



ASSESSING THE EFFECTIVENESS OF THE TERRITORIAL DIFFUSION OF INNOVATION ACTIVITY IN REDUCING INTERREGIONAL ECONOMIC DISPARITIES

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ABSTRACT

This thesis scientifically analyzed the effectiveness of territorial innovation diffusion in reducing interregional economic disparities. The study systematized innovation generation, transmission, and absorption as a unified assessment chain. Using Global Innovation Index indicators, Uzbekistan's innovation inputs and outputs were comparatively examined. The findings showed faster improvement in innovation outputs, stronger conversion capacity, and broader regional absorption opportunities. The proposed approach provided a methodological basis for evidence-based regional innovation policy and assessment of territorial convergence.

Introduction

Regional economic disparity occupies a central position in the theory of spatial development because the geography of production has never been neutral with respect to the geography of knowledge. Contemporary scholarship treats the uneven territorial distribution of income not as a transitory deviation from a long-run equilibrium but as the outcome of durable structural forces that operate through the location of innovative activity, the density of interregional linkages and the institutional quality of receiving territories [1]. The reorientation carries an encouraging analytical implication. If disparity is generated by mechanisms that can be identified and described, then it can be acted upon by policies that address those same mechanisms directly, and the spatial diffusion of innovation is among the most tractable of them.

Comparative evidence assembled across advanced economies indicates that productivity differences between territories inside a single country frequently exceed the differences observed between countries, and that technological progress has functioned as a decisive factor in the formation of that pattern [2]. The corollary deserves emphasis, because it defines the analytical object of the present enquiry. Where technology travels across the national territory, productivity gaps contract; where technological capability remains concentrated in a small number of leading locations, gaps prove persistent. Effectiveness of territorial diffusion therefore constitutes a subject distinct from the volume of innovation generated at national level, and it demands its own conceptual apparatus.

For an emerging economy engaged in rapid modernisation, the distinction acquires immediate practical value. Uzbekistan advanced to 79th place among 139 economies covered by the Global Innovation Index in 2025 and secured recognition as an innovation overperformer relative to its level of development for a fourth consecutive year [3]. National innovative capacity has therefore expanded in a measurable and internationally verified manner. The question that logically follows concerns the territorial reach of that expansion, since an improving aggregate ranking remains compatible with several internal geographies that differ substantially in their developmental consequences.

The strategic framework of the country supplies a normative anchor for the enquiry. The “Uzbekistan - 2030” Strategy formulates balanced territorial development and the elevation of scientific and technological potential as mutually reinforcing objectives, treating the productive use of knowledge in every region as a condition of national competitiveness rather than as a supplementary aspiration [4]. Assessment of diffusion effectiveness accordingly serves an established policy purpose: it converts a strategic commitment into an observable analytical category, and it allows progress to be recognised as it accumulates.

The purpose of the article consists in constructing a theoretical framework for assessing the effectiveness with which innovation activity spreads across the national territory, and in applying that framework interpretatively to verified indicators describing the innovation trajectory of Uzbekistan. Four objectives follow from the purpose. The first reconstructs the theoretical foundations connecting innovation diffusion to interregional convergence. The second formulates an assessment logic organised around generation, transmission and absorption. The third interprets the documented innovation dynamics of the country through that logic. The fourth derives recommendations addressed to the strengthening of regional absorptive capacity.

The scientific novelty of the work resides in the treatment of diffusion effectiveness as a relational property rather than as a stock characteristic. Instead of measuring how much innovation a territory possesses, the framework examines how successfully the national innovation system converts accumulated inputs into outputs that reach beyond the point of origin. The approach yields an interpretable ordinal indicator constructed from internationally comparable data, and it produces recommendations that operate on channels rather than on volumes.

LITERATURE REVIEW

The economic study of diffusion began with the demonstration that the spread of a new technology follows an orderly temporal path governed by profitability rather than by exposure to information alone. The classic investigation of hybrid seed adoption established that differences in the timing and speed of adoption across territories reflected differences in expected returns, in the availability of complementary inputs and in the density of supply networks, producing the familiar sigmoid trajectory that has organised diffusion research ever since [5]. The finding placed economic incentives at the centre of an area previously dominated by descriptive accounts of communication.

