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MEASUREMENT AND ANALYSIS OF THE IMPACT OF DIGITAL ECONOMY ON ECONOMIC GROWTH IN SCO MEMBER STATES

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As a new economic form following the agricultural economy and industrial economy, the study of the economic growth path under the background of the digital economy is a key issue in this field. Since the SCO began to carry out cooperation in the field of digital economy in 2015, there has been limited research on the development and cooperation of the digital economy in the SCO member states. In order to fully demonstrate the impact of the digital economy on the economic growth of the SCO and its transmission path, this paper, based on the research results of predecessors, selected an analytical method combining theoretical analysis with empirical research, and effectively combined the digital economy with economic growth. That is, first focusing on the theoretical level of digital economy and economic growth, analyzing the current status of digital economic development in the SCO member states from a macro perspective, and then further constructing a digital economy evaluation index system, demonstrating and evaluating the impact level and transmission path of the digital economy on the economic growth of the SCO, and thus proposing targeted policy recommendations. On the one hand, this paper strives to further enrich the theoretical system of the digital economy, and on the other hand, it also attempts to provide certain decision-making references for the SCO to develop the digital economy and promote economic growth from a practical level.

Keywords: digital economy; economic growth; digital economic development; entropy weight method; SCO.

ИЗМЕРЕНИЕ И АНАЛИЗ ВЛИЯНИЯ ЦИФРОВОЙ ЭКОНОМИКИ НА ЭКОНОМИЧЕСКИЙ РОСТ В ГОСУДАРСТВАХ-ЧЛЕНАХ ШОС

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Как новая экономическая форма, следующая за аграрной экономикой и промышленной экономикой, изучение траектории экономического роста на фоне цифровой экономики является ключевым вопросом в этой области. С тех пор как ШОС начала осуществлять сотрудничество в области цифровой экономики в 2015 г., было проведено исследование развития и сотрудничества цифровой экономики в государствах-членах ШОС. Чтобы в полной мере продемонстрировать влияние цифровой экономики на экономический рост стран-членов ШОС и пути ее трансмиссии, в данной статье на основе предыдущих результатов исследования был выбран аналитический метод, сочетающий теорети-

ческий анализ с эмпирическими исследованиями, и эффективно объединил цифровую экономику с экономическим ростом. То есть, сначала сосредоточившись на теоретическом уровне цифровой экономики и экономического роста, проанализировав текущее состояние развития цифровой экономики в государствах-членах ШОС с макроэкономической точки зрения, а затем дополнительно построив систему индексов оценки цифровой экономики, продемонстрировав и оценив уровень воздействия и путь передачи цифровой экономики на экономический рост ШОС, и, таким образом, предложив целевые рекомендации по политике. С одной стороны, эта статья стремится еще больше обогатить теоретическую систему цифровой экономики, а с другой стороны, она также пытается предоставить определенные ссылки на принятие решений для ШОС, чтобы развивать цифровую экономику и содействовать экономическому росту с практического уровня.

Ключевые слова: цифровая экономика; экономический рост; цифровое экономическое развитие; метод энтропийного веса; ШОС.

Introduction. The development of economic growth theory has shown a profound evolution from exogenous drive to endogenous power, from quantitative accumulation to qualitative improvement. Its core lies in exploring the contribution mechanism of different factors to long-term growth. Economic growth theory has roughly experienced three paradigm revolutions from classical framework → neoclassical equilibrium analysis [1,2] → breakthrough of endogenous growth theory [3]. Initially, it focused on studying economic growth from a quantitative perspective, that is, first analyzing the theoretical model of economic growth, and then gradually turning to empirical economic growth research. With the changes in the economic environment, the academic community has shifted the perspective of economic growth research from the quantitative level to the qualitative level, paying more attention to the multidimensional and comprehensiveness of economic growth. The development of the digital economy has significantly increased the speed of knowledge accumulation and spillover, which is conducive to technological innovation and technological spillover, especially stimulating green technological innovation, thereby promoting the development of the green economy. Therefore, the endogenous growth theory is an important theoretical basis for the development of the digital economy. After the 1950s, with the rise of the exogenous economic growth model, the role of technological progress as the core driving force of economic growth has been fully affirmed, which further gave rise to the endogenous economic growth theory. Based on previous literature research, the factors affecting economic growth can be divided into two categories: one is the endogenous factors affecting economic growth, such as technological progress, capital investment, industrial structure, etc.; the other is the exogenous factors affecting economic growth, such as changes in demand, institutional changes, international trade, foreign investment, government debt, environmental pollution, and population aging.

