

A Study on The Impact of The Level of Digital Economy Development on The Utilization Efficiency Of FDI

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Abstract. The rapid advancement of the digital economy has garnered significant interest in the efficiency of foreign direct investment (FDI) utilization. This study transcends conventional research approaches and carefully examines the relationship between the two through the lens of efficiency. This study analyzes panel data from 30 provincial-level administrative regions in China between 2012 and 2022, constructing an empirical model. It concludes that the advancement of the digital economy significantly improves the efficiency of foreign direct investment utilization; specifically, a higher level of digital economy development correlates with increased FDI efficiency. These findings remain robust across various testing methodologies. The study's conclusion offers a scientific foundation for the government to develop a policy for the synergistic advancement of foreign investment, thereby enhancing the theory of international investment and supplying robust theoretical support and empirical evidence for the optimization and enhancement of China's foreign investment utilization strategy in the digital economy era.

Keywords: Digital economy development level; Foreign direct investment utilization efficiency; Fixed effect model.

1. Introduction

In recent years, the digital economy, as a novel catalyst for global economic advancement, is significantly altering the dynamics of production, consumption, and markets. Data from the China Academy of Information and Communication Research (CAICR) indicates that the global digital economy surpassed 50 trillion dollars in 2023, representing about 50% of GDP, with a more pronounced increase in poorer nations. Simultaneously, foreign direct investment (FDI) is crucial in fostering economic growth, scientific advancement, and industrial enhancement in recipient nations. Nonetheless, amid the flourishing digital economy, nations continue to encounter numerous hurdles in leveraging foreign direct investment (FDI). Divergences in digital infrastructure have resulted in substantial disparities in the attraction and usage of foreign direct investment (FDI) across various nations, while the swift evolution of digital technology has complicated the adaptation of conventional FDI utilization models to the contemporary economic landscape. It offers a comprehensive platform for scholars to examine the correlation between the digital economy and foreign direct investment (FDI).

The digital economy plays a crucial role in advancing the high-quality development of China's economy. Foreign direct investment, as a significant emblem of economic globalization, is vital in fostering international trade expansion, invigorating technological innovation, and propelling economic prosperity. While there are studies examining the development of the digital economy or the efficiency of FDI in isolation, there is a scarcity of research that integrates both aspects to investigate the influence of digital economy development on FDI from an efficiency perspective. This paper compiles and analyzes data on the digital economy development across 30 provincial-level administrative regions in China from 2012 to 2022. It constructs an econometric model that integrates data characteristics to investigate the correlation between the level of digital economy development

and the efficiency of foreign direct investment (FDI) utilization in China, thereby enhancing FDI efficiency and contributing to the theory of international investment.

2. Review of Literature

2.1. Investigation of the economic ramifications associated with the advancement of the digital economy

The digital economy, a significant trend in contemporary economic development, has generated many economic repercussions due to its heightened level of advancement. He Mengjie and Fan Dingxiang (2025) indicated that an elevated degree of coupling and coordination between new infrastructure and digital industrialization enhances the potential for high-quality economic development, additionally facilitating technological innovation and exhibiting a notable spatial spillover effect [1]. Zhou Rongrong et al. (2025) and colleagues discovered that advancements in digital economy development significantly enhance the manufacturing industry's standing within the global value chain, with variations in the effects of digitalization and technological innovation across different factor-intensive industries [2].

Furthermore, Huang Lu (2025) determined that the advancement of the digital economy significantly enhances consumption upgrading in the Yangtze River Delta urban agglomeration, primarily through the improvement of industrial structure, thereby exerting an indirect influence, with a more pronounced effect on urban consumption upgrading [3]. Zhao Yixing (2025) discovered that the advancement of the digital economy enhances the developmental potential of China's trade and distribution sector, with labor productivity and industrial upgrading serving as intermediary factors [4]. Hu Rong (2024) said that an elevated level of digital economy development will prompt enterprises to implement a more differentiated strategic strategy, hence enhancing company performance [5]. Cui Riming et al. (2024) examined how the digital economy can substantially improve cities' capacity to attract foreign investment, highlighting notable spatial spillover effects. The primary channels of influence include market consumption capacity, knowledge and technology levels, and financial development. Furthermore, the advancement of the digital economy can facilitate the narrowing of disparities among cities in their ability to attract foreign direct investment [6].

