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Abstract

Purpose: This study develops a correlation measurement system between digital infrastructure and the Chinese path to modernization consumption, investigating the mechanisms by which digital infrastructure drives consumption patterns and their spatiotemporal evolution. Grounded in a tripartite framework of "digital infrastructure-consumption upgrading-regional disparities," we develop a comprehensive indicator system to identify heterogeneity in consumption space and structural characteristics. This enables the proposal of targeted policy pathways to optimize the layout of digital infrastructure and foster consumption upgrading.

Materials and Methods: Employing the entropy method, we measure the digital infrastructure and consumption levels across 31 provinces (2012-2022), establishing a comprehensive index. We analyze underlying mechanisms through theoretical modeling and rigorously evaluate causal effects using benchmark regression, robustness tests, and endogeneity exploration, thereby ensuring comparable and reliable findings.

Findings: Digital infrastructure levels remain lower in central and western regions but exhibit rapid growth, signaling a catching-up trend. Conversely, the eastern region boasts high levels yet experiences slowing growth, with regional disparities becoming more pronounced. Consumption peaks in the east, spurring growth, followed by the central region; the western and northeastern regions lag. The upgrading of consumption structures exhibits significant regional asynchrony. Crucially, digital infrastructure demonstrably accelerates the Chinese path to modernization, revealing that the penetration of digital technology catalyzes consumption upgrading by reducing transaction costs, expanding consumption scenarios, and enhancing consumption quality.

Unique Contribution to Theory, Practice and Policy: Theoretically, this research enriches "infrastructure-consumption" interaction theory through a "technology-economy-society" integrative lens, offering fresh perspectives for cross-disciplinary inquiry. Policy-wise, it advocates promoting "infrastructure & scenarios" integration, accelerating technology diffusion in the east, and implementing regionally differentiated consumption promotion policies to cultivate unique growth poles. In practice, it provides actionable data to inform governmental regulation of the digital economy and the formulation of optimal consumption strategies, thereby bridging the "digital divide" and mitigating "consumption differentiation."

Keyword: _China, Digital Infrastructure, Consumption Structure_

JEL Codes: _E21, H54, L86_

INTRODUCTION

Based on Maslow's Hierarchy of Needs theory and New Structural Economics, this paper systematically analyzes the interactive mechanism between digital infrastructure and consumption on the Chinese path to modernization. Specifically, Maslow's Hierarchy of Needs theory provides the logic of "intrinsic motivation" for consumption upgrading, indicating that residents tend to consume at higher levels after their basic needs are met, which explains the willingness and direction of consumption upgrading. New Structural Economics elucidates the logic of "structural transformation" induced by infrastructure, illustrating the path to achieving consumption upgrading and supply-side support. Digital infrastructure serves as a "bridge" connecting the two, promoting the upgrading of the consumption structure by expanding consumption scenarios and optimizing consumption quality. At present, the global digital wave is accelerating, and the improvement of China's digital infrastructure has become a core engine driving the transformation of consumption patterns. However, the "digital divide" and consumption imbalances between regions remain pronounced. Scientific measurement of the driving effect of digital infrastructure on consumption is a key prerequisite for optimizing resource allocation, narrowing the urban-rural gap, and achieving the consumption goal of the Chinese path to modernization.

As the information technology revolution deepens, digital infrastructure, as the foundation of the digital economy, is reshaping the global consumer ecology. In China, investment in new infrastructure, including 5G, big data centers, and industrial Internet, continues to increase, injecting new momentum into consumption expansion and quality improvement. However, there is a significant variation in the level of digital infrastructure across provinces, and consumption upgrading exhibits a gradient pattern of "leading in the east and catching up in the central and western regions". It is urgent to construct a systematic measurement system to reveal its inherent correlation. This study aims to quantify the impact of digital infrastructure on the Chinese path to modernization and consumption through the integration of multidimensional indicators, and to provide theoretical support and practical guidance for addressing the structural contradiction between "consumption differentiation" and "digital divide".

This study innovatively employs the entropy method to assess the digital infrastructure and consumption levels of 31 provinces in China from 2012 to 2022, and constructs a three-dimensional analytical framework of "digital infrastructure consumption upgrading regional differences" to address the limitations of traditional one-dimensional research. In terms of methodology, panel data models, two-way fixed effects, and PPML regression are used extensively for benchmarking, supplemented by robustness checks and endogeneity analysis to ensure the reliability of conclusions and the rigor of causal inference. In terms of indicator design, a comprehensive index is constructed from multiple dimensions, including network coverage, terminal penetration, consumer subjects, environment, and services, to mitigate subjective weighting bias and enhance the scientific and policy operability of measurement results.

Compared with existing research, the breakthrough of this study lies in: Firstly, at the theoretical level, by integrating the interdisciplinary perspective of "technology-economy-society" and utilizing three mechanisms: reducing transaction costs, innovating consumption scenarios, and optimizing regional collaboration, the inherent logic of digital infrastructure promoting consumption upgrading is revealed. Specifically, digital infrastructure, on one hand, drives industrial upgrading and income growth through "cost reduction and efficiency improvement" emphasized by new structural economics, thereby enhancing consumption

capacity. On the other hand, it directly addresses the basic needs identified by Maslow's theory by creating new scenarios and supply, thereby bridging supply and demand. Secondly, at the methodological level, the entropy method, dynamic panel model, and spatial heterogeneity analysis are combined for the first time to enable time-series tracking and interprovincial comparisons of digital infrastructure and consumption levels, thereby filling a gap in the existing literature, which lacks long-term dynamic evolution analysis. Thirdly, at the policy dimension, by identifying the technology spillover effects in the eastern region and the "catch-up potential" in the central and western regions, precise targeting is provided for implementing differentiated regional infrastructure policies.

Overall, this paper not only examines spatiotemporal variation in digital infrastructure and consumption levels but also empirically demonstrates a significant positive effect of digital infrastructure on consumption. It provides data support for the government to optimize the layout of digital infrastructure and for enterprises to adapt to consumer demands, thereby enhancing the resilience of the domestic economic cycle and promoting the evolution of the Chinese path to modernization consumption toward high quality and inclusiveness.

