sustainability

MDPI

Article

The Economic Spillover Effect of the Collaborative Agglomeration between Manufacturing and Producer Services

Xiaoxuan Li [1,*] and Ying Liu [2,*]

[1] School of Economics, Fuyang Normal University, Fuyang 236037, China
[2] School of Economics and Management, University of Chinese Academy of Sciences, Beijing 100190, China
* Correspondence: 201607016@fynu.edu.cn (X.L.); liuy@ucas.ac.cn (Y.L.)

Abstract: High-quality economic development is an inevitable requirement for promoting sustainable development. Stacks of research papers have suggested that the quality of China's economic development will make an important contribution to promoting global sustainable development. The collaborative agglomeration between manufacturing and producer services is determined by multiple factors, including industrial characteristics and industrial associations. This is conducive to the efficient evolution of the industrial structure and to further achieving high-quality economic development. Based on the provincial data from 2010 to 2021 in China, this research evaluated the impact of co-agglomeration between manufacturing and producer services on high-quality economic development by using the double-fixed-effect spatial Durbin model. The benchmark regression results showed that industrial co-agglomeration impacted high-quality economic development in an inverted U-shaped. This result had a significant positive spatial spillover and was robust. In the spatial heterogeneity tests, the co-agglomeration of industries had different effects on high-quality development in regions. The strongest spillover effect of positive externalities was in the eastern region, which played an active role as a "growth pole". The "siphon effect" happened in the central region. The spillover effect had a "U" shape in the western region, and the co-agglomeration inhibited current high-quality development. In the mechanism analysis, the industrial co-agglomeration enhanced high-quality development by stimulating green innovation, and the digital economy had a positive moderating effect. The study presented in this article provides empirical evidence and offers policy recommendations for formulating industrial policies and improving the quality of economic development.

Keywords: collaborative agglomeration; spillover effect; digital economy; green innovation

check for updates

Citation: Li, X.; Liu, Y. The Economic Spillover Effect of the Collaborative Agglomeration between Manufacturing and Producer Services. *Sustainability* **2024**, *16*, 5343. https://doi.org/10.3390/su16135343

Academic Editor: Davide Settembre-Blundo

Received: 11 May 2024
Revised: 18 June 2024
Accepted: 19 June 2024
Published: 23 June 2024

Copyright: © 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

In 2021, China put forward the Global Development Initiative (GDI), calling on the international communities to work together to help achieve the global sustainable development goals. This initiative has received a positive response around the world, and China has also begun to actively implement high-quality development and transformation. China has already made an important contribution to global sustainable development. As the stabilizer of economic growth, the high-quality development of the manufacturing industry is a key part of building an advanced industrial system [1]. China has had the largest manufacturing industry in the world for many years, and it has the most complete industrial categories and chains. However, with the implementation of policies such as "reindustrialization", "return of manufacturing", and "decoupling of science and technology" in Western countries, the cost advantage and market advantage of China's manufacturing industry are gradually being weakened. Problems of "big but not strong" and "low added value" are becoming more and more prominent [2]. The producer service industry depends on the manufacturing industry and provides guarantee services for manufacturing enterprises. With the co-agglomeration of the manufacturing industry, the producer service

industrial structure can be transferred to the high-value chain. This also effectively makes up for the lack of technological innovation and R&D in the manufacturing industry. The role of the "public information pool", such as information exchange, technological innovation, and capital accumulation, can be played [3]. The collaborative agglomeration of the two industries is conducive to the efficient evolution of the industrial structure and is an important tool to break the original factor-driven economic growth model dominated by the manufacturing industry.

Due to the characteristics of high input and high output, the manufacturing industry tends to be close to the upstream and downstream manufacturers when choosing the location, so as to reduce the intermediate transportation cost. Once the site is determined, the location-locking function is created. The producer service industry provides service guarantees for the manufacturing industry, which runs through the upstream, midstream, and downstream links of the production of manufacturing enterprises. The location of the manufacturing industry attracts producer services to choose sites nearby, which is more likely to generate economic linkages technically. With the gathering of enterprises, more companies will be attracted. A larger contiguous spatial agglomeration will be formed in the geographical location.

Industrial co-agglomeration was presented by Ellison and Glaeser [4]. It is interpreted as a phenomenon of spatial agglomeration between heterogeneous industries. Different from single industrial agglomeration among similar enterprises, co-agglomeration occurs between different industries with upstream and downstream linkages or input–output relationships within the industry. It effectively avoids the hollowing out and decay that may be caused by the agglomeration of a single industry and is more conducive to the spatial allocation of factor resources [5]. The co-agglomeration not only includes the Marshall externalities generated by the specialized agglomeration of the same industry but can also present the Jacobs externalities generated by the diversified agglomeration of different industries [6].

As one of the urgent frontier topics, the relevant research has not been fruitful on the impact of the collaborative agglomeration of manufacturing and producer services on high-quality economic development. Moreover, the economic spillover effect of collaborative agglomeration has not been fully explored. Some researchers believed that the collaborative agglomeration of producer services and the manufacturing industry had a linear and positive correlation with high-quality economic development [7]. Zheng and He (2022) took 16 cities in the Chengdu–Chongqing economic circle as examples and found that the overall economic development level is constantly increasing, while the differences among cities are expanding. Industrial co-agglomeration has a positive direct effect on high-quality economic development but a negative spill-over effect [8]. Liu and He (2024) verified that industrial collaborative agglomeration had significantly improved the quality of manufacturing development, and new quality productive forces had played a key intermediary role [9]. Some research has analyzed high-quality economic development from the perspective of total factor productivity. Zhang et al. (2023) studied the impact of collaborative agglomeration of different industries, and they found that the manufacturing agglomeration could not improve the quality of economic development. There was a promotion effect only when the manufacturing industry was co-agglomerated with producer services [10].

