Diversification, Specialization, and Urban Manufacturing Upgrading: A Study Based on Chinese Industrial Enterprise Data

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Abstract. By combining data from Chinese enterprise databases and the Chinese Statistical Yearbook of Cities, this paper calculates indicators of manufacturing upgrading, related diversification, and specialization for 287 prefecture-level and above cities in China based on panel data. Using fixed effects models, random effects models, and dynamic panel GMM models, this study analyzes the impact of related diversification and specialization in the urban agglomeration environment on urban manufacturing upgrading. The results show that the urban agglomeration environment has a significant positive impact on urban manufacturing upgrading, and compared to related diversified agglomeration, the promoting effect of specialized agglomeration on urban manufacturing upgrading is more pronounced. The lagged effect of specialization still has a significant promoting effect on urban manufacturing upgrading. This study contributes to a deeper understanding of the mechanisms of urban industrial development in China and provides valuable insights for policymakers and industry practitioners.

Keywords: Diversification of relevance · Specialization · Industrial enterprise data · Upgrading of manufacturing industry

1 Introduction

Since the reform and opening, China's manufacturing industry has witnessed unprecedented high-speed development, relying on market-oriented reforms and demographic dividends, forming a complete industrial system with diversified categories, promoting China's industrialization and modernization, enhancing its comprehensive national strength, and becoming the engine of China's rapid economic development. However, compared with developed countries, China's manufacturing industry still lags in many aspects and is generally located in the middle and lower end of the global industrial chain and value chain 1. The high-speed development of manufacturing industry mainly depends on low labor costs and other low-cost factors, but in recent years, the increase in labor costs and other factors has led to a continuous rise in the cost of manufacturing industry in China, and the price advantage of industrial products has gradually weakened. This indicates that China's manufacturing industry urgently needs to transform and upgrade, and must enter a growth trajectory to improve its overall level and competitiveness.

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In China, the upgrading of traditional manufacturing industries usually depends on high-tech and R&D investment. However, reasonable industrial spatial layout can also significantly promote the upgrading of manufacturing industries. The agglomeration of industries can achieve economies of scale and shared labor resources 2, better absorb positive knowledge spillovers 3 promote specialized division of labor and regional innovation, and so on. These cost and quality advantages will effectively drive China's manufacturing industry to leap to the mid-to-high end of the global industrial chain, achieve transformation and upgrading, and promote the transformation of the economic growth model to an innovation-driven one.

In the research of agglomeration economies and industrial upgrading, Marshall externality and Jacobs externality are two types of externalities that distinguish different types of agglomeration economies. Marshall externality emphasizes the spillover effects of agglomeration within the same industry, while Jacobs externality focuses on the promotion of knowledge dissemination and innovation among related or complementary economic entities through diversified industrial agglomeration. In addition, Aarstad (2016) and others, based on a diversified classification, argue that related diversification better explains the diversified knowledge spillover effects of Jacobs externality 4.

In summary, this paper uses the three-quartile industry classification standard for 287 Chinese cities and above, and calculates the related diversification and specialization of each city's agglomeration environment using the entropy method. The study employs fixed effects, random effects, and dynamic panel GMM models to examine the impact of two different agglomeration environments on urban manufacturing upgrading. The research results will deepen our understanding of the impact of urban industrial related diversification and specialization on manufacturing upgrading and provide reference for relevant policy formulation.

2 Data Processing and Model Specification

2.1 Data Source

Given that the "Industrial Enterprise Database" is currently only available up to 2013, this study uses a sample of 287 Chinese cities at the prefecture level or above from 2005 to 2013, with a total of 2,583 observations. All data are obtained from the "China City Statistical Yearbook" and the "Industrial Enterprise Database" for each year. Measures of agglomeration environment, specialization, and related diversification are obtained from the "Industrial Enterprise Database," and are calculated using the entropy method with three-quartile industry data.

2.2 Variable Setting

1.manufacturing upgrading. Wang et al. (2013) suggested that the position of a country's manufacturing industry in international trade is often measured by intermediate goods trade 5. Due to the lack of relevant data on regional input-output tables at the city level, it is difficult to accurately describe the division of labor and technological capabilities of the manufacturing industry in the entire value chain. Therefore, this study adopts the method used in previous research, which measures the upgrading of manufacturing output capacity by the ratio of a city's total industrial output value to its employment in the manufacturing industry.

