in 1998-2014 based on an analysis of successful regional examples and econometric methods. In general, development (economic productivity) is determined by natural conditions: advantageous geographical location, raw materials and agro-climatic resources but realizing the potential also depended on the effectiveness of government policies to reduce investment risks and use human capital.

The specificity of the Central Asian regional development is most underexplored, but progress is evident. For example, this paper [14] touches on the administrative and territorial division of the Republic of Kazakhstan, provides a comparison by size of the regions, and presents features of their development. The authors focus on the integrated solution of regional development problems. As a research problem, the authors attempted to assess and systematize the features of regional development in Kazakhstan. Characteristics of socio-economic development of regions are studied and given. Taxonomic levels of research and scientists view, which made a great contribution to the development of theoretical concepts of regional science, were analyzed. The article proves the priority and effectiveness of the application model "smart specialization" to the development process of Kazakhstan regions.

This report [15] based on the study of world experience summarizes the approaches and tools to stimulate the economic development of the country regions, suggests the author's vision of the approach to their selection under increased external impacts on regions and uncertainty. The practice of state regional economic policy in Kyrgyzstan has been analyzed, the approach and some tools to increase its effectiveness have been offered.

Article [16] analyses comparative indicators of regions of Uzbekistan. The study concluded that the regions with the least developed industrial infrastructure were the poorest. These include the Namangan region (the share of industry in the GRP of this region is only 14.7%), Surkhandarya region (8.2%), Andijan (20.8%) and Fergana (24.8%) regions. Hence, to increase the economic potential of these regions and reduce their dependence on higher budgets, it is necessary to develop industrial production in these regions.

Publication [17] describes the change in Uzbekistan's regional policy, including foreign economic relations. It is shown that progression of foreign economic interests of the country has become the number one challenge for the development of regions in modern conditions: increase of exports, attraction of foreign investments and advanced technologies, improvement of transport and transit situation in the country and development of tourism.

## **3 Results**

### **3.1. The reality of the entropy approach to the management of socio-economic development of the region**

Entropy approach to study the economic phenomena began to develop lately. Its fact consists to use terminology and mathematical apparatus of synergetics and econophysics upon studying and explanation of socio-economic phenomena and processes. N. Georgescu-Roegen was the first economist to show the entropic nature of economic processes [18]. He formulated several highly important abstracts:

- economic process is an entropy process;
- a man struggles for low entropy, and the economic deficit is a reflection of the entropy law as the most economical one of all natural laws;
- economic activity, in fact, serves as an extension and complement to the biological evolution of man.

The words V.I. Maevsky "The evolution of living systems is related to a decrease of entropy, and to an increase of energy potential of these systems are better to get the entropic

reality of socio-economic systems. It reaches out in improving living systems, the complexity of their functions and structure... there are two types of evolution, one of which determines the movement of living matter, the other having the opposite arrow of time – the movement of non-living matter” [19, P.6].

J. Chen offered an entropy theory of value based on the scarcity/rarity of resources required for people to reduce entropy in economic systems [20, 21].

Some opportunities for the development of the integrated theory of socio-economic development of the region based on the entropy approach are given in the articles [22, 23]:

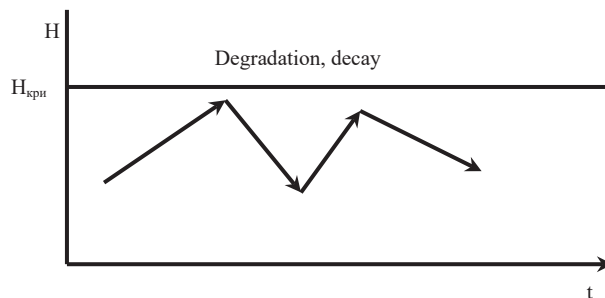
- the properties of socio-economic systems derived from the properties of living systems, which in turn are properties of all open dissipative systems: complexity, hierarchy, emergence, role of information;