Problem Statement

Existing research has confirmed that digital infrastructure can promote consumption through technology penetration, but there is still a gap in the systematic measurement system for the relationship between digital infrastructure and the Chinese path to modernization consumption: first, multi focus on technology coverage or single dimension of consumption scale, failing to capture the synergistic interactions among digital infrastructure, consumption upgrading, and regional disparities. This one-dimensional approach overlooks the complex, multi-level mechanisms driving modernization, thereby limiting the validity and applicability of findings. Secondly, there is insufficient dynamic tracking of spatiotemporal evolution patterns, which obscures temporal trends and regional heterogeneities. Static analyses risk misleading policy design by neglecting the evolving nature of digital infrastructure and consumption structures, ultimately resulting in inefficient or misaligned interventions. Thirdly, policy recommendations tend to focus more on macro guidance and lack precise targeting based on quantitative deviation. Regional heterogeneity plays a critical role in shaping modernization outcomes, as provinces exhibit varying capacities for infrastructure absorption and responsiveness to consumption. Ignoring these spatial asymmetries may exacerbate developmental imbalances rather than fostering inclusive growth. This study is based on the three-dimensional framework of "digital infrastructure consumption upgrading regional differences" and constructs a comprehensive measurement index system. The entropy method is used to assess the levels of digital infrastructure and consumption across 31 provinces from 2012 to 2022. The driving mechanism is analyzed through theoretical models, and dynamic trends and spatial differentiation are revealed through panel regression and robustness testing. The research results can provide a basis for optimizing the layout of digital infrastructure and reducing regional consumption disparities, and help advance China's path to modernization by fostering high-quality consumption.

Research Objective

The purpose of this study is to build a correlation measurement system between digital infrastructure and the Chinese path to modernization consumption and reveal its spatio-temporal evolution, focusing on the following dimensions:

1. Construct a comprehensive measurement index system under the three-dimensional framework of "digital infrastructure consumption upgrading regional differences",

quantifying the driving effect of digital infrastructure on consumption and the degree of deviation from reality. By using the entropy method to address the bias inherent in traditional subjective weighting, a replicable objective measurement paradigm is provided for the "infrastructure consumption" correlation in methodology, and a benchmark is established for cross-regional and cross-temporal comparisons.

2. Analyze the dynamic evolution trajectory of China's digital infrastructure and consumption level from 2012 to 2022, and sort out its long-term trend under the dual drive of digital technology penetration and regional coordinated development. By using panel data models and dynamic indices to reveal the upgrading logic from "element driven" to "scene empowered", we can address the shortcomings of existing static analyses and deepen the transition from "cross-sectional observation" to "process simulation".

3. Through inter-provincial panel data comparison, reveal the spatial differentiation characteristics of digital infrastructure level and consumption capacity, and identify the regional structural differences between the spillover effects of technology in the eastern region and the "catch-up potential" in the central and western regions.

4. Propose policy recommendations for optimizing the layout of digital infrastructure and upgrading consumption, providing decision-making references for alleviating the structural contradictions of "digital divide" and "consumption differentiation", promoting regional consumption coordination, and helping to enhance the resilience of the internal circulation of the economy

Research Questions

1. How to build a comprehensive measurement index system related to digital infrastructure and the Chinese path to modernization consumption?

2. From 2012 to 2022, what is the driving effect of digital infrastructure on the Chinese path to modernization, consumption, and its dynamic evolution trend?

3. What are the significant spatial differences in the level of digital infrastructure and consumption capacity among different provinces in China?

4. Based on measurement results and regional differences analysis, how to alleviate the contradiction between "digital divide" and "consumption differentiation" through digital infrastructure optimization?

Relevance and Importance of the Research

This study examines the multidimensional impact of digital infrastructure on China's path to modernization and consumption and reveals how it promotes consumption upgrading by reducing transaction costs, expanding consumption scenarios, and optimizing resource allocation, using a collaborative analysis framework for the "technology consumption region." The significance of this study lies not only in filling a measurement gap in the relationship between digital infrastructure and consumer modernization but also in providing scientific support for addressing the structural contradiction between the "digital divide" and "consumer differentiation" through methodological innovation and empirical findings.

LITERATURE REVIEW

Research on digital infrastructure has evolved from hardware coverage to system empowerment. Early research primarily focused on hardware indicators, such as Internet ports and optical cable lengths, and later expanded to integrated support that combines software and hardware, including artificial intelligence and the Industrial Internet (Erdoğan et al., 2020). In terms of measurement methods, the academic community has identified two paradigms: single-

indicator substitution and multi-dimensional composite indices. The former uses proxy variables such as Internet penetration, whereas the latter employs the entropy method to construct a comprehensive system comprising fixed broadband penetration, server coverage, and other indicators (Altay, 2025; Gao, 2025). Research has shown that digital infrastructure drives economic growth through technology spillovers and optimized resource allocation, but the issue of the regional "digital divide" remains prominent (Zhang et al., 2024).

Research on consumption in China's path to modernization is shifting from demand upgrading to structural transformation (Ma & Yin, 2024). Its theoretical framework is based on Maslow's theory of needs, emphasizing the collaborative upgrading of consumer subjects, objects, and environment. In terms of measurement, comprehensive indices are often constructed based on indicators such as per capita GDP and total social consumer goods, but there is a lack of characterization of the dynamic process of digital technology empowerment (Bruno et al., 2023). The digital economy stimulates consumption expansion through new formats such as e-commerce and the sharing economy, but the urban-rural gap and service gaps remain prominent.

Research on the mechanism of the correlation between digital infrastructure and consumption reveals a multipath mode of action. Empirical research shows that digital infrastructure directly promotes the increase of consumption scale by reducing transaction costs and expanding consumption scenarios (Wang & Li, 2024). Industrial digitization indirectly improves consumer quality through supply chain optimization, such as the "Broadband China" strategy promoting an increase in the proportion of service consumption (Y. Liu et al., 2025). The regional economic foundation and human capital levels exert significant regulatory effects, with stronger technology spillover in the eastern region, whereas the central and western regions require supporting policies, such as investment in education, to break out of the "low-level trap." (Li & Wu, 2024).

