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Can a Higher Level of Digital Economy Help Manufacturing Transition?

-- Taking Liaoning Province as an example

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Abstract: Liaoning Province has experienced many years of industrial structure adjustment, but there are still industrial structure contradictions. Since the reform and opening up, the economy of Liaoning Province has been developing steadily, and the prosperous development of tertiary industry has played a positive role in promoting the economic development. The "12th Five-Year Plan" of Liaoning Province clearly puts forward the goal of adjusting the industrial structure, focusing on the supportive role of scientific and technological innovation in industrial upgrading, vigorously developing strategic emerging industries, transforming and upgrading traditional industries, and eliminating backward production capacity. However, the optimization of industrial structure in Liaoning Province has always been a concern for Chinese scholars. In studies since the 1990s, it has been found that the industrial structure of Liaoning province relies too much on heavy industry and capital-intensive industries, and that it needs to further upgrade basic industries and promote the transformation of the industrial structure towards the dominance of primary, secondary and tertiary industries.

Keywords: Manufacturing Structure, Digital Economy, Transformation of Manufacturing Industry.

1. Introduction

To understand the specific industrial structure of the manufacturing industry, it is first necessary to analyze the economic composition of Liaoning Province in depth. The purpose of the study is to delve into the deeper issues of industrial upgrading, which is the top priority of industrial transformation in Liaoning Province.

Here, we must introduce the relevant concepts first. In this paper, we first need to distinguish between industrial upgrading and industrial transformation. Transformation is some kind of change in the industrial structure of an economic system while upgrading focuses more on optimization based on the original structure, which is one of the essential differences between the two. In the following, all the related concepts we mention will be industrial transformation.

Secondly, we need to understand the concepts and characteristics of the modern industrial system. China is in the process of transitioning from a past dominated by manufacturing to tertiary industries such as services. Liaoning Province is no exception. It has evolved from an industrial powerhouse where manufacturing accounted for more than half of the total, to one where it now accounts for 40 percent of the total, which is a declining proportion but still occupies an important seat. However, it is not a good thing that the growth of the total economic volume of Liaoning Province shows a downward trend compared with the data of the past years. It is based on this starting point that this paper discusses and researches on the basis of the statistical yearbooks of the Liaoning Provincial Bureau of Statistics in the past years.

2. Literature View

Research on the structure of manufacturing in Liaoning Province has been little discussed over the years. The first study I found was by Jian Wang (2008). He points out that there are four dilemmas for the manufacturing industry in Liaoning province: low internal and external linkages, slow response to demand, and failure to adapt to the international trade structure.

Liu Shucang (2000) points out that there is a close link between economy and industry, a reasonable industrial structure can actively promote economic growth, and then it will in turn promote the transition of industrial structure. Hu Qi (2005) believes that the basic characteristics of secondary sector structure change in the old industrial base in Northeast China is the obvious rigidity of industrial structure change. This is both the appearance of the decline of the northeastern old industrial base and the reason for the decline of the northeastern old industrial base.

According to Hou Zhaoliang (2019), there is more room for optimizing the industrial structure of Liaoning province, and although the tertiary sector has gained a certain degree of development, the level of the industry is still relatively low. The secondary industry has a solid foundation, but the transformation and development of the industry are not satisfactory and even show signs of decline.

3. Literature References

3.1. The Concept and Essential Meanings

3.1.1. Concept

The digital economy is characterized by using digital knowledge and information as the key factors of production, the use of modern information networks as the main carrier, the integrated application of information and communication technologies as the driving force, and the expansion of new spaces and forms of economic activity. It represents all economic activities that promote the development of economic forms to a more advanced state.

The essence of the digital economy lies in the interaction and synergy of its core elements. Firstly, big data provides

massive information resources and becomes an important driving force for economic growth in the new era. Secondly, intelligent algorithms are important tools for processing these data, which can tap the value of the data and improve the efficiency and accuracy of decision-making. Finally, the computing power platform provides powerful computing power for data processing and algorithm execution [6].

3.1.2. Essential impacts on traditional industries

Tertiary sector development is profoundly affecting traditional industries through core elements such as big data, intelligent algorithms, and computing power platforms. Firstly, it improves the efficiency of information search and circulation, reduces production costs, and speeds up market response for traditional industries. Secondly, it promotes the transition of industrial structure, and traditional industries can enter new value chain links through digital transformation, thus enhancing competitiveness. In addition, Tertiary sector development promotes the emergence of new business models and service modes such as the sharing economy and online retailing, which provide new development opportunities for traditional industries [7].