Instead, more research concluded that the relationship between them had a U-shaped or inverted U-shaped nonlinear structure. Affected by technical factors, Yang et al. (2022) indicated that within the intermediary path of green technical innovation, there was a U-shaped influence relationship between industrial collaborative agglomeration and total factor energy efficiency [11]. Peng, Elahi, and Fan (2022) stated that the co-agglomeration of producer services and the high-tech manufacturing industry had an inverted U-shaped structure for high-quality economic development. Industrial co-agglomeration plays a more important role in expediting regional innovation efficiency than that in high-level areas of co-agglomeration in regions with a low level of co-agglomeration [12]. Zhou

(2018) found that industrial upgrading also affected the promotion effect of industrial co-agglomeration on the quality of economic development [13]. Chang et al. (2023) demonstrated that the digital economy and the industrial collaborative agglomeration both had a nonlinear impact on high-quality development [14]. Affected by organizational factors, in the study of Yang et al. (2021), the industrial co-agglomeration affected the local ecological environment pollution control with an inverted U-shaped structure under the financial intervention [3]. Fan et al. (2023), based on the panel data of 285 cities, verified that there was a nonlinear relationship between the industrial collaborative agglomeration and economic green development, and environmental regulation played the threshold role [15]. Zhu and Sun (2023) analyzed the quality of urban economic development in the Yangtze River Delta and found that the impact of the industrial co-agglomeration differed on high-quality development in cities because of the urban scale [16]. At the same time, in the context of the technological and industrial revolution, digitalization and greening factors are two forces that cannot be ignored in the impact of industrial collaborative agglomeration on high-quality development.

Distinguishing from existing studies, the main objective of this research is to examine how industrial co-agglomeration of manufacturing and producer services plays a positive role through spatial spillover effects in the process of achieving high-quality economic development. The academic contribution of this research may include the following: Firstly, from a spatial perspective, this research explores the nonlinear characteristics and spillover effects of the collaborative agglomeration of manufacturing and producer services on high-quality economic development, which can enrich the research on industrial collaborative agglomeration. Secondly, this research considers the spatial correlation characteristics of industrial collaborative agglomeration and high-quality economic development, using the spatial Durbin model to analyze the direct and indirect effects of industrial collaborative agglomeration on improving high-quality economic development. Comprehensively considering the existence of regional differences in China, we examine the heterogeneity of spatial spillover effects by region. Last but not least, the digital and green factors are embedded to analyze the path of the industrial co-agglomeration for improving high-quality development. The conclusions of this research will provide necessary theoretical support and decision-making references for formulating industrial synergy and agglomeration support policies and achieving high-quality development.

2. Theoretical Analysis

Currently, China's development goals are no longer limited to economic growth. The theme and goal of economic development are to achieve sustainable, high-quality development. The specific method and task to realize high-quality development are the new development concepts of innovation, green, coordination, openness, and sharing. According to the theory of industrial collaborative agglomeration, there is an obvious economy of scale effect in the industrial co-agglomeration, which is conducive to aggregating production factors, reducing production costs, improving production efficiency, and promoting the regional economy. At the same time, based on the new economic geography theory and the "center–periphery" theory, there is the Jacobs externality in industrial collaborative agglomeration, which drives the economic development of neighboring regions through spatial spillover effects.

As directly related upstream and downstream industries, the positive externalities of the co-agglomeration of manufacturing and producer services help to reduce the cost of knowledge dissemination [12] and improve the sharing of tacit knowledge between enterprises so as to improve the level of industrial technical innovation. Dominated by the producer service industry, the co-agglomeration is good for intensively regulating pollution emissions and centrally utilizing resources in the manufacturing industry [17]. The industrial co-agglomeration intensifies the competition among industrial enterprises. The demonstration effect forces green development to realize the green transformation and upgrading of the manufacturing industry. The dual attributes of collaborative agglomeration—

industrial linkage and spatial agglomeration—are mutually conducive. The industrial co-agglomeration breaks the "industry lock-in effect" and "regional lock-in effect" brought about by the externality of industrial agglomeration. This effectively enhances the allocation of resources and the coordination of factors among regions, expands the division of labor networks within the spatial scope, and finally realizes the coordinated development of regions [18]. According to the theory of national competitive advantage, the co-agglomeration of manufacturing and producer services contributes to improving the added value of export products and the competitive advantages of exporting countries, attracting foreign direct investment (FDI) inflows [19], and improving the level of openness. Economies of scale are likely to occur in areas where industries collaborate and agglomerate, forming the labor pool in the local area and accelerating the accumulation of human capital. The inflow of human resources facilitates the talent exchange between industries [20] and drives the optimal allocation of resources so as to realize resource sharing, social sharing, and economic sharing.

However, with the deepening of the collaborative agglomeration between manufacturing and producer services, the positive externalities will be gradually inhibited due to the congestion effect of population size, public infrastructure construction, and urban traffic control [21]. Meanwhile, a large number of enterprises continue to gather in the region, the homogeneous competition between enterprises intensifies, and the economic positive externality of industrial collaborative agglomeration gradually evolves into the characteristics of "nonlinear convergence". The industrial co-agglomeration of manufacturing and producer services will inhibit the quality of economic development. From above, hypothesis 1 is proposed:

H1. *The industrial collaborative agglomeration has an inverted "U" effect on high-quality development, and the spatial spillover effect exists.*

The producer services industry is environment-friendly and resource-saving, characterized by high efficiency. The industrial co-agglomeration of manufacturing and producer services can reduce the cost of pollution control in the manufacturing industry by providing clean outsourcing services. It is also good to encourage manufacturing enterprises to innovate low-carbon and energy-saving technologies and produce more clean products. The economies of scale generated by the industrial co-agglomeration can bring about the agglomeration of innovation factors, reduce the cost of technological innovation, and reduce the spillover effect of environmental pollution, thereby promoting green innovation. Specifically, the industrial co-agglomeration mainly stimulates green innovation in the manufacturing industry from three aspects: division of labor channels, cooperation efficiency, and production mode, further achieving high-quality economic development.

