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Digital Economy, Openness, and Regional Economic Growth

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Abstract: Utilizing provincial panel data from 2011 to 2021, this study empirically investigates the distinct roles of the digital economy and economic openness in driving regional growth across China. The findings reveal that digital advancement serves as a robust and consistent catalyst for economic expansion. In contrast, the impact of openness exhibits a non-linear, threshold-dependent pattern. Heterogeneity analysis further indicates that the positive effect of the digital economy is significantly amplified in regions with advanced technological capability and upgraded industrial structures. Concurrently, an inverted U-shaped relationship between openness and growth is specifically identified in areas with lower innovation capacity and in those with more mature industrial frameworks. Based on these insights, the study proposes differentiated strategy recommendations aimed at fostering sustainable and balanced regional development.

Keywords: Digital Economy; Openness; Regional Economic Growth

1. Introduction

In the contemporary global economic landscape, fostering economic growth continues to be a primary objective for nations and regions worldwide. This focus extends to academic inquiry, where regional economic development is gaining heightened attention, partly driven by advancing regional integration. Within this context, the digital economy—distinguished by its speed, pervasive reach, and spillover benefits—is increasingly recognized as a pivotal force for economic expansion. It supplies novel impetus and avenues for achieving high-quality development and establishing a modern economic structure, potentially heralding a forthcoming industrial transformation. Concurrently, prevailing policy directives reaffirm the commitment to "maintaining openness as a fundamental national policy and steadfastly pursuing a strategy of mutual benefit." This underscores the critical contribution of openness to sustaining economic growth momentum.

However, China's extensive geographic scale coincides with pronounced heterogeneity in provincial development, creating a stark contrast in core economic metrics including regional output, income per capita, and technological capacity. This spatial inequality is mirrored in the distribution of both the digital economy and the degree of openness. On the one hand, Evidence from the "China Digital Economy Development Research Report (2023)" illustrates a tiered structure in the nation's digital landscape for 2022. Provincial-level digital economy indices, clustering between 40 and 100, delineate three clear echelons. Notably, the Northeast region trails behind the eastern, central, and western zones in overall digital development. Furthermore, digital capital demonstrates a distinct core-periphery pattern: over 230,000 related transaction events are heavily concentrated in eastern coastal hubs, with Beijing, Shanghai, Guangdong, Jiangsu, and Zhejiang collectively representing nearly 70% of the national total—dwarfing the mere 1% share of all other areas combined. On the other hand, regional openness should be understood as a multifaceted concept involving bidirectional technology flows and profound socioeconomic integration. This conceptual framework helps illuminate the developmental disparity revealed by the 2018 Regional Opening-up Index Report. The data confirms that provinces along the eastern coast, benefiting from inherent locational and economic advantages, have achieved significantly higher levels of openness. In contrast, the central, western, and northeastern parts of the country demonstrate a comparative lag in their integration with the global economy.

In this context, faced with the new normal of slowing global economic growth, rising protectionism, and rapid restructuring of global trade rules, can the digital economy and openness effectively promote regional economic

growth? Will their impacts on regional economic growth vary due to regional differences? To tackle these research questions, this study develops an integrated analytical framework that brings the digital economy and trade openness into a unified system and examines their underlying mechanisms affecting regional economic growth. Building on the empirical evidence, targeted policy implications will be drawn to support the long-term development of regional economies.

2. Literature Review

Research on the relationship between the digital economy, openness, and economic growth has yielded a series of findings from scholars domestically and internationally, primarily focusing on the following two aspects:

2.1 Digital Economy and Economic Growth

The digital economy, broadly defined by forums such as the G20 Hangzhou Summit as economic activity centered on digital inputs, networks, and ICT-driven optimization, is increasingly seen as a fundamental driver of contemporary economic expansion. Scholarly research has deepened this understanding by examining its multifaceted impact through various lenses.

At the core of this inquiry is the link between digitalization and regional development. Studies consistently position the digital economy as a central force in regional advancement[1]. This effect is often quantified through composite indices that capture dimensions like infrastructure, industry, and integration, with research confirming that such development significantly enhances regional total factor productivity[2].

The empirical evidence extends beyond national averages to reveal nuanced spatial and qualitative dynamics. For instance, regional-level analyses, such as those conducted in Russia, demonstrate its capacity to stimulate progress across different geographic scales while improving living standards[3]. Within China, research utilizing convergence theory indicates that the digital economy not only propels urban growth but also exerts a converging force, potentially reducing inter-regional economic disparities[4]. Furthermore, investigations into the quality of growth reveal complex patterns, such as a "J-shaped" relationship and significant spatial spillover effects, suggesting that the digital economy's contribution to balanced regional development is both positive and multifaceted[5].