Sociological elaboration widened the explanatory field by identifying the communication channels, adopter categories and social systems through which innovations circulate, and by clarifying that the attributes of an innovation as perceived by potential users - relative

advantage, compatibility, complexity, trialability and observability - condition the rate of uptake independently of objective technical merit [6]. Territorial application of the framework implies that regions differ not only in what reaches them but in how readily their productive structures recognise the value of what reaches them.

Spatial economics supplied the mechanism that explains why diffusion does not produce automatic equalisation. Formal treatment of increasing returns demonstrated that the interaction of scale economies, transport costs and factor mobility generates cumulative concentration of activity in a limited number of locations, and that such concentration reproduces itself once established [7]. Empirical investigation of knowledge externalities confirmed the spatial boundedness of the underlying process: innovative activity clusters where knowledge spillovers are strongest, and the strength of those spillovers attenuates with distance from the source [8]. Diffusion, in this reading, competes against agglomeration rather than operating in a frictionless environment.

Growth theory contributed the convergence proposition and its qualifications. Systematic examination of regional income series across several countries established that convergence proceeds conditionally and slowly, at rates that depend on the transferability of technology and on the structural similarity of the territories concerned [9]. The result reframed technology transfer as the principal channel through which lagging territories catch up, and it identified the conditions under which the channel functions effectively.

Institutional analysis introduced the regional innovation system as the organisational unit through which diffusion is realised. The concept specifies the institutional and organisational arrangements - research organisations, financing mechanisms, intermediary bodies, governance capacity and inter-firm networks - that determine whether knowledge arriving in a territory is converted into productive application [10]. Subsequent development literature demonstrated that innovation contributes to catching-up primarily through the accumulation of technological and organisational capabilities, and that capability building constitutes a cumulative and path-dependent process requiring sustained investment in human resources [11].

Recent contributions to economic geography examined the global distribution of innovative activity and established a pattern of broad geographical spread combined with pronounced local concentration, indicating that participation in innovation has widened internationally while the intensity of innovative activity has remained highly localised within countries [12]. Policy scholarship responded by advocating place-sensitive approaches that build on the specific assets of each territory rather than replicating the institutional models of leading regions [13]. The smart specialisation framework operationalised the idea by directing regional policy toward domains in which a territory possesses genuine comparative capability, and by embedding an entrepreneurial discovery process in the selection of those domains [14].

Quantitative regional analysis completed the picture by measuring the spatial reach of innovative spillovers directly. Investigation of European regional data established that innovative activity in one region raises innovative performance in neighbouring regions, that the effect declines with distance and that its magnitude depends on the receiving region's own research capacity [15]. The finding carries a constructive policy message: proximity to an

innovative core generates advantage only for territories that maintain the capability to interpret and apply what proximity makes available.

Read together, these strands converge on a coherent proposition. Innovation reduces interregional disparity when three conditions hold jointly: sufficient generation of new knowledge somewhere in the national system, functioning channels through which that knowledge travels, and adequate absorptive capacity in receiving territories. The literature nevertheless devotes far more attention to generation than to the two subsequent conditions, and assessment frameworks that treat transmission and absorption as measurable dimensions in their own right remain comparatively scarce in the context of emerging economies. The framework developed below addresses that gap.

METHODOLOGY

The study adopted a theoretical-analytical design with an interpretative empirical component. The deductive sequence proceeded from established propositions in diffusion theory, spatial economics and regional innovation system analysis toward an assessment construct, which was then applied to verified secondary indicators. The design suited the research purpose, since the object of enquiry - the effectiveness with which innovation travels across territory - constitutes a systemic property that is not directly observable and must be approached through logically structured proxies.

The assessment construct organised diffusion into three sequential stages. Generation denotes the creation of new technological and organisational knowledge within the national system, and is approached through the resources committed to research, education and enterprise development. Transmission denotes the movement of that knowledge across territorial boundaries, and is approached through the infrastructural, institutional and market channels that carry it. Absorption denotes the conversion of received knowledge into productive application, and is approached through the human capital, financial access and institutional quality available in receiving territories. The three stages form a chain in which the weakest link determines the effectiveness of the whole, which supplies the diagnostic value of the construct.

Operationalisation employed the architecture of the Global Innovation Index, which separates innovation inputs from innovation outputs and reports both as internationally comparable ordinal positions [16]. The separation permits a straightforward interpretative indicator. When a country occupies a substantially better position on inputs than on outputs, the national system accumulates resources faster than it converts them, which points to constraints located in transmission and absorption. When the two positions converge, conversion has improved. The distance between the input rank and the output rank therefore served as an ordinal proxy for diffusion effectiveness, and its movement over time served as the principal analytical signal.

