PREFACE

ORBITIR AS A NEW PERSPECTIVE FOR ECONOMIC ANALYSIS

Professor Hayk Sargsyan's "Orbital Development Theory" offers an opportunity to look, from a new perspective, at the history of recent decades of our systemic development, and it also opens new horizons in predicting and modelling the future.

In the early 1990s, after the collapse of the USSR, the alternative development model offered to the former Soviet countries was linear, and no cultural, ecological, social, security, or institutional particularities were taken into account. As a result, decades later, we witness entirely different realities among countries that gained independence under nearly identical starting conditions. This fact alone is sufficient to substantiate the necessity of developing non-linear, non-trivial, systemic and, in this case, orbital models of development. The professor's work is precisely about this.

The history of the Armenian reality is highly illustrative for substantiating the orbital development model, for we have both seen and felt: the incompatibility of the security factor (more specifically, the ongoing war) with the liberal economic model; the disregard for the potential of an immense cultural stratum within linear development models; the inhibiting effect of decayed, underdeveloped, and at times bloated institutions on the discovery and realization of economic potential; the devastating consequences of neglecting ecological imperatives for the country's overall investment attractiveness; the contempt for the technological component amid the artificially elevated priority given to quantitative indicators; and the incongruence of the social system's inertial course with the challenges of the modern times.

As a result, yes, by the author's exact characterization, we have found ourselves, and for quite some time have remained, in a mode of "Unstable Growth," from which the smooth flow toward an orbital trap is merely a matter of time.

Thus, our objective is to prevent such a course. Therefore, through the scientific and theoretical analyses, and applied actions, we must prevent the possibility of regression, substantiate and implement a development model that would best incorporate the possible impact of all the aforementioned factors, especially since Professor Sargsyan provides a well-founded argument for the tendency of any development model to seek systemic equilibrium. In other words, the task is to correctly combine the seven identified pillars (Economy, Social System, Environment, Security, Institutions, Technological System, and Culture — *of course, I would bring Culture to the fore*) — of the integral model (ORBITIR) with their corresponding weighting coefficients. We must also understand that such a synthesis will be unique and inimitable for our country, since the difference in the models, course, and outcomes of sovereign systems is conditioned precisely by the accurate calculation of the weights of the various factors (pillars) noted.

With the presentation of the integral ORBITIR index, the author takes the first serious scientific step toward reversing the course of our country's unstable growth and steering it toward the sustainable development benchmark established by the UN, and opens a broad field for further studies, research, and calculations, for the synthesis and development of adjacent scientific disciplines (economics, political science, psychology, sociology, mathematical modelling and programming, military science, engineering, etc.)

We wish the author great success in this work with the expectation of lasting and further fruitful activity.

Armen Darbinyan
Doctor of Economic Sciences, Professor
Corresponding Member of the National Academy
of Sciences of the Republic of Armenia
Foreign Member of the Russian Academy of Sciences

HAYK SARGSYAN

DOI: 10.64201/18290043-2eaa2024-27

ORBITIR — A FRAMEWORK FOR THE ORBITAL DEVELOPMENT OF COUNTRIES

ABSTRACT

Contemporary development theory has reached important explanatory limits. Linear growth models, composite indices, and conventional institutional approaches are no longer sufficient to explain the complex, multi-layered, and frequently non-linear dynamics of state development.

This study proposes a new theoretical and methodological framework for envisioning development — ORBITIR (Orbital Development Framework; etymology: Latin *orbita* + "IR" — Institutional Resilience, or Integration/ Reform) — which regards the development of states as an orbital dynamic. According to this approach, countries do not move in a single direction toward a "developed end-point"; rather, they reside in different regimes of relative stability — orbits — and effect transitions between them, conditioned by a combination of systemic factors.

The ORBITIR model integrates three interconnected levels — theory, methodology, and an applied toolkit. It functions simultaneously as a paradigmatic reconceptualization of development theory, a multidimensional assessment framework, and an applied instrument for public-policy analysis. At the core of the model lies a system of seven developmental pillars — economy, social system, environment, security, institutions, technology, and culture — whose combination forms an integral indicator of development: the ORBITIR Index.

The methodological foundation of the model is built upon contemporary data-science tools, including Principal Component Analysis (PCA), entropy weighting, the Analytic Hierarchy Process (AHP), and the SHAP approach of explainable artificial intelligence; this makes it possible not only to measure the level of development but also to reveal its internal structure and its determining factors.

The example of Armenia shows that small and medium-sized states often find themselves caught in structural and orbital constraints that cannot be explained by economic or institutional changes alone. The ORBITIR framework affords the possibility of interpreting that situation as a systemic-equilibrium regime, emphasizing the non-linear character of development dynamics.

Thus, ORBITIR is presented as a new platform for development theory, in which the advancement of states is regarded not as a unilinear motion but as an orbital system subject to transitions, constraints, and equilibria.

Keywords: ORBITIR, orbital development, development of states, complex systems, institutional economics, composite indices, PCA, entropy weighting, AHP, SHAP.

INTRODUCTION

The limits of development theory and the necessity of ORBITIR. In the history of the economic and social sciences, the idea of development was formed as a combination of advancement, growth, and transformation. For decades, economic growth, industrialization, and the accumulation of capital were regarded as the principal factors conditioning the development of societies. Over time, however, it has become evident that this conception is not only incomplete but also limited in its explanatory capacity. Contemporary development theory stands before its own internal limits: the linear models of economic growth grounded in the classical theories[1] are unable to explain in full the complex dynamics by which states develop.

The contemporary world is characterized by a profound diversity of development paths. Development can no longer be understood as a simple process of economic growth. Instead, it should be viewed as a systemic and multidimensional process shaped by the simultaneous interaction of interconnected subsystems. In this context, the revision of the phases of development becomes essential — a transition from traditional stage-hierarchies[2] toward more flexible and resilient systems. The same economic policies yield substantially different results in different countries. The same institutional reforms lead, in one environment, to stability, and in another, to instability and even regression. This phenomenon shows that the developmental process does not obey a unilinear, simplistic logic and cannot be fully described within the framework of classical linear models.

The linear development paradigm assumes that all countries move in the same direction, passing through the same phases, merely at different speeds. Reality, however, demonstrates that countries frequently "stop,"

[1] Solow, R. M. (1956) A Contribution to the Theory of Economic Growth. Quarterly Journal of Economics, 70(1).

[2] Rostow, W. W. (1960) The stages of economic growth: Cambridge: Cambridge University Press.

"deviate," or "return" along their developmental path, failing to fit within the classical conceptions of progress and demanding a different theoretical language.

The development of composite indices — from the Human Development Index (HDI) to the system of the Sustainable Development Goals (SDGs) — was an important step toward recognizing the multidimensionality of development. These approaches, however, principally describe the *state* of development at a given moment and do not reveal its internal dynamics. They present "where we are," but they do not explain "why we are here" and "how we are moving."

Thus, development theory, standing before its own internal limits, produces a theoretical vacuum that is especially visible in the case of countries situated in transitional states or confronting multi-layered constraints.

In this context, the experience of small and medium-sized states becomes an important object of study. Armenia's development, for example, cannot be explained solely by indicators of economic growth or by institutional reforms. It is shaped simultaneously by the influence of several factors — the security environment, external factors, institutional memory, cultural capital, and so forth. This multi-layered character demands a theoretical approach capable of combining different factors within a single unified system.

In this situation arises the fundamental question that constitutes the theoretical axis of this work: can development be regarded as a non-linear, systemic motion in which states transition between different regimes of stability?

The formation of the orbital approach. The answer to the question formulated above is proposed within the framework of the ORBITIR model, in which development is regarded as an orbital dynamic. The orbital approach is grounded in the idea that states do not move toward a single final "developed state" but reside in different regimes of relative stability. These regimes may be pictured as orbits within which the system preserves its structural equilibrium.

To grasp this idea more fully, one may turn to two brief metaphors that possess not only an artistic but also a theoretical significance.

The first is the image of A. Pushkin's "Winter Evening." It is the moment when the day seemingly still continues, yet the light is already waning, and motion becomes slow and barely perceptible. Certain phases of development have such a character: external changes are limited, but the internal dynamic continues to operate, shaping the possibility of subsequent transitions.

The second is the metaphor of the meat-grinder "auger" (screw), which displays the multi-layered physical structure of development. Each layer has its own internal logic, but the whole is formed only by the combination of all the layers. Development cannot be understood in a single plane; it is always multidimensional.

These two images allow one to grasp intuitively that which is subsequently formulated as a theoretical structure.

The theoretical placement of ORBITIR. The ORBITIR model proposes an approach within development theory that regards development as a systemic dynamic in which states move between different orbits. The approach is grounded in the theory of complex systems, according to which systems possess non-linear dynamics and the property of self-organization, and may effect transitions between different states of equilibrium.

The distinctive feature of the ORBITIR model is that it unites three interconnected levels:

- the theoretical — development as an orbital system;
- the methodological — the construction of multidimensional indices;
- the applied — policy analysis.

The combination of these three levels makes it possible to overcome the existing limitations of development theory and to propose a new analytical language.

Armenia's role as a domain of theoretical application. In this study, Armenia is regarded not as a separate case but as an environment of "theoretical application." It represents a system in which transitional processes, structural constraints, and developmental potential are simultaneously present.

The particularities of Armenia's development are conditioned by a number of factors, such as:

- the institutional transition;
- security questions;
- a small open economy (hence an objectively heightened vulnerability to external factors);
- high cultural and educational capital.

The combination of these factors creates a complex dynamic that cannot be explained through a single factor. The ORBITIR model makes it possible to present this multi-layered character as a systemic structure.

CHAPTER 1.
THE LIMITS OF THE LINEAR DEVELOPMENT PARADIGM AND THE NECESSITY OF A NON-LINEAR APPROACH

The state is regarded as a complex adaptive system whose functioning cannot be described by simple mechanical regularities. Complexity[3] and network connectivity (Network Science)[4] allow development to be pictured as an orbital motion in which each country has its own gravitational field and trajectory of stability.[5]

The classical structure of development theory was formed around the assumption that the advancement of societies can be described as a sequential, cumulative, and largely predictable process. This conception, which may be characterized as the linear paradigm, lay for a long time at the foundation of economic thought.

Within the framework of the linear approach, development is regarded as a motion in a single direction — from a lower state of development toward a higher state. According to the above logic, this motion has a certain phase structure and obeys general regularities. Different countries may move at different speeds, but it is assumed that their path is, in principle, the same.

Rostow's theory of the stages of development is one of the most prominent expressions of this conception. It proposes a system of five sequential stages — from traditional society to the stage of mass consumption. The strength of this model lies in its simplicity: it provides a clear and intuitive picture of development. Yet that very simplicity becomes its principal limitation. It disregards historical, cultural, and institutional diversity, presupposing a universal developmental path.

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3 Arthur, W. B. (2014) Complexity and the economy. Oxford: Oxford University Press.

4 Barabási, A.-L. (2016) Network science. Cambridge: Cambridge University Press.

5 Holland, J. H. (1995) Hidden order: how adaptation builds complexity. Reading, MA: Addison-Wesley.

The Solow model of economic growth, in turn, offers a more formalized approach, linking economic growth to capital accumulation, labour, and technological progress.[6] Although the Solow model made a major contribution to the quantitative analysis of economic growth, it also has important limitations. The model treats the economy largely as an input–output system and gives insufficient attention to institutions, culture, and governance structures that shape long-term development trajectories. Two further examples may be offered:

The linear chain "primitive communal society – slavery – feudalism – capitalism – socialism / communism," which, at least through the example of the reverse transition back to capitalism, refuted the linear, upward-ascending character of formation theory. In many cases, moreover, the transition centuries ago was effected directly to feudalism, without the slavery phase. Or the agrarian – industrial – post-industrial periodization.

These two approaches, while differing in their methodology, share one common assumption: that development is linear, continuous, and largely upward. The contemporary world, however, increasingly contradicts this assumption.

The crisis of the linear paradigm. Over recent decades, a large quantity of empirical material has accumulated showing that economic growth in itself does not ensure sustainable development. High rates of growth may be accompanied by a deepening of social inequality, institutional decay, or political instability. Even countries that have achieved considerable economic results frequently confront developmental "stops" or regressions.

This phenomenon may be characterized as the crisis of the linear paradigm. It manifests itself at three principal levels.

The first is the explanatory limitation. Linear models are unable to explain why countries respond differently to the same policies. They do not reveal the internal structures that condition differences in development.

The second is the predictive limitation. If development were truly linear, it would be possible to forecast the trajectories of countries by means of relatively simple models. Reality, however, shows that the dynamics of development are frequently unpredictable and depend on numerous interacting factors.

[6] Solow, R. M. (1956). A Contribution to the Theory of Economic Growth. The Quarterly Journal of Economics, 70(1).

The third concerns the limitations of public policy. Policies grounded in the linear paradigm frequently fail, because they do not take into account the complexity of the system. The "emulation of best practice" and the "transplantation" of practice from one country to another frequently do not yield the expected results.

A most important component of this theoretical framework is the institutional environment. Drawing on the foundational tenets of the New Institutional school,[7] we hold that inclusive institutions constitute the principal driving force enabling a country to move into a higher developmental orbit.[8] Formal institutions alone, however, are not sufficient.

According to the theory of A. A. Auzan, the success of economic development also depends on cultural codes, which may either stimulate or inhibit modernization.[9] If a country's value system does not correspond to its economic reforms, an "institutional path dependence" arises, which in the ORBITIR model is defined as an "Orbital Trap." Thus, development is not merely the growth of GDP but a process of expanding human capabilities and freedom of choice.[10] In this context, it is fitting to recall the founder of constitutional economics, the Nobel laureate J. Buchanan, who expanded the boundaries of mainstream economics by shifting the centre of research away from choices *within* existing constraints toward the domain of choices *among* constraints.[11]

The limitations of composite indices. The Human Development Index (HDI), the UN Sustainable Development Goals (SDGs), and other attempts at constructing composite indices were an important step toward overcoming the limitations of the linear paradigm and expanding the possibilities of measuring development.

These indices incorporate not only economic but also social, ecological, and governance factors (ESG). They make it possible to obtain a more

[7] North, D. C. (1990). Institutions, institutional change and economic performance. Cambridge University Press.

[8] Acemoglu, D. and Robinson, J.A. (2012) Why nations fail: The origins of power, prosperity, and poverty. New York: Crown Business.

[9] Аузан А. А. (2022). Культурные коды экономики.

[10] Sen, A. (1999) Development as freedom. Oxford: Oxford University Press.

[11] Buchanan, J. M. (1990) The domain of constitutional economics. Constitutional Political Economy, 1(1).

complete picture of development. Despite their importance, however, they have a number of fundamental limitations.

First, they principally describe the state at a given moment, rather than the dynamics of development. Second, they do not reveal the causal links among the various indicators. Third, they do not provide sufficient information about how a system might effect a transition from one state to another.

Thus, composite indices expand the *measurement* of development but do not change its theoretical foundation.

The necessity of non-linear dynamics. The above limitations lead to the conclusion that development theory must be revised at a deeper level. It is necessary to effect a transition from the linear approach toward an approach capable of taking into account the complexity of the system.

Non-linear dynamics offers precisely such a possibility. Within the framework of complex-systems theory, systems are regarded as a totality of interconnected elements in which small changes may lead to large outcomes, and the behaviour of the system cannot be fully predicted on the basis of its individual components.[12]

This approach makes it possible to understand why countries sometimes remain for a long time in stable but non-developing states, and why at certain moments abrupt changes occur.

From linear to orbital. Non-linear thinking opens a path toward a new conception of development, in which states are regarded not as "moving along the path of progress" but as complex systems residing in different regimes of equilibrium. This transition may be formulated as a passage: *from linear development → to systemic dynamics → to orbital development*.

The orbital approach, developed in this study, is precisely this logical next step. It proposes regarding development as a motion not along a line but along an orbit, in which the system preserves a certain structural equilibrium.

Interim conclusion. The principal result of Chapter 1 may be formulated as follows: the linear development paradigm, despite its historical

[12] As a related theoretical direction, one may consider the idea of the "Nudge" proposed by the Nobel laureate R. Thaler within the context of behavioural economics, whereby small changes may lead to large outcomes.

significance, no longer suffices to explain the complexity of the contemporary world. Composite indices expand the possibilities of measurement but do not change the theoretical foundation. Non-linear dynamics offers a new theoretical language that makes it possible to understand the true nature of development.

This conclusion becomes the foundation upon which the next chapter is built — in which development is regarded as a complex system and the theoretical basis of the orbital approach is established.

