

# Digital Economy Empowers High-quality Development of Traditional Manufacturing Industry: Evidence from Nanjing Metropolitan Area

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**Abstract:** The integration and development of the digital economy and the real economy, especially the traditional manufacturing industry, is the focus of China's development at this stage. With its high efficiency and high value, the digital economy has rapidly exerted its powerful traction in the field of manufacturing, giving the traditional manufacturing industry a chance to usher in a "spring of development" and gradually align itself with the direction of high-quality development. In order to find micro evidence that the digital economy enables the high-quality development of traditional manufacturing industry, this article uses factor analysis methods to measure the development level of its digital economy based on the perspective of Nanjing Metropolitan Area, and conducts an empirical analysis of the effect of the digital economy on the high-quality development of traditional manufacturing industry.

**Keywords:** Digital economy; Manufacturing High quality development; Nanjing Metropolitan Area.

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## 1. Introduction

The term "digital economy" was first popular in Western countries, and was born in the context of emerging technologies such as the Internet, big data, and the Internet of Things until it became a "tidal wave". It can be considered as one of the external effects brought about by technological progress, which is different from another type of economic effect of the real economy. The digital economy started relatively late in China, and it was not until 2017 that the report of the 19th National Congress of the Communist Party of China first mentioned the "digital economy" and its subsequent strategic departments. The report points out that in the process of building a modern socialist country, it is necessary to vigorously strengthen the integration of the digital economy and the real economy, and the direction of development needs to shift from high speed to high quality. Since then, the digital economy has begun to show its edge in all walks of life in China. Meituan takeout, live streaming, online courses, and smart healthcare are specific applications of the digital economy. The report of the 20th National Congress of the Communist Party of China and the two national conferences held recently also mentioned the issue of the integration and development of the digital economy and the real economy again, emphasizing in particular that building competitive industrial clusters through the digital economy is the key point of today's development. In addition, in order to achieve the high-quality development goals of high-end, green, and high-efficiency, the integration of the real economy represented by the manufacturing industry with the digital economy is also imminent, ultimately leading to an efficient transformation between digital industrialization and industrial digitization. Throughout history, the manufacturing industry has always been a giant of the real economy, making a significant contribution to the gross national product. It can be considered that whether the manufacturing industry is strong or not is the criterion for judging a country's economy. For a long time in the past, China has been a major

manufacturing country, occupying an important position in the international arena with its "demographic dividend" and "raw material advantage", and being an important partner of the WTO. However, in recent years, as the "demographic dividend" has subsided and the advantages of raw materials have been exhausted, some manufacturing industries have begun to shift to neighboring countries with lower production costs. Most traditional manufacturing enterprises in China are limited by production costs and production scale, and the "high cost, high energy consumption, low efficiency, and low profit" in the production process are important reasons for many manufacturing enterprises to reduce production or even go bankrupt. This has a significant impact on China's real economy, and the decline of manufacturing giants is highly likely to cause a decline in GDP, resulting in a linkage effect that leads to a lack of vitality in other industries. Therefore, rescuing manufacturing enterprises with the help of the digital economy is a top priority. Only by using the media of the digital economy to restructure the industrial chain, optimize the industrial structure, and build industrial clusters for the manufacturing industry can manufacturing enterprises regain their vitality and shine brightly in the future economy. As a microcosm of the Yangtze River Delta region, Nanjing Metropolitan Area has a sound digital economic system, manufacturing industry chains, and industrial clusters. Therefore, the effect of digital economy enabling high-quality development of traditional manufacturing industries should be more evident in Nanjing Metropolitan Area. In order to explore the practical evidence that the digital economy has enabled the high-quality development of traditional manufacturing industry, this article selects the Nanjing Metropolitan Area as the research carrier, uncovers the quantitative relationship between the digital economy and high-quality development of manufacturing industry, and puts forward suggestions as much as possible.