The empirical base consisted exclusively of published and verifiable sources. Index positions and subindex positions for the period 2020-2025 were taken from the country profile issued by the World Intellectual Property Organization [16]. Contextual characteristics of national innovation performance were drawn from the accompanying analytical report [17]. Research intensity was taken from the World Development Indicators compiled by the World Bank on the basis of UNESCO statistics [18]. Macroeconomic reference values describing the

national growth environment were taken from the analytical bulletin of the Statistics Agency under the President of the Republic of Uzbekistan [19]. Analytical propositions concerning the relationship between productivity and territorial inequality were drawn from the policy synthesis of the Organisation for Economic Co-operation and Development [20].

Two methodological limitations were recognised and are stated openly. The indicator constructed from rank distances is ordinal and comparative rather than cardinal, so it supports statements about direction and relative magnitude but not about elasticities. The Global Innovation Index reports national aggregates, so the framework characterises the national diffusion system as a whole rather than individual regional units; the statistical confidence interval reported for the country ranking further counsels caution in the interpretation of small year-on-year movements [16]. Both limitations restrict the scope of the conclusions without affecting their internal validity, and both indicate a clear direction for subsequent research based on regionally disaggregated data.

ANALYSIS AND RESULTS

The trajectory of Uzbekistan within the Global Innovation Index over the period 2020-2025 provides the empirical foundation for the analysis. Table 1 presents the overall position together with the positions recorded on the innovation input and innovation output subindices, and reports the distance between the two subindex positions as the ordinal proxy for diffusion effectiveness defined in the methodology.

Table 1. Position of Uzbekistan in the Global Innovation Index and the distance between the input and output subindices, 2020-2025¹

Year	Overall position	GII	Innovation inputs	Innovation outputs	Input-output distance	rank
2020	93rd		81st	118th	37	
2021	86th		75th	100th	25	
2022	82nd		68th	91st	23	
2023	82nd		72nd	88th	16	
2024	83rd		71st	91st	20	
2025	79th		69th	92nd	23	

The overall trajectory records consistent improvement. The country moved from 93rd position in 2020 to 79th position in 2025, an advance of fourteen places accomplished within six annual cycles, and the 2025 result represents the strongest position recorded across the observation window [16]. Placement within comparator groups reinforces the reading: the country ranked 7th among the thirty-seven lower-middle-income economies included in the index and 3rd among the ten economies of Central and Southern Asia, having improved on both dimensions relative to the preceding year [16]. Sustained recognition as an innovation overperformer for a fourth consecutive year indicates that performance exceeded the level statistically expected at the country's stage of development [3].

¹ Source: compiled by the author on the basis of the Uzbekistan country profile of the Global Innovation Index 2025, World Intellectual Property Organization [16]. The last column represents the author's calculation as the arithmetic difference between the output and input positions.

Decomposition of the aggregate movement produces the analytically decisive observation. The input subindex advanced from 81st to 69th position, an improvement of twelve places, while the output subindex advanced from 118th to 92nd position, an improvement of twenty-six places. Output performance therefore improved at more than twice the rate of input performance over the full period. Since inputs approximate the generation stage and outputs approximate the joint result of transmission and absorption, the pattern indicates that the conversion capacity of the national innovation system strengthened faster than its resource base expanded. The finding is favourable, because conversion capacity is precisely the property on which territorial diffusion depends.

The rank distance reported in the final column of Table 1 expresses the same result in condensed form. The distance contracted from thirty-seven positions in 2020 to twenty-three positions in 2025, reaching its narrowest recorded value of sixteen positions in 2023. Averaged across the two halves of the observation window, the distance fell from approximately twenty-eight positions during 2020-2022 to approximately twenty positions during 2023-2025. The contraction of roughly one-third indicates a durable structural improvement rather than a single favourable year, and the persistence of a positive distance identifies the direction in which further gains remain available.

Component evidence clarifies the sources of the improvement. The country recorded 9th position globally in the business environment sub-pillar and 24th position in expenditure on education [17]. Both results describe conditions that operate directly on the transmission and absorption stages: an accessible business environment lowers the cost at which firms in any location adopt new methods, while sustained educational financing builds the human capital through which arriving knowledge is interpreted. The combination of a strong business environment with substantial educational investment constitutes an unusually favourable platform for territorial diffusion, since it strengthens both the demand side and the capability side of the adoption process simultaneously.

