A Study on the Impact of Digitization and Service Level on the High-Quality Development of Manufacturing Industry: The Example of Beijing, Tianjin and Hebei

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Abstract: The manufacturing industry influences the overall development of a country's economy, and the high-quality development of the manufacturing industry is an implication of the high-quality development of the economy. In order to explore the factors affecting the high-quality development of the manufacturing industry, the panel data of the three provinces of Beijing-Tianjin-Hebei from 2012 to 2020 were selected, the input-output method and fixed-effect model were used, and the data was processed by Stata14.0 computer data processing software, and the impact on the high-quality development of the manufacturing industry was studied from the perspectives of digitalization and servitization. It is found that: (1) the service level of manufacturing industry has increased in the three provinces of Beijing, Tianjin and Hebei from 2012 to 2020, while the digitalization level of manufacturing industry has decreased; (2) after the panel return, it is found that manufacturing servitization can significantly and positively promote the high-quality development of the manufacturing industry, and the digitalization of manufacturing cannot significantly promote the high-quality development of the manufacturing industry, and investing in digitalization and servitization at the same time can more effectively increase the output value of high-tech manufacturing and promote the high-quality development of manufacturing.

1 INTRODUCTION

The manufacturing industry is the foundation of a strong country and represents the productivity level and strength of a country. In the context of the double cycle, promoting the high-quality development of the manufacturing sector is both a deepening of supply-side reform and an inherent requirement for high-quality economic development. In the era of digital economy, promoting the integration of digital economy development and manufacturing industry is a hot issue in the two sessions in 2022. 5G, big data and artificial intelligence represent the new generation of digital technology to accelerate the penetration and expansion of manufacturing industry, smart design, smart factory and other development new models to transform the growth momentum for manufacturing industry and reshape the value growth model of manufacturing industry. 2020 "The Central Committee of the Communist Party of China on the Formulation of the National Economic and Social The "Proposal on the 14th Five-Year Plan for National Economic and Social Development and the Visionary Goals for 2035" clearly points out that promoting the deep integration of service industry and manufacturing industry can promote high-quality economic development.

The digitalization of the manufacturing industry and the service-oriented model are two important strategies for the high-quality development of the manufacturing industry. Some scholars have studied the impact of digitalization on the high-quality development of manufacturing, and some scholars have studied the impact of servitization on the high-quality development of manufacturing, but they have not studied the impact of digitalization and servitization together on the high-quality development of manufacturing. This paper takes Beijing, Tianjin and Hebei as an example. Taking the Beijing-Tianjin-Hebei region as the research object, this paper can study the digitalization and servitization in the Beijing-Tianjin-Hebei region on the one hand, and discuss the impact of digitalization and servitization on the high-quality development of

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manufacturing industry on the other hand, as a reference for other regions.

2 REVIEWS OF THE LITERATURE

2.1 Digitalization Levels and Service Transformation

Digitalization can bring new technologies and services to the manufacturing industry and promote the transformation of the manufacturing industry into a service industry. The new generation of digital technology can expand the types of services for manufacturing enterprises, provide data-based services for enterprises' production processes, products, suppliers and customers, achieve a value-added model that matches supply and demand, combine hardware and software, reduce transaction costs and rapidly promote the development of servitization in manufacturing (Li 2021). The data of listed companies in the manufacturing industry can verify that digital development can significantly improve the servitization level of enterprises through improving innovation capability and optimizing human resource structure, and also verified that digital development can improve enterprise performance and promote high-quality development through servitization transformation (Zhao 2021). At the same time, servitization is a process by which companies enhance their value chain and increase user value through the digital technology (Cheng, Zhu, Xie 2021).

2.2 Servitization and High-Quality Manufacturing Development

Manufacturing servitization can promote high-quality development of the manufacturing industry by extending the manufacturing value chain and increasing the added value of products. The use of industry data can empirically verify that the degree of servitization of enterprises can improve the performance of servitization in the high-tech manufacturing enterprises (Wei, Chen 2019). At the same time, the servitization of manufacturing industry can positively promote the transformation and upgrading of industrial structure (Hu, Xia, Sun 2017). Furthermore, an empirical study from the perspective of firm mark-up rate finds that the servitization of manufacturing inputs can strengthen the competitive advantage of enterprises (Luo, Duan, Zhu 2021). Servitization of manufacturing is an inevitable trend and potential requirement in the process of achieving high-quality development of manufacturing (Yu, Hu 2021).