2.2. Investigation of determinants influencing the efficiency of foreign direct investment utilization efficiency

The determinants influencing the effectiveness of foreign direct investment usage are increasingly intricate. Jiang Dianchun (2025) noted that the operations of multinational corporations in China are influenced by various factors, including fluctuations in labor costs, modifications in industrial policy, alterations in the global supply chain, advancements in information technology, and geopolitical dynamics. Consequently, as China's locational advantages evolve, foreign investment has increasingly focused on technology-intensive sectors [7]. Wang Hongshu et al. (2025) analyzed panel data from countries participating in the "Belt and Road" initiative and discovered that various distance factors influence outward foreign direct investment (OFDI). They identified that bilateral political relations serve as a moderating variable; for instance, enhanced interaction frequency positively regulates institutional distance, national-level initiatives can reduce cultural distance, and strengthened bilateral political relations mitigate the adverse effects of geographic distance. adverse impact of geographic remoteness [8]. Deng Wendan and Jiang Ying (2024) contended that the dynamic capabilities of enterprises influence the technology spillover effect of foreign direct investment, subsequently impacting the digital transformation of enterprises. They posited that the technology spillover effect is more pronounced in enterprises located in the eastern region, non-state-owned enterprises exhibiting a greater propensity for digital transformation, and those possessing elevated levels of internal governance [9]. Wu Yida (2024) determined that the advancement of the digital economy in the Guangdong, Hong Kong, and Macao Greater Bay Area facilitates the attraction of foreign investment, influenced by industrial agglomeration and cost efficiency. Additionally,

factors such as labor costs, infrastructure development, foreign trade reliance, and fiscal dependence also affect foreign direct investment [10].

2.3. Review of Literature

Collectively, research have examined the correlation between the advancement of the digital economy and the efficacy of foreign direct investment (FDI) utilization. Limited research has examined the correlation between the advancement of the digital economy and foreign direct investment from an efficiency standpoint, revealing a significant connection between the two. This study enhances theoretical research regarding efficiency and offers more specific policy recommendations for the optimal utilization of FDI to foster high-quality economic development.

3. Theoretical Examination and Research Hypotheses

Amidst the flourishing advancement of the digital economy, the effectiveness of foreign direct investment (FDI) utilization has garnered significant scholarly interest. This study systematically examines the fundamental relationship between the development level of the digital economy and the efficiency of foreign direct investment (FDI) usage, grounded in the three principal theories of technical innovation, transaction costs, and economies of scale, while proposing research hypotheses.

According to Schumpeter's theory of technological innovation, the incorporation of novel production components and conditions into the production system can transform economic growth. The digital economy centers on data and depends on cloud computing, blockchain, and other technical advancements to perpetually extend its application bounds. Zhang Ao and Sun Jiowen (2025) assert that the non-competitive nature of data serves as the catalyst for high-quality development. This innovative rationale pertains to the field of foreign direct investment (FDI), suggesting that advancements in digital technology can assist foreign-funded enterprises in minimizing technology application costs by streamlining production processes and enhancing data processing efficiency, thereby augmenting the output benefits of FDI projects [11].

According to transaction cost theory, information search, contract enforcement, and other concealed expenses substantially influence market decision-making, whereas cross-border investment and information asymmetry frequently result in inefficiencies in the deployment of foreign direct investment. From a resource allocation standpoint, the advancement of the digital economy can transcend conventional temporal and spatial constraints, facilitating the swift transmission and dissemination of information. For instance, Ye Jinsong et al. (2024) assert that the advancement of the digital economy mitigates the adverse effects of market segmentation on foreign direct investment (FDI) inflow. The digital economy enhances the market environment and enables foreign-invested firms to access various resources more efficiently, hence enhancing the efficiency of foreign direct investment (FDI) [12].