From the division of labor channels, Liu et al. [22] proposed that the co-agglomeration of the two industries contributes to the pattern where the "producer services industry gathers in central cities while [the] manufacturing industry transfers to outer cities". The producer services industry integrates green innovation elements and provides green innovation services to peripheral manufacturing industries. It effectively stimulates green innovation in the manufacturing industry and realizes regional high-quality development.

Through the efficiency of cooperation, collaborative agglomerations can accelerate the flow of green innovation elements and promote the extension of the green innovation chain within and between regions. Knowledge-intensive enterprises and innovative industrial enterprises expand continuously, which helps to increase the frequency of green R&D cooperation within and across regions [23].

From the production mode, the collaborative agglomeration can deepen the division of labor and extend the industrial value chain. With the industrial transfer, the innovation elements can flow across the regions. The leading regions with a higher level of green innovation have brought advanced green technology and innovation process management experience to relatively low-level areas. The competitive effect forces enterprises to quickly

imitate and master green innovative products and technologies, improve the level of green innovation, and drive the development of green innovation in the surrounding areas at the same time [24]. When continuous improvement of the level of green innovation happens in the manufacturing industry, the negative externalities of production and the damage to the ecological environment are effectively reduced. It achieves the goal of "low input, low consumption, high output, and high efficiency" [25]. Based on this, we proposed:

H2. *Industrial collaborative agglomeration can stimulate green innovation in the manufacturing industry and further promote high-quality development.*

Carlsson (2004) indicated that the wide application of digital technology had promoted the innovation of the organizational form of the service industry. The internal, distributed division of labor within the service products has been formed. Digital technology uses the information and communication system in the manufacturing field as a "network agent" to regulate the allocation of production resources, which has a positive impact on the collaborative agglomeration of manufacturing and producer services [26]. On the one hand, the digital economy creates location advantages and promotes the scale effect of industrial co-agglomeration. The higher the level of the digital economy, the more conducive it is to promote investment, which in turn attracts a larger amount of capital, technology, and high-quality talents, forming strong location conditions [27]. This will stimulate the agglomeration of producer services and manufacturing industries in regions with a high level of digitalization and result in a scale effect. In the industrial co-agglomeration, the digital economy has strengthened the advantages of regional resources and stimulated high-quality economic development [28].

On the other hand, the digital economy enhances the flow of factors and promotes the technology and knowledge spillover effect of industrial co-agglomeration. The openness and sharing features of the digital economy provide a foundation for the smooth dissemination of knowledge and information among regions and industries [29]. The development of the regional digital economy optimizes the interaction between the manufacturing and producer services industries [30], reduces the cost of communication, and effectively drives the efficient flow of knowledge and technology [31]. On the basis of this, the digital economy can significantly improve industrial linkage, enhance the technology and knowledge spillover effect of industrial collaborative agglomeration, and then form a network of collaboration and division of labor between the two industries [32]. The digital economy helps to strengthen the enabling effect of industrial co-agglomeration on high-quality economic development. Based on this, hypothesis 3 is proposed as:

H3. *The level of regional digital economy has a positive moderating effect on the relationship between the co-agglomeration and high-quality development.*

3. Indicators and Data

3.1. Explanatory Variable

High-quality economic development index (HQE). Based on the theoretical analysis, we referred to the practice of Jia et al. (2022) and constructed an indicator system [33]. The entropy weight method was used to calculate the index weight. As a multi-index comprehensive evaluation method, the entropy weight method determines the weight by calculating the entropy value of each index. This approach takes into account the interrelationships between indicators, which allows for a more comprehensive assessment of the importance of indicators and avoids the influence of subjective preferences, making the results more objective and reliable. Table 1 shows the results.

Table 1. The evaluation index system of the high-quality economic development index.

Dimensions	First Indicators	Secondary Indicators	Symbol
Innovation (0.3096)	Innovation Input (0.1569)	R&D Input	+
		R&D Personnel Full-time Equivalent	+
	Innovation Output (0.1527)	Number of Patents Granted Per Capita	+
		Technology Market Turnover	+
Coordination (0.1281)	Urban–rural Coordination (0.0747)	Level of Urbanization	+
		Per Capita Disposable Income of Rural Residents/Per Capita Disposable Income of Urban Residents	+
		Per Capita Consumption Expenditure of Rural Residents/Per Capita Consumption Expenditure of Urban Residents	+
	Industrial Coordination (0.0280)	Industrial Upgrading Coefficient	+
	Economic Fluctuation (−0.0253)	CPI (Consumer Price Index)	−
		PPI (Producer Price Index)	−
Green (0.1984)	Energy Consumption (−0.0486)	Total Electricity Consumption	−
		COD (Chemical Oxygen Demand) Emissions	−
		Emissions of Major Pollutants in Waste Gas	−
	Environmental Governance (0.0739)	Comprehensive Utilization of Industrial Solid Waste	+
		Harmless Treatment Rate of Household Garbage	+
	Environmental Protection (0.0758)	Forest Cover	+
		Urban Green Space	+
Openness (0.1489)	Foreign Trade (0.0995)	Total Import and Export Volume	+
	Foreign Direct Investment (0.0494)	FDI	+
Sharing (0.2149)	Economic Sharing (0.0915)	Total Retail Sales of Consumer Goods	+
		GDP Per Capita in a Region	+
	Social Sharing (0.1235)	Number of Beds in Medical Institutions Per Capita	+
		Unit Road Mileage	+
		Expenditure on Human Settlements Education	+
		Registered Urban Unemployment Rate	−

Note: Below the metric is the indicator weight calculated by the entropy weight method. "+" indicates that this indicator has a positive impact and "−" indicates that this indicator has a negative impact.