2.3 Digitalisation and High-Quality Development in Manufacturing

The key to achieving high-quality economic development in China has become the question of how to deeply integrate the digital economy with the real economy. The data of listed companies in the manufacturing industry can verify that digital transformation of enterprises can improve the total factor productivity of enterprises and promote high-quality development of the manufacturing industry and the economy (Tu, Yan 2022). The integration of digital technology and manufacturing can promote the high-quality development of China's manufacturing industry (Song, Zhong, Wen 2022). An empirical study using provincial panel data and found that the digital economy significantly contributed to the high-quality development of the manufacturing industry, with spatial variability (Wei, Li, Wu 2021). An empirical study using inter-provincial panel data verify that the development of digital economy has a significant positive contribution to the high-quality development of manufacturing (Hui, Yang 2022).

3 MODEL DESIGN

3.1 Model Construction

In order to eliminate the effects of unobservable as well as constant factors associated with the provinces. The key explanatory variables for this study were high technology manufacturing output, the level of digitalisation of manufacturing and the level of servitization of manufacturing and it was hypothesised that unobservable individual heterogeneity was associated with the key explanatory variables and after passing the Hauseman test, the test results rejected the original hypothesis and therefore a fixed effects model was chosen.

Based on the above analysis of the relevant literature, it is clear that the input of both servitization and digitalisation factors in manufacturing can transform the growth momentum of manufacturing quality development. Therefore, the following benchmark model was constructed to verify the level of digitisation, the level of servitization and the impact mechanism of both on manufacturing quality

development. In addition, the data on the manufacturing quality development variables in the model are logarithmized to eliminate the effect of heteroskedasticity. Where hqd_{it} is the explanatory variable, dig_{it} and ser_{it} are the explanatory variables.

$$\ln hqd_{it} = \alpha_0 + \alpha_1 dig_{it} + \alpha_2 ser_{it} + u_i + \varepsilon_{it}$$

Table 1: Meaning of symbols used in the model.

Symbols	Description
$\ln hqd_{it}$	the level of quality manufacturing development in province i in year t
dig_{it}	the level of manufacturing digitalization in province i in year t
ser_{it}	the level of manufacturing servitization in province i in year t
i	province
t	year
u_i	an individual fixed effect that does not vary with province
ε_{it}	a random disturbance term

3.2 Description of Variables

The level of high-quality development of the manufacturing industry. To a certain extent, the output value of high-tech industries reflects the level of high-quality development of the manufacturing industry, so the output value of high-tech industries in the three provinces of Beijing, Tianjin and Hebei is used to measure the level of high-quality development of the manufacturing industry. Each province has different categories for high-tech industries. In this paper, we choose to use the classification of high-tech industries in the China Statistical Yearbook, that is, the sum of the output value of five high-tech industries, namely pharmaceutical manufacturing, aerospace manufacturing, electronic and communication equipment manufacturing, electronic computer and office equipment manufacturing, medical equipment and instrumentation manufacturing, to measure the high-quality development of the manufacturing industry (Chen 2020).

Servitization of manufacturing. Using the input-output method commonly used by scholars, 42 sectors were combined into six categories for ease of calculation, and the ratio of manufacturing consumption of service sector inputs to total inputs was calculated to measure the level of servitization of manufacturing in each province (Hu 2017). The direct consumption coefficient is the level of direct consumption of all service industries per unit of product produced in manufacturing. The specific formula can be as shown in equation (1).

$$\mathrm{d}_{ij} = \frac{q_{ij}}{r_j} \quad (1)$$

In equation (1) d_{ij} is the direct consumption coefficient of manufacturing industry j on service industry i, and q_{ij} refers to the production output of the j industry of the manufacturing industry r_j consuming the services of the service industry i. In addition to direct consumption there is also indirect consumption, and the complete consumption coefficient is the sum of the direct and indirect consumption of the manufacturing industry to the service industry, for which the formula for the complete consumption coefficient can be shown in equation (2) as follows.

$$\mathrm{m}_{ij} = d_{ij} + \sum_{k=1}^{n} d_{ik} d_{kj} + \sum_{k=1}^{n} * \sum_{n=1}^{n} d_{is} d_{ik} d_{kj} + \ldots \quad (2)$$

The first term in equation (2) is the direct consumption coefficient of manufacturing industry j on service industry i. The second term is the first round of indirect consumption of service industry i by manufacturing industry j through manufacturing industry k, and so on for subsequent terms. In this paper, the full consumption coefficient is chosen to measure the level of servitization in manufacturing.