According to economies of scale posits that firms can diminish long-term production costs by increasing output or enhancing the division of labor. Zhang Ao and Sun Jiowen (2025) The capacity for digitization and network transmission has effectively eradicated the expenses associated with data replication, rendering data progressively non-competitive. The non-competitive characteristic of data suggests that economies of scale can be achieved by increasing usage frequency via data flow and sharing [11]. In the realm of foreign investment, once an enterprise attains the minimum effective scale, digital technology can enhance data flow and resource integration, enabling foreign enterprises to achieve cost-effective and efficient production, thereby stimulating regional economic development through industrial interconnection.

In summary, this study posits the following hypothesis, derived from the synergistic impact of the digital economy on the efficiency of foreign direct investment concerning technological innovation, transaction costs, and economies of scale as discussed in the literature.

H1: The level of digital economy development will significantly improve the utilization efficiency of foreign direct investment.

4. Research Design

4.1. Sample Selection and Data Source

This study seeks to thoroughly examine the influence of digital economy development on the efficiency of foreign direct investment utilization, selecting 30 provinces, autonomous regions, and municipalities directly under central government (excluding Tibet) as the research sample from 2012 to 2022, and conducting empirical analysis utilizing provincial panel data. This study addresses the sample as follows: the interpolation method and the mean value method are mostly employed to address missing data, and all variables are standardized to assure data continuity and completeness. The development of the digital economy establishes an index system based on four dimensions and using the entropy value approach to assess each province in China. The data sources include: statistical yearbooks of China and its provinces (municipalities and autonomous regions) from previous years, the China Statistical Yearbook, the China Foreign Investment Statistical Bulletin, the National Bureau of Statistics, the Digital Finance Research Center of Peking University's website, and the CECN statistics database.

4.2. Model construction and definition of Variables

(1) Definition of Variables

Explanatory variables: the explanatory variable is the level of digital economy development in each provincial administrative region, utilizing the comprehensive index of digital economy development level employed in this study as a proxy variable to represent the digital economy development level of each province in China within the model. This paper discusses the research concept proposed by Yang Huimei and Jiang Lu (2021) to develop an evaluation index system for the digital economy's development level across four dimensions: digital infrastructure construction, digital industrialization, industrial digitization, and digital innovation capability. It employs the entropy method to assess the digital economy development level of each province in China.

Explained variable: Efficiency of foreign direct investment use (eff). The efficiency of foreign direct investment is assessed by the investment production rate, calculated as the increase in the gross domestic product (GDP) of each province divided by the total foreign direct investment.

In terms of control variables, in addition to the constructed indicator system, there are other factors that may have an impact on the utilization efficiency of FDI. Therefore, after reading the related literature, the following control variables are introduced:

1) The degree of openness to the external environment (OPEN) significantly influences the effectiveness of information procurement and the transaction costs for foreign-invested firms. This study references the open economy analysis methodology developed by Huining and Yang Xin (2022), computed as the ratio of a province's total yearly import and export trade to its gross domestic product (GDP) [14].

2) The industrial structure (ind) characterized by a predominance of services is frequently associated with enhanced maturity of the factor market, which might diminish the institutional transaction costs for international enterprises. This study utilizes the work of Yuan Yijun and Xie Ronghui (2014) to conduct empirical research by establishing the ratio coefficients of value added in the secondary and tertiary sectors [15].

3) The extent of government expenditure (gov) on state-owned firms is mostly aligned with governmental aims, which skews resource allocation and adversely impacts the efficiency of foreign direct investment (FDI) usage. This research references Zhang Lingjie and Ma Liping (2022), indicating that the ratio of local general budget expenditure to regional GDP reflects the amount of government expenditure [16].

4) Human capital (labor) is a crucial factor influencing the efficiency of usage in foreign direct investment. This research utilizes the average income of urban employed individuals in each province, as referenced by Chen Rong and Wu Fengjiao (2019), to represent the region's human capital [17].

