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ASSESSING THE ROLE OF SPECIAL ECONOMIC ZONES IN REGIONAL ECONOMIC GROWTH ACROSS THE REGIONS OF UZBEKISTAN USING INTENSITY COEFFICIENTS AND CLUSTER ANALYSIS

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Abstract. This article evaluates the role of special economic zones (SEZs) in regional economic growth, using the regions of the Republic of Uzbekistan as a case. Rather than in absolute values, SEZ indicators are measured as intensity coefficients relative to the overall economy of each region, which removes the effect of regional size. Drawing on data for 2018–2024, two composite indices were constructed – the role of the SEZ in the economy and the growth of that role – and the regions were grouped into clusters using the k-means and hierarchical methods. Four strategic groups emerged: leading, developing, stabilized, and underdeveloped regions. The analysis shows that SEZ effectiveness is sharply differentiated across regions and that there are substantial differences in how investment is converted into production.

Keywords: special economic zone, regional economy, cluster analysis, k-means, intensity coefficient, economic growth, Uzbekistan.

Аннотация. В статье на примере регионов Республики Узбекистан оценивается роль специальных экономических зон (СЭЗ) в региональном экономическом росте. Показатели СЭЗ измеряются не в абсолютных значениях, а в виде коэффициентов интенсивности по отношению к общей экономике региона, что исключает влияние размера территории. На основе данных за 2018–2024 годы были составлены два композитных индекса (роль СЭЗ в экономике и рост этой роли), а регионы были разделены на кластеры с использованием k-means и иерархических методов. В результате были определены четыре стратегические группы. Это ведущие, развивающиеся, стабилизированные и слабоактивные регионы. Анализ показывает, что эффективность СЭЗ сильно дифференцирована по регионам и существуют значительные различия в преобразовании инвестиций в производство.

Ключевые слова: специальная экономическая зона, региональная экономика, кластерный анализ, k-means, коэффициент интенсивности, экономический рост, Узбекистан.

INTRODUCTION

Special economic zones (SEZs) are an instrument of regional economic policy designed to attract investment, promote exports, and create jobs through tax, customs, and administrative preferences. Over the past few decades they have become an important engine of industrialization and economic diversification in many developing countries. In Uzbekistan the SEZ network has expanded rapidly, particularly since 2017, and today one or more zones operate in most regions of the country. This makes it a pressing task to assess, on a sound analytical basis, the real contribution these zones make to regional economic growth.

Worldwide, the number of SEZs has grown sharply in recent decades, and today thousands of zones operate in more than a hundred countries. They serve as a means of integrating into global production chains, diversifying exports, and transferring technology. Yet the gap between their theoretical potential and their actual results – that is, why some zones succeed while others fail – remains a central debate in the literature.

LITERATURE REVIEW

The economic impact of SEZs can be explained through several theoretical lenses. According to the theory of agglomeration economies, the dense concentration of firms in one location lowers transaction costs, accelerates the exchange of knowledge and technology, and raises productivity. François Perroux's theory of "growth poles"

holds that investment and industrial activity concentrated in particular places spill over into the surrounding space and stimulate regional growth. Michael Porter's concept of the "economic cluster" shows that the geographic concentration of interrelated industries enhances competitiveness. A terminological distinction must be drawn here: a cluster in Porter's sense is a real economic phenomenon, whereas the "cluster analysis" used in this article is a statistical method that groups regions by their similarity. The two are related but not identical.

Although Uzbekistan's first major free economic zone was established in the Navoi region in 2008, the SEZ network developed on a large scale mainly after 2017. Zone residents are today offered tax and customs preferences, simplified administrative procedures, and infrastructure support, with the duration of incentives ranging from three to ten years depending on the volume of investment. The zones are oriented toward promoting innovative, high-technology, export-oriented, and import-substituting production. Assessing the real impact of this policy on regional growth, however, requires quantitative analysis.