The existing research exhibits three primary limitations, which this study systematically addresses through its integrated framework. First, at the theoretical level, prior studies often analyze the economic effects of digital infrastructure and consumption upgrading in isolation, lacking a cohesive analytical structure that interconnects technology, consumption, and regional disparities (Y. Liu et al., 2025; Wang & Li, 2024). This study overcomes this by constructing a three-dimensional "infrastructure-consumption-region" linkage framework, enabling a holistic examination of their synergistic interactions.

Second, methodologically, existing work relies predominantly on cross-sectional analyses, which fail to capture the temporal evolution and dynamic mechanisms of digital infrastructure's impact on consumption (Schwandt & von Wachter, 2019). In response, this study employs panel data from 2012–2022 and uses bidirectional fixed-effects models to conduct long-term dynamic tracking, thereby revealing spatiotemporal heterogeneity and evolutionary trends.

Third, at the policy level, prior recommendations tend to be generalized and do not adequately account for regional heterogeneity, limiting their practical applicability (Di et al., 2025). By comparing interprovincial data and identifying distinct regional characteristics such as technological spillover effects in the east and catch-up potential in the central and western regions this study provides empirically grounded, regionally differentiated policy recommendations tailored to regional specifics.

The innovation of this article lies in constructing an integrated model of "infrastructure consumption scenarios spatial differences", using entropy method to objectively weight and bidirectional fixed effects model to achieve dynamic measurement, and providing evidence for

regional policy customization through inter provincial comparisons, such as suggesting that the eastern region focus on technological iteration and the western region strengthen basic coverage, in order to systematically respond to existing research gaps.

MATERIAL AND METHODS

The purpose of this study is to systematically develop a measurement system for digital infrastructure and the Chinese path to modernization consumption, and to empirically test the mechanism of their impact on each other. The research design follows the logical mainline of "theoretical framework indicator construction empirical testing policy mapping", and the specific steps are as follows:

First, based on the connotative characteristics of digital infrastructure and modern consumption, a hierarchical, multidimensional, comprehensive evaluation index system is constructed. Taking the goal of "optimizing computing power and improving application capability" proposed in the "Overall Layout Plan for Digital China Construction in 2023" as the guideline, and referring to the deployment requirements of new infrastructure such as 5G networks and data centers in the "14th Five Year Plan for Digital Economy Development", ensure that the indicator design meets national strategic needs. The digital infrastructure is divided into two dimensions: network infrastructure and digital terminal infrastructure (see Table 1).

Table 1: Digital Infrastructure Construction Index

1st index	2nd index	3rd index
Digital infrastructure	Network infrastructure	Number of internet access ports
		Length per unit area of long-distance optical cable
		Number of Internet broadband users
	Digital terminal infrastructure	Mobile station density
		Number of domain names
		Mobile penetration rate

By employing the entropy method for objective weighting, multiple indicators are aggregated into a comprehensive index to mitigate subjective bias and ensure that measurement results are both theoretically rigorous and policy operational.

Using panel data from 31 provinces in China from 2012 to 2022, covering the critical period from the implementation of the "Broadband China" strategy to the deepening of "new infrastructure", ensuring temporal continuity. The primary indicator data are sourced from the China Statistical Yearbook, the China Urban Statistical Yearbook, the EPS database, and the statistical yearbooks of various provinces. Missing values are filled in using the coupled mean method. To eliminate dimensional differences, the original data is normalized using the range normalization formula (See Equation 1) to ensure that all indicator values are in the 0-1 range, ensuring cross-dimensional comparability.

$$XN_{tij} = \frac{x_{tij} - minx_j}{Maxx_j - minX_j} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \ (1)$$

X_{tij} is the i-th indicator value in province j at year t, $minx_j$ is the minimum value of x_j and $maxx_j$ is the maximum value of x_j. A higher value indicates a higher index level. After standardization, the five-step process is required to determine the weights and calculate the composite score:

Step 1: Normalize the data and determine the indicator weights.

$$Y_{tij} = \frac{XN_{tij}}{\sum_t \sum_i XN_{tij}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{(2)}$$

Step 2: Calculate the entropy value e_i, which represents the entropy of the j-th indicator.

$$e_j = -k \sum_t \sum_i Y_{tij} \ln Y_{tij} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{(3)}$$

In this formula, , $k > 0$, $k = 1/\ln rn$, with r years and n provinces in total.

Step 3: Calculate the weights and the information utility value of the j-th indicator:

$$g_j = 1 - e_j \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \dots$$
(4)

Step 4: Calculate the weights of each indicator:

$$W_j = g_j / \sum_j g_j \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots$$
(5)

Step 5: Calculate the comprehensive scores of each province, using the method of coupled average as follows:

$$H_{ti} = g_j \sum_j (W_j XN_{tij}) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{(6)}$$

Based on the model, the development level of digital infrastructure in each province of China can be measured, thereby providing an objective and fair evaluation of the scale of digital infrastructure construction across regions.

The consumption of the Chinese path to modernization is quantified across three dimensions: consumption, consumption environment, and consumption (see Table 2).