3.2. Core Explanatory Variable

Industrial collaborative agglomeration (ICA). Producer services include: leasing and business services; scientific research and technical services; information transmission, software, and information technology services; transportation, warehousing, and postal services; and the financing industry. The original industrial synergy agglomeration index is measured by the quality and height of industrial synergy. Because the measurement method does not fully consider the changes in the level of industrial structure caused by the difference in the scale of industrial sectors in the region, it cannot truly reflect the height of industrial structure evolution. Learning from Zeng et al. [34], we introduced the correction index of industrial collaborative agglomeration.

$$ICA_{it} = \left(1 - \frac{|Maggl_{it} - Saggl_{it}|}{Maggl_{it} + Saggl_{it}}\right) + |\gamma_1 Maggl_{it} + \gamma_2 Saggl_{it}| \quad (1)$$

ICA_{it} is the industrial collaborative agglomeration index of province i in t period. $Maggl_{it}$ and $Saggl_{it}$ are the location entropies of manufacturing and producer services, respectively. γ_1 and γ_2 are the correction coefficients of the location entropy of manufac-

turing and producer services, which are measured by the ratio of the added value of the secondary and tertiary industries to the gross regional product.

$$Maggl_{it} = \frac{M_{it}}{M_t} \Big/ \frac{Q_{it}}{Q_t} \; Saggl_{it} = \frac{S_{it}}{S_t} \Big/ \frac{Q_{it}}{Q_t} \tag{2}$$

M_{it} is the number of people employed in the manufacturing sector of province i in t period. M_t is the total manufacturing employment in the country in period t. S_{it} is the number of people employed in the producer services of province i in t period. Q_{it} is the total employment in province i during period t. Q_t is the total employment in the country in period t.

3.3. Mediated Variable

The level of green innovation in the manufacturing industry. The existing methods of measuring green innovation mainly included: (1) measuring at the process and product level; (2) using DEA (Data Envelopment Analysis) to measure the efficiency of green innovation; and (3) measuring by the number of green patents. We referred to the practice of Liu [35] and measured the level of green innovation in the manufacturing industry from three aspects: (1) green product innovation (PRO), which is measured by the sales revenue of new products per unit of energy consumption in industrial enterprises (sales revenue of new products of industrial enterprises above the designated size/total industrial energy consumption); (2) green process innovation (CRA), which is measured by the ratio of industrial added value to industrial pollutant emissions; and (3) green technology innovation (GRE), which is measured by the number of green patents granted in regions.

3.4. Moderator Variable

The development level of the digital economy (DIG). We referred to the practice of Li et al. (2023) and Shahbaz et al. (2022) and constructed an index from four dimensions: digital foundation, digital industry, digital integration, and digital innovation [36,37]. The weights were determined by the entropy weight method in Table 2.

Table 2. The evaluation index system of the digital economy index.

First Indicators	Secondary Indicators	Symbol
Digital Foundation (0.122)	Number of Mobile Phone Base Stations	+
	Internet Broadband Access Port	+
	Mobile Phone Penetration	+
Digital Industry (0.4693)	Investment in Fixed Assets in Electronic Information Manufacturing	+
	Software Product Revenue Scale	+
	Information Technology Services Revenue	+
	Volume of Telecommunication Service	+
Digital Integration (0.1733)	Proportion of Enterprises Engaged in E-commerce Transactions	+
	E-commerce Sales	+
	Digital Financial Inclusion Index	+
	Online Government Service Capability Index	+
Digital Innovation (0.2354)	Number of Patent Applications Granted	+
	Number of High School Students	+
	Number of R&D Projects of Industrial Enterprises Above the Designated Size	+

Note: Below the metric is the indicator weight calculated by the entropy weight method. "+" indicates that this indicator has a positive impact.

3.5. Control Variables

To ensure the validity of the results, we selected and controlled the factors that may affect high-quality development at the provincial level. Referring to the practice of previous scholars [38,39], the control variables included: (1) the level of human capital (*hr*), measured by the number of people pursuing higher education divided by the total population over 6 years old (including 6 years old); (2) government support (*support*), measured by the ratio of fiscal expenditure to GDP (gross domestic products); (3) macro tax burden (*tax*), measured by the ratio of government tax revenues to GDP; and (4) the level of financial development (*finance*), measured by the ratio of the balance of deposits and loans of financial institutions to GDP. The descriptive statistics of the variables are listed in Table 3.

Table 3. Descriptive statistics of the variables.

Variables	Means	Standard Deviation	Minimum	Maximum	Numbers of Observations
HQE	0.4863	0.1052	0.2726	0.8682	372
ICA	1.5323	0.2701	0.6221	2.3240	372
PRO	3119.4	3116.2	1	13,856	372
CRA	92.097	113.25	3	709.77	372
GRE	4241.9	6187.8	4	46,147	372
DIG	0.2639	0.1234	0.1067	0.9535	372
hr	13.648	7.8516	1.26	50.49	372
support	2.0601	1.4957	0.3029	6.7569	372
tax	14.081	21.064	0.2497	151.76	372
finance	57.906	13.375	22.67	89.83	372