Table.1. Explanation of variables

	variant	notation	Description of indicators
Explained variable	foreign direct investment utilization efficiency (eff)	eff	Utilization of the investment output rate = incremental gross domestic product (GDP)/foreign direct investment in each province
Explanatory variables	level of digital economy development	dev	Composite index of the level of development of the digital economy as measured in the previous section
control variables	The degree of openness to the external environment	open	Total import and export trade/regional GDP
	The Industrial structure	ind	Value added of tertiary industry/value added of secondary industry
	The extent of government expenditure	gov	Local general budget expenditure/regional GDP
	Human capital	labor	Average wage of employed persons in urban units

(2) Model construction

Based on the research hypotheses presented in the previous section, this paper constructs the following equation as an econometric model;

$$eff_{it} = \alpha + \beta_1 lndev_{it} + \beta_2 X_{it} + u_i + u_t + \varepsilon_{it} \quad (1)$$

eff_{it} denotes the explanatory variable FDI utilization efficiency, $lndev_{it}$ denotes the level of development of the digital economy of the explanatory variable: where, i denotes individual province, t represents time: α is a constant term, β_1 denotes the coefficient estimate of the panel data regression of the explanatory variables, X_{it} is the set of control variables; u_i is an individual fixed effect, u_t is a time fixed effect; ε_{it} is a random disturbance term.

5. Empirical analysis

5.1. Descriptive statistics

In order to have a better intuitive understanding of the selected values, this paper selects all the variable data for descriptive statistics, and Table 2 reports the descriptive statistics of all the variables in model (1).

Table 2 illustrates that the maximum value of the explanatory variable FDI utilization efficiency is 44,957, while the least value is -73.75, indicating significant disparities in the efficiency of foreign investment utilization among provinces. The data reveal significant disparities in the development of the digital economy, access to foreign markets, infrastructure construction, and investment environment across China's provincial regions. The study by Pan Kuang and Yang Dan (2019) on the influence of variations in capital, human resources, technology, and institutional factors on regional economic disparities indicates that developmental discrepancies are prevalent in the economic progression of diverse nations [18], thereby validating the appropriateness of the sample data utilized in this paper.

Table. 2. Descriptive statistics

Variable	N	mean	sd	min	max
eff	330	445.7	3,254	-73.35	44,957
dev	330	0.120	0.103	0.019	0.598
open	330	0.265	0.268	0.008	1.354
ind	330	2.577	2.176	0.070	15.50
gov	330	0.249	0.102	0.107	0.643
labor	330	74,593	28,397	36,386	212,476

Source: Compiled from stata 17 output.

5.2. Correlation analysis

Pearson correlation coefficient is a common method to measure the degree of linear correlation between random variables, and Table 3 reports the results of correlation analysis of all variables in model (1).

Table 3 displays the correlation coefficients of the variables. The correlation coefficient between digital economy development and the efficiency of foreign direct investment utilization is 0.277, significant at the 10% level, indicating a correlation between digital economy development (dev) and foreign direct investment utilization efficiency (eff). The direct correlation coefficient between the degree of openness to the outside world (open) and the level of digital economic development (dev) is 0.627, significant at the 10% level, indicating a relationship between these two variables. There exists a notable correlation at the 10% significance level among the industrial structure (ind), the extent of government expenditure level (gov), human capital (labor), and foreign direct investment utilization efficiency (eff). The analysis indicates a strong link among the primary variables, whereas the correlation coefficients between various variables are below 0.700.

Table.3. Correlation analysis

Variables	eff	dev	open	ind	gov	labor
eff	1.000					
dev	0.277*	1.000				
open	0.104	0.627*	1.000			
ind	-0.063	-0.199*	0.471*	1.000		
gov	0.071	-0.456*	-0.424*	-0.093	1.000	
labor	0.072	0.699*	0.461*	-0.231*	-0.076	1.000

Note: ***, ** and * indicate significant at the 1%, 5% and 10% levels, respectively.