- the features of entropy dynamics in socio-economic systems, which are that these systems are able to regulate the entropy level within themselves by using substance, energy and information from the environment, and to accumulate negentropy as stock of goods, raw materials, and products;

- multiple entropy dichotomy in the economy, showing that individuals/firms have to monitor and regulate the level of both current entropy at once, or death/decay, and entropy (uncertainty) of the future. Besides, entropy can be private (entropy of an individual) and public (entropy of a complex socio-economic system) between which it is also necessary to switch locus of control. Well, there is another dichotomy in objective entropy, which reaches itself out in real energy collapse and/or increasing uncertainty of the future, and subjective entropy felt by human senses.

When managing the socio-economic development of the region, the main type of entropy that will serve as a reference when making management decisions is public entropy because the region is a set of individuals, firms, institutions, industries, and territories.

The main principle of the entropy approach to the management of socio-economic development of the region is reduction of the current entropy of the region expressed in social, economic and environmental problems, as well as in disproportionality, randomness of development. If there is no managerial influence, the entropy of the socio-economic system of the region is regularly increasing according to the second law of thermodynamics. If there is no managerial influence, it may result in the critical level of current entropy, i.e. the degradation of the region or even the disintegration of the whole socio-economic system. Each management impact (activity/tool) reduces current entropy and moves away from the critical level. If the offered regional policy activity or tool reduces the current entropy of the region more than it increases, then it is effective (Figure 1).

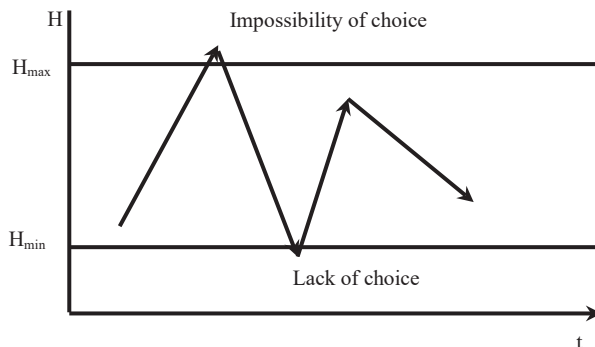


**Fig. 1.** Entropy dynamics of the current status of the socio-economic system of the region.

Moreover, to manage the socio-economic development of the region effectively, it must be considered the entropy dynamics of the future. However, it should be noted that if current entropy should be reduced, future entropy management requires keeping it in some optimal range. In other words, it is impossible to allow both this entropy to decrease to minimal



values, because it goes to show a lack of possible options for management decisions, and to allow its increase above a certain limit, otherwise the number of variants of possible scenarios becomes so great that creates entropy of choice, i.e. it is impossible to choose the best option actually due to the high level of uncertainty (Figure 2).



**Fig. 2.** Entropy dynamics of the future status of the socio-economic system of the region.

Synthetic capabilities of entropy approach to the management of socio-economic development of the region.

One of the criteria thereof that a new theory or hypothesis to be viable, is how this new theory is in keeping with the past theory and approaches. The entropy approach to the socio-economic development of the region can be harmonized with ready-made approaches by allowing all actual approaches to be seen as ad hoc entropy cases (Table 5).

**Table 5.** Actual approaches to managing the socio-economic development of the region in terms of the entropy approach

Approach	Entropy based explanation
Infrastructural development	Infrastructural development lowers the current entropy of the socio-economic system of the region based on improving the material and technical conditions for individuals and firms, providing them with the substance, energy and information required to lower the current entropy
Balanced development	Improving the balance of development lowers the randomness of this development, increases degree of order in the system, which is equivalent to lowering the current entropy
Inclusive development / Community development	The process of globalization increases the current entropy of the region, draining resources and human capital, and globalization leads to an excessive lowering of the entropy of the future, leaving the region with no options for development other than integration into the global agenda. Local resource and community development lowers the entropy effects of globalization.
Knowledge-based development	Knowledge provides a basis for the emergence of new options for the development of the socio-economic system of the region, allowing to move the entropy of the future from the lower border, in which there is a management deadlock
Institutional development	An advanced institutional environment controls a mix of options for individuals, thereby lowering the uncertainty of the future, and thus lowering an excessive entropy of the future
Sustainable development	Integrating the environmental and social dimensions of development lowers current entropy by improving the environment and addressing social challenges. It also allows you