Research intensity supplies the complementary perspective. Gross domestic expenditure on research and development stood at approximately 0.13 per cent of gross domestic product in 2023 according to the World Development Indicators [18]. Interpreted through the framework advanced here, the figure identifies a substantial and readily mobilisable reserve rather than a structural obstacle. Where transmission channels and absorptive capacity have already improved - as the subindex evidence indicates - each additional unit of research expenditure encounters a system better prepared to convert it into applied outcomes, so the marginal territorial return on incremental research investment is correspondingly high. Sequencing that strengthens conversion before scaling volume represents an efficient developmental path, and the observed trajectory corresponds closely to it.

The macroeconomic environment within which diffusion proceeds remained supportive throughout the period. Gross domestic product per capita reached 48,816.4 thousand soums over January-December 2025, exceeding the corresponding value of 41,306.7 thousand soums recorded for January-December 2024 and representing real growth of 5.7 per cent [19]. Expanding domestic demand of this magnitude enlarges the market for innovative goods and services in every region, raises the expected profitability of adoption in territories outside the

principal agglomerations and thereby reinforces the incentive structure on which diffusion ultimately rests, in accordance with the classical formulation of the adoption decision [5].

Figure 1 presents the conceptual model that organises the empirical observations into a single explanatory structure.

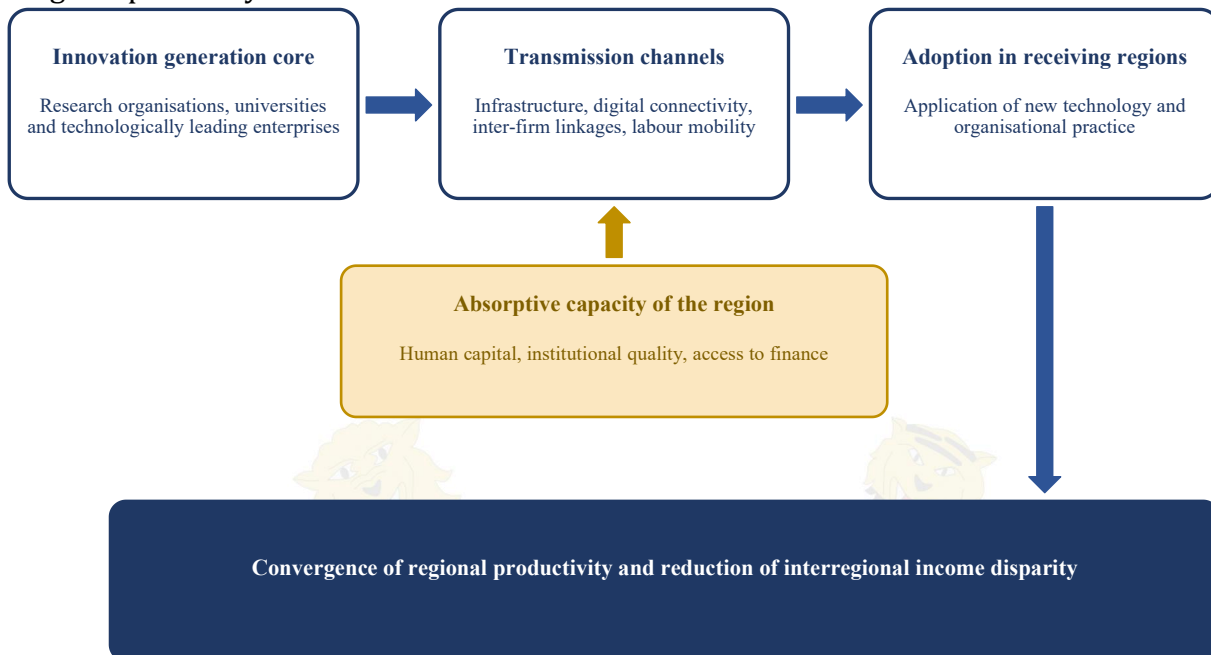


Figure 1. Conceptual model of the territorial diffusion of innovation activity and its effect on interregional convergence²

The model reads as a directed chain moderated by regional capability. Knowledge produced in the generation core travels through transmission channels whose capacity is determined by physical infrastructure, digital connectivity, inter-firm linkages and the mobility of qualified labour. Arrival alone produces no economic effect; conversion depends on the absorptive capacity of the receiving territory, represented in the model as a moderating block acting on the transmission stage. Where absorptive capacity is adequate, adoption raises productivity in the receiving region, and the accumulation of such gains across territories yields convergence in regional productivity and a narrowing of income differences. The structure explains why aggregate innovation performance and territorial equalisation may move independently, and it identifies the moderating block as the point of highest policy leverage.