CHAPTER 2.
DEVELOPMENT AS A COMPLEX SYSTEM: THEORETICAL FOUNDATIONS AND DYNAMIC STRUCTURE

The limits of the linear paradigm presented above lead to the necessity that development be regarded on a different theoretical plane. Such a plane is offered by the theory of complex systems, which forms a new methodological framework for the study of development.

Within complex-systems theory, systems are regarded as a totality of interconnected elements in which the behaviour of each element is conditioned not only by its own internal properties but also by the structure of the entire system. From this perspective, the state cannot be regarded as merely an economic or institutional unit. It is a multi-layered and multi-natured system in which different subsystems operate simultaneously.

The structural multi-layeredness of the system. As a totality of interconnected subsystems, the state's development system has its own internal logic, and the combination of these subsystems forms the overall dynamic.

These subsystems include:

- economic structure;
- social relations;
- ecological environment;
- security environment;
- technological development;
- institutional environment;
- cultural system.

Small changes in the interaction of system-constituting elements may produce disproportionately large consequences; in some cases, by contrast, the system may preserve its structure despite external influences. A schematic depiction of the interaction of subsystems, environments, and contexts

endowed with heterogeneous functional loads (it is, incidentally, evident that this is indeed a complex system) is presented below.

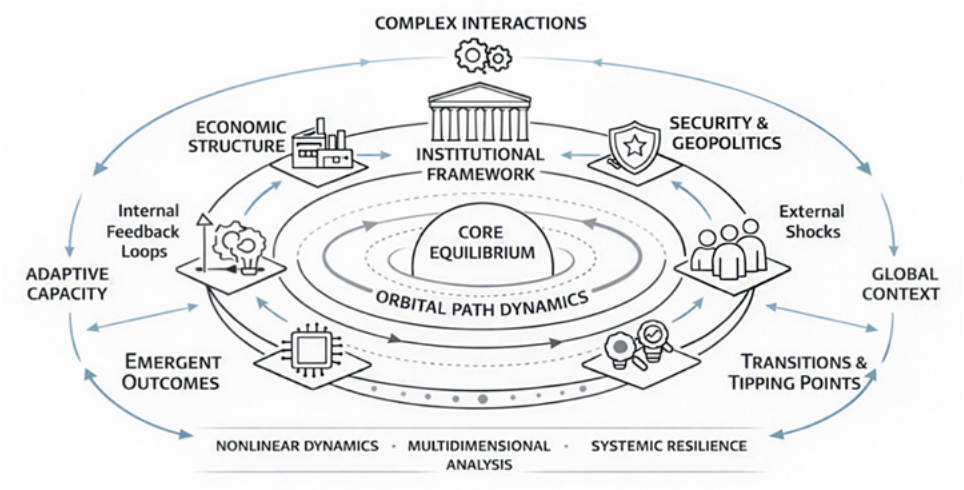

Figure 1. ORBITIR architecture: the systemic structure of development.

Integrated systemic dynamics. Complex-systems theory presupposes that three important properties characterize systems:

1. **non-linearity** — there is no direct proportionality between influences and outcomes;
2. **self-organization** — the system can form ordered structures without external guidance;
3. **emergence** — the properties of the whole system cannot be fully explained through its individual elements.

These properties, which are of importance for the analysis of development, explain why countries are able to maintain certain states for long periods and why, at certain moments, they give way to abrupt changes.

Systemic equilibria and regimes of stability. Complex systems are inclined to form states of equilibrium that may be relatively stable. These states do not signify that the system is not changing; rather, they signify that changes occur *within* the system, without its structural transformation.

In development theory, this phenomenon is expressed in the fact that countries frequently remain for a long time at the same level of development, despite changes in policy or external influences.

These states may be regarded as regimes of stability, which in the ORBITIR model will subsequently be formulated as orbits.

Systemic transitions. One of the most important properties of complex systems is their capacity to transition between different states of equilibrium. These transitions may occur gradually or abruptly.

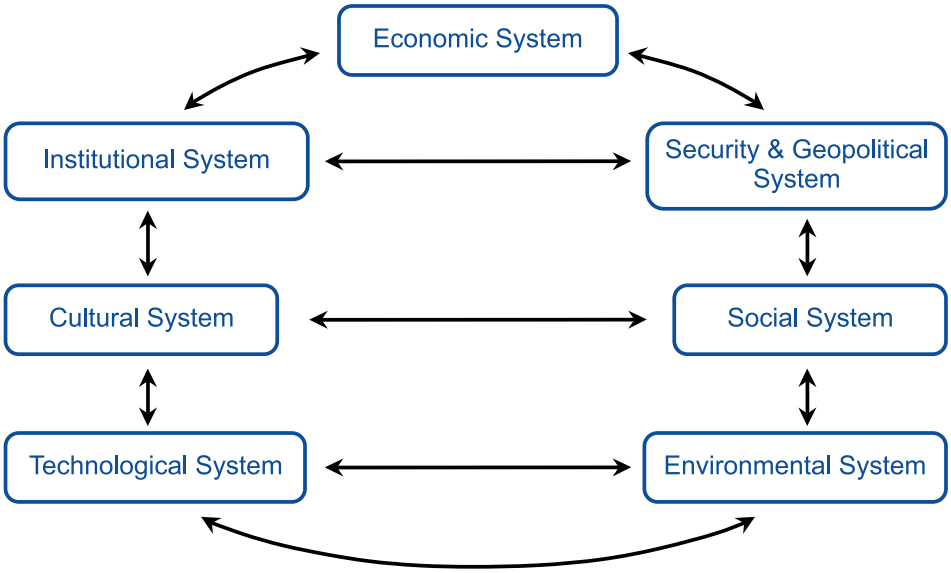

Figure 2. The development landscape: regimes of stability and transitions.

This phenomenon may be understood as a systemic transition that occurs when the internal tension within the system exceeds a certain threshold. The model suggests that such transitions are probabilistic in nature and depend on the structure of the system.

Exiting from orbits and entering a new orbit is a complex and non-linear process.

These transitions depend on three principal factors:

1. internal tension (structural pressure);
2. external shocks;
3. adaptive capacity.

The combination of these factors determines the probability of a transition.

From a mathematical standpoint, it may be represented as:

$$P(orbit_i \rightarrow orbit_j) = \frac{1}{1 + e^{-z}}$$

where z expresses the integral effect of changes in the system.

The role of feedback loops. Feedback loops play a central role in the dynamics of complex systems and may be either positive (reinforcing) or negative (stabilizing). Positive feedback loops can accelerate development or, conversely, intensify instability, whereas negative feedback loops contribute to systemic stabilization. The interaction between these two types of feedback shapes the overall behaviour of the system.

From the standpoint of systems theory, development is regarded as a totality of interconnected feedback loops *(see Figure 3)*. The green arrows depict the reinforcing loops, in which institutional quality stimulates the efficient use of resources, which in turn leads to economic growth. At the same time, the red arrows show the balancing mechanisms, which may create systemic resistance and lead to stagnation if growth rates exceed the limits of institutional stability.

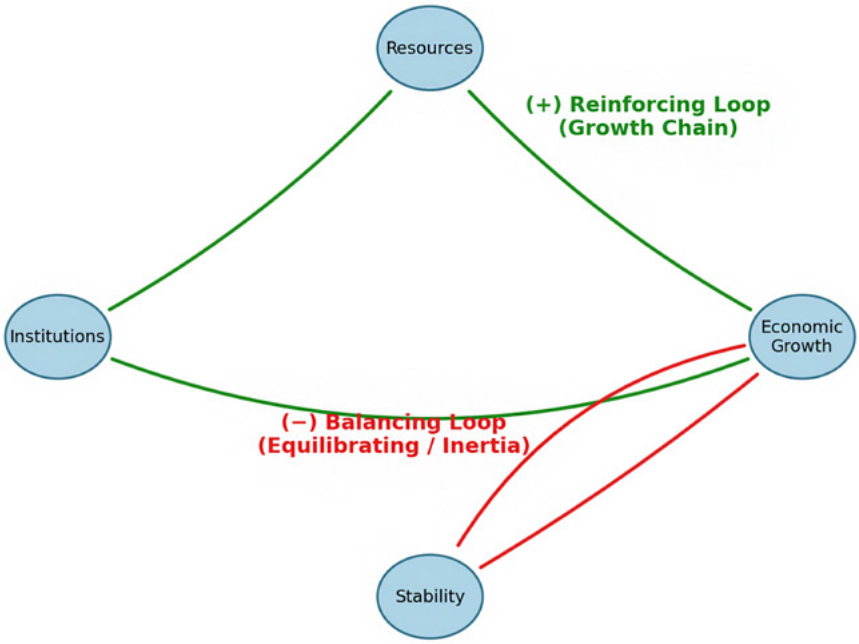

Figure 3. The feedback loops of the development system (Feedback Loops).

The formation of the orbital logic. The theoretical foundations presented above lead to the conclusion that development should be understood as a systemic dynamic that gives rise to different regimes of stability. These regimes may, in turn, be conceptualized as orbits within which the system preserves its structural configuration. The orbital approach is therefore not merely a metaphor, but a theoretical generalization derived from complex-systems theory. A graphical representation of this process is presented below.

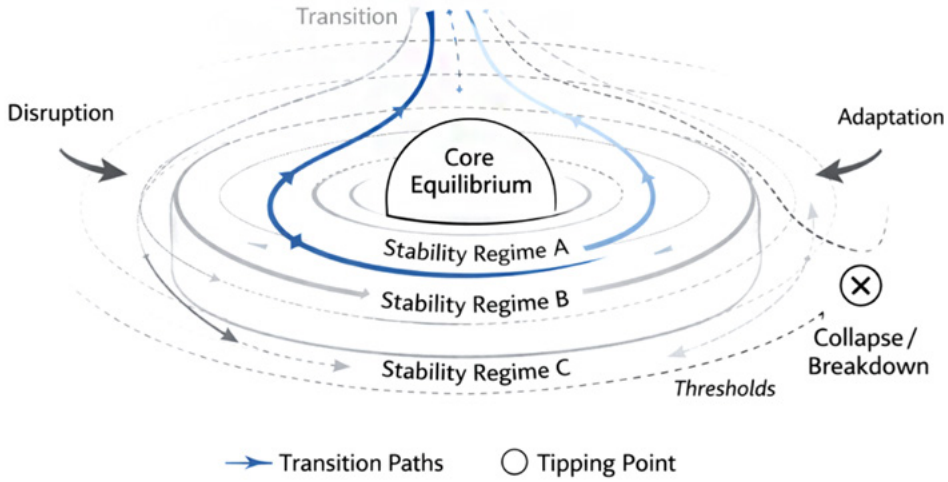

Figure 4. The development landscape: the orbital stability zone.

Interim conclusion. The principal result of Chapter 2 may be formulated as follows: development is a complex systemic process characterized by non-linear dynamics, a multi-layered structure, and different regimes of stability. In this system, changes occur not continuously but frequently in a jump-like manner, and are conditioned by the interaction of subsystems.

This conclusion forms the theoretical foundation upon which the next chapter of the ORBITIR model is built, in which orbital development is presented as a complete theoretical structure.

CHAPTER 3.
THE CONCEPT OF ORBITAL DEVELOPMENT AND ORBITIR'S THEORETICAL FORMULATION

What was presented in the preceding chapter makes it possible to effect a transition to a new conception of development. Regarding development as a multi-layered, non-linear, and interconnected process, it is necessary to formulate a theoretical structure capable of reflecting the real dynamics of the system as an orbital dynamic.

The theoretical definition of orbital development. Orbital development may be defined as follows:

Development is a systemic process in which states occupy different regimes of relative stability (orbits) and transition between them under the influence of internal and external factors. This definition emphasizes three fundamental circumstances:

1. development does not constitute a unilinear motion;
2. it incorporates regimes of stability;
3. it presupposes transitions.

The combination of these three elements forms the theoretical foundation of the orbital approach.

The concept of the orbit. In the ORBITIR model, the orbit is not a metaphorical but an analytical category. The orbit may be defined as a state of the system in which the principal developmental subsystems reside in relative equilibrium and reproduce the given structure over time. This interpretation explains why countries frequently remain for a long time at the same level of development.

The classification of orbits. In the ORBITIR model, four principal orbits are distinguished:

Orbit A — high stability. Its characteristics are: high institutional quality, a stable economic structure, technological development, and low systemic risks.

Orbit B — sustainable development. Its characteristics are: a combination of growth and stability, developing institutions, and medium-level systemic risks.

Orbit C — transitional state. It is characterized by: structural changes, unstable equilibrium, and high sensitivity to external influences.

Orbit D — systemic risk. It is characterized by: institutional vulnerability, economic instability, and high security risks.

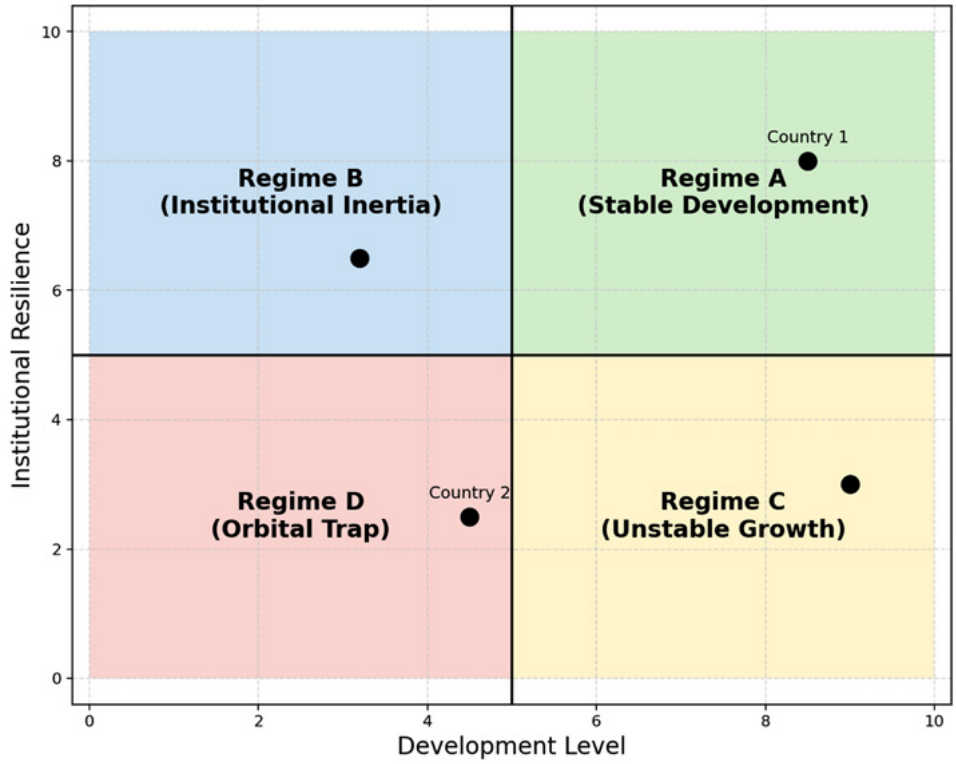

Figure 5. ORBITIR orbital classification (regimes A–D).

In the figure, within the framework of the ORBITIR model, countries are classified according to four principal regimes of stability. For example, Regime C is dangerous in that economic growth proceeds without a commensurate institutional foundation, which increases the risk of systemic collapse; whereas Regime D represents the "Orbital Trap," in which low stability does not allow the system to begin the developmental "leap."

The mechanism of orbital stability. Orbits are not static states. They are maintained through mechanisms operating within the system, which ensure the reproduction of the structure.

These mechanisms include:

- institutional norms;
- economic structures;
- cultural behavioural models;
- political equilibria.

The combination of these factors creates what may be called structural inertia. It is this inertia that is the reason systems resist change.