In summary, while a robust consensus exists on the growth-promoting role of the digital economy, ongoing research continues to refine our understanding of its measurement, heterogeneous impacts across regions, and its influence on the quality and spatial distribution of economic development.

2.2 Opening-up and Economic Growth

2.2.1 Measurement methods for openness level

Regarding the measurement of the degree of openness, existing studies primarily adopt the following two approaches:

First, he comprehensive indicator measurement method involves constructing a multidimensional indicator system to comprehensively evaluate the level of openness. For example, Zhao et al.[6] developed an indicator system encompassing economic, social, cultural, and policy dimensions, and applied principal component analysis to assess the openness of the western regions of China.

Second, the single indicator measurement method, which employs a single indicator or its modified version to gauge the degree of openness. Commonly used indicators include trade dependence, foreign trade dependence, and the Douglas index, among others. For instance, the sum of trade dependence and foreign capital dependence is frequently adopted as a measurement approach in research.

2.2.2 The impact of openness on economic growth

The impact of openness on economic growth has been extensively debated, yielding two predominant strands of conclusions in the literature. The first strand confirms a generally positive correlation. A body of research, spanning cross-country analyses[7] to regional case studies in developing economies[8, 9], consistently identifies that trade and investment openness serve as significant catalysts for growth, even contributing to ancillary benefits like poverty reduction. Notably, the magnitude of this positive effect can be moderated by local conditions, as evidenced by provincial-level studies[10].

The second strand, however, complicates this narrative by highlighting nonlinearities and contingent outcomes. Scholars argue that the growth benefits of openness are not automatic or monotonic. Empirical evidence from specific

national contexts, such as South Africa, even reveals inhibitory effects under certain circumstances[11]. This has led to the recognition of a potential nonlinear (e.g., inverted U-shaped) relationship[12], suggesting that the marginal returns to openness may diminish or turn negative beyond an optimal threshold. Consequently, a consensus emerges that the appropriateness of openness levels must be calibrated to a country's or region's specific developmental stage and economic structure[13].

While these studies richly document the separate linkages, a notable gap remains: few have integrated the digital economy, openness, and regional growth into a unified framework while accounting for regional heterogeneities. This study aims to bridge this gap by employing provincial panel data to concurrently examine these relationships and dissect their variations across regions with differing technological innovation capabilities and industrial structures.

3. Research Hypotheses

3.1 Digital Economy and Regional Economic Growth

With its attributes of strong innovation, high permeability, and expansive coverage, the digital economy can effectively realize economies of scale and scope and stimulate long-tail effects. This form of economy constitutes both an emerging growth source and a vital foundation for advancing traditional industries to higher developmental tiers, infusing new energy into economic progress. In terms of functional mechanics, digital technologies are instrumental in transforming and upgrading legacy industries, achieving deep integration of the digital and real economies, enhancing core manufacturing advantages and the digitization of services, which in turn increases the value-added of products and services. Throughout processes spanning production, circulation, allocation, and consumption, data elements - capitalizing on their intrinsic and communal value - cooperate with traditional factors to yield a significant multiplicative outcome. In parallel, the information-matching functions of digital platforms increase the efficiency with which trading partners are matched and reduce costs incurred from transactions and services in productive and consumptive activities. From a practical perspective, the digital economy demonstrates a clear driving effect on high-quality economic development and has become a key force supporting stable economic growth. Drawing on the preceding discussion, the hypothesis presented below is advanced:

Hypothesis 1: The digital economy promotes regional economic growth.

3.2 openness and Regional Economic Growth

According to relevant research in new growth theory, countries should emphasize the positive effects of openness during their economic development. Foreign trade not only helps expand trade volume but also promotes the global dissemination of advanced knowledge, technologies, and human capital, enabling trading nations to accelerate the accumulation of these resources. In the initial stages of openness, countries or regions can more easily access foreign advanced technologies and management expertise, all of which positively contribute to economic growth. However, as the degree of openness continues to increase and reaches a certain level, further openness may introduce a series of challenges, indicating that openness may exert a non-linear impact on regional economic growth. For example, technology spillover effects may weaken due to intensified international competition, making it difficult for local enterprises to effectively absorb and apply new technologies when facing external pressures. Simultaneously, heightened competition may lead to inefficient resource allocation and even inhibit the development of certain domestic industries, thereby adversely affecting economic growth. In light of the preceding discussion, the subsequent hypothesis is formulated:

Hypothesis 2: openness has a non-linear impact on regional economic growth. At lower levels of openness, it promotes economic growth; however, when the degree of openness exceeds a certain critical value, further openness will inhibit economic growth.