Table 2: Chinese Modernization Consumption Construction Index

1st index	2nd index	3rd index
Chinese modernization consumption	Consumer subject	GDP per capita
		Disposable income per capita
		Social consumption per capita
	Consumption environment	Railway operating mileage (kilometers)
		Water resources per capita (m³/person)
	Consumer service	Digital Inclusive Finance Index

Statistical Analysis

China's digital infrastructure construction has achieved leapfrog development, especially in areas such as 5G, big data centers, and artificial intelligence. Despite these achievements, China still faces some challenges in the construction of digital infrastructure. On the one hand, the problem of the "digital divide" between regions is becoming increasingly serious, and there are significant disparities in the extent of digital infrastructure development across regions. On the other hand, although China's broadband penetration rate has reached the highest level in the world, there remains a significant gap in mobile communications service capabilities, spectrum, and submarine cable facilities. In addition, technological shortcomings are also an important limiting factor in the construction of digital infrastructure. From 2012 to 2022, the number of

Internet users and the network penetration rate in China increased steadily. China's Internet users will reach 589 million by the end of 2022 (Figure 1). In Figure 2, as of December 2022, China's internet access ports have reached 1 billion, 3.33 times the number in December 2012.
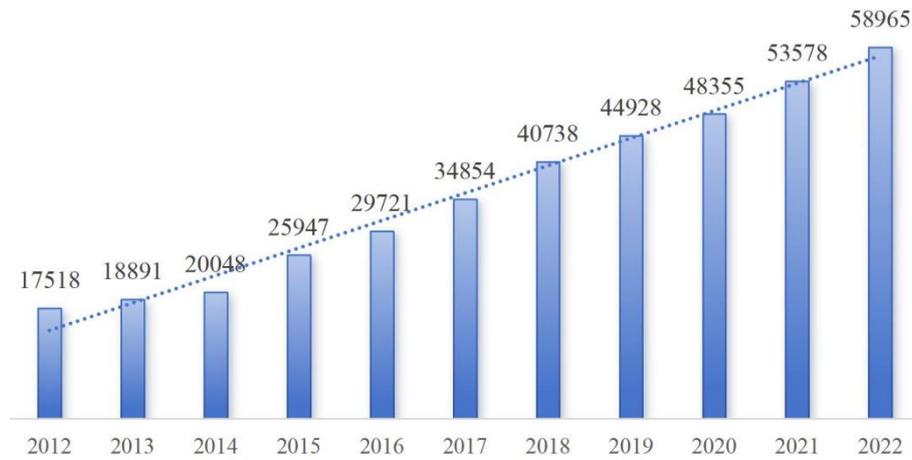

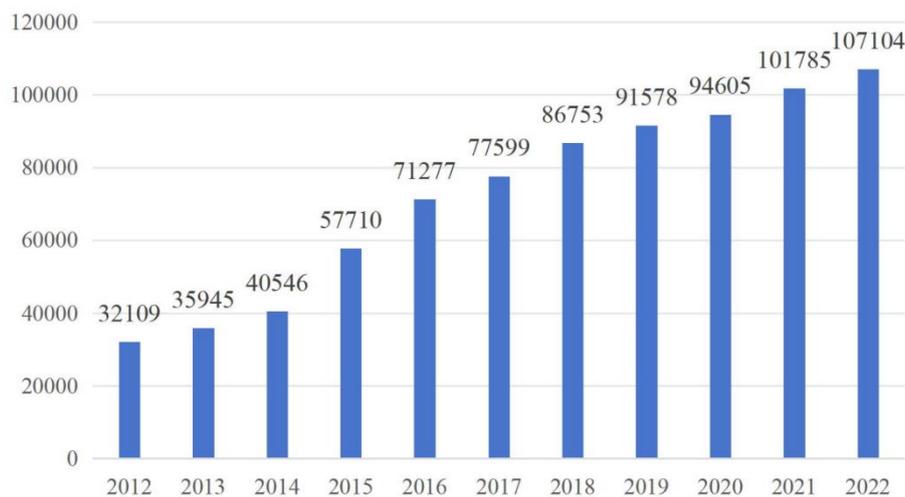*Figure 1: The Number of Internet Broadband Users in China*

Figure 2: The Number of Internet Access Ports in China

According to data from the Ministry of Industry and Information Technology (MIIT), China's internet domain count surged from 12.524 million in 2012 to 50.076 million by the end of 2022 (Figure 3). The figure then declined annually before stabilizing between 2021 and 2022. Due to the advent of IPv6, China's IPv4 address pool reached 301.414 million in 2014, but by 2015 had declined to levels comparable to 2013, eventually stabilizing at 308.491 million in 2017 (Figure 4). Consequently, this metric was not utilized in this study to assess the nation's digital infrastructure development.
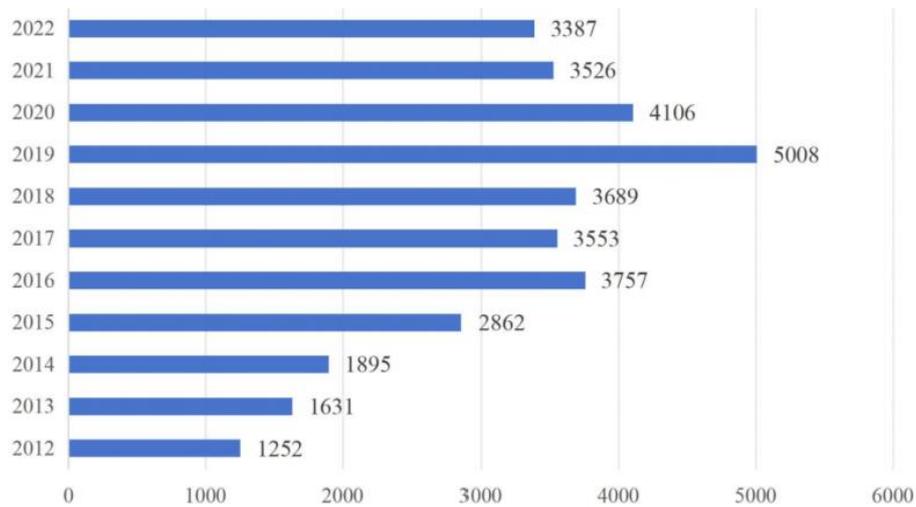
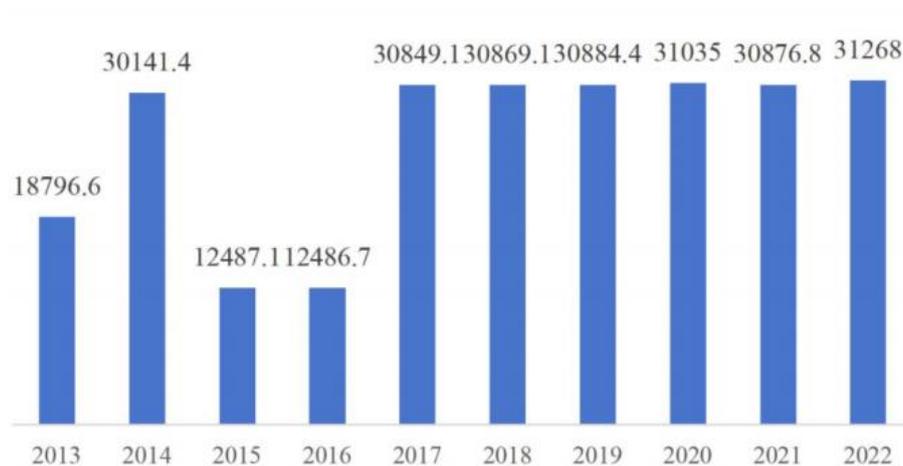*Figure 3: The Number of Internet Domain Names in China*