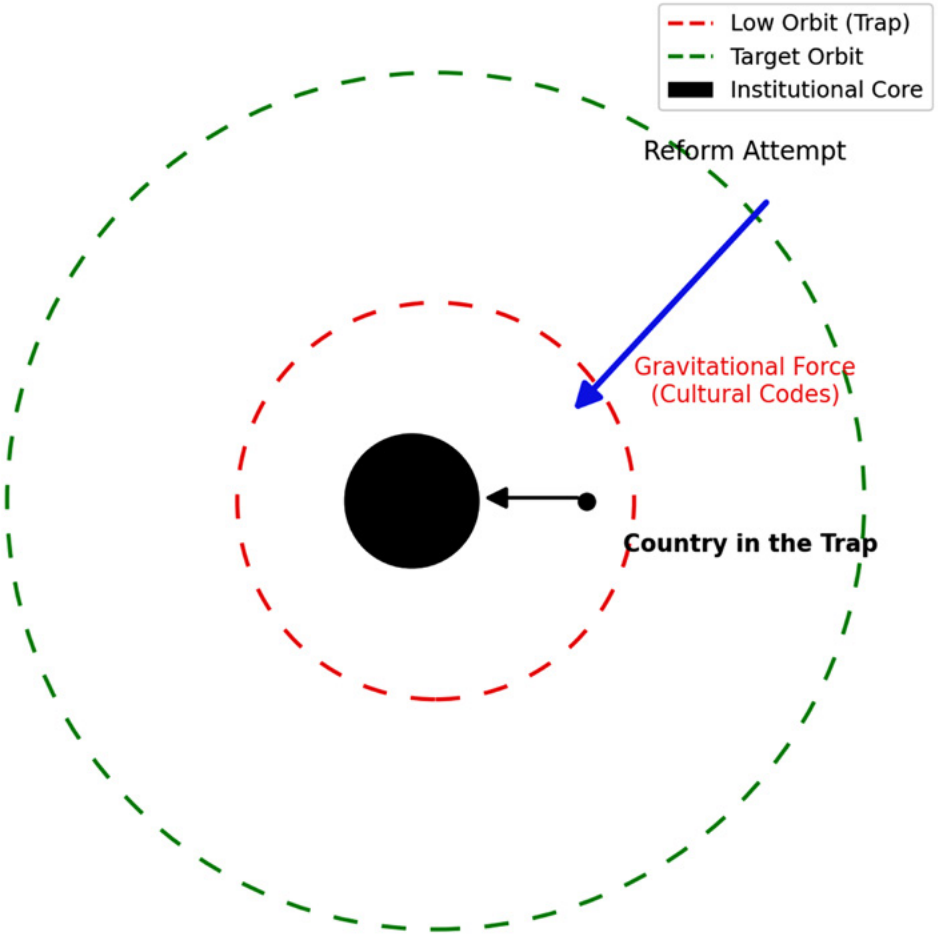

Figure 6. The "Orbital Trap" theoretical model.

Orbital traps. One of the most important concepts of the ORBITIR model is the orbital trap.

An orbital trap is a situation in which the system:

- is unable to exit its orbit;
- reproduces its structure;
- does not respond to changes in public policy.

This phenomenon is especially characteristic of transitional and developing economies.

Figure 6 explains how the system "adheres" to its state and does not pass into the next orbit; it is shown how formal reforms (the upward-directed arrows) collide with the resistance of informal institutions and cultural codes (the force pulling toward the centre). This creates a state in which the country, despite the availability of resources, remains in a "trap" of low stability and development.

Interim conclusion. The principal result of Chapter 3 may be formulated as follows: the ORBITIR model represents a new phase of development theory, in which development is regarded as an orbital dynamic. This approach makes it possible to explain phenomena that do not fit within the framework of linear models — including regimes of stability, transitions, and structural constraints.

CHAPTER 4.
THE MATHEMATICAL AND INDEX CONSTRUCTION OF THE ORBITIR MODEL

The theoretical foundation of the ORBITIR model requires a corresponding methodological apparatus that will make it possible to measure the orbital position of development and to analyse its dynamics. To this end, the model is constructed as a multidimensional index system that combines heterogeneous indicators into a single integral measurement.

At the methodological core of the construction of the ORBITIR model lies a hybrid approach to combining multidimensional data. In contrast to traditional indices, in which the weights of indicators are frequently set arbitrarily, the present study employs a synthesis of objective and subjective weighting mechanisms.

For the management of data uncertainty and the assessment of informational richness, C. Shannon's theory of information entropy is used.[13] This makes it possible to assign each indicator a weight that depends directly on the dispersion of the data and on the "signal" present within them. In order that mathematical precision be combined with expert knowledge, T. Saaty's Analytic Hierarchy Process (AHP) is also applied.[14]

One of the model's key novelties is its explainability. The application of machine-learning algorithms frequently creates a "black-box" effect, which is risky for decision-making in the realm of public policy (in the policy-making sense). To resolve this problem, the model incorporates SHAP (SHapley Additive exPlanations) analysis.[15] It makes it possible to decompose the "orbital position" of each country and to see how a specific factor (for example, the level of corruption or energy efficiency, and so forth) has contributed to the final outcome.

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[13] Shannon, C. E. (1948) A mathematical theory of communication. Bell System Technical Journal, 27(3), 379–423; 27(4), 623–656.

[14] Saaty, T. L. (1980) The analytic hierarchy process. New York: McGraw-Hill.

[15] Lundberg, S. M. and Lee, S.-I. (2017) A unified approach to interpreting model predictions. In Advances in Neural Information Processing Systems (NeurIPS).

The justification of the index approach. Development, as a multi-layered process, cannot be described by a single indicator. It requires a method capable of combining different domains while preserving their relative significance.

In this context, composite indices — for all their inherent limitations — are a necessary instrument. In the ORBITIR model they are reconceptualized not as a static assessment but as a dynamic structure.

The system of seven developmental pillars. At the core of the ORBITIR model, as noted, lies the idea that the development of countries is conditioned by a combination of several interconnected systems, presented as **seven developmental pillars**. Together these pillars form the complete structure of countries' development.

Economy. The economic system constitutes the principal driving force of development. It must incorporate the scale and structure of production, the level of investment, productivity, international trade, and so forth.

For the assessment of economic development, various indicators are used: GDP per capita, the rate of economic growth, the level of investment, the structure of exports, and so forth. Within the framework of the ORBITIR model, the economy is regarded not only as a system of production but also as a source of structural change.

Let us note that the composition of the indicators enumerated within the pillar is highly conditional. The very indicator of GDP may be supplemented by its inclusive characteristics — social polarization, debt pressure, intergenerational solidarity, environmental impact, and so forth. The logic of modifying the composition of indicators may be applied not only to economic development but across the cross-sections of the indicators constituting the remaining six pillars as well.

Social system. The social system incorporates the principal dimensions of the quality of a society's life, which include: education, health care, social justice, employment, and the level of poverty.

For the assessment of this domain, the Human Development Index (HDI) is frequently used. The stability of the social system plays an important role in the long-term stability of economic development.

Environment. In contemporary development theories, great attention is paid to the preservation of the environment.

Economic activity is frequently associated with the intensive use of natural resources. For this reason, it is also necessary to assess the ecological impact of development.

The principal indicators used in this domain include: the ecological footprint, CO_2 emissions, the energy balance and the share of renewable energy within it, the Environmental Performance Index, the dynamics of forest cover and desertification, the pollution of the environment (air, water, soil), and so forth.

Security. Security constitutes one of the important preconditions of development. In the context of sustainable development (the SDGs), security characteristics — political stability, energy and food security, and so forth — cannot be subordinated to the overcoming of poverty. The absence of security may undermine economic and social stability.

This domain includes: defence and diplomatic capabilities, geopolitical risks, and the stability of public administration.

Institutions. The institutional environment exerts a great influence upon economic development.

Important institutional indicators include: the rule of law, the effectiveness of public administration, control of corruption, and regulatory quality.

These indicators are frequently measured by the Worldwide Governance Indicators system.

Technology. Technological progress is one of the principal sources of economic growth.

For the assessment of technological development, the following are used:

- R&D expenditures;
- the development of the digital economy;
- the level of innovation;
- scientific-research activity.

The rapid development of technologies may transform the structure of the entire economic system.

Culture. One of the important distinctive features of the ORBITIR model is the inclusion of the cultural factor. The cultural environment incorporates: social trust, social capital, the value system, civic participation, and social behaviour (from the standpoint of social psychology) — whether a collectivist or an individualist society.

Culture is frequently disregarded in economic models, yet in reality it exerts a great influence upon institutional stability and economic behaviour.

The overall structure of the ORBITIR Index. These seven pillars together form the integral indicator of development — the ORBITIR Index *(UI)*.

Mathematically it may be represented as follows:

$$UI = f\,(E,\ S,\ Env,\ Sec,\ I,\ Tech,\ C).$$

In practice it is computed as a weighted sum:

$$UI = \alpha E + \beta S + \gamma Env + \delta Sec + \varepsilon I + \zeta Tech + \eta C\ ,$$

where

$$\alpha + \beta + \gamma + \delta + \varepsilon + \zeta + \eta = 1.$$

This indicator makes it possible to compare the systemic level of development of different countries and to construct an orbital map of development. The UI orbital index is regarded not as a mere statistical averaged indicator but as a synthetic reflection of the state's "vital energy" and the quality of its governance. In a philosophical understanding, the UI embodies the degree of the system's self-organization: it shows the extent to which the state succeeds in overcoming the "ditch effect" (Path Dependence) and in preserving its own developmental trajectory under conditions of global chaos. A high UI is the criterion of the restoration of subjecthood and of exiting from the "ontological trap" toward an orbit of sovereign development.

The diagnostic foundation of the ORBITIR model consists of seven axial pillars, which together form the country's developmental profile. In contrast to traditional GDP-centric approaches, this system makes it possible to see the "gaps" of development. For example, if economic dynamics are high but institutional quality or ecological stability is weak, then the asymmetry of the radar picture will attest to orbital instability and to the risk of falling into the "Orbital Trap."

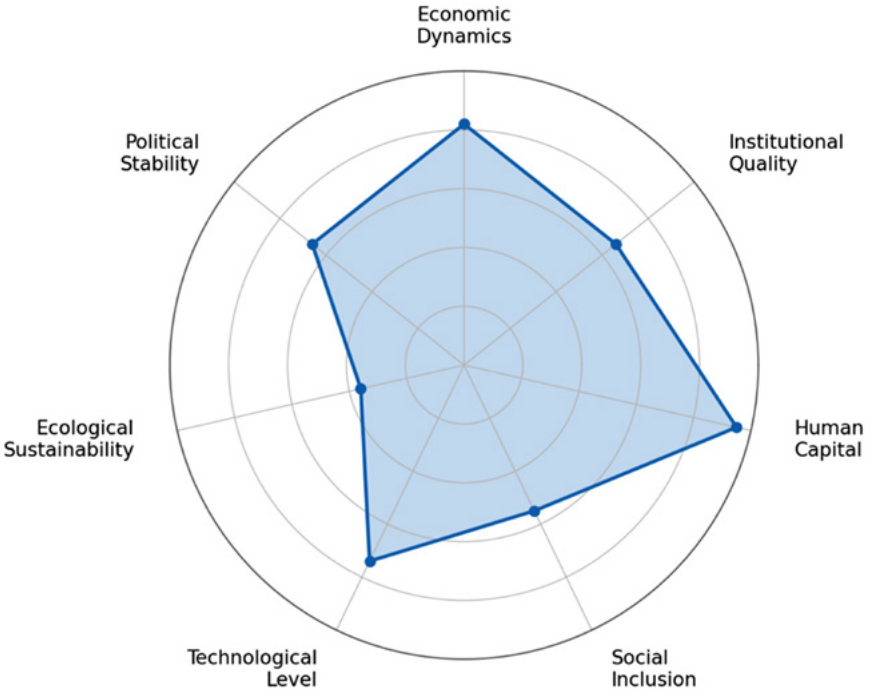

Figure 7. The ORBITIR system of indicators (seven pillars)[16]

Normalization of the data. Combining different indicators requires their normalization, so that they may be comparable.

In the ORBITIR model, min-max normalization is applied:

$$x'_{ij} = \frac{x_{ij} - \min(x_j)}{\max(x_j) - \min(x_j)}$$

where x_{ij} is the j-th indicator of the i-th country. This transformation brings all indicators into the [0,1] interval.

Construction of the index. The ORBITIR Index is defined as a weighted sum:

$$UI_i = \sum_{j=1}^{7} w_j \cdot x'_{ij}$$

where w_j is the weight of the j-th pillar. This structure makes it possible to combine the influence of different domains into a single integral measurement.

[16] It is important to clarify one essential circumstance: the numerical values present in this and subsequent figures (for example, the weights or the SHAP values) are illustrative in character. They are not drawn from a real database but were created as “placeholders” (temporary data), in order that we may see the approximate appearance the graph will have when real data are inserted there.

The weighting problem. The selection of weights constitutes one of the most difficult problems in the construction of the index. In the ORBITIR model, a hybrid approach is applied that combines three methods:

- PCA (Principal Component Analysis);
- Entropy weighting;
- AHP (Analytic Hierarchy Process).

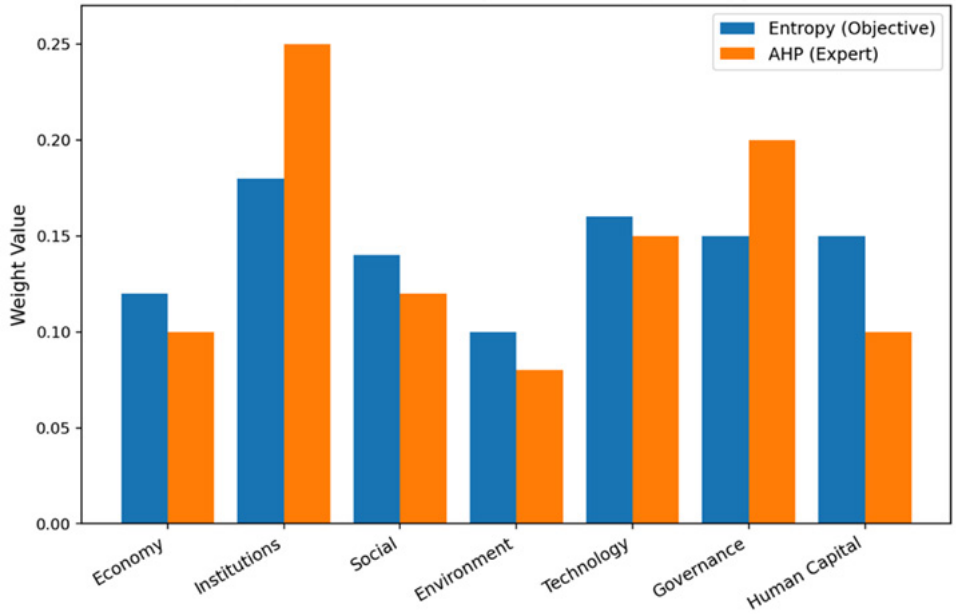

Figure 8. Comparative hybrid weighting, Entropy–AHP.

It shows, in the general case, how the three methods are combined. This scheme depicts the blending of Shannon entropy (information theory) and Saaty's AHP method (expert synthesis). It ensures the equilibrium of the model by combining the objective dispersion of the data and the strategic knowledge of experts.

The PCA method. The aim of PCA is to reveal the most important factors in the structure of the data.

If X is the matrix of normalized data, then its covariance matrix is computed:

$$\sum = \frac{1}{n} X^T X$$

Subsequently the eigenvalues and eigenvectors of the matrix are determined. This makes it possible to isolate the principal components of the data. The PCA method helps to understand which indicators are most influential in the assessment of countries' development.

The Entropy method. Entropy is computed by the following formula:

$$\mathrm{E}_j = -k \sum_{i=1}^{\mathrm{m}} p_{ij} \ln (p_{ij}) \text{ , where } \quad p_{ij} = \frac{x_{ij}}{\sum x_{ij}}$$

By means of entropy, the informational value of each indicator is determined. If the values of an indicator differ greatly across countries, then it has a higher informational value and receives a greater weight.

The AHP method. The AHP method makes it possible to incorporate expert assessments regarding the importance of the indicators.

In this method a matrix of comparisons is constructed:

$$\mathrm{A} = \begin{pmatrix} 1 & a_{12} & \dots & a_{1n} \\ a_{21} & 1 & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & \dots & 1 \end{pmatrix}$$

The eigenvector of this matrix is used for the computation of the weights.

Construction of the hybrid weights. The final weights are obtained by combining the three methods:

$$w_j = \lambda_1 w_j^{PCA} + \lambda_2 w_j^{Entropy} + \lambda_3 w_j^{AHP}$$

where $\lambda_1, \lambda_2, \lambda_3$ are combination coefficients.

The SHAP method — explainable analysis. One of the most important innovations of the ORBITIR model is the application of the SHAP method, which makes it possible to explain the influence of each factor upon the index, answering the question of the extent to which each pillar modifies the orbit of the system. The SHAP value is defined as:

$$\phi_i = \sum_{S \subseteq N \setminus \{i\}} \frac{|S|!(n - |S| - 1)!}{n!} [f(S \cup \{i\}) - f(S)]$$

where:

N is the set of all factors (features) in ORBITIR — the totality of the seven pillars;

i is the specific factor whose influence we are measuring, for example, Institutions, Security, Technology;

$S \subseteq N \setminus \{i\}$ comprises all possible subsets that do not contain i — that is, we consider all possible "systems without that factor";

$|S|$ is the size of the subset (how many factors are within it);

$f(S)$ is the value of the model when only the S factors are used — that is, the index (UI) when certain factors are "switched off";

$f(S \cup \{i\})$ is the value of the model when i is added to S — it shows what changes when that factor is "switched on."