4. Model Specification and Data Sources

4.1 Model Specification

A panel data model is constructed to examine how the digital economy and openness influence regional economic growth. The model takes the following form:

$$igdp_{it} = \beta_0 + \beta_1 digital_{it} + \beta_2 FO_{it} + \theta X_{it} + \lambda_t + u_i + \varepsilon_{it} \quad (1)$$

In the model, the subscripts i and t index the

province and year, respectively. The dependent variable, $igdp_{it}$,captures the per capita GDP of province i and t . The core explanatory variables are the digital economy development level ($digital_{it}$) and the degree of openness (FO_{it}). The vector X_{it} encompasses a set of control variables, including employed labor force, capital stock, and average years of education. The intercept is denoted by β_0 , while β_1 , β_2 , and θ are the coefficients to be estimated for the explanatory and control variables. Time-fixed effects and province-specific individual effects are represented by λ_t and u_i ,respectively. Finally, ε_{it} is the idiosyncratic error term.

Theoretical extension leads to the proposition that the influence of openness on regional development may not be linear. Investigating this possibility requires modeling a nonlinear component, achieved by adding a squared openness term. This leads to the following econometric model:

$$igdp_{it} = \beta_0 + \beta_1 digital_{it} + \beta_2 FO_{it} + \beta_3 FO^2_{it} + \theta X_{it} + \lambda_t + u_i + \varepsilon_{it} \quad (2)$$

4.2 Variable Selection and Data Sources

4.2.1 Explained variable

Regional economic growth level (*igdp*): Measured by regional per capita GDP, with data sourced from the China Statistical Yearbook.

4.2.2 Core explanatory variables

① Digital economy development level (*digital*): following the approaches of Wang et al. [14] and Guo et al. [15] in consideration of data availability. This system comprises three dimensions: digital infrastructure, digital industry development, and digital financial inclusion. The detailed indicators are listed in Table 1.

A composite index is constructed in this research to assess regional digital economy development. The weighting of each dimensional indicator is accomplished through the application of the entropy method. The detailed calculation follows the formula provided below:

Table 1. Dimensions and Detailed Indicator System for Digital Economy Development Level

Primary Indicator	Secondary Indicator	Tertiary Indicator	Indicator Attribute
Digital Economy Development Level	Digital Infrastructure	Number of Domain Names (10,000 units)	Positive
		Number of IPv4 Addresses (10,000 units)	Positive
		Number of Internet Broadband Access Ports (10,000 units)	Positive
		Mobile Phone Penetration Rate (units per 100 persons)	Positive
		Optical Cable Length per Unit Area (km/km²)	Positive
	Digital Industry Development	Number of Informatized Enterprises (units)	Positive
		Number of Websites per 100 Enterprises (units)	Positive
		Proportion of Enterprises with E-commerce Transactions (%)	Positive
		E-commerce Sales Volume (billion RMB)	Positive
		Software Business Revenue (billion RMB)	Positive
	Digital Financial Inclusion	Coverage Breadth Index	Positive
		Usage Depth Index	Positive
		Digitization Level Index	Positive

$$S = \sum_{j=1}^{m}\left(100 \times y_{ij} \times \left(\frac{1-e_j}{\sum_{j=1}^{m}(1-e_j)}\right)\right) \quad (3)$$

$$e_j = -\frac{1}{ln(n)}\sum_{i=1}^{n} y_{ij} ln y_{ij}, y_{ij} = \frac{x'_{ij}}{\sum_{i=1}^{n} x'_{ij}}, x'_{ij} = \frac{x_{ij} - min_{ij}}{max_{ij} - min_{ij}} \quad (4)$$

In the formula, x'_{ij} represents the positive standardization of each indicator, y_{ij} denotes the weight of indicator j for region i ; e_j is the information entropy of indicator j ;and n is the sample size.

Data are drawn from the following: the Peking University Digital Finance Research Center; the China Industrial Statistical Yearbook; the China Statistical Yearbook; and various provincial statistical yearbooks.