International experience has accumulated a rich but uneven body of evidence on the economic effects of SEZs. Studies of Chinese municipalities show that establishing zones significantly raises local economic activity and total factor productivity [4, 7]. When India's 2005 SEZ policy was analyzed using satellite imagery, the zones were found to have boosted economic activity not only within their boundaries but also in the surrounding areas [5]. A recent study of Laos, in turn, emphasizes that the positive effect of SEZs depends on the presence of a unified legal framework, a clear strategy, and institutional support [6].

At the same time, Thomas Farole's comprehensive study of African SEZs advances an important conclusion: a zone's success depends less on tax incentives than on the reliability of infrastructure and the quality of the national investment climate, while incentives by themselves produce no measurable effect [1, 2]. The underperformance of many zones is attributed to high start-up costs, weak local governance, and a lack of integration [3]. This evidence calls for viewing SEZs not as automatic sources of growth, but as instruments that work only when properly managed.

A national literature on Uzbekistan's SEZs is also taking shape. A number of studies note the positive role of zones in attracting investment, diversifying industrial production, and raising employment [8, 9, 11]. Some authors examine the geographic and institutional factors that limit the inflow of foreign direct investment into the zones [10], while others show that zone effectiveness depends not only on incentives but also on digital governance and administrative efficiency [12, 13]. A United Nations Development Programme report analyzes the problems of Uzbekistan's SEZs in light of the experience of developed countries [14].

Most existing national studies, however, assess SEZ effectiveness mainly through absolute indicators – the volume of investment or exports – and do not consider the zones in relation to the overall economic potential of the region. Under this approach a large region appears to be a leader automatically, even if the SEZ accounts for only a small share of its economy. Moreover, the cluster-analysis methods widely used in regional economics [15, 16] have scarcely been applied in the context of Uzbekistan's SEZs. Filling precisely this gap is the aim of the present study.

The scientific novelty of the study is that, for the first time, it assesses the effectiveness of Uzbekistan's SEZs relative to the overall economy of the region – through intensity coefficients and a two-dimensional (role and growth) cluster approach. This matters in a setting of regional inequality: the economic differences among Uzbekistan's regions are substantial, and SEZs are also regarded specifically as a tool for accelerating less-developed regions. Measuring the relative role of an SEZ in each region's economy is therefore more meaningful for policy than measuring its absolute scale.

The aim of the study is to group the regions of Uzbekistan by the relative role of SEZs in their economies and the growth of that role over 2018–2024, and on this basis to identify the regional differentiation of zone effectiveness. Two main questions are addressed: (1) in which regions' economies do SEZs play a real and growing role; and (2) into what strategic groups can the regions be divided, and what do these groups mean from a policy standpoint?

RESEARCH METHODOLOGY

The analysis draws on data from the National Statistics Committee of the Republic of Uzbekistan [17]. The database contains SEZ-related and general economic indicators for 14 regions (the Republic of Karakalpakstan, 12 provinces, and the city of Tashkent) for the years 2018–2024.

The years 2018 and 2024 were chosen as the endpoints of the analysis. 2018 reflects the baseline situation before the expansion of the SEZ network, while 2024 reflects the most recent complete data available. The difference between these two points serves as the basis for measuring the growth of the SEZ role.

Thirteen regions were taken for clustering. The city of Tashkent was excluded because it has no SEZ on its territory and all its SEZ indicators equal zero, which makes clustering this unit meaningless.

To remove the effect of regional size, each SEZ indicator was computed as a share of the region's corresponding general indicator (with units of measurement made consistent):

- Production share = SEZ output / GRP;
- Jobs share = SEZ jobs / total employment;
- Investment share = SEZ investment / total investment.

Because the three shares fall in different ranges, they were first standardized, and their average was used to build two indices. The Role index is the standardized average of the three shares in 2024 (the current relative weight of the SEZ in the region's economy). The Growth index is a standardized average based on the change in these shares between 2018 and 2024 (the dynamics of the SEZ role).