5.3. Examination of Multicollinearity

To prevent the covariance among variables from influencing the outcomes of the empirical analysis, this paper conducts the Variance Inflation Factor (VIF) test on the explanatory and control variables prior to the regression analysis, to ascertain the presence of multicollinearity issues among the variables. Table 4 presents the outcomes of the multicollinearity assessment for model 1, utilizing Stata 17 software to compute the variance inflation factor. As demonstrated in the table The mean VIF value is 3.16, and all variable VIF values are below 5, indicating the absence of multicollinearity issues among the explanatory and control variables in this study.

Table.4. Variance inflation factor test (VIF)

Variable	VIF	1/VIF
dev	4.40	0.227
open	4.53	0.220
ind	2.84	0.352
gov	1.56	0.640
labor	2.48	0.404
Mean VIF	3.16	

5.4. Regression Analysis of the Two-Way Fixed Effects Model

(1) Hausman test

The initial step prior to modeling is to ascertain whether to employ a random effects model or a fixed effects model, to guarantee the precision of the benchmark regression. A Hausman test was performed, and the results for model (1) are presented in Table 5. The test result yields a p-value of 0.0001, indicating statistical significance at the 1% level; hence, the fixed effect model was employed in developing the benchmark regression model.

Table.5. Hausmann test

Test of HO:Difference in coefficients not systematic
$\chi^2(4) = (b-B)'[(V_b - V_B)^{-1}](b-B)$
=26.94
Prob > $\chi^2 = 0.0001$

(2) Regression analysis

This paper conducts regression test on the empirical regression model, and the resulting regression results are shown in Table 6. column (1) shows the regression results without the introduction of control variables, and columns (2) to (5) introduce the degree of openness to the external environment (open), the industrial structure (ind), The extent of government expenditure level (gov), and human capital (labor) control variables in turn. The results show that the coefficients of the explanatory variables of the level of digital economic development are significantly positive regardless of the introduction of control variables. Column (5) presents the results of the baseline regression and this result passes the 1% significance test. Thus, the hypothesis H1 is verified; the level of digital economy development will significantly increase the efficiency of foreign direct investment utilization.

Table.6. Benchmark regression results

	(1)	(2)	(3)	(4)	(5)
Variables	eff	eff	eff	eff	eff
dev	0.601*** (0.153)	0.454*** (0.174)	0.443** (0.175)	0.440** (0.176)	0.588*** (0.195)
open		-0.468* (0.267)	-0.574* (0.322)	-0.575* (0.323)	-0.738** (0.335)
ind			0.0781 (0.132)	0.0770 (0.132)	0.0687 (0.132)
gov				-0.0419 (0.226)	-0.144 (0.233)
labor					-0.531* (0.305)
Constant	0.217 (0.188)	0.242 (0.188)	0.164 (0.231)	0.159 (0.233)	-0.260 (0.334)
individual fixed effect	yes	yes	yes	yes	yes
time fixed effect	yes	yes	yes	yes	yes
Observations	330	330	330	330	330
Number of id	30	30	30	30	30
R-squared	0.077	0.086	0.088	0.088	0.097

Note: ***, **, and * indicate significant at the 1%, 5%, and 10% levels, respectively; robust t-values adjusted for heteroskedasticity are in parentheses.

5.5. Robustness Tests

(1) Instrumental variables

This paper acknowledges the potential bidirectional causality between the explanatory variables, despite the inclusion of various control variables, which may still result in omitted variable bias and selection bias within the model. To address the issue of endogeneity, this study employs the methodology proposed by Xu, Li-Mei and Zhang, Yu (2025), utilizing the lagged level of digital economic development ($L.dev$) as an instrumental variable [19]. The findings, presented in column (1) of Table 7, indicate that the regression coefficient for the level of digital economic development remains significantly positive, thereby corroborating hypothesis H1.