2. Related diversity agglomeration environment. Based on previous studies, this paper uses the three-quartile industry in the Industrial Enterprise Database as the classification standard for related diversity, and uses the entropy method to measure the related diversity level of each prefecture-level and above city. The specific method is as follows:

Assuming that the three-digit industry i belongs to the two-digit industry sector S_g, where g = 1,…, G, the three-digit industries under the same two-digit industry are considered as related industries. The proportion of the annual average number of employees in the city's two-digit manufacturing industry sector to the annual average number of employees in all manufacturing industry sectors is represented by P_g. The proportion of the annual average number of employees in the city's three-digit manufacturing industry to the annual average number of employees in all manufacturing industry sectors is represented by P_i. The relationship between the two is as follows:

$$P_g = \sum_{i \in S_g} P_i \tag{1}$$

The related variety index (RVP) can be represented as the entropy index of all two-digit industries:

$$RVP = \sum_{g=1}^{G} P_g H_g \tag{2}$$

where,

$$H_g = \sum_{i \in S_g} \frac{p_i}{P_g} \ln\left(\frac{P_g}{p_i}\right) \tag{3}$$

3.Specialization agglomeration environment. This paper adopts the relative specialization index to measure the externalities of specialization agglomeration in cities 6, and the calculation formula is as follows:

$$SPP_j = \sum_i \left| \frac{p_{ij}}{\sum_i p_{ij}} - \frac{\sum_{k \neq j} p_{ik}}{\sum_i \sum_{k \neq j} p_{ik}} \right| \tag{4}$$

In this equation, j, k, and i represent city j, city k, and three-digit manufacturing industry i, respectively. p_{ij} Represents the proportion of the average annual number of employees in the i-th three-digit manufacturing industry enterprise in the j-th city. The higher the value of this index, the higher the degree of specialization of the city in the relevant industries.

4. Other control variables. In addition to considering agglomeration factors, we introduced several control variables, including the average wage level of the city (measuring labor quality), actual use of foreign investment/GDP of each city (measuring the abundance of foreign investment and its role in promoting manufacturing upgrading),

Table 1. Descriptive Statistics of Variables

Variable names	Observations	Mean	SD	Min	Max
UMI	2583	14.1796	0.8241	10.8656	18.5744
rvp	2583	0.7019	0.2882	0.0017	1.3548
spp	2583	0.9410	0.1177	0.5586	1.4839
lnaw	2583	10.19	0.43	8.77	12.68
lnse	2583	9.02	1.66	3.53	14.76
dis	2583	221.15	191.45	0	1928.5
fc	2583	0.0032	0.0086	0	0.3809
gi	2583	8.01	3.40	0.43	23.46

GDP/fiscal expenditure of each city (measuring the degree of government intervention), scientific expenditure of each city, and the distance from the city to the provincial capital (measuring the impact of technological innovation and knowledge spillover on manufacturing upgrading).

2.3 Model Specification

The agglomeration environment evolves with the dynamic changes of cities, and it is necessary to consider the impact of time and individual effects on manufacturing upgrading. In order to evaluate the impact of agglomeration environment on urban manufacturing upgrading, this study establishes a panel data regression analysis model. The basic model is as follows:

$$UMI_{jt} = f\left(rvp_{jt}, spp_{jt}, lnaw_{jt}, lnse_{jt}, dis_j, fc_{jt}, gi_{jt}\right) + \varepsilon_{jt} \quad (5)$$

In the model, UMI represents manufacturing upgrading, rvp represents related variety, spp represents specialization, lnaw represents the natural logarithm of average wages, lnse represents the natural logarithm of scientific expenditures, dis represents the distance from the city to the provincial capital, fc represents foreign investment abundance, gi represents government intervention, the subscript j represents the city, t represents the year, and ε represents the random disturbance term.

2.4 Descriptive Statistics

Table 1 provides a statistical description of the variables used in the analysis. In order to reduce heteroscedasticity, the ratio of industrial output value to employment and the average wages and scientific expenditures of each city were logarithmically transformed.

3 Empirical Test and Result Analysis

Firstly, a preliminary analysis of the data was conducted using a mixed data model, a fixed effects model, and a random effects model, with the introduction of a time variable. The results showed that both related diversification and specialization have significant positive effects on urban manufacturing upgrading, with specialization having a greater impact than related diversification. Additionally, urban average worker wages, scientific expenditures, distance from each city to its provincial capital, and foreign capital abundance all have significant positive effects on urban manufacturing upgrading, while government intervention is not significant. Please refer to Table 2 for details.

To select the appropriate model, the results in Table 3 indicate that the inclusion of individual effects better reflects the relationship between variables. However, the

Table 2. Estimated Results of the Effects of Related Diversification and Specialization on Manufacturing Upgrading.