Figure 4: The Number of IPv4 Addresses in China

We uses data released by multiple ministries such as the National Bureau of Statistics website and the China Academy of Information and Communications Technology, as well as statistical yearbooks from various provinces, China Digital Economy Development Reports such as the China Statistical Yearbook, China Information Yearbook, China Information Industry Yearbook, and China Regional Economic Statistical Yearbook, to reveal the scale characteristics of China's high-tech product exports from a macro perspective. Using the method described above, the weighted results for the measured provincial data from 2012 to 2022 were analyzed, including the current status of digital infrastructure development, the modernization consumption index, and the annual growth rate in each province.

Table 3: Index of Development Level of China's Digital Infrastructure and Annual Growth Rate

Region		2012	2017	2022	Annual Growth Rate
	Beijing	0.16	0.31	0.35	12.49%
	Tianjin	0.06	0.11	0.12	11.38%
	Hebei	0.07	0.16	0.20	13.45%
	Shanghai	0.16	0.42	0.60	14.88%
	Jiangsu	0.39	0.29	0.38	4.56%
East	Zhejiang	0.19	0.28	0.9	6.24%
	Fujian	0.09	0.36	0.25	14.30%
	Shandong	0.10	0.21	0.30	15.28%
	Guangdong	0.20	0.33	0.47	9.25%
	Hainan	0.02	0.06	0.07	13.33%
	Average	0.14	0.25	0.30	11.52%
	Shanxi	0.04	0.09	0.11	11.37%
	Anhui	0.04	0.13	0.20	18.37%
	Jiangxi	0.03	0.10	0.15	18.03%
Central	Henan	0.07	0.17	0.25	13.87%
	Hubei	0.06	0.11	0.17	11.56%
	Hunan	0.05	0.12	0.18	13.95%
	Average	0.05	0.12	0.18	14.53%
	Inner Mongolia	0.03	0.06	0.08	10.81%
	Guangxi	0.07	0.09	0.16	11.97%
	Chongqing	0.04	0.11	0.13	14.39%
	Sichuan	0.05	0.16	0.23	17.56%
	Guizhou	0.02	0.07	0.15	21.07%
	Yunnan	0.03	0.07	0.11	16.21%
West	Shaanxi	0.04	0.08	0.14	14.70%
	Gansu	0.02	0.05	0.07	12.42%
	Qinghai	0.02	0.02	0.03	6.89%
	Ningxia	0.02	0.04	0.05	11.52%
	Xinjiang	0.03	0.05	0.08	11.72%
	Xizang	0.01	0.01	0.02	5.52%
	Average	0.03	0.07	0.10	12.90%
	Liaoning	0.06	0.11	0.14	9.73%
Northeast	Jilin	0.04	0.06	0.08	7.06%
	Heilongjiang	0.03	0.06	0.09	18.67%
	Average	0.04	0.07	0.10	11.82%
China	Average	0.07	0.06	0.02	12.66%

Based on the entropy method, the comprehensive index of the digital economy development level from 2012 to 2022 exhibits significant heterogeneity across time and space (Table 3). Overall, the development level of China's digital economy peaked in 2015, with growth of 31.08% relative to 2014, and the development levels of each province also showed significant improvement. Qinghai, Guizhou, Gansu, Ningxia, and Jilin have maintained high growth rates, particularly Guizhou, which has an average annual growth rate of 25.86% and has entered the ranks of catching up with the "digital economy". Regional disparities remain prominent, with Guangdong's level of digital infrastructure development in 2018 being 13.5 times that of

Qinghai. Across the four major regions of East, West, Central, and Northeast China, annual growth rates have increased steadily. The central region has the highest annual growth rate at 14.53%, followed by the western region at 12.90% and the northeast at 11.82%. The difference in the eastern region is not significant, with 11.52% at the bottom. However, in terms of the level of digital economy development, in 2022, the eastern region was 3.64, followed by the western region at 1.50, the central region at 1.45, and the northeast at 0.55. This indicates that the stock of digital economy assets in the eastern region is large, but the pace of digital infrastructure development is the lowest; by contrast, the pace in the northeast is faster than that in the east. There are significant regional differences in the development level of China's digital economy. In 2022, Xinjiang, Ningxia, and Qinghai remained relatively backward, particularly Xinjiang, which had a 0.39 gap relative to Guangdong's level of digital infrastructure, indicating a substantial gap. There are differences in the level of digital economy development among different regions in China. As of the end of 2022, the eastern region was the dominant region, with an average of 0.30; the central region had an average of 0.17, and the western and northeastern regions had 0.10 and 0.10, respectively, with little difference between the two. However, upon closer inspection of differences in digital economy development across regions, the catching-up effect is significant in the western and central regions, whereas the catching-up pace in the northeast region is relatively slow. Meanwhile, substantial development potential remains in the flat and low-lying areas. Therefore, improving the level of digital economy development in relatively backward regions and narrowing the "digital divide" between regions remain urgent problems that must be addressed.