4. Study Design

4.1. Spatial Correlation Test

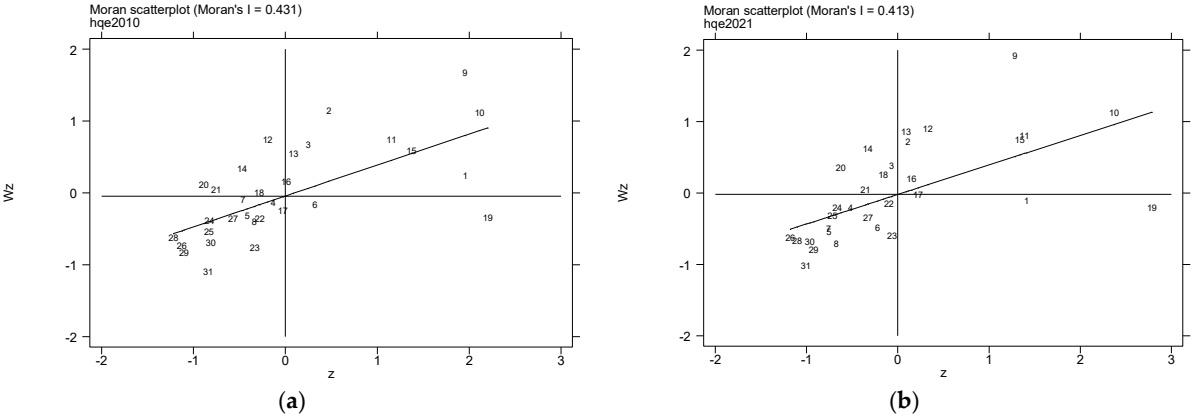
In order to explore the spatial agglomeration characteristics, we made use of geographic distance weights to test the correlation between the Global Moran's I index of high-quality economic development and industrial collaborative agglomeration. The results are shown in Table 4. The Global Moran' I index of high-quality development and the industrial collaborative agglomeration between the manufacturing and producer services industries are all greater than 0 and pass the 1% significance level test, which means that the indicators of HQE and ICA show a strong spatial positive correlation. Therefore, the research conclusions will inevitably be biased without the spatial spillover effect.

Table 4. The values of Moran's I index.

Year		2010	2011	2012	2013	2014	2015
Moran's I	*HQE*	0.445 ***	0.432 ***	0.439 ***	0.442 ***	0.419 ***	0.440 ***
	ICA	0.355 ***	0.330 ***	0.339 ***	0.309 ***	0.302 ***	0.317 ***
Year		**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Moran's I	*HQE*	0.423 ***	0.395 ***	0.379 ***	0.377 ***	0.406 ***	0.427 ***
	ICA	0.316 ***	0.317 ***	0.248 ***	0.349 ***	0.364 ***	0.379 ***

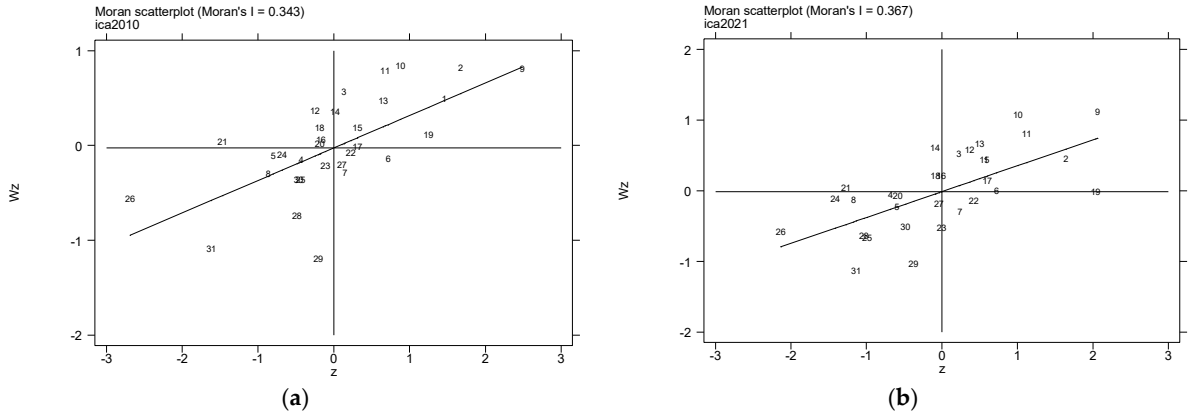
Note: *** indicate a significance level of 1%.

Furthermore, the local Moran scatter plots of *HQE* and *ICA* are shown in Figures 1 and 2, respectively (due to the limited space of the manuscript, only the results for 2010 and 2021 are presented). The local Moran index of *HQE* and *ICA* is concentrated in the first and third quadrants, presenting obvious high-high and low-low agglomeration characteristics. This verifies the necessity and feasibility of conducting spatial econometric analysis.



(**a**) (**b**)

Figure 1. The local Moran scatter plot of high-quality economic development. (**a**) presents the local Moran's I index in 2010; (**b**) presents the local Moran's I index in 2021.



(**a**) (**b**)

Figure 2. The local Moran scatter plot of industrial collaborative agglomeration. (**a**) presents the local Moran's I index in 2010; (**b**) presents the local Moran's I index in 2021.

4.2. Models

Based on the results of the spatial correlation test, OLS (Least Squares Regression), SAR (Spatial Auto Regressive Model), SEM (Spatial Error Model), and SDM (Spatial Durbin Model) are tested sequentially. The specific test results are shown in Table 5. The fixed-effect model is considered when Hausman test statistics are significant at the 5% level. The spatial lag and error test statistics are both significant at the level of 5% in the LM (Lagrange Multiplier) test and robust LM test, indicating that the spatial term is necessary to be introduced into the model. The LR (Likelihood Ratio) test and Wald test both reject the null hypothesis at the 1% significance level. The spatial Durbin model is the optimal model, and it cannot be degraded into the SAR model or the SEM model.

Table 5. The results of spatial econometric models.