Combining the three shares into a single measure poses a problem: they are of different magnitudes. The production share, for instance, reaches tens of percent, whereas the jobs share is usually below one percent. If left as they are, the largest figure would dominate the rest. To prevent this, each share was converted into a "z-score" – a measure of how far above or below the average a given region lies. The three indicators then carry equal weight, which is why the indices in the table take positive (above-average) or negative (below-average) values.

For some SEZs the 2018 values were zero. Growth from a zero base cannot be expressed as a percentage, since division by zero is impossible. Growth was therefore measured not as a percentage but as the simple difference in shares – the 2018 share subtracted from the 2024 share. In this way division by zero never arises, and all regions are assessed in the same manner.

On the basis of these two measures, the regions were grouped (clustered) by their similarity to one another using the k-means method: similar regions fall close together, dissimilar ones far apart. The number of groups was chosen with the silhouette coefficient, which gauges how clearly the groups are separated – the higher its value, the more distinct the groups.

To check that the result was reliable, an entirely different method – hierarchical clustering – was also applied. The two methods produced almost identical results, with an agreement of 0.88 (where 1 denotes complete agreement). This indicates that the groups found are not accidental.

ANALYSIS AND RESULTS

Between 2018 and 2024 the overall indicators of Uzbekistan's SEZs grew considerably; in most regions the zones' shares of production, investment, and employment rose from zero or from very low levels. This growth, however, was distributed very unevenly across regions – and it is precisely this unevenness that is the principal subject of the cluster analysis.

Figure 1 shows the three intensity shares by region for 2024. SEZ intensity is clearly differentiated across regions: in Jizzakh the SEZ's output relative to GRP is the highest (34%); in one group of regions the investment share leads (Bukhara – 12.7%, Samarkand – 9.5%); and in most regions all three shares remain low (Figure 1).

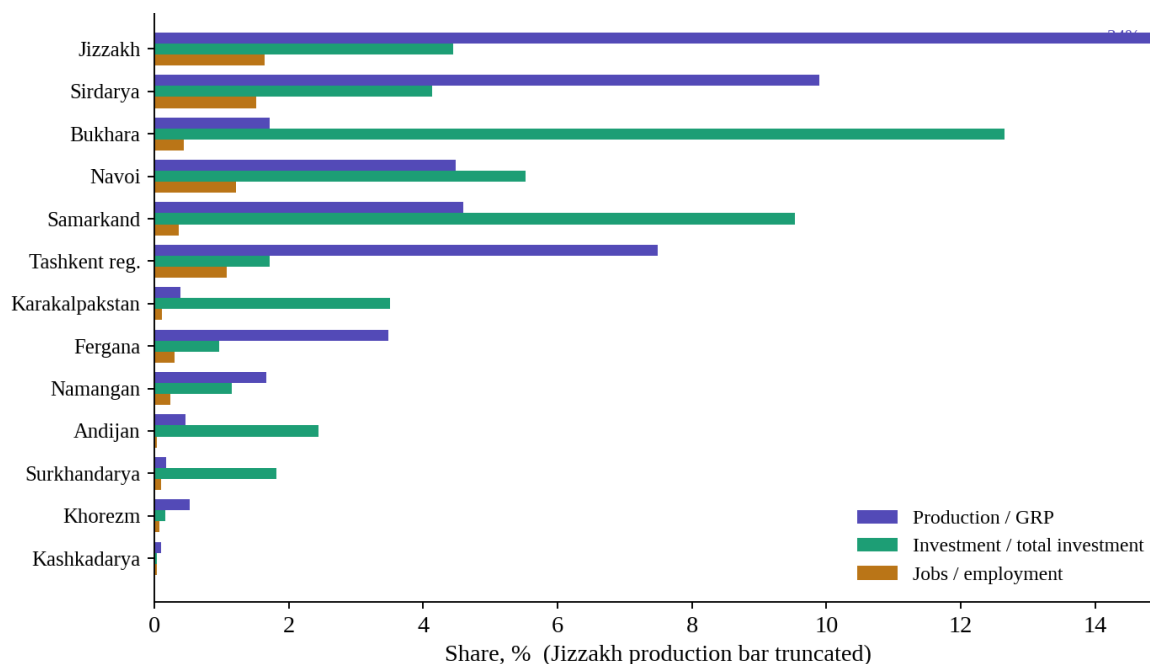


Figure 1. SEZ intensity by region: the three share indicators in 2024, %¹

¹ Source: authors' calculations based on data from the National Statistics Committee.

