



## Economic Security Management in Regions with Weak Economies in the Conditions of Digital Transformation

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**Abstract.** This study aimed to examine the dynamics of economic security management in regions with weak economies amid digital transformation, focusing on an empirical analysis of economic security indicators across ten regions of the Russian Federation from 2017 to 2022. The study adopted quantitative metrics, such as the Economic Diversification Index (EDI), the Quality of Economic Growth Index (QEGI), and the Digital Transformation Index (DTI). The result showed significant heterogeneity in the impact of digitalization on regional economic security. All analyzed regions maintained economic diversification within non-crisis thresholds. However, a concerning trend has become evident in several regions, which experienced sectoral stagnation. By 2022, QEGI has declined to crisis levels, showing a deteriorating quality of economic growth. This trend was further increased by the pandemic, leading to significant shifts in the quality of entrepreneurial activity and population well-being, with some regions witnessing up to a 30% decline in the latter. A 2022 cluster analysis identified two distinct clusters that represented the varied influence of digital transformation on economic security. In regions where digitalization was effectively harnessed, economic security experienced a significant increase of up to 25% in the DTI, which correlated with positive shifts in economic stability and growth. Conversely, regions lagging in digital adoption faced compounded economic challenges, showing the critical role of qualitative growth strategies and digital competencies in securing economic resilience. This study shows the significant role of digital transformation as both a strategic and a differential factor in bolstering the economic security of regions with inherently weak economies. Furthermore, digital transformation offers insights into the nuanced interplay between digitalization and regional economic policies.

**Keywords:** Digital transformation; Economic security; Management; Regions with weak economy; Resilience

### 1. Introduction

Ensuring the economic security of regions is an important direction in the national security strategy of many countries ([Avduevskaya, Nadezhina, and Zaborovskaia, 2023](#);

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Khaykin and Babkin, 2022; Bezdenyevnykh, Pecheritsa, and Sharafanova, 2021; Feofilova, Radygin, and Litvinenko, 2021; Akberdina and Smirnova, 2018). In regional management practices, there is a lack of a unified system to manage risks and threats to economic security (Krasnoselskaya and Mamatelashvili, 2017). Federal and regional strategic documents establish a broad framework for regional management, yet global and local changes have diverse effects on the socio-economic systems of these regions (Kuzior, Arefiev, and Poberezhna, 2023; Kuznetsova and Ivanov, 2023; Doszhan *et al.*, 2022; Burström *et al.*, 2021; Fedorov *et al.*, 2021; Bencsik, 2020; Susur, Hidalgo, and Chiaroni, 2019; Kuklin, 2017; Pita, Cheong, and Corbitt, 2013). According to previous studies, the increased processes of digital transformation allowed some regions to reduce evident developmental disparities (Akbar and Tracogna, 2022; Agus *et al.*, 2021; Surovitskaya, 2021; Albukhitan, 2020; Karanina and Sobolevskaya, 2020; Chanias, Myers, and Hess, 2019; García-Esteban *et al.*, 2018). However, this digital transformation has a distinct effect on economic security (Gangopadhyay, Suwandar, and Bakry, 2021). The achievement of quantitative-values listed in strategic documents does not necessarily translate to qualitative regional development (Koroleva, 2021).

A distinctive feature of regions with weak economies is the unexplored potential, which has been altered by various unfavourable factors. Therefore, studying economic security in the context of digital transformation will show the regions that perceive digitization as an additional tool for the development and stabilization of economic security (Shinshinov and Vasilieva, 2023; Song *et al.*, 2023; Tret'yakova, Lavrikova, and Azarova, 2023).

Considering the geographical and climatic conditions of most economically weak regions, there is a need to objectively assess how quantitative data accurately reflects the on-ground situation in these regions (Cao and Wyatt, 2020; Landucci, Khakzad, and Reniers, 2020; Chang and Khan, 2019). In this context, it is important to recognize that digitalization processes will be uneven when evaluating indicators of digital transformation (Vlasov *et al.*, 2022). Most of the disparity arises from the existing developmental level of the industry (Vysikantsev, Kambarov, and Novikov, 2023; Narwaria, 2019).