Test Methods	Statistics	Statistical Values
Spatial Error Test	LM—Error Robust LM—Error	403.792 *** 263.213 ***
Spatial Lag Test	LM—Lag Robust LM—Lag	146.580 *** 6.001 **
Hausman Test	Chi2	65.41 ***
LR Test—SAR	Chi2	46.26 ***
LR Test—SEM	Chi2	65.76 ***
Wald Test—SAR	Chi2	34.72 ***
Wald Test—SEM	Chi2	32.28 ***

Note: **, and *** indicate a significance level of 5% and 1%, respectively.

According to the above theoretical analysis, an inverted U-shaped characteristic might be exhibited between industrial collaborative agglomeration and high-quality economic development. Here, the spatial Durbin model of double-fixed-effect is:

$$HQE_{it} = \alpha_0 + \rho W \times HQE_{it} + \beta_1 ICA_{it} + \beta_2 ICA_{it}^2 + \theta_1 W \times ICA_{it} + \theta_2 W \times ICA_{it}^2 + \gamma Control_{it} + \delta W \times Control_{it} + u_i + \sigma_t + \varepsilon_{it} \quad (3)$$

HQE_{it} is the level of high-quality development of province i in t period. ICA_{it} is the industrial collaborative agglomeration, and ICA_{it}^2 is the square term of ICA. α_0 is the constant. ρ represents the spatial autoregressive coefficient of high-quality development. W is the spatial distance weight matrix. u_i and σ_t are the individual and temporal fixed effects, respectively. ε_{it} is the random disturbance term. Once the model results are displayed as $\rho \neq 0$, the regression coefficient cannot directly measure the effect of explanatory variables. It is necessary to further use the partial differential method to decompose the effect [40].

5. Empirical Analysis

5.1. Benchmark Results

Based on the regression results in Table 6, it can be seen that the coefficient of ρ is significantly positive. There is a positive spatial spillover effect on high-quality development.

Table 6. The results of benchmark regression and spatial spillover effect estimation.

Variables	Fix Effect Model	SDM Model	Effect Decomposition		
			Direct Effect	Indirect Effect	Total Effect
ICA	0.1479 *** (2.75)	0.1129 ** (2.67)	0.1329 ** (2.82)	−0.6307 ** (2.70)	−0.4978 ** (−1.90)
ICA^2	−0.0436 *** (−2.65)	−0.0322 *** (−3.53)	−0.0377 ** (2.66)	0.1793 ** (−2.72)	0.1416 ** (1.89)
hr	0.0071 (0.15)	0.0022 * (1.37)	0.0024 * (1.41)	-0.0128 (-0.58)	−0.0105 (−0.44)
$support$	0.0251 *** (7.89)	0.0304 *** (7.44)	0.0337 *** (8.74)	0.0935 *** (6.02)	0.1272 *** (8.17)
tax	−0.0038 (−0.83)	−0.0081 (−1.39)	−0.0089 (−1.21)	−0.0275 (−1.38)	−0.0365 (−1.18)
$finance$	0.0488 *** (3.11)	0.0345 ** (2.60)	0.0393 ** (1.94)	0.1552 ** (2.13)	0.1945 *** (2.76)
Constant	0.2794 *** (3.62)				
ρ			0.2667 *** (3.08)		
Sigma2_e			0.0002 *** (3.08)		
Individual/Time Fixed	YES		YES		
R^2	0.821		0.432		
$LogL$			1059.09		
Obs	372		372		

Note: *, **, and *** indicate a significance level of 10%, 5%, and 1%, respectively. The values in parentheses represent t-statistics.

Similar to the conclusions of Peng, Elahi, and Fan (2022) and Yang et al. (2021), the coefficient of the primary term of industrial collaborative agglomeration is positive while the coefficient of the second term is negative, indicating the inverted U-shaped

structure between industrial collaborative agglomeration and high-quality economic development [3,12]. Lind and Mehlum [41] pointed out that this criterion was insufficient. When the relationship is monotonically convex, the model estimation might incorrectly produce extreme points. The results would be biased. In order to solve the problem, they proposed the UTEST. The test results reveal that the inflection point value of the inverted U-shaped curve is 1.6972 (the 95% confidence interval is [1.4511, 2.1723]), which passes the significance test at the 5% level and validates hypothesis 1. From the level of collaborative agglomeration of manufacturing and producer services in 2021, except for Beijing, Tianjin, Hebei, Liaoning, Shanghai, Guangdong, and Chongqing, which have crossed the inflection point and are influenced by the crowding effect, the remaining 24 regions can improve the level of high-quality economic development with the deepening of industrial collaborative agglomeration.

In spatial econometrics, the influence of explanatory variables on the explained variables includes direct and indirect effects. The direct effect measures the initial effect of the local dependent variable, while the indirect effect reflects the spillover effect of the explanatory variable of the local dependent variable to other regional dependent variables. The partial differential method was used, and in Table 6, it is found that the industrial collaborative agglomeration has a positive impact on the high-quality development locally, and then it will inhibit it. However, the impact on other regions is quite the opposite. In the early stage, the level of industrial co-agglomeration is low; the "siphon effect" caused by industrial technology transfer is greater than the spillover effect of industrial co-agglomeration, which plays a certain role in inhibiting the high-quality development of other regions. With the deepening and maturity of local industrial co-agglomeration, the spillover effect of industrial co-agglomeration on the technology and knowledge of neighboring regions gradually emerged, enhancing the high-quality development in neighboring regions.

Among the control variables, human capital, government support, and financial development level have a significant positive impact on HQE, while the macro tax burden inhibits HQE, but it is not significant. The popularization of higher education provides high-quality talent support. Government financial support can effectively activate the market, boost economic growth, and coordinate regional development. The development and improvement of financial markets are conducive to economic openness, sharing, and coordination in urban and rural areas.