The figure shows that regions do not line up in the same order across the three indicators. Some lead on the investment share but lag on production, while others lead on production and jobs. This imbalance reflects different stages of SEZ development and is precisely why it is appropriate to combine the three shares into a single composite index.

The silhouette coefficient was highest at $k = 2$ and $k = 3$ (0.66 and 0.62, respectively) and stood at 0.50 at $k = 4$. This means the strongest natural structure in the data consists of three groups. Because it is important from a policy standpoint to distinguish “rising” regions from “stable but slowing” ones, however, four clusters ($k = 4$) were adopted as the final solution. The agreement between the k-means and hierarchical methods was high ($ARI = 0.88$), confirming the stability of the clusters.

Figure 2 positions the regions along two axes – the role of the SEZ in the economy (horizontal) and the growth of that role (vertical). This map answers the central question of the study directly (Figure 2).

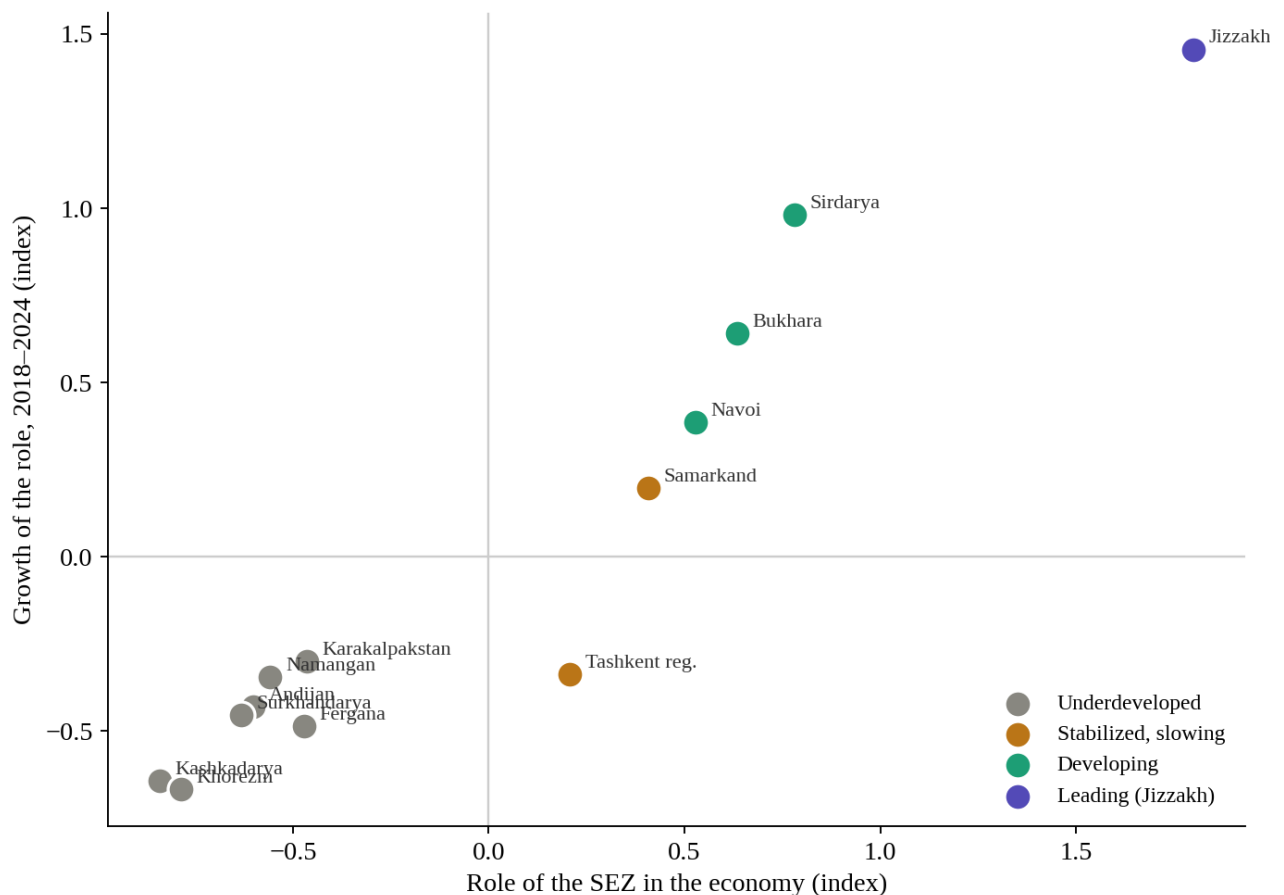


Figure 2. Positioning of regions by the role of the SEZ in the economy and its growth²