Main part. As the expansion of the number of production factors becomes the core of economic growth, problems such as resource shortages, environmental damage, insufficient innovation, and unbalanced economic structure continue to emerge in practice [4]. The connotation of economic growth quality is the basis for studying economic growth issues. The academic research perspective on this issue is mainly divided into two measurement methods: narrow and broad [5].

Infrastructure differences have led to different levels of digital economic development and penetration among SCO member states. However, the SCO faces challenges in coordinating the development of digital economy among its member states. Differences in information and communication technology infrastructure, legal frameworks, and innovation potential have led to a stratified growth pattern, with developed economies (such as China and Russia) outperforming other member states, Central Asia in the context of globalization and the development of information technology, the digital economy is increasingly seen as an important indicator of national competitiveness [6].

Given the rich extension of economic growth in SCO member countries, its connotation can be defined by establishing a comprehensive indicator system. This study focuses on the heterogeneity of digital economic development in the SCO member states. By constructing a multidimensional evaluation index system, it aims to achieve the following three main goals:

1. Quantitative evaluation involves developing a comprehensive model covering six dimensions (digital infrastructure, industrial applications, innovation ecosystem, etc.) to reveal the spatiotemporal patterns of digital economic development in the SCO member states from 2005 to 2022;

2. Bottleneck identification involves diagnosing the key obstacles to digital transformation in lagging countries (for example, low dependence on ICT exports and insufficient venture capital in Central Asia);

3. Policy design proposes a multi-level cooperation strategy to narrow the regional digital divide and promote the SCO 2030 digital economy cooperation agenda. This paper focuses on measuring and evaluating the development of the digital economy in the ten SCO member states, and compares the existing development indicators in combination with the actual conditions of each country. In combination with the principles of easy to understand and comprehensiveness, it constructs an index system for the digital economic development index of the SCO member states, and conducts a quantitative analysis of the measurement results. The digital economic development index of the SCO member states includes 6 primary indicators and 18 secondary indicators.

Digital Economy Development Index for the SCO member countries

Primary indicators	No.	Secondary indicators	Indicator attribute
Digital infrastructure	V1	Fixed telephone subscriptions (per 100 people)	Positive
	V2	Mobile cellular subscriptions (per 100 people)	Positive
	V3	Secure Internet servers (per 1 million people)	Positive
	V4	Access to electricity (% of urban population)	Positive
Digital connectivity	V5	Fixed broadband subscriptions (per 100 people)	Positive
	V6	Mobile broadband subscriptions (per 100 inhabitants)	Positive
	V7	Individuals using the Internet (% of population)	Positive
Digital industry development	V8	High-technology exports (% of manufactured exports)	Positive
	V9	ICT goods exports (% of total goods exports)	Positive
	V10	ICT service exports (% of service exports, BoP)	Positive
Digital innovation competitiveness	V11	Tertiary gross enrollment ratio (%)	Positive
	V12	Availability of latest technologies (1–7)	Positive
	V13	Venture capital availability (1–7)	Positive
	V14	Scientific and technical journal articles	Positive
Digital economic environment	V15	Foreign direct investment, net inflows (% of GDP)	Positive
	V16	Charges for the use of intellectual property (BoP, $)	Positive
Digital governance	V17	Government effectiveness: estimate (ranging from approximately -2.5 to 2.5)	Positive
	V18	Cost of business start-up procedures (% of GNI per capita)	Positive

Overall, the construction of these six indicators will be able to comprehensively evaluate the status and potential of the digital economy of a country or region, and provide a comprehensive

indicator system for government strategic planning and corporate investment decisions, thereby promoting the healthy and sustainable development of the digital economy.

Considering the availability and completeness of data from SCO member states, we selected data from 2005 to 2022. In addition, considering that Belarus will become a new member of the SCO in 2024, the final index covers ten countries including China, Russia, India, Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan, Pakistan, Iran, and Belarus. The entropy method is used to evaluate the development level and dynamic cooperation of the SCO digital economy. It is more objective than other methods. Select the entropy weight method (EWM) In practical applications, the entropy weight method (EWM) calculates the entropy weight of each indicator according to the degree of variation, and then adjusts the entropy weight of each indicator to obtain a more objective weight. Since the indicators selected in this study are all positive (the measured phenomenon is positive), the original data is standardized using the following formula (1):

$$Y_{ij} = \frac{x_{ij} - \min(X_i)}{\max(X_i) - \min(X_i)}, \tag{1}$$

where Y*ij* is the standardized value of the *j*-th indicator in the year i; X*ij* is the original data of the *j*-th indicator in the year I; min(X*i*) and max(X*i*) are the minimum and maximum values of the original data of the *j*-th indicator in the year *i*, respectively.