References are cited in the text just by square brackets [1]. (If square brackets are not available, slashes may be used instead, e.g. /2/.) Two or more references at a time may be put in one set of brackets [3, 4]. The references are to be numbered in the order in which they are cited in the text and are to be listed at the end of the contribution under a heading References, see our example below.

3.2. Tertiary Sector Development Facilitates Manufacturing Firms' Optimization of Resource Allocation

The allocation and construction of enterprise infrastructure resources are critical to increasing the level of mutual assistance among factors of production in the industry. Digital infrastructure is increasingly becoming a key element of enterprise production. The development of Tertiary sector development such as digital economy enables enterprises to respond to market changes in a more timely and rapid manner, helping to better match supply and demand and to form a more complete pricing mechanism. In addition, it can break through the framework of traditional models, facilitate the introduction of new factors of production, and improve the efficiency of resource allocation.

It also promotes the circulation and sharing of data, reduces transaction costs, increases market transparency, and further stimulates market competition. In addition, the digital economy has given rise to new business models and formats, such as e-commerce and online customization, which provide manufacturing enterprises with more market opportunities and means of competition.

4. Variable Design and Model Selection

In the study of this paper, based on the principle of a scientific and true reflection of the purpose of the study, an evaluation system including three dimensions of digitalization, manufacturing capacity, and economic development capacity was constructed.

4.1. Data Source

This paper will draw on the research findings of relevant scholars (Li Jie et al., 2019; Guo Han and Lian Yuyan, 2020; Liao Xinlin and Yang Zhengyuan, 2021) [9-11], considering the availability of data, to construct indicators for measuring the level of digital economic development from three dimensions: digital economic infrastructure index, digital economic industry development index, and digital economic innovation development index [13].

Meanwhile, regarding the level of manufacturing transformation and upgrading, this paper will draw on the research findings of Song Dejun and Yu Qing (2022) [12], utilizing the entropy weight method, and select digital infrastructure, digital industrialization, and industrial digitalization as secondary indicators to construct and measure.

4.2. Research Design

4.2.1. Model Selection

In this paper, we will draw on the theoretical model construction method proposed by Song Dejun and Yu Qing (2024) to further study the specific degree of digital economy promoting the transition of the manufacturing industry structure in Liaoning Province.

MA represents the level of manufacturing transition, DE indicates the level of development of digital economy, Control contains a series of control variables, including but not limited to PGDP, FDI, etc., and ε_{it} is a random disturbance term.

$$MA_{it} = \alpha_0 + \alpha_1 DE_{it} + \alpha_2 \sum Control_{it} + \varepsilon_{it}$$

Meanwhile, to explore whether innovation moderates the digital economy's impact on manufacturing transition, this paper introduces the regional innovation output level (INN) as a mediating variable and establishes the following model:

$$\ln(INN_{it}) = \beta_0 + \beta_1 \ln(DE_{it}) + \beta_2 \sum \ln(Control_{it}) + \varepsilon_{it}$$

$$MA_{it} = \gamma_0 + \gamma_1 INN_{it} + \gamma_2 DE_{it} + \gamma_3 \sum Control_{it} + \theta_{it}$$

4.2.2. Variable Selection

(1) Dependent variable (MA)

This article evaluates the level of manufacturing transformation and upgrading from three secondary indicators: scale, quality, and efficiency, utilizing the entropy weight method for measurement.

Table 1. Evaluation Indicators for Manufacturing Upgrading Level

Objective	Primary Indicators	Secondary Indicators	Unit
The Level of Upgrading and Transformation in Manufacturing	Scale	Number of Industrial Enterprises	Individual
		Industrial Added Value	Billion Yuan
	Efficiency	Profit margin of main business	Main business income
		Proportion of employment in the manufacturing sector	Percentage
	Quality	Energy Consumption per Unit of GDP	/
		Electricity Consumption per Unit of GDP	/

(2) Explanatory Variables (DE)

The digital economic development level is constructed

from three primary dimensions: digital infrastructure, digital industrialization, and industrial digitalization, incorporating multiple secondary indicators, utilizing the entropy weight method.