## 2. Literature Review

Shen Yunhong et al. (2020) used entropy method to

quantify the level of digital economy and manufacturing industry structure to consider the quantitative impact of digital economy on manufacturing industry structure. Li Chunfa et al. (2020) [2], in order to explore the mechanism of transformation and upgrading of the manufacturing industry, qualitatively discussed the upgrading and changes of the manufacturing industry chain under the influence of the digital economy from the perspective of the industrial chain, and finally concluded that the digital economy promotes the upgrading of the manufacturing industry by improving the efficiency of the manufacturing industry chain and reducing transaction costs. For a long time, the academic community only conducted a relatively comprehensive analysis of the relationship between the digital economy and the industrial structure of the manufacturing industry, until scholars such as Ma Zhongdong (2020) and others began to shift their research focus to high-quality development of the manufacturing industry, no longer limited to the industrial structure or industrial chain, using factor allocation as a transmission medium and combining actual data to analyze how the digital economy affects factor allocation, How does the allocation of factors affect the high-quality development of the manufacturing industry. Finally, the conclusion is drawn that the digital economy can promote the high-quality development of manufacturing industry by improving the allocation distortion of labor and capital factors. However, the source of its data is not clearly indicated in the article, so the final conclusion is not strongly convincing. Wei Zhuangyu et al. (2021) [4] recognized the importance of data to corroborate literature conclusions, expanded the source of sample data to the provincial level, and used relevant data from 2005 to 2016 to corroborate the promotion of the digital economy for high-quality manufacturing. In order to complete the research system, Lv Tie (2021) [5] and others proposed from a theoretical perspective that due to the development of the digital economy, the way of value creation and value acquisition in the manufacturing industry has undergone significant changes. Compared to communication, the ways of engaging users in value creation are more diverse, and the ways of enterprise value acquisition are also more diversified. In order to expand the evidence of the quantitative relationship between the digital economy and the high-quality development of the manufacturing industry, Zhang Aiqin et al. (2021) [6] improved the measurement method of indicators of the digital economy to verify the relationship between the two with more careful mathematical analysis. At the same time, Huining et al. (2022) [7], based on the intermediary effect model proposed in the original literature, transformed the intermediary influencing factors and proposed that the intermediary variable green total factor productivity is also a bridge between the digital economy and the high-quality development of the manufacturing industry.

Existing research has laid the foundation for in-depth exploration of the relationship between the digital economy and the high-quality development of the manufacturing industry. However, through a review of the literature, it can be found that previous literature has mostly used actual data, constructed or referenced relevant indicators to quantify the level of digital economy and high-quality development of the manufacturing industry, and then constructed a certain model for quantitative analysis. Most of the research levels are located at the macro level, without specific research on a specific region, and there is no innovation in the construction of high-quality development indicators for the digital

economy and manufacturing industry combined with the actual literature. The innovation points of this article may be as follows: First, innovative selection of factor analysis methods to measure the high-quality development level of the digital economy and manufacturing industry; The second is to no longer limit the research level to the macro level, and analyze the micro entities represented by the Nanjing metropolitan area to obtain practical evidence that the digital economy has enabled the high-quality development of the manufacturing industry.

### 3. Research Design

#### 3.1. Data source and indicator design

##### 3.1.1. Data source

The data carrier of this study is the Nanjing metropolitan area, mainly including 33 municipal districts, 11 county-level cities, and 16 counties, including Nanjing, Zhenjiang, Yangzhou, Huai'an, Ma'anshan, Chuzhou, Wuhu, Xuancheng, and Liyang and Jintan in Changzhou. Considering the availability and representativeness of the data, this article only selects the data from Nanjing, Zhenjiang, Yangzhou, Huai'an, Maanshan, Chuzhou, Wuhu, and Xuancheng from 2006 to 2021 as sample data. All data are from the official website of the China Bureau of Statistics and the statistical yearbook of cities from 2006 to 2021.

##### 3.1.2. Core Variables

(1) Explanatory variables and their measures. The core explanatory variable of this article is the level of the digital economy (Dg). Currently, there is no clear standard for the measurement of the level of the digital economy in the academic community. Different scholars have different views on the measurement of the level of the digital economy, but they all have a common characteristic, that is, they are good at using the entropy weight method to weight the relevant indicators of the digital economy. In order to make the indicators for measuring the level of the digital economy more universal, this article innovatively uses factor analysis methods to explore potential indicator factors and obtain a comprehensive indicator level that can contain most of the indicator information to measure the level of the digital economy. That is, the final factor score for each city can be used to measure its digital economy level. Referring to the indicator system for the level of the digital economy constructed by scholars such as Jiao Shuitao (2021) [8], combined with the characteristics of the current development of the digital economy, and referring to the factor analysis steps used by Liu Qunhong (2016) [9], this article selects the influencing factors for the level of the digital economy as shown in Table 1 for factor analysis.