The study addressed the problem of managing economic security in regions with weak economies during digital transformation. This study is important due to the exploration of the influence of digitalization on economic resilience and growth of vulnerable regions, showing potential strategies for overcoming the challenges.

The main objective is to examine the challenges and factors of managing economic security in digitally transforming regions, characterized by weak economies. The key questions addressed by the study include:

1. How have economic security indicators evolved across regions with weak economies?
2. What are the distinct factors influencing economic security in these regions, as identified by the cluster analysis?
3. How does digital transformation impact the economic security of these regions, especially in the context of their socio-economic challenges?

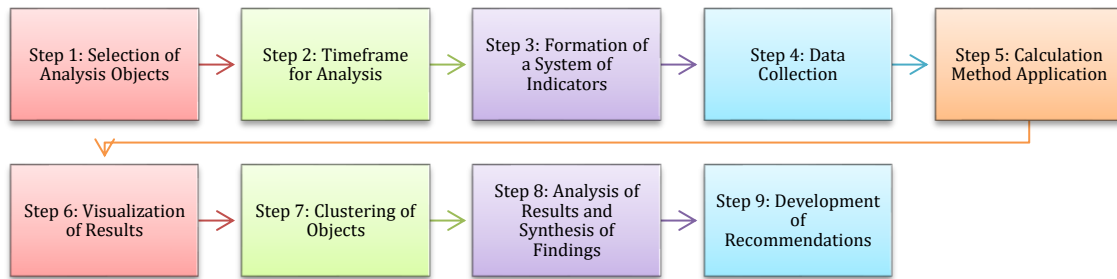
An in-depth analysis and evaluation of economic security indicators were conducted across ten regions of the Russian Federation with weak economies from 2017 to 2022. This includes a cluster analysis to identify distinct factors influencing economic security. The impact of digital transformation on these regions was also addressed, showing the importance of enhancing economic security despite socio-economic challenges.

The novelty of this study is the in-depth examination of the influence of digital transformation on economic security in regions with weak economies, focusing on the distinct effects of digital technologies on regional development and crisis mitigation. This

method provides new insights into the role of digital transformation in enhancing economic resilience, beyond the scope of previous study.

## 2. Methods

The methods include a combination of quantitative and cluster analysis, as well as qualitative synthesis to investigate the economic security of regions with weak economies during digital transformation, as shown in Figure 1. Table 1 shows the overview and breakdown of the study method.



**Figure 1** The study methodology framework

**Table 1** System of indicators for calculations of regions' economic security

Indicator	Notation	Formula for calculation	
1 Quality of Economic Growth Indicator (QEGI)	X1	$QEGI = \sqrt{\frac{I_{in} * I_{in}}{I_p * I_e}}$	lin – chain index of innovative production; lp – chain index of total production; le – chain index of capital investment
2 Quality of Entrepreneurial Activity Indicator (QEAI)	X2	$QEAI = \frac{kb}{k_i} * m$	kb – birth rate coefficient; ki – organization liquidation coefficient; m – financing index of entrepreneurship support programs
3 Economic Diversification Indicator (EDI)	X3	$EDI = \sqrt{\frac{\sum(d_1 - d_0)^2}{n}}$	d0 – value share of each GDP sector at the beginning of the period; d1 – value share of each GDP sector at the end of the period; n – number of economic sectors forming the GDP
4 Population Well-being Indicator (PWI)	X4	$PWI = \sqrt{\frac{d_w * I_{ip}}{d_p * I_{so}}}$	dw – proportion of the population with the highest incomes; dp – proportion of the population with the lowest incomes; lip – chain index of labor productivity; Iso – chain index of social payments from the budget

Step 1. The study targets ten Russian Federation regions identified as economically depressed, namely Adygea, Altai Territory, Kalmykia, Karelia, Kurgan regions, Mari El, Pskov regions, Tyva, Chuvashia, and Altai. The classification of regions as those with weak economies was based on low values of several indicators, namely capital investment, unemployment, and the proportion of the population with per capita incomes below the subsistence minimum (Oborin, 2021).