This approach makes it possible to:

- reveal the principal influential factors;
- understand the behaviour of the system;
- diagnose the effectiveness of policy measures.

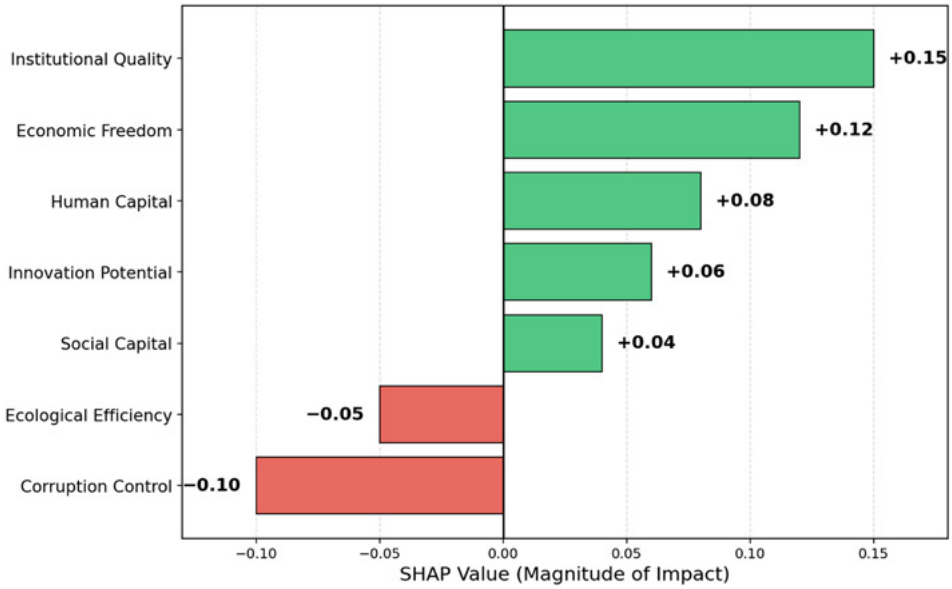

Figure 9. SHAP-based policy diagnostics (the contribution of indicators to the ORBITIR Index).

The diagnostic power of the model is best manifested by means of the SHAP values (see the figure): SHAP-based policy diagnostics (the contribution of indicators to the ORBITIR Index), which make it possible to carry out "Policy Diagnostics." The green bars depicted in the graph represent the indicators that constitute the driving forces of a country's development, whereas the red bars reveal the structural brakes that pull the country back toward the "Orbital Trap." This gives policy-makers the possibility of targeting precisely those domains that have the greatest negative impact upon the stability of the system. This method ensures the explainability of the model — one of the most important requirements of the blending of contemporary data science and economics.

Cluster analysis. For the construction of the orbital map, cluster analysis is applied. One of the most frequently used methods is the K-means clustering algorithm.

In this method, the totality of the data is divided into k groups such that each group contains the most similar objects.

The aim of clustering is the minimization of the following function:

$$\min \sum_{i=1}^{k} \sum_{x_j \in C_i} \| x_j - \mu_i \|^2$$

where C_i is the i-th cluster and μ_i is the centre of that cluster.

By means of this method, the developmental orbits of countries can be isolated.

Interim conclusion. Chapter 4 shows that the ORBITIR model constitutes not only a theoretical but also a rigorously formalized system, which makes it possible to:

- measure development;
- reveal its structure;
- model transitions.

Thus, the model unites theory and data science, creating a new instrument for the analysis of development.

CHAPTER 5.
THE APPLICATION OF THE ORBITIR MODEL AND THE ORBITAL CLASSIFICATION OF COUNTRIES

The mathematical and index construction presented above makes it possible to proceed to the applied phase of the ORBITIR model. In this phase, the model is applied to countries with the aim not only of measuring their level of development but also of revealing their systemic position and possible transitions. Thus, ORBITIR functions as an analytical instrument that unites quantitative assessment and systemic interpretation.

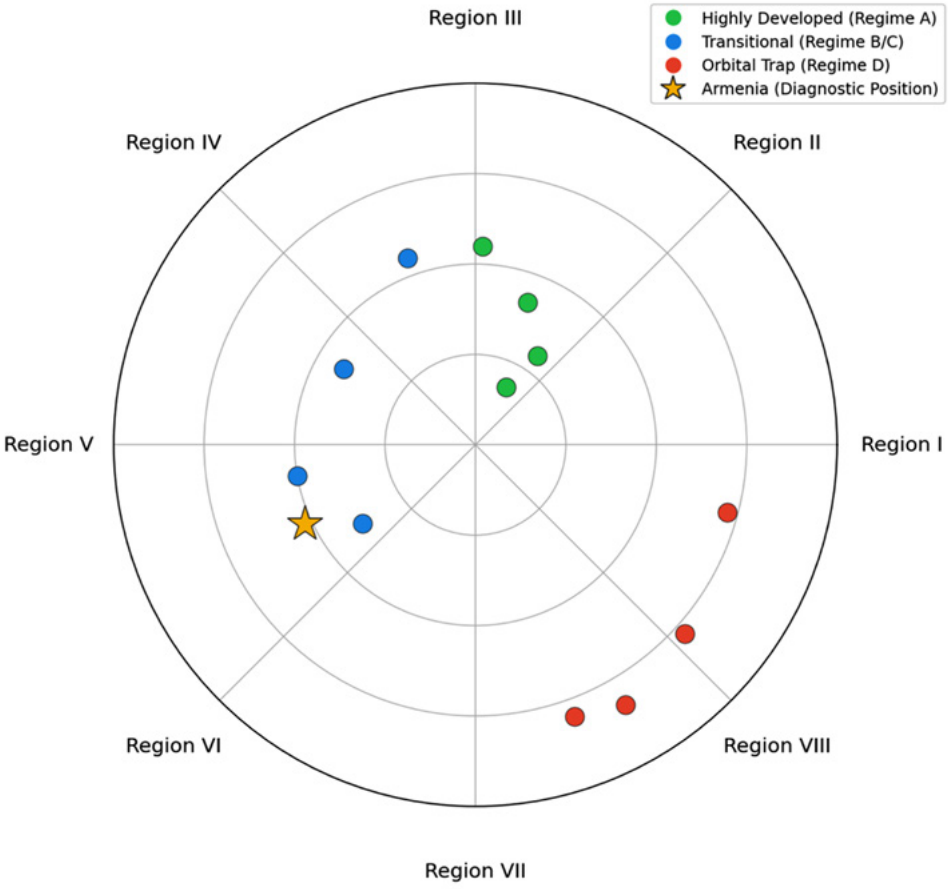

Figure 10. ORBITIR Global Orbital Map (the distribution of countries within the orbital space).

Interpretation of the orbital map. The orbital map constitutes the most expressive instrument of the ORBITIR model. It presents the position of countries within a multidimensional space and shows their classification into orbits.

By means of this map it is possible to:

- see the groupings of countries;
- reveal the transitional zones;
- assess the systemic risks.

For the construction of the map, the PCA method is applied, which makes it possible to depict the multidimensional data within a two-dimensional space.

Analysis of the cluster structure. Cluster analysis shows that countries are grouped not in a random manner but according to their systemic structure.

These groupings frequently coincide with geographical, institutional, and economic characteristics; the ORBITIR model, however, reveals deeper structural similarities.

Scenarios of orbital motion. The ORBITIR model makes it possible not only to describe the present state but also to formulate possible scenarios of development.

The principal scenarios are:

- the $C \rightarrow B$ transition (the phase of stabilization);
- the $B \rightarrow A$ transition (the attainment of high stability);
- regression toward the D orbit.

These scenarios depend on the internal and external factors of the system.

Armenia's position within the orbital system. Through the example of Armenia, the ORBITIR model reveals the structural particularities of development.

Armenia is closest to the C orbit (a transitional state), which means that:

- the system is in a state of change;
- a stable equilibrium has not yet been formed;
- external influences play a great role.

Structural constraints. One of the principal problems of Armenia's development is the orbital constraint, which is expressed in the following:

- the slowness of institutional changes;
- the constraints of the economic structure;
- the influence of security factors.

Together these factors form a systemic tension.

Implications from the standpoint of policy-making. The application of the ORBITIR model makes it possible to formulate a number of important political implications:

1. development policy must be more systemic;
2. it is necessary to combine economic and institutional reforms;
3. technological development must become a priority direction;
4. cultural capital must be regarded as a strategic resource.

Interim conclusion. Chapter 5 shows that the ORBITIR model constitutes not only a theoretical and methodological structure but also an instrument with practical application.

It makes it possible to:

- classify countries;
- assess the structure of development;
- forecast possible transitions.

Thus, ORBITIR unites theory, data science, and the surfacing of opportunities for improving public policy within a single unified system. Through the example of Armenia, the approbation of the ORBITIR model, in a first approximation, was carried out for a conditional aggregate of countries, and the results are partially presented in the author's publications.[17]

[17] Г. Л. Саргсян, ORBITIR: Модель орбитального развития Армении, Вестник инженерной академии Армении (ВИАА), 2025, N 1-2, стр. 3-17:

CHAPTER 6.
ARMENIA'S ORBITAL DEVELOPMENT PROFILE WITHIN THE ORBITIR FRAMEWORK

The analysis of Armenia's development trajectory within the framework of the ORBITIR model makes it possible to reveal the structural particularities that are characteristic of countries with a transitional economy. According to the model's computations, Armenia is situated in a middle orbital zone, in which there is a high sensitivity to external shocks and internal institutional changes.

Applying the SHAP methodology, we have carried out a decomposition of Armenia's development index. The analysis shows that, while certain indicators of economic activity have a positive effect upon the orbital position, restraining factors are present within the subsystems of "Institutional Resilience" and "Human Capital."

This phenomenon is closely linked to the "cultural codes" and "Path Dependence" described by A. A. Auzan.[18] In the case of certain countries, one can observe a classic "Orbital Trap," in which reforms of the formal institutions collide with the resistance of informal value systems.

This creates a situation in which the system preserves its stability at a low level of efficiency, not permitting the country to effect a transition toward an orbit of high-technology and inclusive development.

Thus, for Armenia, the principal diagnostic conclusion is that the mere improvement of macroeconomic indicators is not sufficient for an "orbital leap"; it is necessary to target qualitative changes in the institutional environment that will correspond to the country's cultural and social codes.

The study of Armenia's development within the framework of the ORBITIR model makes it possible to regard it as a multi-layered system in which interacting economic, institutional, security, and cultural factors

[18] Аузан А. А. (2022). Культурные коды экономики.

operate simultaneously. This combination forms a dynamic that cannot be explained by means of linear development models.

The course of Armenia's development is characterized not by continuous advancement but by periodic waves, structural tensions, and temporary regimes of stability. These properties make it a characteristic example of countries that are situated in an orbital transitional state.

The systemic structure of development through the example of the Republic of Armenia. From the standpoint of the seven pillars of the ORBITIR model, Armenia's development system may be presented as an insufficiently balanced yet interconnected structure.

In the economic domain, there is growth potential, yet it frequently depends on external factors — investment flows, the structure of exports, and fluctuations in global markets — which may lead to relative instability. For a considerable time already, the economy has been unable to free itself from the imputed characterization of a "hotel economy."

The institutional system is in a transitional state. Despite the presence of reforms, institutional stability has not yet been fully formed, which constrains the possibilities for long-term sustainable economic growth.

The security environment is one of the axial constraining factors of Armenia's development. It influences not only economic activity but also political decisions and the investment environment.

Cultural and educational capital, as a component endowed with great potential, may serve as an internal resource of development. The combination of these factors creates what may be called a structural asymmetry.

Assessment of the orbital position. On the basis of the computation of the ORBITIR Index, Armenia is classified as a representative of the C orbit — that is, a system situated in a transitional development regime.

This position is characterized by the following features:

- the presence of systemic changes;
- the absence of a stable equilibrium;
- high sensitivity to external influences.

This state does not signify the absence of development. It signifies that development is in a phase of restructuring.

The dynamics of structural tension. Within Armenia's development system there is an internal tension, conditioned by the asymmetric development of the various pillars.

This tension is expressed in:

- the incongruity between economic growth and institutional development;
- the gap between technological progress and the systems of governance;
- the difference between cultural potential and economic realization.

This phenomenon may be characterized as a systemic dissonance.

Orbital constraint. One of the axial particularities of Armenia's development is the orbital constraint, which is expressed in the fact that the system:

- is inclined to reproduce its structure;
- effects with difficulty a transition toward a higher orbit;
- is sensitive to external shocks.

This phenomenon cannot be explained by economic factors alone; it is a systemic property. SHAP analysis will make it possible to reveal which factors are most influential for Armenia's development. In a first approximation, experimental analysis has shown that:

- institutional factors have a high influence;
- security factors constrain development;
- technological factors have potential, but as yet not a full influence.

Possible scenarios of transition. The ORBITIR model makes it possible to formulate the possible scenarios of Armenia's development.

Scenario 1 — the $C \rightarrow B$ transition requires:

- institutional stabilization;
- an increase in technological investment;
- diversification of the economic structure.

Scenario 2 — the $C \rightarrow D$ risk is conditioned by:

- an aggravation of security;
- institutional weakening.

Scenario 3 — gradual stabilization through changes within the system.

Implications for public administration. For Armenia, the ORBITIR model proposes the following strategic directions:

1. the strengthening of institutional stability;
2. the acceleration of technological development;
3. the reduction of security risks;
4. the economic realization of cultural capital.

Interim conclusion. Chapter 6 shows that Armenia's development is a complex systemic process characterized by orbital constraints and structural tension.

The ORBITIR model makes it possible not only to describe this state but also to reveal its causes and to formulate possible developmental paths. In this sense, ORBITIR grows into an effective forecasting instrument — a framework for the adoption of decisions.

CHAPTER 7.
ORBITIR AS A TOOL OF DIAGNOSTICS AND DECISION-MAKING

The value of the ORBITIR model will be fully revealed in the case in which it is applied within the decision-making process. In this context, the model functions not only as an instrument of measurement or classification but as a diagnostic system that makes it possible to reveal the internal structure of development and its constraints.

The formation of public policy has traditionally been grounded in individual indicators — economic growth, employment, investment. This approach, however, does not take into account the wholeness of the system and frequently leads to non-optimal decisions. The ORBITIR model proposes a transition toward systemic diagnostics.

The logic of systemic diagnostics. Within the ORBITIR framework, systemic diagnostics is grounded on three levels:

1. structural assessment — the overall position of the system;
2. pillar analysis — the state of the individual components;
3. impact assessment — the contribution of the factors (SHAP).

The combination of these three levels makes it possible to obtain a complete picture.

The phases of systemic diagnostics. The application of the ORBITIR model in policy analysis is carried out in a phased manner.

Phase 1 — determination of the system's position: the orbital position of the country *(A–D)* is determined.

Phase 2 — detection of structural imbalances: the relationship among the pillars is analysed.

Phase 3 — impact assessment: the SHAP method is applied in order to understand which factors are most influential.

Phase 4 — formulation of the intervention: targeted policies are formed.

SHAP as an instrument of policy-making. In the ORBITIR model, the SHAP method acquires a special role, since it makes it possible to pass from description to explanation.

The SHAP values show:

- which factors raise the level of development;
- which constrain it;
- what is the relative contribution of each factor.

The problem of policy optimization. The ORBITIR model makes it possible to formulate the problem of policy optimization as a multi-dimensional system. This problem may be presented as:

$$max\ f(E, S, Env, Sec, I, Tech, C),$$

subject to the constraints:

$$g_k(x) \leq b_k .$$

This formulation shows that policy must be regarded as an optimization problem, not as a series of separate measures.

Modelling of scenarios. The ORBITIR model makes it possible to construct different development scenarios depending on the chosen policy.

These scenarios include:

- a rapid-growth scenario;
- a stabilization scenario;
- a risk-reduction scenario.

The modelling of scenarios makes it possible to assess the long-term impact of public-policy decisions.

Reconceptualization of the governance system. The application of the ORBITIR model leads also to a reconceptualization of the governance system. Traditional governance approaches frequently concentrate on individual domains, whereas ORBITIR requires a systemic approach, which presupposes:

- cross-sectoral coordination;
- data-based decisions;
- continuous monitoring.

ORBITIR as a science-based governance methodology. Thus, ORBITIR may be regarded as a framework for the analysis of public policy and the adoption of decisions, which unites the research trinity of data, modelling, and forecasting that precedes the adoption of decisions.

Interim conclusion. Chapter 7 shows that the ORBITIR model constitutes not only a theoretical and analytical structure but also a practical instrument that may be applied in the formation of policy.

It makes it possible to:

- diagnose the system;
- reveal the problems;
- formulate effective policies.