② Degree of openness (*FO*): Due to limited data availability, this study focuses specifically on the economic dimension of openness. The degree of openness is measured by selecting the sum of trade dependence and foreign capital dependence, with the specific calculation

method as follows:

$$FO = (\frac{X+M}{GDP} + \frac{FDI}{GDP}) \times 100\% \quad (5)$$

In the formula, X and M represent the regional import and export value, respectively, and FDI denotes the regional actual foreign direct investment. The data are sourced from the China Economic Network Statistical Database and the China Statistical Yearbook.

4.2.3 Control variables

Based on the Cobb-Douglas production function, the control variables used in this analysis are as follows:

① Labor input (*labor*): Measured by the number of employed persons in each region. Data are obtained from the China Population and Employment Statistical Yearbook.

② Capital input (k): This variable refers to the capital stock, estimated through the application of the perpetual inventory method on total fixed asset investment. With the year 2000 as the base period, data are deflated using the fixed asset investment price index. The base period capital stock is derived by dividing the total real fixed asset investment in the initial year by 10%, and an annual depreciation rate of 9.6% is applied. Data are sourced from the EPS database and the CSMAR database.

③ Human capital (*education*): Following the measurement approach of Wan et al.[16], this study employs the average years of education of the labor force as the proxy for human capital. This indicator is calculated by applying a weighted average to the educational attainment structure of the population aged 6 and above, with standard year-weights assigned to different education levels. The relevant data are sourced from the China Population and Employment Statistical Yearbook.

Drawing on data from 30 Chinese provinces (2011-2021), this research constructs a balanced panel of 330 observations, with summary statistics for all variables presented in Table 2.

Table 2. Descriptive Statistics

Variable	Observations	Mean	Std. dev.	Min	Max
igdp	330	1.276	0.808	0.513	4.807
digital	330	0.138	0.110	0.017	0.655
FO	330	0.271	0.294	0.008	1.575
labor	330	7.606	0.767	5.624	8.864
k	330	6.817	5.021	0.403	25.05
education	330	9.269	0.906	7.474	12.78

5. Empirical Process and Results Analysis

5.1 Benchmark Regression

Table 3 presents the benchmark regression results estimating the impacts of the digital economy and openness on regional economic growth, with province and year fixed effects included in all specifications.

Initially, even without control variables (columns (1), (3), and (6)), the coefficients for both the digital economy (*digital*) and openness (*FO*) remain significant, suggesting their preliminary importance for regional growth. Specifically, as openness and other controls are progressively incorporated (columns (1), (2), (5), and (6)), the coefficient for the level of digital economy development stays positive and statistically significant at the 1% level. This provides strong support for Hypothesis 1, confirming the digital economy as a crucial driver of regional economic expansion.

Furthermore, the impact of openness exhibits a distinct nonlinear pattern. Upon sequentially adding the digital economy variable and control variables (columns (3), (4), (5), and (6)), the coefficient for the linear term of *FO* is significantly positive, while that for its quadratic term is significantly negative, together forming a downward-opening parabolic relationship. This result validates Hypothesis 2, indicating an inverted U-shaped, nonlinear association between openness and regional economic growth.

Regarding the control variables, labor input (*labor*) shows a significantly positive effect on growth. Although the coefficient for capital input (k) is negative and significant, its minimal absolute value implies a very limited adverse effect, which may point to issues in capital allocation or utilization efficiency. The coefficient for human capital (*education*) is statistically insignificant, suggesting that the current stock of human capital may not yet have reached the threshold necessary to contribute significantly to economic growth.

5.2 Robustness Tests

5.2.1 Endogeneity test

To mitigate potential endogeneity concerns like reverse causality, this study employs an instrumental variable (IV) approach, using the one-period lagged digital economy development level (following Xiao and Zhang [17]) as the

instrument. The two-stage least squares (2SLS) estimates are reported in Column (1) of Table 4. The validity of the instrument is confirmed by a significant LM statistic (p=0), and the Cragg–Donald Wald F statistic (4333.693) far exceeds the critical threshold of 16.38, ruling out weak instrument concerns. These results affirm that the core findings regarding Hypothesis 1 and Hypothesis 2 are robust after accounting for endogeneity.

5.2.2 Replacing the explanatory variables

As a further robustness check, this study adopts a one-period lag for the core explanatory variables to mitigate potential endogeneity. The estimates in column (2) of Table 4 affirm that both the digital economy (*digital*) and openness (FO) retain their respective significant positive and non-linear impacts on growth. The stability in the signs and significance of all control variables further corroborates the robustness of the benchmark findings.