(2) Substitution of explanatory variable

Due to the absence of a standardized index for measuring the development of the digital economy, this study utilizes the development coefficient of the digital economy (new_dev) as employed by Yingying Shao et al. (2024) and Jianhui Wu and Yongxin Guo (2024). By substituting the original explanatory variables, a regression analysis was conducted anew [20] [21]. The findings, presented in column (2) of Table 7, indicate that the level of digital economy development significantly enhances the efficiency of foreign direct investment utilization, achieving a notable positive correlation at the 1% significance level, thereby substantiating hypothesis H1.

(3) Substitution of the explained variable

This work employs the technique of substituting the measurements of the explanatory variables. Specifically, according to Liu Lian (2023), the logarithm of the foreign direct investment amount (new_eff) serves as the new explanatory variable for the measure [22], and regression analysis is performed. The regression outcomes are presented in column (3) of Table 7. The analysis results indicate that the regression coefficient for the level of digital economy development remains significantly positive, thereby confirming hypothesis H1: the level of digital economy development will significantly enhance the utilization efficiency of foreign direct investment.

(4) Replacement model examination

According to Hong Hua (2023), the primary regression model is substituted with a least squares model for the robustness test [23]. Define the dependent variable foreign direct investment utilization efficiency as eff , the amount of digital economy development as dev , the degree of openness to external markets as $open$, the level of government expenditures as gov , the industrial structure as ind , and human capital as $labor$. develop the model;

$$eff_i = \beta_0 + \beta_1 dev_i + \beta_2 open_i + \beta_3 gov_i + \beta_4 ind_i + \beta_5 labor_i + \varepsilon_i \quad (2)$$

The robustness test findings in column (4) of Table 7 indicate that the regression coefficient for the degree of digital economic development is considerably positive at the 1% level, hence confirming hypothesis H1.

Table.7. Results of robust-type tests

Variables	(1)	(2)	(3)	(4)
	eff	eff	new_eff	eff
	Instrumental variables	Substitution of explanatory variable	Substitution of the explained variable	Replacement model examination
L.dev	0.721*** (0.243)			
new_dev		0.805*** (0.201)		
dev			1.257*** (0.114)	0.661*** (0.109)
open	-0.774* (0.425)	-0.456 (0.347)	-0.738*** (0.196)	-0.157 (0.110)
ind	-0.0275 (0.197)	-0.0441 (0.135)	0.159** (0.0771)	0.0900 (0.0874)
gov	-0.0998 (0.259)	-0.116 (0.230)	-0.0760 (0.136)	0.151** (0.0648)
labor	-0.511 (0.336)	-0.456 (0.283)	-0.853*** (0.178)	-0.286*** (0.0816)
constant	0.00916 (0.316)	0.105 (0.336)	-0.294 (0.195)	-0 (0.0517)
time fixed effect	yes	yes	yes	yes
individual fixed effect	yes	yes	yes	yes
Observations	300	330	330	330
Number of id	30	30	30	30
R-squared	0.101	0.118	0.414	0.130

Note: ***, **, and * indicate significant at the 1%, 5%, and 10% levels, respectively; robust t-values adjusted for heteroskedasticity are in parentheses.

6. Study Conclusion

The advancement of the digital economy is crucial for improving the efficiency of foreign direct investment utilization. This paper examines the efficiency of foreign direct investment utilization as a focal point for empirical analysis. It assesses the level of digital economy development through various metrics, revealing that different measures of digital economy development can significantly enhance the efficiency of foreign direct investment utilization. Recognizing the digital economy as a novel catalyst for economic advancement not only positions China favorably in attracting foreign investment but also injects renewed momentum into the domestic economy for sustained growth, while fostering the integration of the global economy. The utilization of the digital economy as a novel catalyst for economic advancement not only enables China to secure a competitive edge in attracting foreign investment and infusing new momentum into the continuous growth of its domestic economy, but also fosters the profound integration and evolution of the global economy. The study's conclusions indicate that the government must expedite the enhancement of digital infrastructure and elevate the development of the digital economy; revise the foreign investment strategy and refine the regulatory framework for foreign investment; and execute a focused digital economy development strategy to mitigate regional development disparities.

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