5.2. Robustness Test

In order to ensure the robustness of the regression results of the model, the following methods were used: (1) replace the core explanatory variable and use the E-G index proposed by Shen and Peng (2021) [42]; (2) use the adjacency matrix and the economic distance matrix to replace the geographic distance matrix of the benchmark model. The regression results are shown in Table 7. By comparing with the benchmark model results, the estimation is basically consistent, indicating that the research conclusions are robust and reliable.

Table 7. The results of the robustness test.

Variables	E-G Index		Adjacency Matrix		Economic Distance Matrix	
	Direct Effect	**Indirect Effect**	**Direct Effect**	**Indirect Effect**	**Direct Effect**	**Indirect Effect**
ICA	0.0878 *** (2.76)	−0.5802 ** (−1.93)	0.1013 *** (4.21)	−0.5209 ** (−2.15)	0.1101 ** (2.51)	−0.6081 *** (−3.23)
ICA^2	−0.0252 ** (−2.17)	0.0629 *** (5.06)	−0.0365 *** (−3.47)	0.0512 *** (3.51)	−0.0618 ** (−2.37)	0.0419 *** (4.34)
Control Variables	YES		YES		YES	
ρ	0.2757 ** (3.25)		0.5542 *** (12.01)		0.4505 ** (4.70)	

Table 7. *Cont.*

Variables	E-G Index		Adjacency Matrix		Economic Distance Matrix	
	Direct Effect	Indirect Effect	Direct Effect	Indirect Effect	Direct Effect	Indirect Effect
Sigma2_e	0.0001 *** (13.53)		0.0002 *** (13.37)		0.0002 *** (13.60)	
R^2	0.595		0.479		0.578	
LogL	1064.33		997.67		1019.66	
Obs	372		372		372	

Note: **, and *** indicate a significance level of 5% and 1%, respectively. The values in parentheses represent *t*-statistics.

5.3. Spatial Heterogeneity Analysis

The results of the existing research showed that individual-level factors (including urban and provincial factors) both had great influences on industrial collaborative agglomeration and economic green development in time and space [43,44]. Due to the imbalance of regional economic and industrial development, the sample is divided into three regions: the eastern, central, and western regions. The impact of industrial co-agglomeration on the regional spatial differences of high-quality development is discussed.

Table 8 suggests that there are great differences in the impact of industrial co-agglomeration on high-quality development in the three regions of China. In the study of Chen et al. (2023), the impact effect of industrial co-agglomeration on high-quality development was the most significant in the eastern region, while it was unsignificant in the central and western regions that occupied the edge of the correlation network [45]. On the contrary, in the regression results of this manuscript, the inverted U-shaped impact is obvious in the eastern and central regions, and the effect is the most pronounced in the central region.

Table 8. The results of the spatial heterogeneity analysis.

Variables	Eastern		Central		Western	
	Direct Effect	Indirect Effect	Direct Effect	Indirect Effect	Direct Effect	Indirect Effect
ICA	0.2380 * (1.7)	1.2901 ** (-6.55)	0.7529 ** (2.36)	−1.3785 ** (−2.23)	−0.2289 *** (−3.20)	−1.2596 *** (−2.66)
ICA^2	−0.0704 * (−1.81)	−0.3061 ** (−5.44)	−0.2210 ** (−2.34)	0.3899 *** (4.15)	0.0838 *** (3.16)	0.4247 *** (2.66)
hr	0.0548 *** (2.81)	0.6217 *** (3.21)	0.0052 (0.46)	−0.0323 ** (−2.22)	−0.0091 ** (1.97)	−0.4533 ** (−2.40)
support	0.0336 *** (4.40)	−0.1029 *** (−3.55)	0.0429 *** (5.02)	0.0608 *** (2.69)	0.0266 *** (6.16)	0.0641 *** (3.41)
tax	−0.0409 *** (−4.74)	0.0208 * (1.83)	−0.0368 ** (−2.38)	−0.0469 ** (−1.88)	−0.0123 ** (−2.31)	−0.0821 ** (−3.96)
finance	0.0398 *** (4.43)	0.0485 (0.60)	0.0209 (0.29)	−0.0264 (−0.27)	0.0317 (1.03)	−0.3330 *** (−2.61)
ρ	0.2379 ** (2.40)		0.4031 *** (4.50)		0.3968 *** (−3.15)	
Sigma2_e	0.0001 *** (8.06)		0.0002 *** (6.71)		0.0000 *** (8.59)	
R^2	0.731		0.661		0.638	
LogL	299.4201		279.6934		506.3519	
Obs	132		96		144	

Note: *, **, and *** indicate a significance level of 10%, 5%, and 1%, respectively. The values in parentheses represent *t*-statistics.

Further combined with UTEST, it is found that the inverted U-shaped inflection point value is 1.817 (the confidence interval at the 95% significance level is [1.6326, 2.2298]), which is bigger than the average value of industrial co-agglomeration of 1.6972. Because of the high level of industrial development and co-agglomeration, the promotion potential for high-quality development has been greatly released in the early stages in the eastern area. In the effect decomposition, the positive spatial spillover effect is the most obvious in the eastern area. The externality of industrial collaborative agglomeration radiates significantly to the surrounding areas. Human capital and financial development both manifest positive spillover effects.

In the central area, the results of UTEST show that the inverted U-shaped inflection point value is 1.711. The *t*-statistics value is 1.20 and not significant at the 95% confidence level. At present, the central region is dominated by a single positive impact. According to the regression coefficient, industrial co-agglomeration in the central area plays the most important role in promoting high-quality development. In terms of geographical location, the level of industrial co-agglomeration and the upgrading of industrial structures in the central area are first affected by the spillover effect in the eastern region. The indirect effect results reflect that the siphon effect is quite obvious. Human capital and financial development also show a siphon effect. Prices are increasing significantly, and the population is crowded in the eastern area, while the western region is relatively opposite. The central region is in a period of rapid development, with a large demand for industrial resources, human capital, and finance. As a result, there has been a trend of resource transfer to the central region.