5.2.3 Adjusting the sample period

As a further robustness check, following the approach of Qi et al.[18], the sample period is confined to 2017 – 2021. This adjustment reduces noise from earlier, potentially heterogeneous policy environments and focuses on the phase where the digital economy ' s developmental trajectory is more distinctly established. The estimation results, presented in column (3) of Table 4, demonstrate that the relationships of interest remain statistically consistent, thereby strengthening confidence in the main findings.

Table 3. Full Sample Benchmark Regression Results

Variable	Explained Variable: igdp					
	(1)	(2)	(3)	(4)	(5)	(6)
digital	2.088***	2.047***			1.029***	1.187***
	(0.211)	(0.227)			(0.258)	(0.259)
FO			0.522**	0.616***	0.562***	0.636***
			(0.214)	(0.202)	(0.209)	(0.195)
FO^2			-0.658***	-0.666***	-0.553***	-0.553***
				(0.0979)	(0.103)	(0.0978)
labor		0.483***		0.548***		0.417***
		(0.120)		(0.113)		(0.113)
k		-0.0174***		-0.0133***		-0.0179***
		(0.00371)		(0.00343)		(0.00346)
educa tion		0.0582		-0.0391		-0.0154
		(0.0412)		(0.0410)		(0.0400)
Constant	1.136***	-2.993***	1.268***	-2.535***	1.162***	-1.848**
	(0.0233)	(0.924)	(0.0507)	(0.912)	(0.0561)	(0.894)
Observations	330	330	330	330	330	330
Number of Regions	30	30	30	30	30	30
R-squared	0.285	0.396	0.356	0.440	0.390	0.479
Control Variable	No	Control	No	Control	No	Control
Province	Control					
Year	Control					

Note: Regression coefficients appear sans parentheses, featuring robust standard errors within parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. The same notation applies to the significance levels in the tables that follow.

Table 4. Robustness Tests

Variable	Explained Variable：igdp		
	IV_2SLS(1)	FE(2)	FE(3)
	Endogeneity Test	Replacing Explanatory Variables	Adjusting Sample Period
L.digital	1.167***	1.129***	
	(0.350)	(0.309)	
L.FO		0.962***	
		(0.203)	
$L.FO^2$		-0.721***	

		(0.100)	
digital			1.250***
			(0.405)
FO	0.940***		1.517***
	(0.325)		(0.524)
FO^2	-0.730***		-1.697***
	(0.174)		(0.402)
labor	0.390**	0.462***	0.387**
	(0.190)	(0.118)	(0.154)
k	-0.0192***	-0.0182***	-0.0356***
	(0.00471)	(0.00378)	(0.00754)
education	0.0489	-0.0473	-0.00511
	(0.0313)	(0.0411)	(0.0593)
Constant	-	-1.948**	-1.741
	-	(0.931)	(1.171)
Observations	300	300	180
Number of Regions	30	30	30
R-squared	0.438	0.501	0.377
Control Variable	Control		
Province	-	Control	
Year	-	Control	
Anderson LM	42.166	-	-
Cragg-Donald Wald	4333.693	-	-

5.3 Heterogeneity Analysis

This study further explores whether the core relationships vary across regions with different inherent conditions, focusing specifically on technological innovation capacity and industrial structure upgrading. Table 5 presents the corresponding heterogeneity analysis. All estimates incorporate province and year fixed effects and are derived from the balanced provincial panel.

5.3.1 Technological innovation capability

The sample is bifurcated into high- and low-innovation groups based on 2021 provincial patent counts relative to the national mean. The results reveal a clear divergence (Table 5, columns 1-2): the digital economy's (*digital*) growth-promoting effect is concentrated in high-innovation regions, while its impact in low-innovation areas is statistically negligible. Conversely, a significant inverted U-shaped relationship for openness (*FO*) only emerges in low-innovation regions; in high-innovation regions, openness does not exhibit a statistically significant effect on growth.

In summary, technological innovation directly influences digital economic contributions to economic growth. In regions with low technological innovation capability, firms initially promote economic growth by introducing external resources through openness. However, as the degree of openness increases, intensified market competition and external economic fluctuations may introduce negative effects. In regions with high technological innovation capability, firms possess strong technological innovation and market adaptation capacities, enabling them to autonomously respond to external changes. These firms tend to focus more on internal technological innovation and research and development to enhance competitiveness, which explains why the degree of openness does not exhibit a significant impact on economic growth in such regions.