Step 2. Six years, from 2017 to 2022, were chosen to observe the changes in economic security indicators during digital transformation. Step 3. Four key indicators were established for calculating the economic security of the regions, as shown in Table 1. When the value of each indicator individually is below one, the regions are significantly influenced

by crises. The lower the indicator value, the higher the possibility of negative impacts. Any indicator reaching a value of one shows the regions' relatively stable development. Higher values show a lower influence of risks and threats on the regions.

Step 4. The key results of the analysis for each region from 2017 to 2022 were presented (Supplementary). Data was sourced from the Unified Interdepartmental Statistical Information System (EMIS) and the Expert RA rating agency, ensuring the analysis was grounded on official and reliable statistics.

Step 5. Considering that the selected regions for study belong to different federal districts and pertain to various natural and climatic zones, the study of economic security should not be based on comparison (Kyziiurov, 2021; Noskin, 2021). Alternatively, the study of economic security should aim to produce results that provide insights into both positive and negative influencing factors. Based on this reason, economic security was assessed by calculating the resulting indicators of regional cases (Tsvetkov, Dudin, and Lyasnikov, 2019). This method considers factors that can potentially form and destroy the level of economic security.

### 3. Results and Discussion

#### 3.1. Dynamics of economic security indicators in regions with weak economies in the Russian Federation in the period from 2017 to 2022

Each regions displayed unique trends in the four indicators but common patterns of fluctuation exist in QEGI and QEAI. The EDI remained relatively stable for most regions, while the PWI generally showed an upward trend, suggesting an improvement in the well-being of the population (Figure 2).

The Adygea experienced a decline in the QEGI from 2017 to 2022, with a major dip to 0.069 in 2022. The QEAI showed fluctuations, with a peak in 2017 and a decline in subsequent years. EDI remained relatively stable around 1.4 while PWI showed an increasing trend, suggesting an improvement in the well-being of the population over the years. The Altai Territory showed a fluctuating trend in QEGI, with a peak in 2021. Furthermore, QEAI showed a significant decline from 2017 to 2019, followed by an increase in 2020. The EDI remained fairly stable, with minor fluctuations while PWI showed a general increasing trend, suggesting an improvement in the well-being of the population. From 2017 to 2019, Kalmykia experienced an increase in QEGI, followed by a decline. The QEAI showed fluctuations, with a peak in 2018 while EDI showed a general increasing trend. PWI showed an upward trajectory, suggesting improved well-being. Karelia's QEGI showed fluctuations, with a peak in 2022 and QEAI experienced a decline from 2017 to 2019, followed by an increase. EDI remained relatively stable and PWI showed a consistent increase, suggesting improved well-being. The Kurgan regions showed a relatively stable QEGI, with minor fluctuations. Furthermore, QEAI showed a decline from 2017 to 2019, followed by an increase and EDI remained stable, while the PWI showed a general upward trend. The Mari El's QEGI showed fluctuations, with a peak in 2018 while QEAI experienced a decline from 2017 to 2019, followed by an increase. The EDI remained relatively stable, while the PWI showed fluctuations with a general upward trend.

The important results include the identification of fluctuations in the QEGI and QEAI across most regions from 2017 to 2022. Meanwhile, the EDI remained stable, while PWI showed a trend of increase. Unique trends in each region were identified for all four indicators, reflecting both improvements and deteriorations in economic security.



**Figure 2** The unique trends and common patterns of fluctuation of economic security indicators for ten regions with weak economies of the Russian Federation: Republic of Adygea, Altai Territory, Republic of Kalmykia, Republic of Karelia, Kurgan Region, Republic

of Mari El, Pskov Region, Republic of Tuva (Tyva), Chuvash Republic, Republic of Altay (top to bottom, left to right)

### *3.2. Distinctive factors affecting economic security in regions with weak economies, identified as a result of the 2022 cluster analysis*

Dendrograms, derived from cluster analysis conducted in 2022 to identify factors affecting economic security in depressed regions, are provided for each relevant economic indicator (Figure 3). The cluster analysis was conducted using IBM SPSS Statistics, using hierarchical clustering with the "Ward's method" based on the squared Euclidean distance. Variables included in the analysis were the resulting economic security indicators of the regions and two measures of digital transformation. Clustering was determined according to scaled distances, with larger and smaller distances forming fewer and greater numbers of clusters, respectively.