Variable names	(1)ols	(2)fe	(3)re
rvp	0.1366** (0.0687)	0.7768*** (0.0973)	0.4870*** (0.0819)
spp	0.4193*** (0.1512)	1.1246*** (0.1595)	0.9882*** (0.1510)
lnaw	1.1395*** (0.0497)	0.9531*** (0.0416)	1.0087*** (0.0396)
lnse	-0.0255* (0.0149)	0.0889*** (0.0119)	0.0684*** (0.0115)
dis	0.0006*** (0.0001)		0.0008*** (0.0002)
fc	12.8751*** (1.5505)	17.4085*** (0.8753)	17.1159*** (0.8864)
gi	0.0057 (0.0044)	0.0015 (0.0068)	-0.072 (0.0057)
Constant	2.1127*** (0.4575)	2.0351*** (0.4259)	1.8795*** (0.3994)
Observations	2583	2583	2583
R-squared	0.3376	0.6935	0.6917

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively; standard errors are reported in parentheses

Table 3. The Model Selection Test Table

No.	Compare	Testing method	p-value	Conclusion
1	ols vs. fe	Wald test	0.0000	Selecting the fe model
		LR test	0.0000	Selecting the fe model
2	ols vs. re	B-P test	0.0000	Selecting the re model
		LR test	0.0000	Selecting the re model
3	fe vs. re	Hausman test	0.0000	The assumption of random effects cannot be met

assumption of the random effects model, which assumes correlation between individual effects and explanatory variables, results in biased estimates. To obtain more effective estimates, this study will further analyze the mutual influence between variables based on refining the fixed effects analysis, using the Hausman-Taylor estimation, first-difference GMM, and system GMM estimation methods.

In GMM estimation, to address endogeneity issues, we differentiated the explanatory variables by exogenous and endogenous variables. Exogenous variables include the related diversification and specialization of cities because the degree of industrial

Table 4. Presents a comparison between the Hausman-Taylor estimation and the GMM estimation results.

Variable names	(1) Hausman-Taylor estimate	(2) The first-difference GMM estimation	(3) The system GMM estimation
L.UMI		0.1032*** (0.0295)	0.2589*** (0.0867)
rvp	0.5995*** (0.0903)	0.4330*** (0.1442)	0.7896*** (0.2352)
L.rvp		0.1669 (0.1624)	0.1668 (0.2718)
L2.rvp		0.1736 (0.1648)	0.5621** (0.2686)
spp	1.1183*** (0.1581)	1.2050*** (0.2222)	0.7130** (0.2956)
L.spp		0.0425 (0.2220)	0.3357 (0.3761)
L2.spp		1.2443*** (0.2221)	1.6093*** (0.3818)
lnaw	0.9955*** (0.0396)	0.6032*** (0.0741)	0.3494 (0.6344)
lnse	0.0708*** (0.0115)	0.1320*** (0.0351)	-0.1831 (0.2936)
dis	0.0009*** (0.0002)	0.0129*** (0.0032)	0.0006 (0.0013)
fc	17.1931*** (0.8705)	17.7518*** (0.8654)	39.0724** (19.7418)
gi	-0.0066 (0.0058)	-0.0331*** (0.0116)	-0.1790** (0.0721)
Constant	1.7790*** (0.4063)		6.4431 (4.4465)
Observations	2583	1722	2009
Number of groups	287	287	287

agglomeration is formed by the existing agglomeration environment and is not affected by current shocks. On the other hand, variables measuring urban manufacturing upgrading and their one-period lag were set as endogenous variables. Using GMM estimation, we obtained the results of models (2) and (3), as shown in Table 4.

Based on the GMM estimation results presented in Table 4, it can be concluded that, after controlling for other variables, urban related diversification and specialization are positively related to manufacturing upgrading. The effect of specialization on manufacturing upgrading is greater, and the lagged two periods of urban specialization have a significant impact on manufacturing upgrading. The manufacturing productivity in the current period is significantly positively correlated with that in the lagged period, while the natural logarithm of the average wage of urban workers, distance from the provincial capital, and natural logarithm of scientific expenditure are positively related to urban manufacturing upgrading, but not significant in the system GMM estimation. Abundant foreign investment is significantly positively correlated with urban manufacturing upgrading, while government intervention is negatively related to urban manufacturing upgrading, but not significant in the Hausman-Taylor estimation.

4 Conclusion

This paper classifies agglomeration environments according to related diversification and specialization, combines data from the China Enterprise Database and the China City Statistical Yearbook, calculates manufacturing upgrading, related diversification, and specialization indicators for 287 prefecture-level and above cities in China using panel data, and analyzes the impact of related diversification and specialization in urban agglomeration environments on urban manufacturing upgrading using fixed effects models, random effects models, and dynamic panel GMM models. The results show that urban agglomeration environments have a significant positive effect on urban manufacturing upgrading, and the promoting effect of specialization agglomeration on urban manufacturing upgrading is more obvious than that of related diversification agglomeration. Looking at the lagged periods of agglomeration environments, there is still a significant promotion effect of specialization with a lag of two periods on urban manufacturing upgrading.

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