The map can be read in terms of four quadrants. The upper-right quadrant holds regions where the SEZ's role is both high and growing (Jizzakh, Sirdarya, Bukhara, Navoi) – the most effective situation. The lower-right quadrant holds regions where the role is high but growth has slowed (Tashkent region), signaling stabilization or stagnation. The lower-left quadrant holds regions where the role is both low and slow-growing, where the SEZ does not yet play a real part. Such a quadrant analysis helps make policy measures precisely targeted.

The dendrogram in Figure 3 shows the structure of similarity among the regions. The largest jump lies between heights 3 and 6, indicating that the natural structure of the data supports above all three large groups; the fourth cluster splits the high-level group of five into two (Figure 3).

² Source: authors' calculations based on data from the National Statistics Committee.

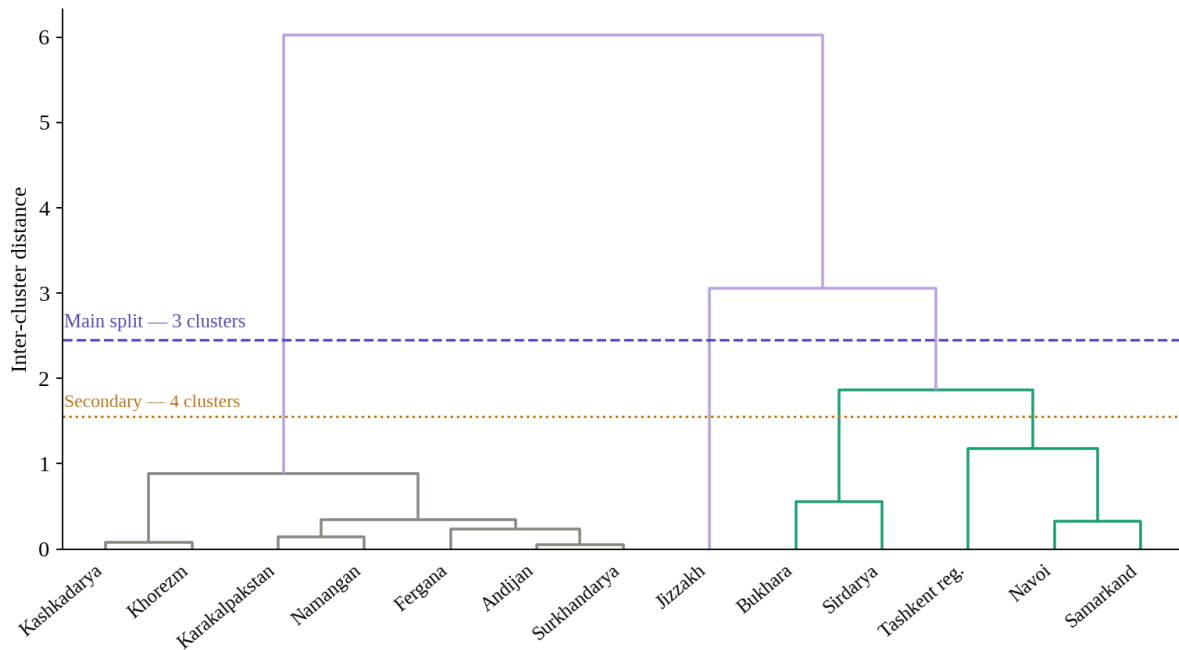


Figure 3. Hierarchical clustering of the regions (Ward's method)³

The full composition of the clusters and their main indicators are presented in Table 1.