Table 4: The Chinese Modernization Consumption Index and Its Annual Growth Rate

Region		2012	2017	2022	Annual Growth Rate
	Beijing	0.11	0.19	0.23	8.04%
	Tianjin	0.08	0.13	0.13	5.32%
	Hebei	0.06	0.11	0.12	7.43%
	Shanghai	0.12	0.18	0.26	8.10%
	Jiangsu	0.11	0.14	0.22	7.05%
East	Zhejiang	0.09	0.15	0.18	7.48%
	Fujian	0.09	0.14	0.18	8.28%
	Shandong	0.08	0.14	0.15	7.24%
	Guangdong	0.10	0.13	0.19	7.08%
	Hainan	0.04	0.09	0.09	9.52%
	Average	0.09	0.14	0.17	7.05%
	Shanxi	0.06	0.10	0.12	8.40%
	Anhui	0.05	0.10	0.14	11.44%
	Jiangxi	0.07	0.11	0.13	7.81%
Central	Henan	0.07	0.08	0.12	6.67%
	Hubei	0.08	0.10	0.16	7.49%
	Hunan	0.08	0.10	0.15	6.63%
	Average	0.07	0.10	0.14	6.95%
	Inner Mongolia	0.12	0.18	0.19	5.70%
	Guangxi	0.09	0.10	0.13	4.97%
West	Chongqing	0.05	0.10	0.13	10.67%
	Sichuan	0.06	0.11	0.13	7.83%
	Guizhou	0.04	0.09	0.10	10.68%
	Yunnan	0.05	0.10	0.12	9.06%

	Shaanxi	0.65	0.68	0.59	7.83%
	Gansu	0.07	0.09	0.14	9.43%
	Qinghai	0.05	0.07	0.10	1.92%
	Ningxia	0.12	0.11	0.14	10.12%
	Xinjiang	0.04	0.06	0.09	6.30%
	Xizang	0.08	0.11	0.15	-0.65%
	Average	0.12	0.15	0.17	3.22%
Northeast	Liaoning	0.09	0.10	0.14	4.66%
	Jilin	0.08	0.09	0.12	3.92%
	Heilongjiang	0.09	0.10	0.13	4.08%
	Average	0.09	0.10	0.13	5.24%
China	Average	0.10	0.13	0.16	7.11%

Table 4 presents the consumption index for the Chinese path to modernization from 2012 to 2022, calculated using the entropy method described above. Since the per capita water resources (m3/person) are used to measure the consumption of Chinese path to modernization, for example, the per capita water resources in Beijing will be 108.39 in 2022, and the per capita water resources in Xizang will be 113416.43, the consumption index of Xizang's Chinese path to modernization in the table is particularly high, which is not a measurement error.

Research shows significant temporal and spatial disparities in the development of China's digital economy. Overall, the modernization consumption index with Chinese characteristics peaked in 2016, increasing by 10.42% from 2014, with an average annual growth rate of 7.11%. The development level of each province has also significantly improved. Specifically, from 2018 to 2022, the Chinese path to modernization in Beijing, Shanghai, Jiangsu, and Zhejiang was at the forefront. In addition, the annual growth rates of Anhui, Guizhou, Chongqing, Ningxia, and Hainan will be the highest, with Anhui's at 11.44%, the highest among the catch-up team. However, the interprovincial gap remains pronounced. For example, in 2021, Beijing's is 2.8 times that of Qinghai, indicating that the interprovincial gap remains substantial. From a regional perspective, average annual growth rates across the four regions have been steadily increasing. Among them, the average annual growth rates are 7.05% in the eastern region, 6.95% in the central region, 5.24% in the northeast, and 3.22% in the western region. However, from the perspective of the Chinese path to modernization, the level of consumption development in 2022 was 0.17 in the east, 0.13 in the middle, 0.13 in the west (excluding Xizang), and 0.13 in the northeast. This indicates that the consumption stock of the Chinese path to modernization in the East is large, and its consumption growth rate is the fastest. The level of consumption in the Chinese path to modernization exhibits pronounced regional heterogeneity.

In 2022, Guangdong, Beijing, Jiangsu, Shandong, Zhejiang, and Shanghai ranked among the leading provinces in China, whereas Xinjiang, Ningxia, and Qinghai had low levels of digital economy development, with a 0.04 gap between Guangdong and Xinjiang. The same regional heterogeneity is evident in the development of consumption in China's path to modernization. By the end of 2022, the eastern region will lead in consumption on the Chinese path to modernization, with an average of 0.17; the central region, 0.14, will be second, while the northwest region, 0.13, and the northeast region, 0.13, will not differ much. However, across regions, the heterogeneity in the development of Chinese-style consumption levels is evident: the catching-up effect is significant in the western and central regions, whereas the catching-up speed in the northeast is relatively slow. In these regions with lower indicators, there remains substantial room for development. Therefore, how to enhance the level of digitally enabled

Chinese-style consumption in our country, narrow regional disparities in consumption development, and prevent the consumption gap from continuing to widen remains an urgent issue that needs to be addressed.

Model specification

After the descriptive analysis of the data indicators, the next step is to develop a regression model. First, the type of model needs to be determined. The general form of a classical panel data model is:

$$lny_{ij} = \alpha_i + \mu_1 lnH_{ti} + \mu_2 lnE + \mu_3 lnP + \mu_4 lnB + \mu_5 lnT \ldots\ldots\ldots\ldots\ldots \quad (7)$$

Where: H_{ti} is the independent variable, digital infrastructure level, E is the related variable, education fund, P is the related variable, electricity consumption, B is the related variable, that every 10000 people own public transport vehicles, T is the related variable, total telecommunications business, and y_{ij} is the dependent variable Chinese path to modernization consumption level.