Table 2. Evaluation Indicators for the Level of Digital Economy Development

Primary Indicators	Secondary Indicators	Tertiary Measurement Indicators	Unit
Digital Infrastructure	Hardware Facilities	Length of Long-Distance Optical Cable Lines	Ten thousand kilometers
		Internet Broadband Access Ports	ten thousand
		Mobile Phone Base Stations	ten thousand
	Software infrastructure	Number of Internet Domain Names	ten thousand
		Number of IPv4 addresses	ten thousand
		Number of Internet Websites	ten thousand
Development of the digital industry	Digital Industrialization	Software Business Revenue	billion yuan
		Total Telecommunications Service Volume	billion yuan
		Number of electronic information manufacturing industries	Individual
	Industrial Digitalization	Number of websites per hundred enterprises	Individual
		The proportion of enterprises engaged in e-commerce transactions	%
		E-commerce Sales	billion yuan
Digital Economy Environment	Application Environment	Mobile Internet Users	10,000 households
		Mobile phone users	10,000 households
		Digital TV Subscribers	10,000 households
	Talent Environment	The proportion of information sector employment to total employment	%
		Number of Undergraduate Graduates	People
	Innovative Environment	Full-time equivalent of R&D personnel	Person-years
		Number of R&D Institutions	Unit
		Number of Patent Grants	Unit

(3) Mediating Variable (INN)

In this paper, innovation capability indicators will be constructed from five dimensions: knowledge creation, knowledge acquisition, corporate innovation, innovation environment, and innovation performance, serving as the mediating variables.

(4) Mediating Variable

In this paper, economic development level (PGDP), government fiscal expenditure (GI), and foreign direct investment (FDI) are used as control variables. PGDP is represented by per capita GDP, and GI is represented by local fiscal and public budget expenditures.

5. Empirical Analysis

5.1. Descriptive and Relevance Analysis

First, we did a preliminary descriptive analysis of Manufacturing Upgrading Level, the level of development of Digital Economy Development, the results are roughly as shown in Table3.

Table 3. Summary Statistics

Var Name	Obs	Mean	SD	Min	Median	Max
y	168	0.4805	0.065	0.22	0.47	0.68
x	168	0.1275	0.051	0.06	0.12	0.46
z	168	10.4975	1.516	8.03	10.28	14.42
ln_v1	168	10.7849	0.440	10.01	10.75	11.77
ln_v2	168	14.7313	0.578	14.02	14.57	16.20
ln_v3	168	9.7094	1.865	2.77	9.59	14.15

Next, we try to plot the matrix scatterplot and fitted regression of the level of digital economy development and the level of manufacturing transformation.