Digitisation of manufacturing. Using the direct consumption coefficient of manufacturing for digital economy factors in the input-output table was used to measure the direct consumption coefficient of manufacturing for digital economy factors (Song 2022). A direct dependency approach was also created to measure the direct consumption coefficient of digital economy factors in manufacturing as a proportion of the sum of the direct consumption coefficients of all other sectors, which enables an indication of the relative importance of manufacturing industries consuming digital economy factors versus those consuming other industries.

4 DATA COLLECTION AND MEASUREMENT

Indicators for the high-quality development of the manufacturing industry were obtained from the 2012-2020 Beijing Statistical Yearbook, Tianjin Statistical Yearbook, Hebei Statistical Yearbook, Tianjin Science and Technology Statistical Yearbook, Hebei Science and Technology Statistical Yearbook and the input-output tables of Beijing, Tianjin and Hebei for 2012 and 2017. The input-output tables of each province in China are not continuous, so the coefficient of complete consumption can only be calculated in the input-output tables of 2012 and 2017, while for the intermediate years, the same "equalization" approach is adopted as other scholars. Since the digitalisation and manufacturing service models only became widespread in China in 2013 and 2015 respectively, the article uses the input-output tables of the Beijing-Tianjin-Hebei region in 2012 and 2017, and uses the complete consumption coefficient of 2012 as the data for 2012-2016 and the complete consumption coefficient of 2017 as the data for 2017-2020(Du 2020, Liu 2020, Chen 2014). The results of the digitalization and servitization coefficient of the Beijing-Tianjin-Hebei manufacturing industry are shown in Table2 and Table3.

Table 2: Beijing-Tianjin-Hebei manufacturing servitization coefficient.

Year	Beijing	Tianjin	Hebei
2012	0.7293	0.4229	0.3107
2017	0.9461	0.5755	0.3353

Table 3: Beijing-Tianjin-Hebei manufacturing digitalization coefficient.

Year	Beijing	Tianjin	Hebei
2012	0.5977	0.7033	0.5657
2017	0.4891	0.6986	0.4688

5 SOFTWARE COMMAND CODE AND RESULT ANALYSIS

5.1 Program Code

Use stata14.0 computer software technology to write software command code to statistically analyse the collected data.

```
   begin
   rename var1 pro
   rename var2 year
   rename var3 dig
   rename var4 ser
   rename var5 hqd
   gen lnhqd=log(hqd)
   reg lnhqd dig
   est store m1
   reg lnhqd ser
   est store m2
   reg lnhqd dig ser
   est store m3
   esttab m1 m2 m3, replace
   esttab m1 m2 m3, replace p ar2
   esttab m1 m2 m3, replace b(%6.4f)
p(%6.4f) ar2(4)
   esttab m1 m2 m3, replace b(%6.4f)
p(%6.4f) ar2(4)///
   star(* 0.1 ** 0.05 *** 0.01)///
   compress nogap///
   mtitle ("model1""model2""model3")///
   esttab m1 m2 m3 using reg1. rtf,
replace b(%6.4f) p(%6.4f) ar2(4)
compress nogap
   mtitle ("model1""model2""model3")
   End.
```

5.2 Descriptive Statistical Analysis Results

The data were analysed descriptively using stata14.0. From Table4, it can be seen that the maximum digitization level of the three provinces in Beijing-Tianjin-Hebei is 0.703 and the minimum value is 0.469, while the maximum value of manufacturing servitization level is 0.946 and the minimum value is 0.311, which shows that there is a large gap between the level of manufacturing servitization and the development of manufacturing digitalization level between the three provinces, especially the gap between the level of manufacturing service. At the same time, the average value of manufacturing digitalization in the three provinces of Beijing-Tianjin-Hebei is 0.591, while the average value of manufacturing service-oriented level is 0.546, which is lower than the average of digitalization level, indicating that the digitalization level of the Beijing-Tianjin-Hebei region is better than the development of service-oriented level. In addition, the standard deviation of the level of digital development of manufacturing is 0.091, and the standard deviation of the level of manufacturing servitization is 0.227, indicating that the gap between the level of manufacturing digitalization in the three provinces of Beijing-Tianjin-Hebei is smaller than that between the level of manufacturing service. However, these data show that there is a large gap between the high level of service and low level of service in the manufacturing industry and between the high level of

digitalization and low digitalization level of the manufacturing industry, indicating that there is a clear difference in the level of manufacturing service in the Beijing-Tianjin-Hebei region.