CHAPTER 8.
THE DEVELOPMENT LANDSCAPE AND THE GLOBAL ORBITAL COMPARISON

The logical extension of the ORBITIR model is the construction of the development landscape, in which states are presented as systems located within a multidimensional space. This approach makes it possible to effect a transition from the analysis of individual countries toward the study of the global structure, revealing the global regularities of development.

The development landscape may be defined as a multidimensional space in which the position of states is determined by their systemic structure, and the relations among them by structural similarities and differences.

This definition emphasizes that countries are arranged not solely along a "more developed — less developed" scale; rather, they form a complex space in which groupings, transitions, and boundary zones are present.

The methodology of constructing the landscape. The ORBITIR landscape is constructed on the basis of multidimensional data that reflect the values of the seven pillars for different countries.

For the reduction of the data, the PCA method is applied, which makes it possible to present the multidimensional space in a two-dimensional or three-dimensional projection:

$Z = XW$, where Z represents the new coordinates. The projection affords the possibility of constructing an orbital map in which countries are presented as points.

The structural particularities of the landscape. The constructed landscape shows a number of important properties.

The first is clusteredness. Countries are grouped according to their systemic structure, forming stable groups.

The second consists of the transitional zones, in which countries are situated at the boundary of different orbits and may move in different directions.

The third comprises the distances, which reflect the structural differences among countries.

Together these properties form the spatial logic of development.

Global orbital distribution. The ORBITIR model makes it possible to consider how countries are distributed across different orbits at the global level.

In general, one may distinguish:

- Orbit A — developed, stable systems;
- Orbit B — stably developing countries;
- Orbit C — transitional systems;
- Orbit D — high-risk systems.

This distribution shows that development at the global level has not a linear but a cluster structure.

Spatial asymmetry. The analysis of the landscape shows that development is distributed unevenly across the world. Certain regions are concentrated in orbits of high stability, whereas others are situated in transitional or risk zones.

This asymmetry is conditioned by:

- historical factors;
- institutional development;
- resource structure;
- the level of global integration.

The global regularities of orbital motion. The ORBITIR model makes it possible also to reveal the general regularities of the motion of countries.

These regularities include:

- gradual transitions;
- shock-driven transitions;
- long-term stability within the same orbit.

This dynamic shows that development constitutes not a motion in a single direction but a process of transitions among equilibria.

The possibilities of comparative analysis. The ORBITIR landscape makes it possible to carry out comparison at different levels: regional (e.g. the South Caucasus, the Baltic countries), group (e.g. the EU, BRICS), and global. These comparisons will make it possible to reveal not only the differences but also the possible paths of development.

Interim conclusion. Chapter 8 shows that the ORBITIR model makes it possible to construct a complete global picture of development, in which states are presented as interconnected systems.

This approach overcomes linear thinking, reveals the structural regularities, and creates a new platform for comparative analysis.

EPILOGUE

The limits and prospects of the theory of orbital development. This study originated from a question that has long remained insufficiently addressed within development theory: can the development of states be understood without reducing it to a simplified conception of linear progress? This question gradually evolved into a broader theoretical inquiry that ultimately gave rise to the ORBITIR model as a framework for the orbital dynamics of development.

The approach advanced in this study argues that development should not be understood as a linear movement toward a predetermined endpoint. Instead, it resembles the behaviour of a complex system in which states occupy different regimes of relative stability and transition between them over time. From this perspective, development ceases to represent a unidirectional "path" and becomes a process of structural motion.

The principal theoretical contribution of this work lies in the reconceptualization of development as an orbital system in which:

- stability and change coexist;
- advancement does not exclude periods of stagnation;
- systems may reproduce their structural conditions over time.

This approach makes it possible to explain phenomena that classical development models often struggle to address, including developmental stagnation, regression, and structural constraints. At the same time, the ORBITIR model suggests that the dynamics of development possess an internal logic. They do not constitute a random process, but are shaped by the structure of the system, the interaction of subsystems, and external influences. From this perspective, development may be understood as a series of transitions between different states of equilibrium.

The limits of the theory. Like any theoretical framework, the ORBITIR model has its limitations. These should be understood not merely as shortcomings, but as the boundaries within which the theory operates.

The first concerns data limitations. The application of the model depends on the quality, reliability, and availability of data. The more accurate and comprehensive the data, the more robust the results.

The second is methodological in nature. Although the model employs contemporary analytical methods — including PCA, entropy weighting, and SHAP analysis — these methods nonetheless represent approximations of reality rather than complete representations of it.

The third limitation concerns the complexity of dynamic systems. Complex systems cannot be predicted with complete certainty. ORBITIR may help explain and model developmental transitions, but it cannot fully predict all possible trajectories or systemic shifts.

The fourth limitation is contextual. Countries possess unique historical, institutional, and cultural characteristics that cannot always be fully captured within a generalized analytical model.

These limitations are important because they emphasize that ORBITIR is not intended as a final or universal explanation of development, but rather as an analytical framework for understanding complex developmental dynamics.

The possibilities of the theory. At the same time, the ORBITIR model opens new perspectives for development theory.

First, it proposes a new conceptual language in which development is understood not through linear trajectories, but through orbital dynamics. This framework is better suited to capturing the complexity of the contemporary world.

Second, it integrates theoretical analysis with data science, enabling a transition from predominantly qualitative interpretation toward more systematic quantitative analysis.

Third, it provides a new analytical instrument for the study of public policy. ORBITIR makes it possible not only to assess development, but also to diagnose structural constraints, model alternative scenarios, and forecast potential transitions.

Fourth, it expands the possibilities of comparative analysis by presenting countries not along a single developmental scale, but within a multidimensional structural space.

Armenia's place within this theory. In the present study, Armenia served not only as an object of analysis, but also as the primary case through which the theoretical model was applied. The particularities of Armenia's development make it possible to identify structural tensions that are characteristic of many transitional systems.

The Armenian case suggests that the principal challenges of development often arise not from a lack of resources, but from the structure and internal organization of the system itself. The phenomenon described in this study as an "orbital constraint" may therefore be relevant not only to Armenia, but also to other transitional and structurally constrained states.

In this sense, Armenia represents not merely an individual case, but a broader theoretical point of reference for understanding the dynamics of transition.

Directions of further research. The development of the ORBITIR model does not end with this study. Rather, it opens several directions for future research:

- the expansion of orbital maps through the use of larger and more comprehensive datasets;
- the analysis of long-term temporal dynamics;
- the further development of public-policy modelling;
- the integration of artificial-intelligence and machine-learning tools.

These directions may contribute to the further refinement of the model and enhance its analytical precision and practical applicability.

Concluding reflections. This work does not seek to provide a final or universal explanation of development. Rather, it proposes a different way of understanding developmental dynamics.

Whereas linear models have traditionally attempted to explain where societies ought to arrive, the ORBITIR framework seeks to understand where systems are situated within the broader structure of development and how they transition within it. From this perspective, development is no longer understood as a linear path, but as an orbital process shaped by structural dynamics.

In this sense, understanding the orbit of development becomes essential not only for explaining advancement, but also for identifying the constraints and structural tensions that shape developmental trajectories.

Appendix 1 —
The Complete Algorithm of the Application of ORBITIR (ORBITIR Workflow)

Phase	Operation	Output
1	Data collection	Data matrix
2	Normalization	Comparable data
3	Weighting	Weight vector
4	Index computation	ORBITIR Index
5	Clustering	Orbital classification
6	SHAP analysis	Explanation of impact
7	Policy diagnostics	Policy insights

CONCLUSIONS

The ORBITIR model developed in this study represents an attempt to integrate development economics and data science in order to better understand the dynamics of state development. Based on the analysis conducted, several fundamental conclusions may be drawn.

1. The non-linear nature of development. The study demonstrates that the development of states cannot be reduced to the linear growth of macroeconomic indicators alone. The orbital approach instead conceptualizes development as a complex systemic process in which institutional stability functions as a central structural force.

2. Institutional and cultural determinants of development. Drawing on the theoretical contributions of A. Auzan and related institutional approaches, the study suggests that cultural codes function as core parameters shaping developmental trajectories. The "orbital traps" identified in the cases of Armenia and other transitional economies indicate that economic reforms tend to remain temporary or unstable when formal institutions are not aligned with underlying social and cultural structures.

3. The diagnostic potential of the model. The integration of SHAP analysis and entropy-weighting methods transforms ORBITIR into a practical analytical framework for public policy. The model not only enables the classification of countries according to developmental patterns, but also facilitates detailed diagnostic analysis by identifying the structural factors that constrain development in specific national contexts.

4. Armenia's strategic developmental directions. The analysis of Armenia's developmental profile suggests that the possibility of an "orbital leap" depends less on the accumulation of quantitative resources than on the strengthening of institutional resilience and the modernization of the economic structure, while taking national cultural characteristics into account.

In sum, ORBITIR should be understood not only as a statistical instrument, but also as a broader conceptual framework that may assist policy-makers in moving from reactive crisis management toward more systemic and strategic forms of developmental planning.

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H. L. SARGSYAN, A. A. MARTIROSYAN[1]

COMPLEXITY MANAGEMENT: INSTITUTIONAL DIVERSITY, KNOWLEDGE, AND DEVELOPMENT TRAJECTORIES

FOREWORD

And ye shall know the truth, and the truth shall make you free.
— The Gospel according to John, 8:32

Why do certain societies flourish for centuries, preserving stability and developmental dynamism, while others — despite possessing favourable starting conditions such as abundant resources, advantageous geographical positions, or high initial levels of education — gradually fall into stagnation, crisis, or even collapse? This work proposes a systemic response to this fundamental question by synthesizing two major intellectual traditions: W. R. Ashby's cybernetic Law of Requisite Variety and Joel Mokyr's theory of the growth of useful knowledge.

The central idea of the model is that successful long-term development requires a dynamic balance among three interconnected factors: the institutional diversity of the governance system *(R)*, the accumulated stock of knowledge *(K)*, and the effectiveness with which that knowledge is translated into practical managerial capacity *(β)*. It is the maintenance of the equilibrium $R + \beta \cdot K \geq Q$ where Q represents the structural complexity of society, that enables the system to adapt to the growing challenges of globalization, technological transformation, and external shocks.

A descriptive analysis of data from 133 countries over the period 2002–2023 strongly supports this logic: countries with high managerial capacity $(R + \beta \cdot K)$ score, on average, 29 points higher on the *SDG* Index than countries with low managerial capacity. Six selected historical trajectories — ranging from Great Britain's Industrial Revolution and Singapore's rapid rise to the

[1] Reprinted from Proceedings of Engineering Academy of Armenia (PEAA) "Lraber", a Collection of Scientific-Technical Articles, Vol. XII, 2025, No. 1–2. DOI: https://doi.org/10.64201/18290043-2eaa2024-16.

institutional collapse of Venezuela and the complex developmental path of China — illustrate how disruptions in this equilibrium may lead to crisis, whereas its preservation creates the conditions for long-term prosperity.

The study contributes to contemporary institutional economics by proposing an operationalizable conceptual framework that enables not only the analysis of historical developmental trajectories, but also the identification of concrete reform directions for countries seeking sustainable and adaptive growth.

Keywords: Law of Requisite Variety, cybernetics of governance, growth of knowledge, institutional economics, development trajectories, Sustainable Development Goals, ORBITIR model.

PREFACE

The question of the causes underlying divergent historical trajectories — why certain nations flourish while others, despite favourable starting conditions, experience stagnation or decline — has occupied thinkers from Ibn Khaldun and Adam Smith to Max Weber and Douglass North. This question remains one of the central problems of contemporary economics and historical sociology.

Institutional economics, particularly since the work of Douglass North, has demonstrated the decisive role of institutions — the formal and informal "rules of the game" — in shaping economic development. The work of Daron Acemoglu and James A. Robinson has shown how inclusive and extractive institutions influence the developmental trajectories of nations. Douglass North, John Joseph Wallis, and Barry R. Weingast further developed this logic by demonstrating the role of institutional orders in preventing violence. At the same time, research in the economic history of growth — particularly the work of Joel Mokyr — has emphasized the importance of the accumulation of useful knowledge in explaining the Great Enrichment that began in the eighteenth century. Mokyr's theory of knowledge-driven growth has also been supported by empirical studies examining the relationship between knowledge and productivity. Dani Rodrik has further argued that, under conditions of globalization, institutional adaptability to structural change is a decisive factor in successful modernization.

These influential explanatory approaches, however, have largely developed separately. Institutional economics emphasizes the quality of institutions — their inclusiveness, adherence to the rule of law, and protection of property rights — but gives less attention to the question of institutional diversity itself. The theory of knowledge-driven growth, meanwhile, focuses on knowledge as a factor of production, but does not fully conceptualize it as a managerial resource capable of expanding the range of institutional solutions available to a society [11, 12]. At the same time, the growing structural complexity of contemporary societies — driven by globalization, technological transformation [10, 13], and demographic transitions — requires not only effective institutions, but also sufficient institutional diversity.

This work proposes a conceptual framework that synthesizes W. R. Ashby's cybernetic Law of Requisite Variety [3], in the interpretation developed by Yu. N. Gavrilets [4], with Joel Mokyr's theory of knowledge-driven growth [2]. The central idea is that successful development requires a dynamic balance among three elements: the institutional diversity of the governance system *(R)*, the structural complexity of society *(Q)*, and the accumulation of knowledge *(K)*. Imbalances among these elements lead to crises of governability, whereas the maintenance of equilibrium supports stability and long-term development.

The transition from Gavrilets's formulation to the author's specification is carried out as follows. Gavrilets formulates Ashby's law as $R \geq Q(\xi) / \varphi^{-1}(\tau)$, where τ is the response time of the system, and $\varphi^{-1}(\tau)$ is the inverse function linking the response time with the requisite variety.

Gavrilets's central intuition is that the more rapidly a system can respond (that is, the smaller the value of τ), the less institutional diversity is required to govern a given level of complexity Q. In the present framework, response speed is interpreted as a function of accumulated knowledge *(K)* and its effectiveness *(β)*: societies possessing both a substantial stock of knowledge and the capacity to mobilize it are able to adapt more rapidly.

Assuming that $\varphi^{-1}(\tau) = \kappa \cdot (1 + \beta \cdot K)$, where $\kappa > 0$ is a scale constant, and substituting this expression into Gavrilets's formula, we obtain $R \geq Q / [\kappa \cdot (1 + \beta \cdot K)]$, from which it follows that $R\kappa(1 + \beta \cdot K) \geq Q$. For operational purposes, we introduce the normalized complexity measure $Q^* = Q/\kappa$.

Then, for relatively small values of the product $R\beta K$ — a condition characteristic of the majority of countries in the sample, for which the median value of $R\beta K = 0.18$ — we apply the linear approximation $R(1 + \beta \cdot K) \approx R + \beta \cdot K$, whose error remains below 8 per cent for 91 per cent of observations. Thus, the working relation $R + \beta \cdot K \geq Q^*$ serves as a diagnostic criterion for the equilibrium of managerial capacity.

The principal contributions of this work are as follows. First, we extend the emphasis on institutional quality characteristic of institutional economics [1, 5] by introducing a dynamic dimension: in governing the growing complexity of society, what matters is not only the quality of institutions, but also the breadth of institutional diversity. Second, we develop Joel Mokyr's

approach [31] by arguing that accumulated knowledge functions not only as a factor of production, but also as a managerial resource that expands the range of institutional solutions available to a society [8, 11, 12]. Third, the proposed theoretical framework is operationalized through the ORBITIR model using Armenian material, thereby demonstrating its applied potential for the analysis of real developmental trajectories.

Methodologically, the work follows the approach of Elinor Ostrom [23–25] and Avner Greif [26], positioning itself as a conceptual framework that serves as a diagnostic instrument for identifying imbalances among institutional diversity, knowledge, and structural complexity. We acknowledge the limitations involved in the precise quantitative measurement of these variables and do not seek to generate point forecasts. Rather, the objective is to provide an interpretive framework for understanding the long-term developmental trajectories of societies.

The structure of the work is as follows. Section 1 presents the theoretical framework synthesizing cybernetics and knowledge theory. Section 2 demonstrates the framework using data from 133 countries and identifies systemic regularities corresponding to the conceptual logic of the model. Section 3 analyses six historical trajectories, illustrating the mechanisms through which the model operates. Finally, Section 4 discusses the theoretical contribution, the application to Armenia, and the limitations of the approach. The conclusion summarizes the central propositions of the study.