Table 1
Cluster results and SEZ intensity indicators (2024)⁴

Region	Cluster	Production share, %	Jobs share, %	Investment share, %	Role index	Growth index
Jizzakh	Leading	34.02	1.64	4.45	1.80	1.46
Sirdarya	Developing	9.90	1.51	4.13	0.78	0.98
Bukhara	Developing	1.72	0.44	12.66	0.63	0.64
Navoi	Developing	4.49	1.21	5.52	0.53	0.38
Samarkand	Stabilized	4.60	0.37	9.53	0.41	0.20
Tashkent	Stabilized	7.49	1.07	1.71	0.21	-0.34
Karakalpakstan	Underdeveloped	0.39	0.10	3.50	-0.46	-0.30
Fergana	Underdeveloped	3.49	0.30	0.96	-0.47	-0.49
Namangan	Underdeveloped	1.66	0.24	1.15	-0.56	-0.34
Andijan	Underdeveloped	0.47	0.04	2.44	-0.60	-0.43
Surkhandarya	Underdeveloped	0.18	0.10	1.81	-0.63	-0.45
Khorezm	Underdeveloped	0.52	0.08	0.16	-0.79	-0.67
Kashkadarya	Underdeveloped	0.09	0.03	0.03	-0.84	-0.64

The four groups can be described as follows. Leading (Jizzakh). The single exception that stands out sharply from all other regions in both the relative role and the growth of the SEZ. Its production intensity is the highest and is rising rapidly – the clearest example of what an SEZ's role can be.

Developing (Sirdarya, Bukhara, Navoi). The SEZ share is both above average and growing steadily. In these regions the SEZ has become a real and expanding part of the economy.

Stabilized, slowing (Samarkand, Tashkent region). The SEZ share is above average, but the pace of growth has slackened. Notably, in the Tashkent region the SEZ investment share fell from 7.1% in 2018 to 1.7% in 2024.

³ Source: authors' calculations based on data from the National Statistics Committee.

⁴ Source: authors' calculations based on data from the National Statistics Committee.

Underdeveloped (Karakalpakstan, Andijan, Namangan, Kashkadarya, Surkhandarya, Fergana, Khorezm). These seven regions are below average on both measures. The SEZ does not yet play a significant role in their economic growth.

In sum, in only four of the thirteen regions (Jizzakh, Sirdarya, Bukhara, Navoi) is the SEZ's role both above average and growing. The real effect of the country's SEZ policy is, for now, concentrated in a small group of regions, with untapped potential in the rest.

The results show that the role of Uzbekistan's SEZs in the regional economy is developing along diverse regional trajectories. The economic impact of SEZs has already reached a significant level in several regions, while in many others the zones are progressing through an active development stage and possess substantial growth potential. This is consistent with views in the international literature: the effectiveness of an SEZ is enhanced by strong infrastructure, high-quality governance, and a favorable national investment climate [1, 3, 6].

A particularly noteworthy case is the relationship between investment and production. In the Bukhara region, for example, the investment share is the highest (12.7%), creating a strong foundation for future production expansion, while the production share currently stands at 1.7%. This suggests that the capital invested in the SEZ is in the process of being transformed into production capacity and is expected to generate increasing results over time. Studies of the Chinese experience likewise note that the effect of SEZs strengthens gradually over time [4].

The sharp decline in the SEZ investment share in the Tashkent region, by contrast, reflects a different tendency: a slowing of growth in mature zones. This points to a "stable but at risk of stalling" situation and may call for additional incentive measures.