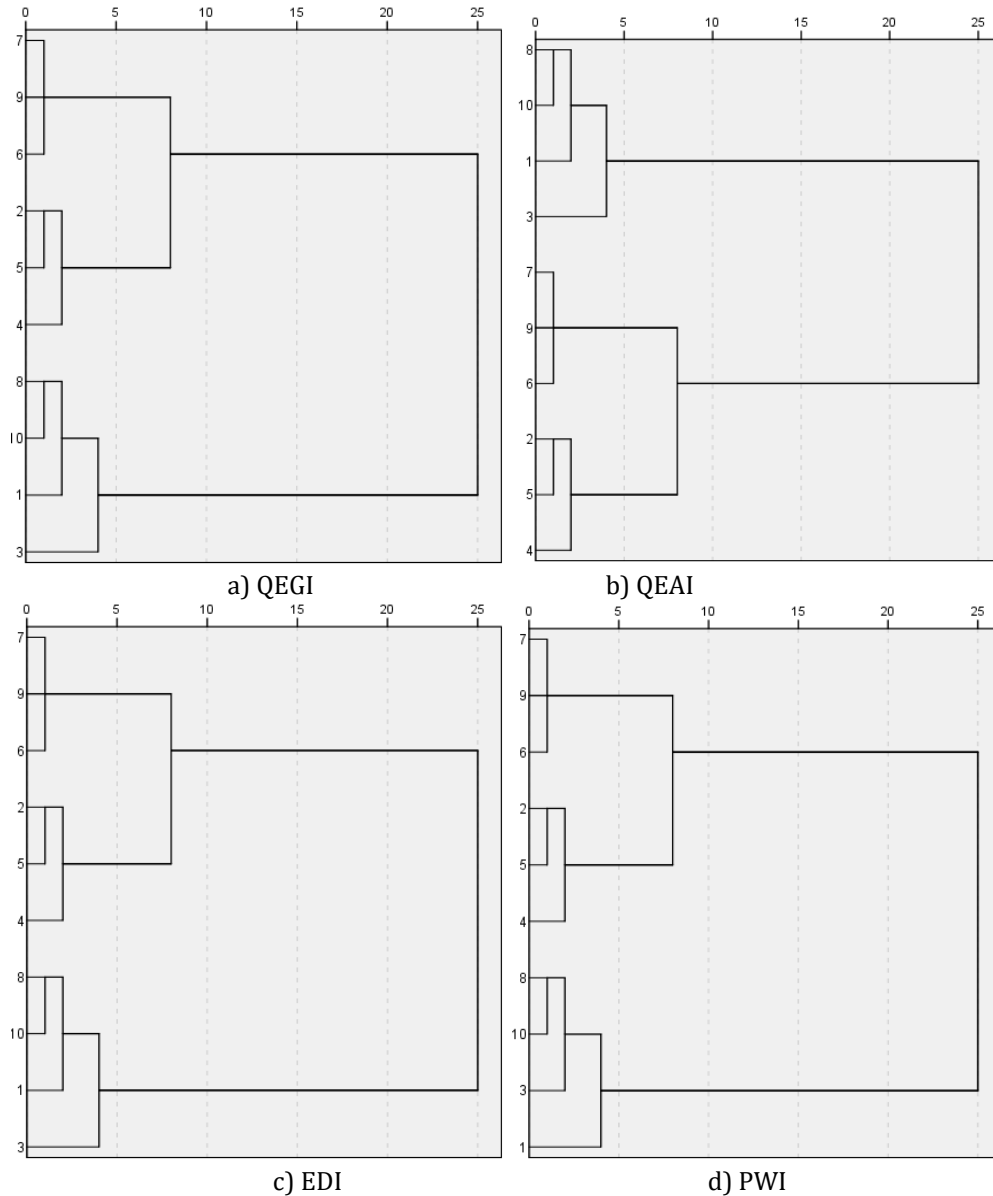
During the analysis of the QEGI and selected digital transformation indicators, two clusters were identified at a scaled distance of up to eight units during the analysis of QEGI, as shown in Figure 3a. In the regions comprising the first cluster, characteristic features include lower values of the digital transformation indicator, accounting for 84.1%. A factor logically connecting the influence of digital transformation on the quality of economic growth of the second cluster regions could be the low standard of living of the population. This is due to the insufficient development of real sector productions. The narrow specialization of industry directions does not allow for an increase in regional potential. However, the development can contribute to improving industry results.