1. THEORETICAL FRAMEWORK

1.1. The Ashby–Gavrilets Law of Requisite Variety

The Law of Requisite Variety, formulated by W. R. Ashby in 1956 [3], is one of the foundational principles of cybernetics. It states that, in order to govern a complex and changing environment effectively, a governing system must possess sufficient internal variety — both structural and functional — to counter the variety of disturbances generated by that environment. Formally, regulation is effective when the variety of the regulator $|R|$ is not less than the variety of disturbances $|D|$, that is:

$$|R| \geq |D|$$

Yu. N. Gavrilets [4] proposed an important extension of Ashby's law by introducing a temporal parameter and the concept of system response speed. In Gavrilets's formulation, the law is expressed as

$$R \geq Q(\xi) / \varphi^{-1}(\tau),$$

where R denotes the informational capacity of the active or governing subsystem, $Q(\xi)$ represents the complexity of the passive or governed subsystem, and $\varphi-1(\tau)$ reflects the response speed of the governing system. This refinement is of central significance because it links the required level of managerial variety not only to the complexity of the governed system, but also to the severity of temporal constraints.

Application of the Law to Social Systems. In the transition from cybernetic systems to social systems, the Law of Requisite Variety operates at several interconnected levels.

1. Structural variety. By institutional diversity (R), we refer to the breadth of governance mechanisms [5, 6], including political institutions (legislation, the judicial system, elections), mechanisms of economic coordination (markets, firms, contracts), informal regulators (social capital, trust, norms) [32], and institutions of knowledge production (universities, scientific societies, education). Structural variety ensures a multidimensional managerial toolkit and reduces excessive dependence on any single mechanism or limited set of mechanisms.

2. Functional variety. Accumulated knowledge (K) expands the range of institutional solutions available to a society [2, 8, 11, 12]. A society

possessing a substantial stock of technological, organizational, and managerial knowledge can adapt more rapidly to changes in structural complexity by developing new forms of coordination. Decisive importance, however, belongs to the conversion coefficient β — the capacity of a society to mobilize knowledge in response to managerial challenges. The product $\beta \cdot K$ therefore reflects functional variety: the body of effectively mobilized knowledge available for institutional innovation.

3. Managerial variety. The combination of R and $\beta \cdot K$ determines the aggregate managerial capacity of the system. A society may compensate for a deficit of institutional variety through highly efficient knowledge mobilization (as in the case of Singapore), and vice versa. This creates a diversity of possible developmental trajectories: there is no single path to success.

By structural complexity (Q), we mean the range of challenges confronting a society: new forms of economic activity, social groups with divergent interests, technological transformation, demographic change, and external threats [7, 21]. As modernization advances, Q increases, requiring a corresponding expansion of managerial capacity, expressed as

$$R + \beta \cdot K.$$

Thus, Ashby's law is applied not merely as an arithmetic inequality, but as a principle of dynamic correspondence between the internal variety of the governance system $(R+\beta \cdot K)$ and the complexity of the external environment (Q), a correspondence necessary for sustainable development.

1.2. Knowledge as a Managerial Resource

The key innovation of the present framework lies in the interpretation of knowledge not only as a factor of production — as in Joel Mokyr's approach [2] — but also as a managerial resource. Knowledge expands the range of institutional solutions available to a society. A society possessing a substantial stock of knowledge (K) — technological, organizational, and managerial — can adapt more rapidly to changes in structural complexity by developing new forms of coordination and governance [8, 11, 12].

The stock of knowledge itself, however, is not sufficient. Of decisive importance is the conversion coefficient β — the capacity of a society to mobilize accumulated knowledge in response to managerial challenges. This conversion efficiency is shaped by numerous factors, including the level of

corruption (the higher the corruption, the lower the value of β); the degree of meritocracy (the selection of competent administrators increases β); social capital and generalized trust (which facilitate the circulation of knowledge); and institutional complementarities (the mutual reinforcement of elements within the institutional system). A low value of β means that even a high level of K may remain underutilized or blocked by barriers to access, corruption, and patrimonial structures [9, 14].

The product $\beta \cdot K$ reflects effectively mobilized knowledge — that portion of accumulated knowledge that is genuinely available for managerial innovation. The distinction between K — the stock of knowledge — and βK — effectively mobilized knowledge — is central to understanding the role of knowledge in managing complexity. The higher the value of β, the more effectively accumulated knowledge is transformed into institutional innovation and economic practice [2, 7].

1.3. The Central Formula

By combining the Ashby–Gavrilets law with the conception of knowledge as a managerial resource, we obtain the central relation:

$$R + \beta \cdot K \geq Q.$$

Successful development requires the maintenance of this equilibrium: institutional diversity *(R)* and effectively mobilized knowledge *(βK)* together must not be less than the structural complexity of society *(Q)*.

When $R + \beta \cdot K < Q$, a deficit of governability emerges, as the system becomes unable to cope with the complexity of the challenges it confronts, thereby increasing the likelihood of systemic crisis.

The relation also allows for complementarity: a deficit of institutional variety may be partially compensated through highly efficient knowledge mobilization, and vice versa. Full substitutability, however, is impossible, since a minimum level of both R and $\beta \cdot K$ remains necessary. The relation is also dynamic: Q increases alongside modernization, globalization, and technological transformation. This, in turn, requires a corresponding increase in R, in $\beta \cdot K$, or in both simultaneously.

1.4. Two Types of Institutional Diversity

The Chinese trajectory discussed below reveals an important conceptual distinction between political and functional forms of institutional diversity. Political diversity refers to the distribution of power within a society — including the plurality of power centres, systems of checks and balances, political pluralism, and mechanisms of accountability. Functional diversity, by contrast, refers to the diversity of available governance instruments — including the capacity for experimentation, policy adaptability, and the heterogeneity of problem-solving mechanisms.

What is particularly important is that functional diversity may remain high even under conditions of limited political diversity. An authoritarian regime characterized by deep administrative decentralization and encouragement of managerial experimentation — such as China between 1978 and 2010 — may possess a relatively low level of political R, while simultaneously maintaining substantial functional diversity. Conversely, a democratic order with a rigidly centralized bureaucracy may exhibit high political R but significantly constrained functional diversity.

The present conceptual framework incorporates both forms.

In the relation $R + \beta \cdot K \geq Q$ R represents aggregate institutional diversity, encompassing both political and functional dimensions. Long-term stability, however, requires a balance between these two forms. Xu Chenggang [15] cautions that regional competition — as a form of functional diversity — constitutes only a temporary solution: without constitutional protection of property rights, the state may ultimately violate them once again. Functional substitutes for political diversity may operate effectively in the short and medium term, but over the long run they cannot provide durable institutional protection against arbitrary power.

2. DESCRIPTIVE ANALYSIS: PATTERNS IN THE DATA

2.1. The Data and the Operationalization of the Variables

To demonstrate the conceptual model, we employ data from 133 countries covering the period 2002–2023. The principal variable of interest is the United Nations Sustainable Development Goals Backdated Index (Backdated SDG Index) [19, 20], which provides a multidimensional measure of societal well-being. The core variables of the conceptual framework are operationalized as follows.

Institutional diversity *(R)* is measured by means of the Worldwide Governance Indicators *(WGI)*, which incorporate six dimensions of governance: control of corruption *(cc)*, government effectiveness *(ge)*, political stability *(pv)*, rule of law *(rl)*, regulatory quality *(rq)*, and voice and accountability *(va)*. Since the aggregated WGI indicators primarily measure institutional quality, we distinguish between institutional quality *(G)* and institutional diversity *(R)*. The diversity index is constructed as an entropy-based measure of the balance among the six dimensions: $R_i \to 1$ indicates a broad range of functionally differentiated governance mechanisms, whereas $R_i \to 0$ indicates institutional one-sidedness.

Accumulated knowledge *(K)* is operationalized by means of a composite index:

$$K = 0.6 \cdot HDI + 0.2 \cdot R\&D + 0.2 \cdot Publications,$$

where *HDI* is the Human Development Index (education, longevity),
R&D is research-and-development expenditure (normalized),
and Publications is scientific productivity (normalized).

The conversion efficiency *(β)* is measured through a composite index combining control of corruption and rule of law:

$$\beta = 0.5 \cdot cc + 0.5 \cdot rl.$$

The index is normalized to the [0, 1] interval: $\beta \to 1$ signifies high efficiency of converting knowledge into managerial capacity, whereas $\beta \to 0$ reflects the presence of systemic obstacles. Illustrative examples include Denmark $(\beta \approx 0.94)$; Singapore $(\beta \approx 0.93)$; Venezuela $(\beta \approx 0.03)$.

Structural complexity (Q) is operationalized, in simplified form, through available proxy variables:

$$Q = 0.6 \cdot IEI + 0.4 \cdot HDI,$$

where IEI denotes the innovation/economic-complexity index. We acknowledge the limitations of this operationalization: ideally, Q should also incorporate the Economic Complexity Index (ECI), urbanization, ethnic fragmentation, and globalization; however, consistent data for these variables are unavailable for the full country sample.

The central variable of the conceptual framework is $R + \beta \cdot K$, which represents the aggregate managerial capacity of a society.[2]

2.2. Descriptive Statistics and Patterns in the Data

Before turning to the historical trajectories, we first outline the principal patterns observed in the data, which illustrate the relationship between managerial capacity $(R + \beta \cdot K)$ and sustainable development, as measured by the SDG Index. The principal characteristics of the sample are presented in Table 1.

Table 1. Descriptive statistics of the variables
(N = 133 countries, latest available year)

Variable	Mean	Std. dev.	Mini-mum	Maxi-mum	Comment
SDG Index	68.8	12.3	35.2	89.5	Composite well-being
R (diversity)	0.00	0.002	-0.01	0.01	Entropy of institutions*

[2] The low variation observed in R reflects the methodological limitations of the entropy measure constructed from the WGI data. Specifically, the six WGI components are highly correlated due to the presence of an underlying structural factor. As a consequence, the entropy-based balance index is unable to capture empirically the full extent of cross-country differences in institutional diversity. Several complementary approaches may improve the estimation of R. At present, most of the variation in managerial capacity (R+βK) is generated by the βK; a more precise estimation of R, however, may be achieved through three complementary strategies: 1. replacing the entropy-based WGI index with Feinstein's multidimensional diversity index, which is more robust to correlations among components; 2. replacing the WGI indicators with the Polity Project [33] or Varieties of Democracy Institute [34] datasets, which are specifically designed to measure institutional diversity; 3. applying factor analysis to the WGI components in order to isolate a principal diversity factor by maximizing explained variance. The implementation of these approaches remains a task for the future empirical extension of the model (see also the discussion in Section 2.3).

Variable	Mean	Std. dev.	Mini-mum	Maxi-mum	Comment
K (knowledge)	0.50	0.17	0.17	0.92	Human capital
β (conversion)	0.46	0.24	0.00	0.98	Efficiency of mobilization
R + β·K	0.26	0.22	0.00	0.90	Managerial capacity
Q (complexity)	0.39	0.18	0.11	0.90	Structural complexity

The interrelationships among the variables of the model are presented in the correlation matrix (Table 2).

Table 2. Correlation matrix of the principal variables

	SDG	R	K	β	R + β·K
SDG Index	1.00				
R	0.00	1.00			
K	0.86**	-0.02	1.00		
β	0.72**	0.01	0.87**	1.00	
R + β·K	0.75**	0.04	0.93**	0.97**	1.00

The correlation matrix indicates that accumulated knowledge (K) and its conversion efficiency (β) are strongly associated with progress in achieving the Sustainable Development Goals. The composite variable $R + \beta \cdot K$, which represents managerial capacity, is correlated with the SDG Index at the level of $r = 0.75$. This finding points to a strong relationship between a society's capacity to manage complexity and its overall level of well-being. The grouping of countries by managerial-capacity level, presented in Table 3, further illustrates the "high $R + \beta \cdot K$-high SDG" pattern.

* *The low variation observed in R reflects the methodological limitations of the entropy-based measure constructed from the WGI data. Most of the variation in managerial capacity is generated by the βK component.*

** *A strong correlation is denoted by* |r|>0.7. *The correlation matrix reveals three principal patterns: (1) both K and β are strongly associated with SDG performance; (2) R exhibits little correlation with the SDG Index because of its low empirical variation; and (3) managerial capacity (R+βK) is strongly correlated with societal well-being (r=0.75).*

*Table 3. Grouping of countries by level of managerial capacity (R + β·K)**

Group	R + β·K range	N of countries	SDG (mean)	Examples of countries
Low (Q1)	< 0.10	33	52.3	Afghanistan, Chad, South Sudan, Syria
Lower-middle (Q2)	0.10-0.23	34	63.5	India, Egypt, the Philippines, Kenya
Upper-middle (Q3)	0.23-0.38	33	72.8	China, Brazil, Mexico, Turkey
High (Q4)	> 0.38	33	81.2	Denmark, Singapore, Switzerland, Japan
Q4–Q1 difference	–	–	+28.9	–

Verification of the threshold relation $R + \beta \cdot K \geq Q$. To evaluate the central proposition of the model, we compare countries characterized by equilibrium in managerial capacity $(R + \beta \cdot K > Q)$, corresponding to the upper quartile, with countries characterized by a deficit of governability $(R + \beta \cdot K < Q)$, corresponding to the lower quartile. Among the balanced countries, the mean SDG Index score is 80.2, whereas among countries exhibiting a deficit of governability the mean score is 55.7. The difference amounts to 24.5 points, confirming the importance of maintaining equilibrium between managerial capacity and structural complexity for sustainable development.

Qualitative interpretation. The observed patterns are consistent with the conceptual logic of the model. Countries with high managerial capacity — particularly those with elevated K and β indicators — systematically attain higher levels of societal well-being. The threshold comparison further suggests that when managerial capacity exceeds structural complexity $(R + \beta \cdot K > Q)$, societies tend to display more sustainable developmental trajectories. Conversely, when a deficit emerges $(R + \beta \cdot K < Q)$, problems of governability arise, which are reflected in lower SDG Index scores.

* *Countries with high managerial capacity (Q4) score, on average, 29 points higher on the SDG Index than countries with low managerial capacity (Q1). This pattern is consistent with the central proposition of the conceptual framework.*

It is important to emphasize that the descriptive statistics do not establish causality; rather, they reveal empirical patterns consistent with the theoretical framework. To understand the underlying mechanisms more deeply, we now turn to the analysis of historical trajectories (Section 3), which illustrates how the interaction among R, K, β, and Q evolves over time and shapes the developmental trajectories of nations.

2.3. The Limitations of the Descriptive Analysis

It is necessary to acknowledge several important limitations of the descriptive approach. First, correlations do not establish causality: the high correlation between $R + \beta \cdot K$ and the SDG Index may reflect both the influence of managerial capacity on development and the reverse relationship, whereby more developed societies accumulate greater stocks of knowledge and improve their institutions. Establishing causal relationships would require the use of instrumental variables, natural experiments, or quasi-experimental methods, which lies beyond the scope of the present study.

Second, the operationalization of the variables remains approximate. Existing aggregated governance indices primarily measure institutional quality, while the entropy-based proxy for diversity has important limitations, as reflected in the low variation of R. Structural complexity (Q) is likewise operationalized through a simplified composite index because of incomplete data availability. The development of more precise indices of institutional diversity and structural complexity therefore remains an important direction for future research.

Third, aggregation at the country level conceals substantial internal heterogeneity. Large states may display considerable regional differences in managerial capacity and development that are not captured by national averages.

Fourth, it is necessary to note the potential endogeneity of the operationalization strategy. The Human Development Index (HDI) is incorporated both into K — with a weight of 0.6 — and into Q — with a weight of 0.4 — while also being closely correlated with the SDG Index itself. Consequently, the observed correlation of $r = 0.75$ between $R + \beta \cdot K$ and the SDG Index is partially driven by this shared component, rather than exclusively by the theoretical mechanism proposed by the model. A more

precise estimate of the independent contribution of managerial capacity would require replacing HDI in the operationalization of Q with independent proxies of structural complexity — for example, the Economic Complexity Index (ECI) or the KOF Globalization Index- which remains a task for future research. Furthermore, the extremely low variation of the R variable (a standard deviation of approximately 0.002 with a mean near 0.00; see Table 2) suggests that institutional diversity is not empirically identified within the present entropy-based specification applied to the WGI data.

In the present sample, most of the variation in managerial capacity is generated by the $\beta \cdot K$ component. The development of a more precise index of R- for example, on the basis of the Polity Project [33] or Varieties of Democracy Institute [34] datasets — therefore represents an important direction for the further empirical extension of the model.

Notwithstanding these limitations, the descriptive analysis reveals empirical patterns consistent with the conceptual logic of the model. Countries with high managerial capacity, particularly those characterized by high K and β values, systematically attain higher levels of societal well-being. The 29-point difference in SDG Index scores between the upper and lower quartiles of $R + \beta \cdot K$ represents a substantial empirical gap requiring explanation. The conceptual framework

$R + \beta \cdot K \geq Q$ offers such an explanation, which is further illustrated below through the analysis of historical trajectories.