After importing the data into stata, first test whether the selected variable data is suitable for factor analysis, and the final test value obtained is 0.5747. From the judgment criteria, it can be seen that the test value of data suitable for factor analysis should be greater than 0.6. However, considering that the test value at this time is almost the same as 0.6, there may also be observation errors in the data, it is considered here that the data is still suitable for factor analysis. Set the factor model to the following format.

$$\begin{cases} X_1 = \mu + \alpha_{11}F_1 + \alpha_{12} + F_2 + \dots + \alpha_{1m}F_m + \varepsilon_1 \\ X_2 = \mu + \alpha_{21}F_1 + \alpha_{22}F_2 + \dots + \alpha_{2m}F_m + \varepsilon_2 \\ \dots \\ X_p = \mu + \alpha_{p1}F_1 + \alpha_{p2}F_2 + \dots + \alpha_{pm}F_m + \varepsilon_p \end{cases} \quad (1)$$

In the factor model,  $X_i$  ( $1 < i < 10$ ) represents the  $i$ th variable, with a maximum of 14 variables;  $a_{ij}$  represents the  $j$ th common factor load value of the  $i$ th variable pair;  $\varepsilon_i$  represents the part of the  $i$ th variable that cannot be explained by a common factor, and is called a special factor." Using stata, principal component factor analysis is performed on data and variables to obtain common factor load values, which can be used to interpret variables. From Table 2, it can be seen that the cumulative variance contribution of the first five common factors is as high as 0.7219. After factor rotation, the extracted correlation coefficients between the five common factors are shown in Table 3.

**Table 1.** Variable Selection and Description

Variable	Description
X1	Internet broadband access port
X2	Length of long-distance optical cable line
X3	Number of enterprise intelligent industrial chains
X4	Number of mobile phone users at the end of the year
X5	Total telecom services
X6	Software business income
X7	Number of employees in the software industry at the end of the year
X8	Revenue from main business of electronic equipment such as communications
X9	Number of patent applications authorized
X10	Internal expenditure of research and development funds

Factor score refers to using the change of variables in turn to calculate the change of common factors, i.e. making the calculation shown in Equation (2). Finally, the comprehensive score is calculated from the variance contribution table according to Formula (3). After calculating the factor score, this article can make a visual evaluation of the digital economy level of each city. Combining the coefficient table 4 derived from formula (2), the relevant data is brought in. Finally, the comprehensive digital economy score of each city is shown in table 5, which can be used as the corresponding digital economy development level to participate in subsequent model calculations.

**Table 5.** Comprehensive Scores of Urban Factors

Number	City	F1	F2	F3	F4	F5	F
1	Nanjing	1.978053	1.540805	3.77681	-1.083	1.075591	1.628536
2	Yangzhou	1.990081	1.676057	-1.96678	0.822364	1.042343	1.023408
3	Zhenjiang	-0.47769	4.283616	-0.66054	0.569739	-0.18319	0.792088
4	Wuhu	1.806939	-0.86743	-0.10642	2.066026	-0.7394	0.613331
5	Ma'anshan	1.68947	-0.0771	-0.25233	0.187196	0.412401	0.612016
6	Chuzhou	1.059833	-1.06124	-1.03406	0.733222	2.396683	0.346118
7	Xuancheng	-0.27128	0.527961	1.110498	1.041326	-0.03649	0.341744
8	Huai'an	0.833124	-0.90328	0.795368	0.458728	-1.06128	0.143578

(2) Interpreted variable. The explained variable is the high-quality development level of the manufacturing industry ( $y$ ). This article adopts a relatively uniform measurement standard in the academic community, that is, the high-quality development level of the manufacturing industry is equal to the ratio of the production value of the high-end industry to