1. The consumption level of Chinese path to modernization (y_{ij}) is the explained variable of this study. Based on the relevant data provided by the EPS database, referring to the entropy method used above, the per capita GDP, per capita social consumption goods, railway operating kilometers (km), per capita water resources (m3/person), and per capita disposable income (yuan) of residents from 2012 to 2022 are classified and summarized in turn (missing 2012 data, supplemented by the coupling average method), and the consumption level of Chinese path to modernization in each province in each year is calculated and brought into the regression equation. The data are sourced from the China Urban Statistical Yearbook, the China Statistical Yearbook, and the EPS database, among others.

2. The level of digital infrastructure （H_{ti}）is the core explanatory variable in research.

3. Education funding (10000 yuan) (*E*): In terms of residents' consumption level, the population dominates. In China, the number and composition of the main consumer group will significantly affect the level and quality of consumption. The total population will affect the total consumption, and the composition of the population will affect the composition of consumption

4. Electricity consumption (in billions of kilowatt hours) (*P*). The operation of digital infrastructure cannot be separated from the support of the power system. Advertising, shopping malls, and mobile phones used by consumers cannot function without electricity.

5. Every 10000 people have public transportation vehicles (standard platform) (*B*). When the author calculates the consumption level of the Chinese path to modernization in each province, the railway operating mileage is taken as its constituent indicator. The development of the social economy will also affect the consumption level of the Chinese path to modernization, so the author selects similar variables.

6. Total telecommunications business volume (in billions of yuan) (*T*). The total amount of telecommunications services can reflect the level of communication development between regions. The more developed the communication, the closer the connection between various activities in consumer life.

Table 5: Descriptive Statistics of Variables

Variable	Obs	Mean	Std.Dev.	Min	Max
id	341	16.00	8.96	1.00	31.00
year	341	2017.00	3.17	2012.00	2022.00
y_{ij}	341	0.13	0.10	0.04	0.70
H_{ti}	341	0.14	0.11	0.01	0.60
E	341	11.17	0.35	10.50	12.27
P	341	7.35	0.92	3.32	8.97
B	341	2.52	0.23	1.73	3.28
T	341	6.55	1.15	3.50	9.62

FINDINGS

Empirical Results

We first conducted preliminary tests using both random effects and fixed effects models, with results presented in columns (1) and (2) of Table 6. The Hausman test yielded a statistic of 14.27, which was statistically significant at the 5% level, leading to rejection of the null hypothesis and adoption of a fixed-effects model. While the single fixed-effects model effectively addressed variables that varied by individual but were constant over time, it also omitted variables that were independent of time. Although this model resolved the issue of variables that differed across individuals but remained constant over time, it inadvertently introduced omissions in variables that did not change over time. To address this, we incorporated time fixed effects into the fixed-effects model to account for omissions of variables that varied over time but were constant across individuals. Consequently, we then applied a two-way fixed effects model for regression estimation of the equation (see columns (3)-(7) of Table 6).

Table 6: Estimation of Digital Infrastructure and Modernization Consumption Regressions

	(1) FE	(2) RE	(3) T-W-FE	(4) T-W-FE	(5) T-W-FE	(6) T-W-FE	(7) T-W-FE
H_{ti}	0.2270***	0.2182***	0.2268***	0.2260***	0.2185***	0.2146***	0.2115***
	(0.0220)	(0.0221)	(0.0225)	(0.0225)	(0.0225)	(0.0225)	(0.0226)
P	0.0528***	0.0651***		-0.0172	-0.0129	-0.0139	-0.0145
	(0.0075)	(0.0066)		(0.0208)	(0.0207)	(0.0207)	(0.0206)
T	-0.0098	-0.0268***			-0.0249**	-0.0231**	-0.0208**
	(0.0093)	(0.0079)			(0.0100)	(0.0100)	(0.0101)
E	-0.0118*	-0.0128**				-0.0139*	-0.0124*
	(0.0062)	(0.0063)				(0.0073)	(0.0074)
B	-0.0030***	-0.0033***					-0.0079
	(0.0011)	(0.0011)					(0.0059)
_cons	-0.3687***	-0.3759***	0.0931***	0.2880	0.4085*	0.4498*	0.4856**
	(0.0443)	(0.0468)	(0.0076)	(0.2368)	(0.2397)	(0.2396)	(0.2408)
Year	NO	NO	YES	YES	YES	YES	YES
Province	YES	NO	YES	YES	YES	YES	YES
Hausman	14.27**						
N	341	341	341	341	341	341	341
r2_a	0.7019	/	0.7196	0.7198	0.7270	0.7310	0.7323

Note: *, **, and *** indicate significance at the 10%,5%, and 1% levels, respectively. Robust standard errors are shown in parentheses. For tabulation convenience, some coefficients are rounded to 2 or 3 decimal places and are not repeated.

Regression analysis controlling for relevant variables indicates that digital infrastructure consistently has a positive effect on consumption in China's modernization process, with the effect remaining statistically significant at the 1% level. This indicates that digital infrastructure exerts a substantial positive influence on consumption during China's modernization phase, as evidenced by the correlation between consumption growth and infrastructure development. Improvements in digital infrastructure have driven growth in consumption in this context. Notably, electricity consumption and bus ownership per 100 people show no significant impact at the 10% significance level, suggesting they may have negative effects on consumption promotion. Meanwhile, total telecom service volume has a negative effect at the 5% level, whereas education expenditure has a negative effect at the 10% level.

Robustness Test and Endogeneity

Robustness Test. To further verify the robustness of the above empirical conclusions, this section adopts the PPML model to regress the equation, following the approach of Silva and Tenreyro (2006). The structure is shown in Table 7.

Endogeneity Discussion. Digital infrastructure has a positive effect on the consumption of Chinese-style modernization. However, the development of Chinese-style modernization consumption may have a reverse effect on digital infrastructure, for example, whether the rise in consumption levels in central and western regions will increase digital infrastructure investment, or whether residents' consumption psychology will change. In view of this, the core explanatory variables are recalculated using the two-stage least squares (2SLS) method. The impact of digital infrastructure on Chinese-style modernization consumption is reestimated using the 2SLS method. The regression results in Table 7 strongly reject the null hypothesis of no endogeneity. This indicates that, after accounting for various potential endogeneity issues, the main empirical conclusions remain valid. The 2SLS results are consistent with previous

findings, indicating no endogeneity between the level of digital infrastructure and Chinese-style modernization consumption.