A visual representation of the regimes of governability and developmental trajectories is provided by the phase diagram (Figure 1), which illustrates the possible paths of societal movement relative to the threshold relation $R + \beta \cdot K = Q$.

The figure presents the phase space of governability, in which the horizontal axis represents the structural complexity of society (Q), while the vertical axis represents managerial capacity,

$$M = R + \beta \cdot K,$$

where R denotes institutional diversity, K the accumulated knowledge, and β the efficiency with which knowledge is converted into institutional and managerial capacity. The diagonal threshold line $R + \beta \cdot K = Q$ separates regimes of sustainable development from regimes characterized by a deficit of governability and an elevated probability of systemic crisis.

The coloured trajectories reflect different regimes of institutional dynamics. The green lines correspond to sustainable and adaptive trajectories, in which the growth of institutional diversity and knowledge mobilization compensates for increasing complexity. The red lines represent trajectories characterized by a deficit of governability, in which the growth of complexity outpaces the adaptive capacity of the system. The orange dotted lines indicate conditionally possible developmental trajectories that may emerge through increases in the β coefficient, even without a corresponding expansion of the resource base.

The placement of Armenia and neighbouring countries within the diagram constitutes a conceptual reconstruction reflecting their historical-institutional dynamics and long-term developmental trajectories, rather than a precise empirical estimation of coordinates.

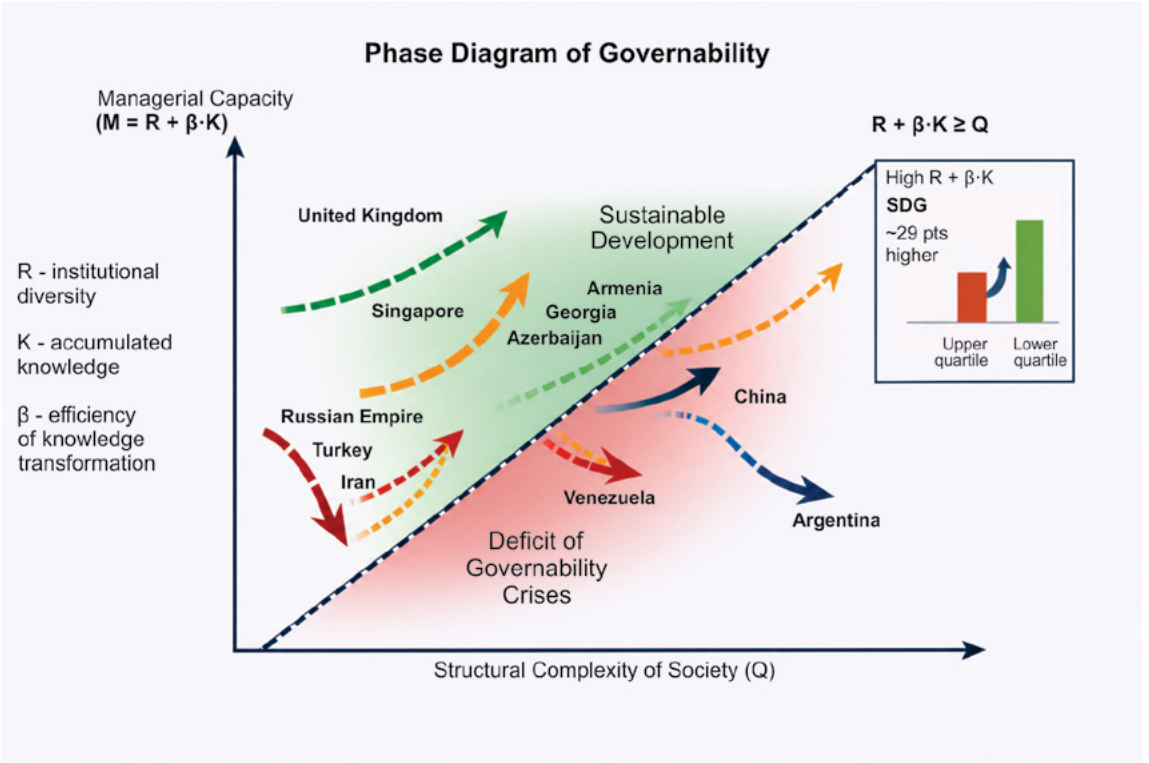

Figure 1. Phase diagram of the governability of socio-economic systems.

3. HISTORICAL TRAJECTORIES: DEMONSTRATION OF THE CONCEPTUAL LOGIC

The methodological foundation of this section is rooted in the intellectual development of optimal-control theory, schematically illustrated in Figure 2.

The figure traces the methodological evolution of optimal-control theory from its mathematical foundations to its applied extensions in the domain of culturogenesis. The first stage is associated with Lev Pontryagin's Maximum Principle, which established the mathematical apparatus for solving problems of dynamic optimization. The second stage is represented by the work of Emmett Keeler, A. Michael Spence, and Richard Zeckhauser (1972), in which the maximum principle was applied to the problem of environmental pollution control. The third stage is the model of the optimal management of culturogenesis, which extends this logic into the cultural sphere.

The historical demonstration of the conceptual model through six contrasting trajectories makes it possible to illustrate the operation of the mechanism $R + \beta \cdot K \geq Q$ under concrete historical conditions. We examine two successful trajectories (United Kingdom, Singapore), two failed trajectories (Russia, Venezuela), and two structurally complex trajectories (China, Argentina).

3.1. Great Britain in the Eighteenth and Nineteenth Centuries: Gradual Institutional Adaptation

The Industrial Revolution in the United Kingdom sharply increased structural complexity *(Q)* through industrialization, urbanization, and the emergence of new social groups. The institutional system responded through an expansion of institutional diversity *(R)*, including parliamentary reforms, municipal governance, trade unions, and cooperative institutions. The accumulation of knowledge *(K)* was facilitated by scientific societies, the patent system, and the mechanics' institutes. A high conversion coefficient *(β)* — supported by relatively low corruption, broad access to knowledge, and strong institutional complementarities — ensured the rapid transformation of knowledge into innovation. As a consequence, $R + \beta \cdot K \geq Q$ was maintained despite the rapid growth of complexity, thereby supporting a trajectory of sustainable development.

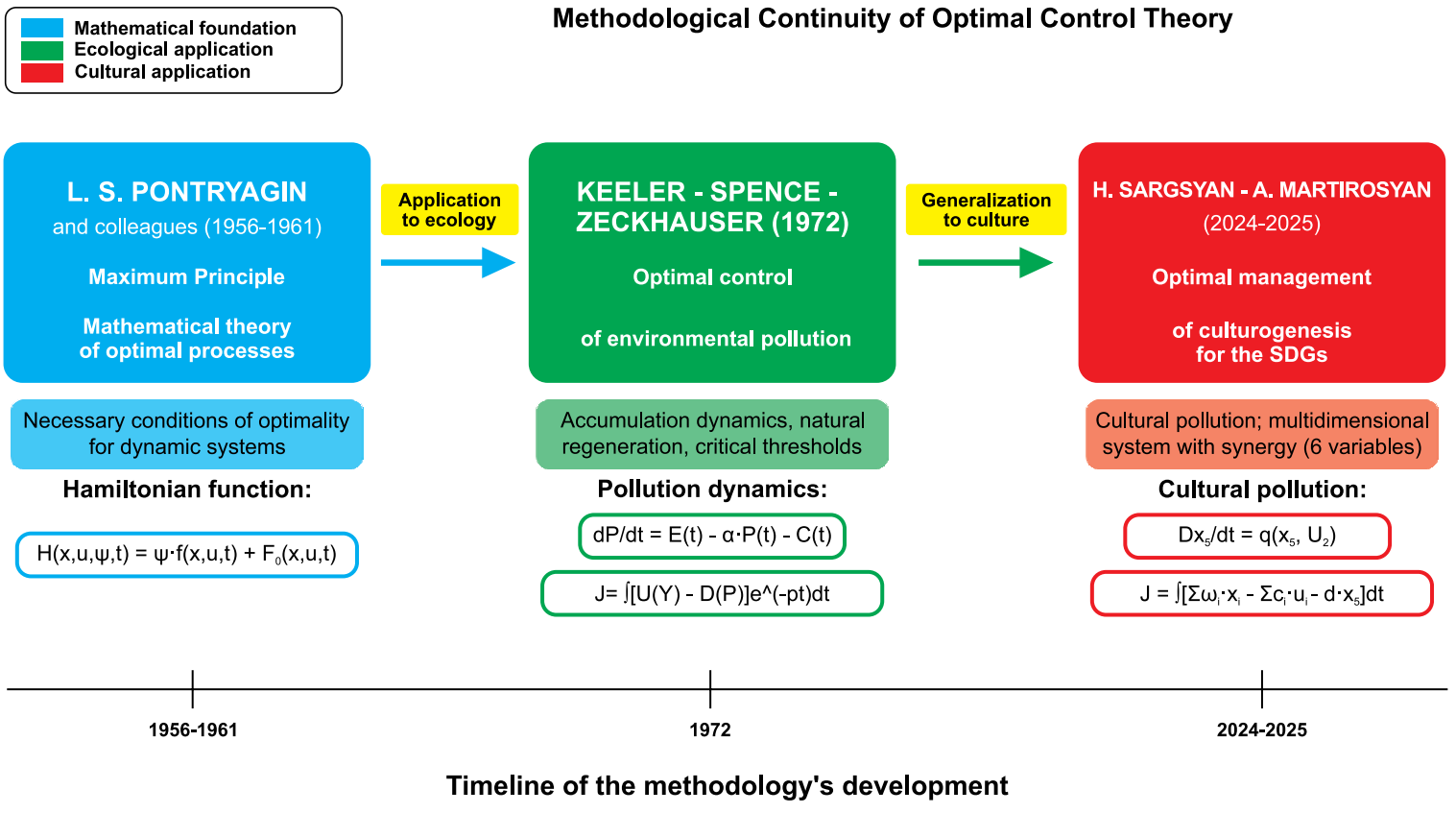

Figure 2. The methodological continuity of optimal-control theory.

Source: compiled by the authors.

3.2. The Russian Empire at the End of the Nineteenth and Beginning of the Twentieth Century: A Crisis of Governability

Modernization in Russia led to a rapid increase in structural complexity *(Q)* through the abolition of serfdom, industrialization, railway expansion, and the emergence of an educated intelligentsia. Institutional diversity *(R)*, however, remained limited: autocratic rule, the restricted role of the zemstvo institutions, and the absence of meaningful political accountability constrained the adaptive capacity of the system.

The accumulation of knowledge *(K)* was taking place, but the conversion coefficient *(β)* remained low. The separation of the intelligentsia from political power, together with patrimonialism and the absence of meritocratic governance, hindered the transformation of knowledge into institutional innovation. As a consequence, $R + \beta \cdot K << Q$ producing a persistent deficit of governability. This imbalance, further intensified by the pressures of the First World War, ultimately contributed to the Revolution of 1917.

3.3. Singapore and Venezuela: A Contrast of Trajectories

Singapore demonstrates how limited political diversity may be partially compensated for by a substantial expansion of accumulated knowledge *(K)* and by a high conversion coefficient *(β)*. Despite the authoritarian character of the political system, a relatively high level of functional diversity was preserved through meritocratic governance, economic rule of law, and pragmatic policy experimentation. Targeted investment in education and the attraction of highly skilled talent contributed to the rapid growth of K. A high β coefficient, supported by anti-corruption policies and strong linkages between science, education, and business, enabled effectively mobilized knowledge *(β·K)* to compensate for the relative deficit of political R. The result was a developmental transformation that, within a single generation, carried Singapore "from the Third World to the First."

Venezuela illustrates the opposite dynamic: the systemic erosion of all major components of managerial capacity. Under the Chávez–Maduro regime, institutional diversity *(R)* was progressively reduced through pressure on the opposition, the judiciary, and the media. The stock of knowledge *(K)* deteriorated because of the outflow of specialists and the decline of the university system, while the conversion coefficient *(β)* weakened through corruption, patronage

networks, and extensive nationalizations. The result was a profound institutional crisis despite the country's substantial oil resources.

3.4. China: Authoritarian Modernization and the Question of Stability

The reforms initiated in China in 1978 launched a distinctive developmental experiment characterized by limited political diversity but high functional diversity, achieved through decentralization, regional experimentation, and interprovincial competition. The rapid accumulation of knowledge *(K)*, driven by educational expansion, investment in research and development, and the acquisition of foreign technologies, was accompanied by a relatively high conversion coefficient *(β)*, supported by pragmatic experimentation and the effective assimilation of external experience. As a consequence, $\beta \cdot K$ grew more rapidly than structural complexity *(Q)*, thereby supporting a prolonged period of modernization and economic transformation. Under the leadership of Xi Jinping, however, the renewed centralization of political and institutional control may be reducing functional diversity and weakening the β coefficient. Whether a high level of effectively mobilized knowledge $(\beta \cdot K)$ can ensure long-term stability under conditions of limited political diversity therefore remains an open question.

3.5. Argentina: Decline under Favourable Conditions

At the beginning of the twentieth century, Argentina was among the ten wealthiest countries in the world. The military coup of 1930 initiated a process of institutional degradation: institutional diversity *(R)* contracted, external shocks and dependence on raw-material exports constrained the growth of accumulated knowledge *(K)*, while recurrent populist cycles and corruption weakened the conversion coefficient *(β)*.

As a consequence, $R + \beta \cdot K$ declined under conditions of increasing structural complexity *(Q)* associated with urbanization and industrialization. This imbalance contributed to repeated economic and political crises, as well as to the country's gradual relative decline toward middle-income status. The broader lesson is that favourable initial conditions do not guarantee long-term stability: institutions are fragile, and prolonged institutional erosion may become difficult to reverse.

The results of the comparative analysis of the six historical trajectories are summarized in Table 4.

Table 4. The philosophy of the six trajectories

Country	R	K	β	R + βK : Q	Outcome
Great Britain	high	growing	high	≥	Success: sustainable modernization
Russia	low	medium	low	<	Crisis: the 1917 revolution
Singapore	medium (high functional)	high	very high	≥	Miracle: from Third World to First
Venezuela	collapse	outflow	→ 0	<<	Catastrophe: humanitarian crisis
China	medium (high functional)	rapid growth	high	≥	Success, but with the question of stability
Argentina	declining	stagna-tion	low	<	Decline: from top-10 to middle income

The comparative analysis reveals several central regularities. First, political diversity is not a strictly necessary condition for successful development if functional diversity remains high, as illustrated by Singapore and China. Second, the conversion efficiency of knowledge *(β)* is decisive: under conditions of low β, even a high level of accumulated knowledge *(K)* is not effectively transformed into managerial capacity, as demonstrated by Russia.

Third, equilibrium remains fragile. Initial advantages may be lost through processes of institutional degradation, as illustrated by Argentina. Fourth, not only the current level of $R + \beta \cdot K$, but also its long-term trajectory is of decisive importance. Venezuela demonstrates that even favourable initial conditions, including oil revenues and democratic institutions, do not protect a society from systemic crisis if all three components of managerial capacity progressively deteriorate.

Finally, historical context matters. The United Kingdom developed within a comparatively favourable international environment, whereas

Russia confronted external shocks that exposed its internal fragility. The principal difference, however, lay not in initial conditions themselves but in the capacity of institutions to adapt to the growth of structural complexity *(Q)*. The United Kingdom consistently expanded institutional diversity *(R)* and strengthened effectively mobilized knowledge *(βK)*, whereas Russia maintained a relatively narrow institutional structure and a persistently low β coefficient. In this sense, Venezuela initially possessed more favourable structural conditions than the United Kingdom, yet followed a markedly less sustainable developmental trajectory.

Anomalous cases and the limitations of the model. The proposed framework does not fully explain all developmental trajectories. Botswana, for example, achieved average annual growth rates of approximately 7 per cent during the period 1966–2000 despite limited political diversity *(R)* — reflected in the long-term dominance of the Botswana Democratic Party *(BDP)* — and a relatively low initial stock of knowledge *(K)*, with literacy standing at approximately 41 per cent in 1966.

A possible explanation lies in the presence of relatively high functional diversity, supported by traditional kgotla councils, transparent management of diamond revenues, and the concentration of effectively mobilized knowledge *(βK)* within strategically important sectors. This case suggests that the model does not yet sufficiently account for sectoral specialization and uneven distributions of managerial capacity across institutional domains.

Venezuela during the period 1970–1990 presents a different anomaly. Formally, the country appeared to satisfy the conditions of equilibrium through democratic institutions and substantial oil revenues, yet experienced chronic structural stagnation. This suggests that the model does not adequately distinguish between robust and fragile forms of equilibrium: oil rents temporarily masked the underlying weakness of the β coefficient and the limited adaptability of the institutional system.