Table 4: Descriptive statistics of variables.

Variable name	Avera-ge	Standard deviation	Mini-mum	Maxi-mum
digitisation	0.591	0.091	0.469	0.703
servitization	0.546	0.227	0.311	0.946
high-quality	7.964	0.356	7.362	8.543

5.3 Regression Results

Model 1 is a complete model that includes only the level of manufacturing digitisation, model 2 includes only the level of manufacturing servitization, and model 3 is a complete model that includes both manufacturing digitisation variables and servitization variables. The results are shown in Table 4, when only the variables of the digitalization level of the manufacturing industry are considered in model 1, the correlation coefficient of the digitalization level on the high-quality development of the manufacturing industry is positive but not significant, which may be because the digitalization level in the Beijing-Tianjin-Hebei region is not high, which has insufficient impact on the high-quality development of the manufacturing industry. In Model 2, when the direct effect of manufacturing servitization level on the high-quality development of manufacturing is verified, the servitization level is significantly positively correlated with the high-quality development of manufacturing. When two explanatory variables are added to model 3 at the same time, the level of servitization and digitalization have a significant positive impact on the high-quality development of the manufacturing industry, and the correlation coefficient is higher than that of a single variable.

Table 5: Regression analysis of the fixed effects model of factors influencing quality development in manufacturing.

Variable name	(1) Model 1	(2) Model 2	(3) Model3
Level of digitisation	1.2901 (0.0940)		1.7576*** (0.0004)
Level of servitization		1.1390*** (0.0000)	1.2444*** (0.0000)
constants	7.2018*** (0.0000)	7.3424*** (0.0000)	6.2459*** (0.0000)
Sample size	27	27	27
R^2 values	0.0725	0.5091	0.7012

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6 CONCLUSIONS

For the level of manufacturing servitization, from 2012 to 2020, all three provinces of Beijing, Tianjin and Hebei have increased their level of servitization, with Beijing having the highest and fastest growing level of manufacturing servitization, followed by Tianjin. The level of manufacturing servitization in Hebei province is relatively low and the development rate is slow. However, the level of digitization of manufacturing declined in all three provinces. In response, the digital economy elements were further divided into two aspects: digital infrastructure and digital applications, and it was found that the three provinces had a relatively high proportion of digital infrastructure and a relatively low proportion of digital applications. Such a result may be due to the fact that building digital infrastructure is a large capital investment, high technical barriers and long construction time. The advancement of digitization requires the building of digital infrastructure and the improvement of digitization level; in the process of digital infrastructure improvement, the development in digital information services is slow due to the existence of technical barriers, which makes the overall digitization show a lower trend.

In the above regression results, it can be found that the level of service in manufacturing can significantly enhance the output value of high technology industries and thus promote the high quality development of manufacturing, the level of digitalization of manufacturing alone cannot significantly promote the high quality development of manufacturing, but the simultaneous input of both digitalization and service in manufacturing can significantly promote the high quality development of manufacturing and has a higher impact than either of them on the output value of high technology. Therefore, in the process of manufacturing development, it is important to invest not only in service-related elements, but also to focus on the development of digital technology in manufacturing. However, when provinces or enterprises have limited resources, they can focus on investing more in service factors, while building digital facilities that are adapted to the development direction of the province or enterprise. In the long run, digital technologies and platforms can support the manufacturing industry to provide more quality services and accelerate the service-oriented transformation of the manufacturing industry.

The article has certain limitations, because the input-output data is released by the National Bureau of Statistics every 5 years, and the input-output data

for 2022 has not yet been released, it is impossible to accurately measure the level of manufacturing digitalization and service-oriented in the Beijing-Tianjin-Hebei region in 2022. Therefore, it can only be replaced by the data of 2012 and 2017 and it can be further studied after the subsequent release of the input-output data in 2022.

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