Placing the empirical evidence within the model produces a consistent interpretation. The improvement in output performance relative to input performance corresponds to a strengthening of the transmission and absorption stages. The strong position in the business environment sub-pillar corresponds to reduced friction in the adoption decision at firm level across all territories. Sustained educational expenditure corresponds to the progressive reinforcement of the moderating block. The remaining rank distance corresponds to the portion of the conversion process that further institutional and infrastructural development can still improve. The analytical picture is therefore one of a system advancing along the

² Developed by the author on the basis of the regional innovation system approach [10]

trajectory that theory identifies as the productive one, with clearly located opportunities for additional gain.

Comparative evidence supports the general applicability of this reading. The finding that productivity disparities within countries commonly exceed those between countries, and that sectoral reallocation toward tradable and technologically dynamic activities raises overall productivity growth in non-metropolitan territories, indicates that the diffusion channel retains substantial potential even in economies with long-established regional policies [20]. For a country whose conversion capacity is improving from a lower base, the potential is correspondingly greater, and the evidence assembled here suggests that it is already being realised.

CONCLUSION AND SUGGESTIONS

The article established that the contribution of innovation to the reduction of interregional economic disparity depends less on the aggregate volume of innovative activity than on the effectiveness with which that activity spreads across the national territory. Diffusion effectiveness was conceptualised as a chain comprising generation, transmission and absorption, and was operationalised through the ordinal distance between the input and output subindices of the Global Innovation Index. Application of the framework to Uzbekistan produced a consistently favourable result: the overall index position improved from 93rd to 79th between 2020 and 2025, output performance improved at more than twice the rate of input performance, and the input-output rank distance contracted from thirty-seven to twenty-three positions [16]. The national innovation system therefore strengthened its conversion capacity, which constitutes the precise property on which territorial equalisation depends.

Several recommendations follow directly from the analysis and are formulated to build upon the progress already achieved.

1. Consolidating the observed gain in conversion capacity through the establishment of regional technology transfer offices attached to universities and research organisations located outside the principal agglomerations, so that the transmission stage acquires permanent institutional carriers in every territory.

2. Expanding gross domestic expenditure on research and development along a planned multi-year path, with a defined share allocated to applied projects conducted jointly by regional higher education institutions and enterprises, thereby directing incremental resources into the stage of the chain that currently offers the highest marginal return [18].

3. Reinforcing the educational financing effort that already places the country among the leading performers on this indicator, with emphasis on engineering, digital and managerial competences in regional institutions, since the absorptive capacity block of the model is built primarily through qualified personnel [17].

4. Extending high-capacity digital connectivity across all territorial units as a transmission channel of first importance, given that spatial spillovers attenuate with distance and that digital infrastructure substantially reduces the effective distance between the innovation core and peripheral regions [15].

5. Applying the smart specialisation logic to regional development programmes so that each territory concentrates support on domains in which it possesses demonstrable

comparative capability, which raises the probability that arriving knowledge encounters a productive structure prepared to use it [14].

6. Developing regionally disaggregated innovation statistics that record adoption, patenting, technology licensing and research expenditure at the level of individual territorial units, thereby enabling direct measurement of diffusion effectiveness and replacing ordinal proxies with cardinal indicators.

7. Strengthening the business environment advantage recorded in international assessment through continued simplification of enterprise procedures in regional centres, since the adoption decision remains fundamentally an economic calculation responsive to transaction costs [5].

8. Establishing interregional innovation partnerships that link enterprises and research organisations across territorial boundaries, thereby converting the distance-decay property of spillovers from a constraint into a manageable design parameter of national innovation policy [12].

Implementation of these measures would operate on the transmission and absorption stages simultaneously, which the analysis identified as the points of highest leverage within the diffusion chain. The evidence assembled here indicates that the national innovation system has already moved decisively in this direction, and that the conditions for continued convergence between territories are being established through a coherent and internationally recognised reform trajectory. Subsequent research should extend the framework by constructing a regionally disaggregated diffusion index, which would permit econometric estimation of the relationship between diffusion effectiveness and the rate of interregional convergence..

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