This normalization process eliminates dimensional differences between different indicators, allowing them to be compared and analyzed on the same scale.

The weight of the primary indicator is equal to the sum of the weights of the secondary indicators. The weights of the secondary indicators are calculated using the following formula (2):

$$P_{i_j} = \frac{Y_{ij}}{\sum_{i=1}^{n} Y_{ij}}, \tag{2}$$

where P*ij* is the proportion of the *i*-th sample value under the j indicator of each country in each year.

The weights of indicators are calculated using the following formula (3):

$$W_j = \frac{Dj}{\sum_{j=1}^{m} D_j}. \tag{3}$$

Conclusion. The study shows that the digital divide among SCO member states is mainly due to differences in infrastructure investment (such as broadband coverage, security server density), education level (higher education enrollment rate), and insufficient coordination policies. For example, the Internet penetration rate in Central Asian countries (such as Tajikistan and Kyrgyzstan) is only one-third of that in China, while their ICT exports are still low, reflecting the dual gaps in technology absorption and industrialization.

The study also found that the SCO presents a core-periphery structure, the SCO digital economy presents a hierarchical structure, and China and Russia have formed a technology lock-in effect through ICT exports (accounting for 18.3% of total exports); there are bottlenecks in digital governance, and the contribution rate of digital governance indicators to the growth of Central Asian digital economy is less than 5%, indicating that institutional quality is an invisible

obstacle to digital transformation. As for the threshold for accelerating digital economic growth, the broadband penetration rate exceeds 55% and the venture capital availability exceeds 4.2 (level 1-7). However, the data of some Central Asian countries are based on interpolation estimates, which may weaken the heterogeneity of small countries. In 2023, the "Statement of the Council of Heads of State of the Shanghai Cooperation Organization on Cooperation in the Field of Digital Transformation" was signed and adopted, promoting further progress in the innovation and development of the SCO in the field of digital communications. According to the results of the digital economy development index analysis of the SCO member states, it can be concluded that the digital economy development of the SCO member states is still facing the following opportunities and challenges.

The SCO member states have huge economic strength and population size, and the potential for digital economy development is also great. In the future, the development of the digital economy will become an important driving force for economic growth on both sides. Judging from the closeness of the traditional economic and trade cooperation among the SCO member states, there is a good cooperation foundation and market foundation in the field of digital economy. Most of the SCO member states have a high Internet penetration rate and a high level of development in Internet of Things technology, which provides strong support for the development and cooperation in the digital economy of the SCO member states. In addition, the governments of the SCO member states have increased their support for the development of the digital economy and international cooperation, providing more opportunities for cooperation between the two sides in digital transformation, innovative development and other aspects from the policy level.

In view of the opportunities and challenges faced by the development of the digital economy of the SCO member states, future cooperation can focus on strengthening the following aspects.

1. Strengthen the construction of Internet infrastructure, including increasing Internet coverage, strengthening network security, and ensuring reliable digital channels and data transmission. We should learn from the technological development experience of leading countries such as China and Russia, establish a regional digital infrastructure fund, and provide targeted support for the construction of 5G networks and cloud computing centers in Central Asian countries.

2. Increase investment in the training of digital economy talents, establish a professional education system for digital technology, train more professional talents, and improve the technical level in the field of digital economy.

3. Relying on the SCO University Alliance, carry out cross-border digital talent training projects to improve the core skills of member states such as programming and data analysis. Strengthen cooperation and exchanges in digital education among member states, jointly study and formulate digital economy policies through bilateral and multilateral cooperation mechanisms, and share experiences and best practices in the development of digital economy.

4. Pay more attention to the security of the digital economy, strengthen cooperation in areas such as network security, digital data protection and privacy, and jointly promote the application and research and development of new technologies such as artificial intelligence, big data, and block chain. It is necessary to formulate a standardized data governance framework-the SCO Cross-Border Data Flow Agreement, balance data security and data sharing needs, and reduce the cost of countermeasure policies.

5. Establish an industrial cooperation alliance to promote cooperation among member states in digital economy-related fields, jointly promote industrial innovation and development, and enhance competitiveness.

To solve the challenges faced by SCO member states in developing the digital economy, it is necessary to strengthen infrastructure construction, cultivate digital talents, carry out cooperation and exchanges, strengthen security guarantees, promote innovative technology cooperation, strengthen policy coordination and industrial cooperation, and jointly promote the rapid development of the digital economy in SCO member states.

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