At a scaled distance of eight units for the QEAI and selected digital transformation indicators, the list of regions of the two clusters matches the result of the previous indicator (Figure 3b). In the regions of the first cluster, the most evident unifying feature is the lowest values of the organization liquidation coefficient. The interpretation of indicator influence on the proportion of households provided with broadband access to the Internet on the QEAI is evident. Achieving an improvement in the state of the entrepreneurial structure is possible by increasing online sales with high values of the indicator. A negative factor in the first cluster regions is the lack of developed transport and road infrastructure, which meets the needs of sellers and buyers. Even achieving relatively high digitalization indicators among other studied depressive regions does not compensate for the low level of development of entrepreneurial structures. In the second cluster, a negative factor is the decline in the working-age population. To some extent, this trend is related to population migration to more developed regions.

At a level of eight units of scaled distance, two clusters were formed based on the EDI and selected digital transformation indicators, namely Figure 3c. The composition of the clusters is identical to the results of the two previously analyzed indicators. Due to the narrow specialization of industries requiring modernization, it is logical to consolidate conclusions for both clusters regarding influencing factors. A positive factor is the transition of socially significant state and municipal services to an electronic format, facilitating the process of document flow between participants. A negative factor is the insufficient effectiveness of households in applying information and communication technologies. This is evident in the fact that a quantitative increase in internet users does not always influence the qualitative application of capabilities.

The results of the cluster analysis for the PWI and selected digital transformation indicators are presented in the form of a dendrogram in Figure 3d. The negative factors influencing the regions of the first cluster include increasing transaction costs for the population (information search, contract conclusion) residing in areas where there are significant problems with or lack of internet access. Despite achieving 100% for the

indicator of the proportion of socially significant services available electronically, a clear question arises concerning the accessibility of using such social services in regions with limited internet access. This factor also applies to the second cluster, but the regions included have a higher value of the household internet access indicator. Another negative factor is the extremely low level of socio-economic development, and despite expanding digital opportunities, payment for digital services is not accessible for a certain category of the population. According to the socio-economic status of the regions in 2022 by the rating agency "Expert RA", the Adygea ranked 71<sup>st</sup>, and the other cluster regions ranked 82<sup>nd</sup> to 84<sup>th</sup>.



**Figure 3** The dendrograms for each resulting indicator of economic security in 2022 of ten regions with weak economies of the Russian Federation, where *notations: horizontally – association of clusters by scaled distance; vertically – number of depressed regions (1 – Adygea, 2 – Altai Territory, 3– Kalmykia, 4 – Karelia, 5 – Kurgan regions, 6 – Mari El, 7 – Pskov regions, 8– Tyva, 9 – Chuvashia, 10 – Altai)*

Based on the conducted cluster analysis, it was concluded that the distribution across clusters is consistent for all resulting indicators of economic security. After identifying factors of negative influence on economic security, a series of positive factors were also

determined, summarizing the results of the indicative analysis and cluster analysis. The factors of advanced digitalization processes had a positive influence on the regions forming the clusters Tyva (Tuva), Altai, Adygea, and Kalmykia. Essentially, a foundation was laid for the development of digital infrastructure based on priority elements, such as the installation of fiber-optic communication lines, the development of platforms, and other electronic services for organizing the provision of various social services. For the regions forming the other cluster, Among the factors of positive influence, in the regions forming the other clusters, the digitalization process and achieved level of socio-economic development was significantly higher than the previously mentioned four regions. A distinctive feature of the factors ensuring economic security for the Pskov, Chuvashia, Mari El, Altai Territory, Kurgan, and Karelia regions is the accumulation of potentials, aimed at improving socio-economic development. For the Tyva (Tuva), Altai, Adygea, and Kalmykia, the key factor is the qualitative implementation of digitalization processes.