The findings also connect with the existing national literature. A number of studies have noted, in general terms, the positive role of zones in investment and exports [8, 9, 11]. The present analysis differentiates that role quantitatively across regions, showing where it is real and where it remains nominal. The conclusion that zone effectiveness depends not only on incentives but also on the quality of governance and administrative efficiency [12] is likewise consistent with our results: the late arrival of the production effect even in some high-investment regions may point to obstacles at the governance and implementation stage.

Jizzakh's high production share (34%) is high precisely because it measures gross output against value added. It confirms that the Jizzakh SEZ is indeed the region's largest industrial center, but it does not mean that the zone accounts for a quarter of the economy.

The sharp differentiation among regions is also consistent with international evidence: the effect of SEZs is not uniform and is higher where institutional and infrastructural conditions are strong [1, 6]. For Uzbekistan, too, this shows that effectiveness is achieved not merely by opening new zones or expanding incentives, but by strengthening governance, infrastructure, and supply chains in existing zones.

From the standpoint of growth-pole theory, Jizzakh and the other developing regions may act as potential growth poles – the economic activity concentrated in them is expected to spread over time to surrounding areas. This spillover is not automatic, however; it depends on transport connectivity, integration with suppliers, and labor mobility. Strengthening the economic links that connect underdeveloped regions to the leaders is therefore of particular importance.

Methodologically, the intensity approach corrects an important shortcoming of conventional assessment based on absolute indicators: it removes the effect of regional size and reveals the true relative weight of the SEZ. The high agreement of the cluster analysis across two independent methods (k-means and Ward, ARI = 0.88) confirms that the groups found are not accidental.

The two-dimensional "role × growth" framework used here also has practical value for regional policy. It positions each region along two questions at once: how important is the SEZ now, and is it becoming more important faster? Such two-dimensional assessment gives a fuller picture than approaches that rely on a static share alone or on a growth rate alone, and it makes it possible to direct resources to the regions where they yield the greatest return.

CONCLUSION AND RECOMMENDATIONS

The study grouped the regions of Uzbekistan into four strategic clusters according to the relative role of SEZs in their economies and the growth of that role: leading (Jizzakh), developing (Sirdarya, Bukhara, Navoi), stabilized and slowing (Samarkand, Tashkent region), and seven underdeveloped regions. The main conclusion is that the role of SEZs in regional economic growth has already achieved tangible significance in a number of regions and demonstrates considerable opportunities for further expansion and strengthening across the remaining regions.

The results suggest several directions for practical policy. The experience of the leading and developing regions – especially the mechanisms for converting infrastructure and investment into

production – can be transferred, in adapted form, to the underdeveloped regions. Where there is a large gap between investment and production (for example, Bukhara), attention should focus on converting capital into real production capacity. In zones whose growth is slowing, measures to reinvigorate growth are needed.

First recommendation – a differentiated approach. Rather than a uniform policy for all regions, it is advisable to apply measures suited to each cluster: in underdeveloped regions the main focus should be on building infrastructure and governance capacity, and in developing regions on supporting the growth already under way.

Second recommendation – assessing effectiveness through relative rather than absolute indicators. If intensity coefficients (the SEZ's share in the region's output, employment, and investment) are calculated regularly in monitoring zone activity, as a complement to absolute volume indicators, regions can be compared fairly.

Third recommendation – monitoring the conversion of investment into results. In regions with high investment but low production, the time and obstacles involved in converting capital into production capacity should be monitored separately, and support that accelerates implementation should be provided where necessary.

Overall, cluster analysis has proved to be a tool that objectively reflects the current state of Uzbekistan's SEZ policy: it has quantified the regional unevenness of zone effectiveness and provided a basis for defining an appropriate policy direction for each region. The approach based on intensity coefficients, in turn, has removed the effect of regional size and made the assessment fairer. This methodology can also be used in future for regular monitoring and for evaluating other regional-policy instruments.

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