**Table 2.** Variance Contribution Table

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	3.99070	1.85350	0.2850	0.2850
Factor2	2.13720	0.53372	0.1527	0.4377
Factor3	1.60347	0.31111	0.1145	0.5522
Factor4	1.29236	0.21001	0.0923	0.6446
Factor5	1.08235	0.15586	0.0773	0.7219
Factor6	0.92649	0.14808	0.0662	0.7880
Factor7	0.77842	0.07695	0.0556	0.8436
Factor8	0.70147	0.13923	0.0501	0.8937
Factor9	0.56223	0.12258	0.0402	0.9339
Factor10	0.43965	0.27565	0.0314	0.9653

**Table 3.** Common factor correlation coefficient matrix

Factor	Factor1	Factor2	Factor3	Factor4	Factor5
Factor1	0.8947	0.3734	-0.0853	-0.2120	0.0891
Factor2	-0.3686	0.9084	-0.1662	0.1050	-0.0145
Factor3	-0.0107	0.1817	0.9043	-0.2218	-0.3162
Factor4	0.1694	0.0422	0.3408	0.8259	0.4138
Factor5	0.1867	-0.0234	-0.1768	0.4612	-0.8489

$$F_i = \alpha_1 X_1 + \dots + \alpha_{10} X_{10} \quad (i = 1, 2, 3, 4, 5) \quad (2)$$

$$F = 0.35F_1 + 0.24F_2 + 0.16F_3 + 0.14F_4 + 0.12F_5 \quad (3)$$

**Table 4.** Coefficient Table

Variable	Factor1	Factor2	Factor3	Factor4	Factor5
z1	0.30093	-0.07525	0.05813	0.08986	-0.10124
z2	0.14156	0.03990	0.43847	0.06845	-0.25776
z3	0.11808	0.16947	0.11980	-0.02242	0.25385
z4	0.23768	0.00433	0.06308	0.06449	0.17137
z5	-0.25123	0.00748	0.04456	-0.02680	0.17920
z6	-0.18367	0.09311	0.40436	0.04546	0.14564
z7	0.04803	-0.01234	0.11015	-0.42944	0.06149
z8	0.11330	-0.22680	0.25058	0.26821	0.21206
z9	0.07705	0.01968	0.09437	0.60993	0.03430
z10	0.05057	-0.01789	0.03443	0.00960	-0.69105

the production value of the middle end industry.

(3) Control variables. Referring to the previous literature on the selection of control variables, this paper draws on the views of scholars Wei Zhuangyu et al. (2021) [4], and sets the control variables as: government function (gov), technological progress (pat), industrial structure (is),

urbanization level (urban), human capital level (hum), infrastructure construction (infra), fixed assets investment (inv), and openness to the outside world (fdi).

### 3.2. Model Settings

Considering that there is currently no conclusion that there is a non-linear relationship between the digital economy and the high-quality development level of the manufacturing industry in the existing literature analysis, this article sets the model as a linear regression equation about the level of the digital economy and the high-quality development level of the manufacturing industry. Where,  $i$  represents one of the major cities in the Nanjing metropolitan area mentioned above,  $t$  represents time, and  $X$  represents the total impact of various control variables on the high-quality development level of the manufacturing industry,  $\varepsilon$  is a random perturbation term, the final model setting is as follows:

$$Y_{it} = c + \alpha Dg_{it} + \sum_j \beta_j X_{it} + \varepsilon_{it} \quad (4)$$

## 4. Empirical Results and Analysis

### 4.1. Economic test and statistical inference test

Use the least square method to estimate the relevant parameters,  $\alpha$  is greater than 0, indicating a positive correlation between the level of the digital economy and the high-quality development of the manufacturing industry, consistent with existing research conclusions, and the model has passed economic testing.

(1) Goodness of fit test. The principle of goodness of fit testing is to test the proportion of the sum of squares of regression to the sum of squares of total variances. The sum of squares of regression is the sum of squares of the difference between the predicted value and the mean value of the explained variable. The sum of squares of total variances is the sum of squares between the true value and the mean value of the explained variable. That is, the greater the value of RSS/TSS, the better the goodness of fit of the model. When there are multiple explanatory variables in the model, the adjusted multiple determinable coefficients are more suitable for determining the goodness of fit. The relatively high multiple determinable coefficients of the model indicate that the model has a good goodness of fit.