The important results in this study include the identification of two main clusters for each economic security indicator, showing the impact of digital transformation and other factors. This study showed the influence of digital transformation on economic security, with low levels of digitalization in some regions correlating with narrow industrial specialization and insufficient development of the real sector.

### *3.3. Impact of digital transformation on the economic security of regions with weak economies of the Russian Federation in the context of their socio-economic problems*

Several critical issues and opportunities were found in the detailed analysis of socio-economic problems in the context of digital transformation's impact on regions with weak economies in the Russian Federation. In Tyva, the rudimentary state of transportation infrastructure is a significant impediment to the advancement of digital transformation, which is essential for the socio-economic upliftment. The region's reliance on coal is a double-edged sword having significant economic burdens and environmental concerns. However, the energy sector showed a substantial opportunity for digital initiatives that could lead to increased growth in the Gross Regional Product (GRP). Several initiatives, such as the introduction of digital substations, aimed to augment the efficiency and accessibility of the electricity supply. The concept of digital energy products could potentially reduce existing logistic and production obstacles. In the Altai regions, the prevailing issue is the low level of disposable income, presenting a considerable socio-economic challenge.

The establishment of technoparks was viewed as a strategic intervention to address socio-economic issues and to act as a catalyst for digital transformation (Polyanin *et al.*, 2020). In Adygea, the agro-industrial complex is a cornerstone for digital advancements. This complex has prospects to evolve into technoparks and eventually a technopolis that revolves around fundamental clusters. Kalmykia's strategic focus was on the cultivation of digital competencies within its workforce. This was recognized as a critical step towards integrating digital transformation into its socio-economic fabric. Similarly, Pskov concentrated on the development of a workforce proficient in digital skills to increase digitalization in the regions. Chuvashia identified an opportunity in the existing industrial base to transition towards the production of microelectronics. This strategic move is integral to the country's import substitution strategy and represents a vital component of digital advancement. The creation of a special industrial production zone shows a supportive environment for economic growth. For regions with distinct geographical and sectoral identities, such as Mari El, Altai Territory, Kurgan regions, and Karelia, the unified recommendation was to leverage artificial intelligence technologies within the leading



regional industries. This strategy was aimed to drive modernization and enhance competitive edges.

The significant result of this study includes the impact of digital transformation on economic security. The result shows the challenges related to the need for industry modernization and effective use of digital services, as well as opportunities for improving economic security through infrastructure enhancement, service provision, and socio-economic development. The advantage of this method is the comprehensive and multi-dimensional analysis, which allows for a distinct understanding of the influence of digitalization on economic security. The detailed aspects of this advantage include holistic understanding, identification of challenges and opportunities, data-driven insights, regional and sectoral analysis, future-proofing economies, and policy implications.

#### 4. Conclusions

In conclusion, this study showed the primary challenges and determinants shaping the governance of economic security in economically fragile regions, as well as the significant role of digital transformation in improving economic resilience. The investigation exposed a widespread socio-economic development crisis across these regions, characterized by stagnation or decline in key indicators. Despite economic fragility, the resource potentials of the region's resource provided a beacon of hope for revitalizing development paths. However, current regional policies could not address the crisis effectively. Utilizing cluster analysis, this study identified crucial factors for enhancing economic security, showing the importance of methods designed for digital transformation based on each region's socio-economic status and resource base. Econometric analyses should be used by future studies to further explore these factors, considering the transformative potential of digital technologies on economic paradigms. While acknowledging the study's limitations, including the temporal focus and the intrinsic constraints of cluster analysis, the results had global implications for managing economic security in vulnerable regions. Finally, the necessity for regions-specific digital transformation strategies and the broader applicability of the study insights showed the universal relevance of digitalization in advancing economic security.

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