	to prevent the growth of entropy of the future by cutting off the most dangerous development options.
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Source: by author based on research

As you can see in the table, all current approaches to the management of the socio-economic development of the region can somehow be explained from the point of view of the entropy approach. Hence, the hypothesis that actual approaches can be taken as ad hoc cases of an entropy approach may be seen as proved.

### 3.2. Useful results of the entropy approach

So, useful result is another criterion for the validity of a theory or hypothesis. Therefore, you need to show how the entropy approach allows you to choose the best management solutions.

Setting Priorities of economic development is one of the directions of using approach results to managing socio-economic development in practice. The entropy approach offers a universal criterion for Setting Priorities: each of the priorities should provide either a lowering in the current entropy of the region, or regulation of the entropy of the future within an allowed range.

Another area of useful results is the choice of economic development activities and tools. Here, by analogy with the Setting Priorities development: if the offered activity or tool lowers the current entropy or somehow controls the entropy of the future, then such an activity should be seen effective. However, in contrast to development priorities, the entropy effect of the tools and activities should also be weighed against the entropy cost of their implementation. If the activity increases current entropy to a greater degree than it reduces, then its use is ineffective.

Another useful result is the consideration of regional development. Each region has its own level and dynamics of entropy, so when Setting Priorities it is necessary to choose those that provide the maximum lowering of the current entropy of the region or do not lead to the release of entropy of the future beyond the allowed limits. The same thing is when choosing activities and tools: the entropy effect of their using should be calculated based on the entropy level of the region at this step of development.

## 4 Discussion

Indeed, the entropy approach to managing the socio-economic development of the region is unused for most economists, both theorists and practitioners. Although for practitioners, in our opinion, it is intuitive, because practitioners can not explain over and over again why they prefer a particular tool or activity. It is believed that practitioners just intuitively determine the entropic effectiveness of these activities.

The advantages of the entropy approach can be attributed:

- intuitive comprehension for regional management practitioners;
- synthetic capabilities to form an integrated approach to the management of the socio-economic development of the region;
- possibility to develop new tools and activities based on the entropy approach.

Disadvantages of the entropy approach:

- aversion to economic theorists, especially economic mainstream;
- force to master synergy and environmental terminology and methodology.

Opportunities for further development of the entropy approach consist in the formation of a mathematical apparatus for level calculating and entropy dynamics of the socio-

economic system of the region and its integrated parts, harmonization of actual regional development terminology and methodology with the entropy approach.

## 5 Conclusion

The number of theories describing the socio-economic development of the region is quite high. All theories can be roughly divided into economic-centric and semi-economic. Attempts are being made to form an integrated theory of regional development.

Based on the theory of regional development, six most common approaches to the management of the socio-economic development of the regions have emerged: infrastructural development, balanced development, Inclusive development / Community development, knowledge-based development, institutional development, and sustainable development. There are strengths and weaknesses to each of the approaches, but they are poorly coordinated.

The entropy approach to the study of economic processes and phenomena appeared lately, but it can be offered as an integrated approach that will support integrate all actual approaches to regional development and address them as a special case.

The entropy approach has not just theoretical but also practical results, as it allows a more conscious approach to choose the priorities of regional development, tools and activities of regional strategies and programmes, and also including the specific development of particular regions.

Entropy approach to managing the socio-economic development of the region has its strengths and weaknesses, but has very great prospects to use and to develop.

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