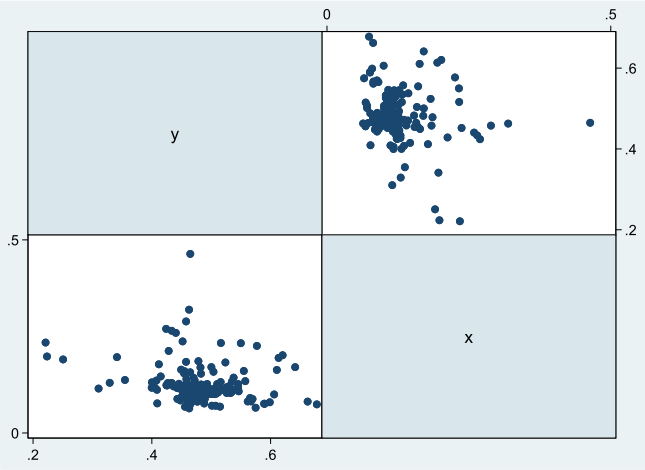

Figure 1. Matrix Scatterplot

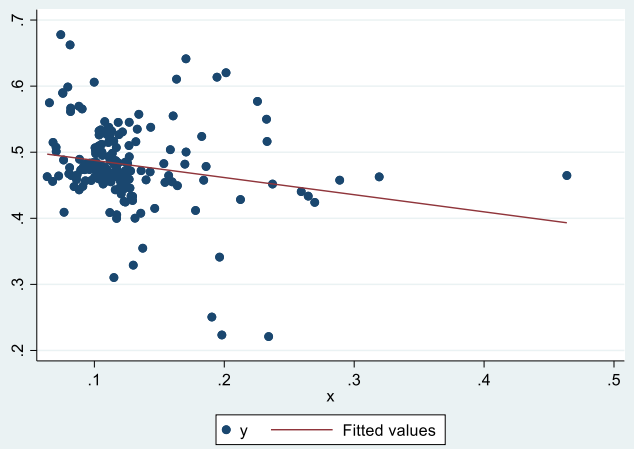

Figure 2. Fitted Regression

5.2. Regression Analysis

In section 5.1, we initially found a negative correlation between the two. To further determine the specific correlation between the two, we performed a regression analysis. In this process, we introduced PGDP, GI and FDI as control variables and constructed different combinations of variables to explore the regression equation with the best fit.

Surprisingly, we found that the degree of DE does play a negative role in the transition of the manufacturing industry in Liaoning Province. At the same time, when the level of digital economy development is considered together with FDI, the variable has the highest degree of significance at this point, and FDI plays a certain positive role in promoting the development of manufacturing industry in Liaoning Province. The level of digital economy development seems to have always played a significant negative role, but the absolute value of the negative coefficient is small, while PGDP and GI do not have a significant impact on the level of manufacturing transformation in Liaoning Province.

Table 4. Regression Results

	(1)	(2)	(3)
	y	y	y
x	-0.2596***	-0.4187***	-0.3849***
	(-2.7125)	(-4.1553)	(-2.9077)
ln_v3		0.0107***	0.0111***
		(3.8574)	(3.7313)
ln_v2			-0.0050
			(-0.3954)
_cons	0.5136***	0.4298***	0.4949***
	(39.0663)	(17.1009)	(2.9725)
N	168	168	168
adj. R^2	0.037	0.111	0.106

5.3. Analysis of Moderating Effects

First, we constructed an indicator of the innovation output level of each prefecture-level city in Liaoning Province for each year starting from 2011 and ending in 2022 based on the five dimensional indicators and obtained the following fitted regression results.

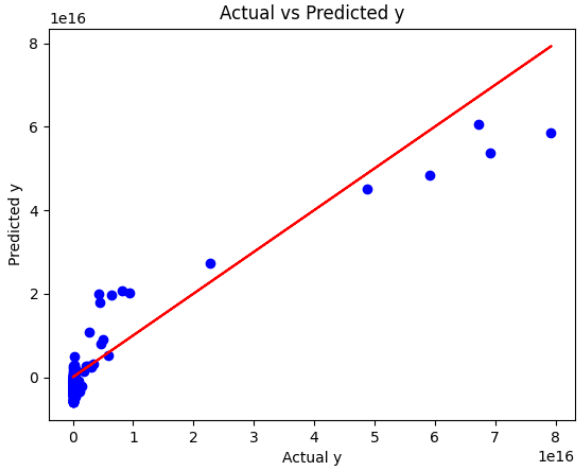

Figure 3. Level of Innovation output

Then, we also explore whether the level of innovation output plays a moderating role. The results show that the development of the level of DE exerts a significant negative effect on the level of innovation output. The level of innovation output in turn exerts a positive effect on manufacturing transition, with a high significance level.

Table 5. Moderating Results

	(1)	(2)	(3)
	y	z	y
x	-0.4187***	-15.7390***	
	(-4.1553)	(-7.2436)	
ln_v3	0.0107***	0.2789***	0.0048*
	(3.8574)	(4.6527)	(1.8656)
z			0.0116***
			(3.6468)
_cons	0.4298***	9.7958***	0.3120***
	(17.1009)	(18.0739)	(7.9056)
N	168	168	168
adj. R^2	0.111	0.244	0.091

6. Conclusion

To summarize, we believe that the level of digital economy may to some extent play a negative role in the level of manufacturing transformation in Liaoning Province. This may be caused by the transformation of industrial results in Liaoning Province in recent years, before 2015, the proportion of manufacturing, and even the secondary industry in Liaoning Province was high, but after 16 years, the economic development of Liaoning Province continued to be low in vitality, and at the same time, faced with the transformation and upgrading of the industrial structure and other difficult problems, the proportion of the tertiary industry did not at the same time lead to the development of the secondary industry, and therefore there will be a result of the results in the above study Therefore, the results in the above study will occur.

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