Table 5. Heterogeneity Analysis

Variable	Explained Variable：igdp			
	(1)	(2)	(3)	(4)
	High Technological Innovation Capability	Low Technological Innovation Capability	High Industrial Structure Upgrading	Low Industrial Structure Upgrading
digital	0.975***	-0.373	1.623***	4.035***
	(0.339)	(0.781)	(0.421)	(0.719)
FO	-0.471	2.491***	0.997***	-0.739

	(0.295)	(0.469)	(0.294)	(0.472)
FO^2	-0.131	-4.286***	-0.711***	0.880
	(0.134)	(1.051)	(0.140)	(1.062)
labor	-0.310*	0.808***	0.123	0.658***
	(0.178)	(0.126)	(0.192)	(0.109)
k	-0.0259***	-0.00881	-0.0188***	-0.0106***
	(0.00395)	(0.00534)	(0.00502)	(0.00396)
education	0.117**	-0.0474	0.0254	-0.0112
	(0.0575)	(0.0468)	(0.0710)	(0.0329)
Constant	3.317**	-4.617***	0.140	-3.765***
	(1.450)	(0.966)	(1.517)	(0.850)
Observations	154	176	176	154
Number of Regions	0.695	0.456	0.522	0.544
R-squared	14	16	16	14
Control Variable	Control			
Province	Control			
Year	Control			

5.3.2 Industrial structure upgrading

The digital economy's growth-enhancing effect is markedly stronger in regions with more advanced industrial structures, while openness exhibits a significant inverted U-shaped relationship only in these regions (Table 5, columns 3-4). For this analysis, industrial structure upgrading is gauged by the tertiary-to-secondary sector output ratio, with provinces classified into high- and low-level groups relative to the sample mean. In less upgraded regions, the impact of openness on growth is not statistically discernible.

The results imply that the digital economy's growth-enhancing effect is most potent in tertiary-sector-dominated economies, likely because traditional sectors therein still lack deep digital integration. Conversely, in regions with less upgraded industrial structures, the economy remains anchored in traditional primary and secondary sectors. These sectors are often more domestically oriented and insulated from global markets, which may explain why increased openness fails to translate into a significant growth stimulus despite greater external demand.

6. Conclusions and Implications

6.1 Key Findings

A provincial panel data analysis from 2011 to 2021 reveals distinct roles for the digital economy and openness in shaping regional growth in China. The principal findings are twofold.

First, the digital economy is a robust driver of growth, but its efficacy is contingent upon regional characteristics. Its positive effect is particularly pronounced and statistically significant only in regions with strong technological innovation capacity. Furthermore, while universally positive, the digital economy's impact is substantially amplified in regions with more advanced industrial structures.

Second, the impact of openness exhibits a threshold-dependent pattern, following an inverted U-shaped curve. Increased openness initially promotes growth, but beyond an optimal point, further openness is associated with diminishing returns. This nonlinear relationship is statistically identifiable specifically in regions with lower innovation capacity and in those with more advanced industrial structures.

6.2 Strategic Implications

The empirical findings lead to three targeted policy implications, each addressing the specific contingencies and nonlinearities identified in this study.

6.2.1 Target innovation capability to unlock digital dividends

Given that the digital economy's growth effect is significant only in high-innovation regions, policy must prioritize building technological innovation capacity as a prerequisite for digital gains. This involves not only increasing R&D investment but also fostering industry-university-research collaboration to cultivate a skilled talent pool. The goal is to create regional ecosystems where innovation and digitalization are mutually reinforcing, thereby enhancing resilience in an open economy.

6.2.2 Leverage industrial upgrading to amplify digital impact

Since the digital economy's positive effect is

strongest in regions with advanced industrial structures, policy should actively promote the digital and intelligent transformation of traditional sectors. For regions with weaker industrial foundations, targeted support is needed to incubate nascent digital industries. Strategic fiscal and regulatory incentives can accelerate the integration of the digital and real economies, systematically optimizing the industrial framework to maximize the growth contribution of the digital transition.

6.2.3 Implement dynamic, threshold-sensitive openness strategies

In light of the inverted U-shaped relationship between openness and growth, a one-size-fits-all approach to opening up should be avoided. Initial policy should focus on leveraging openness to absorb foreign investment and technology. However, as openness deepens, continuous monitoring is essential to identify when a region approaches its optimal threshold. Beyond this point, further opening requires careful calibration to mitigate potential negative impacts on growth, ensuring openness remains a net positive.

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