These limitations indicate several important directions for the further development of the framework, including sectoral analysis, the differentiation between robust and fragile equilibria, and the measurement of systemic resilience to external shocks

4. DISCUSSION

4.1. Theoretical Contribution

The proposed framework contributes to the literature along several dimensions. First, it extends institutional economics [1, 5, 6] by introducing a dynamic perspective: what matters is not only the quality of institutions but also the breadth and adaptability of their institutional repertoire. The distinction between political and functional diversity *(R)* is consonant with Francis Fukuyama's differentiation between state capacity and political accountability [28, 29], and helps explain cases of authoritarian modernization, such as Singapore and China, as systems characterized by high functional diversity under conditions of limited political pluralism.

Second, the framework further develops the theory of Joel Mokyr [2] by interpreting knowledge not only as a factor of production but also as a resource of governance and institutional adaptation [8, 11, 12]. The β parameter operationalizes the concept of institutional complementarities [27], reflecting the capacity of societies to convert accumulated knowledge into effective managerial and institutional practices.

Third, the framework projects the logic of cybernetics [3, 4] onto the macrosocial level, applying the principles of adaptive systems theory to the analysis of long-term developmental trajectories.

Fourth, it qualifies the thesis concerning the primacy of institutions over geography [30]. Institutions are effective not in isolation, but under conditions in which societies possess sufficient knowledge *(K)* and a sufficiently high conversion coefficient *(β)*. In this sense, βK may partially compensate for a deficit of institutional diversity *(R)*. This helps explain why some societies possessing formally high-quality institutions nevertheless experience stagnation, while others achieve rapid development through the effective mobilization of knowledge.

4.2. Application to Armenia: The Sequencing of Transformations

The application of the proposed framework to Armenia reveals a problem characteristic of many transitional societies: structural complexity *(Q)* grows more rapidly than the adaptive capacity of institutions. Global integration,

technological transformation [11], and geopolitical uncertainty continue to increase the level of structural complexity. Institutional diversity *(R)* remains limited because of low public trust in state institutions, the weakness of the judicial system, the underdevelopment of local self-government, and the fragmentation of civil society.

The stock of accumulated knowledge *(K)* presents a mixed picture: relatively high human capital coexists with limited research funding and the continuous outflow of skilled professionals. Most importantly, the conversion coefficient *(β)* is likely constrained by corruption, oligarchic structures, weak meritocratic mechanisms, and clientelistic networks, all of which raise the costs of access to opportunities and institutional participation [9, 14, 16].

As a consequence, $R + \beta \cdot K < Q$, which helps explain the persistence of institutional fragility.

Empirical studies of Armenia's cultural factors confirm the importance of the socio-cultural context for the realization of the Sustainable Development Goals [9, 16]. The analysis suggests that certain cultural characteristics — including high power distance, collectivist social structures, and strong uncertainty avoidance — exert a dual influence on sustainable development outcomes. Models of the optimal management of cultural [8] and educational [11, 12] processes indicate the possibility of exerting targeted influence upon the β and K parameters in order to reduce learning poverty and strengthen human capital.

The principal strategic conclusion concerns the sequencing of reforms. A direct expansion of institutional diversity *(R)* or accumulated knowledge *(K)* is unlikely to be effective under conditions of a persistently low β. The priority sequence should therefore be the following: first, strengthening β through the digitization of public services [10], meritocratic governance, stronger linkages between science and the economy, and broader accessibility of knowledge; second, investment in K through research funding, educational modernization [11, 12], diaspora reintegration, and niche specialization; and only thereafter, under conditions of sufficiently high K and β, the expansion of institutional diversity *(R)* through judicial reform, local self-government, and the strengthening of civil society.

Attempts to accelerate the expansion of R in the absence of sufficiently developed K and β frequently lead to the formal imitation of institutions without their effective functioning. For Armenia, the proposed framework is operationalized through the ORBITIR dynamic model [17].

4.3. Limitations and Directions of Future Research

It is necessary to acknowledge the principal limitations of the conceptual framework. First, the measurement of institutional diversity and structural complexity remains approximate, and the development of more precise indices constitutes an important task for future research. Second, the model does not provide deterministic forecasts. Although this limits its predictive precision, it is consistent with the diversity and non-linearity of observed developmental trajectories. Third, the question of the optimal level of institutional diversity remains open, since excessively high levels of R may generate significant coordination costs and institutional fragmentation.

The model also does not yet sufficiently incorporate cultural values, trust, and social capital — factors that influence both institutional diversity and the accumulation of knowledge. For example, Saribekyan [18] emphasizes that, in post-war Armenia, the overcoming of the crisis of trust occurred largely through processes of social consolidation and the strengthening of social capital. These cultural dimensions therefore deserve more explicit integration into future extensions of the framework.

A separate methodological limitation concerns the empirical operationalization of the variables. The use of the Human Development Index *(HDI)* both in the operationalization of K and as a component of Q creates a form of structural endogeneity, which partly explains the observed high correlation between $R + \beta \cdot K$, and the *SDG* Index $(r = 0.75)$. To reduce this endogeneity, the *HDI* component within Q should be replaced by more independent proxies of structural complexity, such as the Economic Complexity Index *(ECI)* or the KOF Globalisation Index. The estimation of the partial correlation associated specifically with managerial capacity should therefore become a priority direction of the model's empirical refinement.

In addition, the current entropy-based measure of institutional diversity *(R)* derived from the *WGI* data displays extremely low variation, which limits the possibility of empirically isolating the independent contribution of

institutional diversity as a distinct explanatory factor. In the present version of the model, the principal explanatory weight therefore falls upon the βK component.

The principal directions for future research include the formalization of dynamic models of the co-evolution of R, Q, and K; the development of a typology of institutional crises; the analysis of subnational variation; and the application of the framework to global challenges such as climate change and pandemics.

CONCLUSION

The Law of Requisite Variety, formulated by W. Ross Ashby in 1956 for cybernetic systems, remains profoundly relevant for understanding the developmental trajectories of nations in the twenty-first century. By synthesizing the Ashby–Gavrilets cybernetic principle with Joel Mokyr's theory of the growth of knowledge, the present work has proposed a conceptual framework for the analysis of long-term development. Its central proposition is that successful development requires the maintenance of equilibrium among institutional diversity (R), effectively mobilized knowledge (βK), and the structural complexity of society (Q):

$$R + \beta \cdot K \geq Q$$

The descriptive analysis of data from 133 countries reveals a strong association between managerial capacity and sustainable development. Countries with high levels of $R + \beta \cdot K$ display SDG indicators that are, on average, 29 points higher, while the difference between balanced systems $(R + \beta \cdot K \geq Q)$ and systems characterized by a deficit of governability amounts to 24.5 points. The six historical trajectories examined in the study — from Great Britain's Industrial Revolution to the institutional collapse of Venezuela — demonstrate how the disruption of systemic equilibrium contributes to institutional crises, whereas its preservation supports long-term stability and adaptive development.

The principal theoretical contribution of the work lies in several interconnected advances. First, it extends institutional economics by introducing a dynamic dimension: what matters is not only the quality of institutions but also the diversity and adaptability of institutional arrangements. Second, it further develops the theory of knowledge-based growth by interpreting knowledge not only as a productive resource but also as a managerial and adaptive resource. Third, it projects cybernetic principles onto the macrosocial level, applying the logic of adaptive systems theory to the analysis of state development. The distinction between political and functional diversity also makes it possible to interpret cases of authoritarian modernization not as anomalies, but as systems characterized

by high functional diversity under conditions of limited political pluralism — while leaving open the question of the long-term sustainability of such equilibria.

In a world characterized by increasing complexity — globalization, technological revolutions, climate change, and pandemics — the capacity of societies to expand institutional diversity and mobilize knowledge becomes a decisive condition not only of prosperity, but also of resilience and survival. Societies that fail to maintain the equilibrium $R + \beta \cdot K \geq Q$ risk confronting crises of governability and systemic fragility. By contrast, societies that invest in institutional innovation and the accumulation of knowledge acquire greater stability, adaptability, and strategic flexibility.

The sequencing of transformations is therefore of fundamental importance. The strengthening of the conversion coefficient (β) should precede the expansion of the stock of knowledge (K), which in turn creates the necessary foundation for the enlargement of institutional diversity (R). In this sense, the proposed framework is not merely an abstract theoretical construction, but also a practical guide for societies seeking sustainable development under conditions of growing complexity.

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IN PLACE OF AN AFTERWORD

ORBITIR emerged not merely as a new methodology for the assessment of development, or as another variant of a composite index, but as an attempt to reconceptualize the broader logic of development itself. The increasing complexity of the modern world, the growing interconnectedness of systems, and the non-linear nature of contemporary crises have exposed important limitations in traditional approaches to development. Linear growth models, classical modernization theories, and even multidimensional development indices often fail to explain why states with similar resources, educational potential, or institutional reforms follow fundamentally different developmental trajectories.

In the twenty-first century, states do not move along a single trajectory toward a common "developed end-point." They exist within different regimes of stability, possess different structural constraints and adaptive capacities, and respond differently to the same external or internal stimuli. The same policy may, in one country, produce sustainable growth, while in another it may lead to systemic crisis. Likewise, the same technological progress may increase productivity in one society, while in another it may contribute to social polarization and instability in governance. This in itself demonstrates that the developmental process cannot be explained solely through economic indicators or fragmentary institutional changes.

The central idea of this monograph is that development should be understood as an orbital dynamic. States exist within different regimes of relative equilibrium — orbits — and transitions between them are shaped not only by material resources, but also by the structural organization of the system as a whole. From this perspective, ORBITIR understands development as a multi-layered, non-linear, and interconnected process in which the economy, the social system, the environment, security, institutions, technology, and culture function not as separate policy domains, but as interacting subsystems of an integrated whole.

It is this idea of wholeness that constitutes the principal distinctive feature of ORBITIR. The framework attempts to overcome the limitations of both classical development theories and contemporary composite indices.

Whereas traditional approaches primarily sought to answer the question of where a state is situated, ORBITIR attempts to understand the structural regime within which a system operates, the conditions under which it preserves or loses stability, the internal contradictions that shape the limits of its development, and the circumstances under which a controllable orbital transition becomes possible.

From this perspective, development ceases to be understood merely as a problem of economic growth and instead becomes a problem of managing complexity. Contemporary societies are becoming increasingly complex at the technological, economic, informational, social, and geopolitical levels. This complexity increases the demands placed upon governance systems. If a state is unable to adapt its institutional structure, mobilize knowledge, preserve the equilibrium of its subsystems, and respond to growing diversity, it gradually loses its orbital stability.

Within this framework, the monograph introduces the following central systemic principle:

$$R + \beta \cdot K \geq Q$$

Here, Q represents the complexity of society and its environment, R denotes institutional diversity, K refers to the stock of knowledge, and β reflects the cultural and managerial environment through which knowledge is transformed into effective capacity. Within ORBITIR, this inequality is understood not merely as a mathematical relation, but as a principle of systemic equilibrium in development. When the complexity of a society exceeds the diversity of its governance system and its capacity to mobilize knowledge, structural tension emerges, which over time may lead to orbital instability or even systemic collapse.

In the development of this theoretical framework, ORBITIR draws upon two major intellectual traditions. The first is associated with the cybernetic theory of W. Ross Ashby. Ashby's "Law of Requisite Variety" suggests that a complex system can be governed effectively only by a governance structure that itself possesses sufficient variety. In other words, a system can manage only that level of complexity for which it has a corresponding adaptive and structural capacity. If the complexity of the environment exceeds the organized variety of the governance system, the system loses controllability

and becomes vulnerable to both external and internal shocks. Within ORBITIR, this logic is expressed through the variable R and becomes a fundamental condition of orbital stability.

Variety alone, however, is not sufficient. A system must not only possess institutional and structural diversity, but also be capable of creating, accumulating, and mobilizing knowledge. Here ORBITIR draws upon a second important intellectual tradition associated with the work of Joel Mokyr. In Mokyr's theory of development, useful knowledge functions as a principal driver of historical progress — that is, knowledge that can be transformed into technological, economic, and organizational capacity. ORBITIR, however, takes this argument one step further by emphasizing that knowledge alone is insufficient. Knowledge must also be translated into effective managerial and institutional capacity. For this reason, the product $\beta \cdot K$ acquires central significance.

In this context, culture acquires a distinctive role within ORBITIR. It is no longer understood as a secondary or "soft" component of development. Instead, culture functions as the intermediary environment through which knowledge is transformed into effective adaptive capacity. Cultural codes shape a society's ability to build trust, convert knowledge into cooperation, institutionalize innovation, and sustain long-term strategic thinking. For this reason, the coefficient β is not merely a technical parameter. It reflects the broader civilizational and institutional environment within which knowledge acquires practical force.

From this perspective, ORBITIR may be understood as a synthesis of Ashby's cybernetic logic and Joel Mokyr's knowledge-based theory of development, applied to the non-linear dynamics of state development. If Ashby explained why institutional variety is necessary for managing complexity, and Mokyr why knowledge serves as a driver of historical progress, ORBITIR attempts to explain how these two processes together shape orbital stability, adaptive capacity, and the developmental limits of states.

One of the important conclusions of this work is that developmental processes are profoundly asymmetric. Transitioning to a higher orbit requires long-term institutional accumulation, educational and cultural capital, technological modernization, and the gradual complexification of governance

systems. Decline, however, may occur far more rapidly. History has repeatedly shown that states may accumulate capacities over decades, yet lose them within a short period as a result of war, institutional degradation, demographic crisis, or cultural fragmentation. From this perspective, development concerns not only advancement, but also the preservation of systemic resilience.

In this monograph, the case of Armenia appears not as an isolated example, but as a theoretically significant context. Armenia simultaneously possesses substantial educational and cultural capital, while also facing security vulnerabilities, institutional constraints, and geopolitical dependencies. This contradictory combination suggests that the developmental constraints of small and medium-sized states often arise not within individual domains, but from structural imbalances between them. ORBITIR is, above all, an attempt to understand this interconnectedness.

At the same time, ORBITIR seeks to possess not only theoretical, but also practical significance. It proposes a new approach to strategic planning, public administration, and educational policy. Whereas traditional strategies are often reduced to a mechanical collection of separate sectoral indicators, the orbital approach requires systemic coordination, in which the central objective is not the isolated growth of individual KPIs, but the equilibrium of the system as a whole. From this perspective, a development strategy should be understood as the management of the internal configuration of the system, taking into account its orbital position, structural constraints, and the nature of possible transitions.

This monograph, however, does not claim to present a finished theory. Rather, it should be understood as a research platform that opens a broad field for future study. Within ORBITIR, further research may develop along several major directions.

The first direction concerns mathematical and system-dynamic modelling. Agent-based models may be developed to reproduce the dynamics of orbital transitions, the influence of feedback loops, and the formation of systemic thresholds. This would enable the study not only of regimes of stability, but also of the mechanisms underlying their decay.

The second direction involves the further empirical development of the ORBITIR Index. Future research may include large-scale comparative analyses aimed at identifying structural patterns characteristic of different orbits,

threshold values, and the frequency of transitions. Particular importance may be attached to the study of the orbital behaviour of small and medium-sized states.

The third direction concerns the application of explainable artificial intelligence (XAI). SHAP and related methods make it possible to identify which specific pillars are preserving or undermining the orbital stability of a state at a given moment. In the future, this approach may evolve into a practical instrument for strategic decision-making.

The fourth direction concerns the further study of culture and the coefficient β. Within ORBITIR, culture is understood not as an additional factor, but as a central environment for the mobilization of knowledge. The relationships among cultural codes, systems of trust, historical memory, and institutional behaviour, however, still require substantial theoretical and empirical investigation.

The fifth direction concerns the relationship between security and development. In the twenty-first century, security is no longer understood merely as an external condition of development, but increasingly as one of its internal components. Within ORBITIR, this makes it possible to examine how security crises reshape the orbital structure of systems, and under what conditions states are able to preserve stability during prolonged shocks.

Finally, a separate line of research may emerge around the co-evolution of the seven pillars of ORBITIR. Future researchers may seek to understand which combinations produce stable orbits, which imbalances generate "orbital traps," and under what conditions a systemic transition toward a higher developmental regime becomes possible.

Thus, ORBITIR represents an attempt to propose a new language of development — one in which the advancement of states is measured not only through rates of economic growth, but also through the capacity to manage complexity, preserve internal variety, mobilize knowledge, and carry out controllable orbital transitions. From this perspective, one of the central challenges of twenty-first-century development theory lies not simply in understanding how societies grow, but in understanding how they preserve systemic stability within a world that is becoming increasingly complex, interconnected, and unpredictable.

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