(2) Parameter significance test. The parameter significance test is to test whether the parameters have a significant impact on the explained variable, usually using a T test. T is to construct a statistic. When the parameter is assumed to be zero, the statistic is calculated and compared with the T value at a given significance level, which can be referred to as a critical value. If the statistical value is greater than the critical value, the assumption that the parameter is zero is rejected, indicating that the explanatory variable has a significant impact on the explained variable. The specific form of T statistic is:

$$(\check{\beta}_i - \beta_i)/se(\check{\beta}_i) \quad (5)$$

The original hypothesis and alternative hypothesis used are respectively  $H_0=0$ ;  $H_1 \neq 0$ .

When estimating model parameters, the T statistics corresponding to the explanatory variables are large, and their corresponding concomitant probabilities are all less than 0.05. Therefore, it can be considered that the level of the digital economy has a significant impact on the high-quality development of the manufacturing industry

(3) Equation significance test. The principle of the equation significance test is similar to that of the parameter significance test, both of which use the construction of statistics to determine the significance of the equation. After calculation, it can be seen that the adjoint probability corresponding to the F statistic is less than 0.05, so the equation of this model.

### 4.2. Results of regression analysis

The results of regression analysis are shown in Table 6.

Table 6. Regression analysis results

Variable	Coefficient
C	-2.68
Dg	0.56
gov	-5.54
pat	-0.04
is	0.19
urban	-0.41
hum	0.01
infra	0.29
inv	0.02
fdi	0.03

From the regression results, it can be seen that the role between the digital economy and the high-quality development level of the manufacturing industry is positive, that is, whenever the level of the digital economy improves, the high-quality development level of the manufacturing industry will also improve. Specifically, when the level of the digital economy increases by 1 unit, the high-quality development level of the manufacturing industry will increase by 0.56 units. This is an empirical study of the impact of the digital economy on the high-quality level of the manufacturing industry at the micro level, especially demonstrating the strong traction of the digital economy on the manufacturing industry in the major cities of the Nanjing metropolitan area, with a high contribution rate to the high-quality development level of the manufacturing industry. Based on this, it can be inferred that the level of the digital economy is a new production factor in the manufacturing industry at this stage, namely, the data factor, which will be a "panacea" to save the manufacturing industry for a long time in the future. For other control factors, only the level of government functions and urbanization have a relatively significant impact on the high-quality development level of the manufacturing industry in this regression model. It can be considered that only when the level of government functions and urbanization reaches a certain level, the level of the digital economy will play a stronger and powerful role in promoting the high-quality development of the manufacturing industry.

## 5. Conclusions and Suggestions

Combining the above empirical results with the current level of the digital economy and the high-quality development characteristics of the manufacturing industry, this article proposes the following recommendations. First, strengthen the construction of infrastructure for the digital economy, continue to promote the construction of relevant information industries, and ensure that the digital economy plays its efficient role. The second is to properly handle the relationship between the digital economy and the manufacturing industry, reasonably integrate the digital

economy into the development of the manufacturing industry, and control the degree and proportion of integration between the two. Only by properly handling the relationship between the two can the two be combined to maximize their effectiveness and maximize the effectiveness of resource allocation. Third, increase investment in the field of technological innovation. The source of the digital economy is emerging technology. Without the development of emerging technology, there will be no development of the digital economy. Continue to strengthen core technology research, appropriately introduce high-tech talents, break through the barriers of "stuck neck" technology, and avoid technological dependence, making it difficult to form a complete domestic technology industry chain and obtain greater value in the international digital economy industry value chain. Fourth, attach importance to the cultivation of domestic digital economy professionals, while building a bridge between training units and employers, to avoid the mismatch between talent supply and employment demand resources. Currently, digital economy majors are only offered in some universities, while manufacturing enterprises have a strong demand for digital economy talents, which requires simultaneous opening of relevant majors and allocation of high-quality teachers to reserve talents.

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