Table 7: Robustness and Endogeneity Test

	PPML	2SLS
H_{ti}	1.4368***	0.2529***
	(0.3992)	(0.0449)
E	0.6147***	0.0020
	(0.1146)	(0.0228)
P	-0.3493 ***	-0.0386 ***
	(0.0503)	(0.0114)
B	-0.4384 ***	-0.0183 **
	(0.0868)	(0.0077)
T	-0.0048	-0.0071
	(0.0259)	(0.0062)
_cons	-5.4961 ***	0.4301
	(1.5375)	(0.2713)
F	/	336.6944
N	341	310
Adj-R^2	/	0.9796

CONCLUSION AND RECOMMENDATIONS

Conclusion

Against the backdrop of rapidly advancing digital infrastructure development, this study examines the impact of digital infrastructure on consumption patterns in China's modernization process through theoretical analysis and empirical evidence. The research conducts empirical tests across four dimensions: macro-level, regional, sectoral, and multiple influencing factors. Key findings include:

1. Digital infrastructure exhibits diverse complexity, primarily shaped by regional disparities. While provinces generally show upward trends in digital infrastructure development, the original disparities between central and western regions (with lower initial infrastructure levels) led to higher rates of improvement in the former. By 2022, the eastern region's comprehensive digital infrastructure level nearly tripled that of the western region.

2. Consumption patterns in China's modernization also demonstrate diversity and complexity. The study constructs indicators through three dimensions: consumer demographics, consumption environment, and service quality. Provincial consumption indices indicate that the eastern region leads, followed by the central region, whereas the northeastern region lags behind. Notably, the northeastern region's average level exceeds that of the western region because fewer provinces are included in the sample, whereas the western region's consumption growth rate remains the lowest.

3. Digital infrastructure has a significant promoting effect on Chinese modernization consumption, and there is no endogenous problem between the two. After controlling for relevant variables, the impact of education expenditure on Chinese modernization

consumption is not heterogeneous across time or regions; however, the effect is significant at the 10% level.

When using the 2SLS method for endogeneity testing, there are endogeneity issues in the relationship between education funding and the Chinese path to modernization consumption. Other variables, such as electricity consumption, the number of buses per 100 people, and total telecommunications business volume, do not exhibit endogeneity and have varying degrees of negative impact on the Chinese path to modernization.

Recommendations

Based on the paper's research conclusions, the following policy recommendations are proposed to promote the development of digital infrastructure and the modernization of consumption with Chinese characteristics.

1. Strengthening the Construction of Digital Infrastructure. At the national level, the construction of digital infrastructure has been elevated to a national strategy, emphasizing its important role in the development of the digital economy. To this end, the following measures can be taken:
   i. Accelerating the construction of next-generation information infrastructure. The construction of next-generation information infrastructure has become a key to accelerating the realization of a digital China and a smart society.
   ii. Advances in digital technology have driven the upgrading and innovation of computing power architecture. Diversification, intelligence, and green development are the current trends in data center development.
   iii. New infrastructure represented by 5G, artificial intelligence, and industrial internet has become a key area of national investment, playing a crucial role in the digital economy. New infrastructure not only promotes the continued expansion of these industries' scale but also accelerates the development of industrial digital transformation.

2. Reducing the Regional "Digital Divide"
   i. There is a significant disparity in the level of informatization between the central and western regions and the eastern coastal regions of China. The state should increase investment in infrastructure construction and education in these regions to improve the quality of public information services. In recent years, the pace of digital infrastructure development in China's central and western regions has been significantly faster than in the east, indicating that increased infrastructure investment is an effective way to narrow the digital divide between regions.
   ii. The government should take appropriate measures to prevent the further widening of the gap, including formulating clear industry-oriented policies to promote the development of high technology, encouraging the participation of private institutions, promoting information technology, popularizing information technology, and popularizing information education, etc. At the same time, a series of measures adopted by the state for the economic development of the western region will also lay a solid foundation for narrowing the digital divide between the east and the west.
   iii. Many countries and regions around the world have already taken effective measures to narrow the digital divide, such as the U.S. government's initiatives to address the digital divide and the beneficial experiences of Europe and other countries. China, drawing on foreign experience and adapting to its domestic context, has formulated a development strategy suited to its national conditions.

Eliminating the "digital divide" between regions requires the concerted efforts of the government, enterprises, and society as a whole. By combining various measures such as increasing investment in infrastructure construction, promoting the popularization and education of information technology, government policy support, leveraging opportunities brought by the pandemic, and international cooperation and experience sharing, this phenomenon can be effectively narrowed or even eliminated.

3. Boosting Consumption Growth in China's Modernization

Strategies to drive consumption growth in China's modernization can be analyzed and implemented through multiple dimensions:

i. Establishing rational consumption concepts: Through education and public awareness campaigns, cultivate appropriate consumption values to guide consumers toward rational, healthy, and sustainable purchasing behaviors.

ii. Designing evidence-based consumption policies: Governments should formulate and implement scientific consumption policies, including fiscal subsidies and tax incentives, to stimulate consumer demand.

iii. Improving household income: Enhancing residents' income is crucial for optimizing consumption structure. This can be achieved by creating more job opportunities and raising wage levels.

iv. Cultivating new consumption models: Aligning with consumption upgrade trends, develop innovative consumption models such as e-commerce and green consumption to meet modern consumers' needs.

v. Enhancing consumption environment and quality: Create a safe and reassuring consumption environment by improving quality standards and integrity systems, promoting product and service quality, and boosting consumer confidence.

vi. Expanding domestic demand: Accelerate the establishment of a new development paradigm centered on domestic circulation, using domestic demand as the driving force to boost economic growth.

Acknowledgments and Conflicts of Interest Declaration.

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