In contrast, the impact of industrial co-agglomeration on high-quality development has a U-shaped structure in the western area. The results of UTEST show that the inflection point value is 1.293 (the value is significant at the 95% level, and the confidence interval is [1.0955, 1.5824]), which is smaller than the average value of industrial co-agglomeration. It shows that the level of co-agglomeration is on the left of the inflection point, which has an inhibitory effect on high-quality development. The western region has inherited the transfer of declining enterprises from the eastern and central areas. It lacks human capital, and the transportation is inconvenient, leading to the difficulty of co-agglomeration.

5.4. Mechanism Analysis

5.4.1. The Mediator Effect of Green Innovation

It is necessary to further understand the path mechanisms of Chinese manufacturing and producer service industries to promote high-quality development. Here we take green innovation as the mediating variable to reveal the path from three aspects: green product innovation, green process innovation, and green technology. The model is as follows:

$$\begin{aligned} M_{it} = \alpha_1 + \rho W \times M_{it} + \beta_1 ICA_{it} + \beta_2 ICA_{it}^2 + \theta_1 W \times ICA_{it} + \theta_2 W \times ICA_{it}^2 \\ + \gamma Control_{it} + \delta W \times Control_{it} + u_i + \sigma_t + \varepsilon_{it} \end{aligned} \tag{4}$$

$$\begin{aligned} HQE_{it} = \alpha_2 + \rho W \times HQE_{it} + \beta_1 ICA_{it} + \beta_2 ICA_{it}^2 + \sigma W + \tau W \times M_{it} \\ + \theta_1 W \times ICA_{it} + \theta_2 W \times ICA_{it}^2 + \gamma Control_{it} \\ + \delta W \times Control_{it} + u_i + \sigma_t + \varepsilon_{it} \end{aligned} \tag{5}$$

M_{it} is the mediating variable; the rest of the variables are the same as above. The results of the regression are shown in Table 9.

The regression result of the benchmark model is presented in Model (1). The core explanatory variables and the mediating variables are significant at the 10% level in Models (2)–(7). Hypothesis 2 was verified. The mediating effect exists in the impact path of industrial co-agglomeration to promote high-quality development. Models (2) and (3) indicate that industrial co-agglomeration can stimulate green product innovation, thereby improving the quality of economic development. The mediation effect accounts for 75.58% of the total effect. The knowledge spillover effect brought by industrial collaborative agglomeration is conducive to improving the level of green research and development of

new products within the region. The promotion of green innovation in products will help improve the level of regional green development and the quality of the economy.

Table 9. The regression results of the mediating effect.

Variables		Product Innovation		Process Innovation		Technology Innovation	
	HQE **(1)**	***PRO*** **(2)**	***HQE*** **(3)**	***CRA*** **(4)**	***HQE*** **(5)**	***GRE*** **(6)**	***HQE*** **(7)**
ICA	0.1129 ** (2.67)	9.9058 *** (15.18)	0.0287 ** (1.90)	1.5912 * (1.71)	0.0881 * (2.15)	1.5096 *** (10.14)	0.0418 *** (5.29)
ICA^2	−0.0322 *** (−3.53)	−3.4796 *** (−12.97)	−0.0401 ** (−1.92)	−0.6821 ** (2.38)	−0.0304 * (2.30)	−2.0344 *** (−8.16)	−0.3418 *** (−5.29)
PRO			0.0085 *** (2.90)				
CRA					0.0156 *** (2.61)		
GRE							0.0471 *** (12.09)
hr	0.0022 * (1.37)	−0.6501 *** (−3.73)	0.0054 (0.92)	−0.1436 * (−1.78)	0.0785 *** (5.46)	−0.4532 *** (−2.83)	0.0619 *** (5.15)
$support$	0.0304 *** (7.44)	0.8684 *** (9.05)	0.0247 *** (5.78)	0.2055 *** (3.62)	0.0782 *** (9.51)	0.9019 *** (10.19)	0.0324 *** (4.33)
tax	−0.0081 (−1.39)	−0.0842 ** (−2.20)	−0.0109 ** (−1.88)	−0.1538 ** (−1.96)	−0.0261 *** (−8.47)	−0.4329 *** (−12.2)	−0.0063 ** (−2.01)
$finance$	0.0345 ** (2.60)	1.6692 *** (4.52)	0.0435 *** (2.37)	1.6836 *** (5.64)	0.0431 (1.47)	1.0085 *** (2.96)	0.1107 *** (4.26)
ρ	0.2667 *** (3.08)	−0.1682 ** (−1.83)	0.6067 *** (11.20)	0.6933 *** (15.87)	0.2749 *** (2.71)	−0.1574 ** (−1.69)	0.0133 *** (4.13)
Sigma2_e	0.0002 *** (3.08)	0.3782 *** (13.16)	0.0002 *** (11.20)	0.0352 *** (3.47)	0.0023 *** (13.65)	0.3233 *** (13.49)	0.0002 *** (13.52)
Individual/Time Fixed	YES	YES	YES	YES	YES	YES	YES
R^2	0.432	0.627	0.657	0.835	0.794	0.401	0.823
$LogL$	1059.09	−341.54	1039.34	934.19	600.91	−316.57	1062.85
Obs	372	372	372	372	372	372	372

Note: *, **, and *** indicate a significance level of 10%, 5%, and 1%, respectively. The values in parentheses represent *t*-statistics.

Models (4) and (5) reveal that industrial co-agglomeration can promote high-quality development through green process innovation. The mediator effect accounts for 21.99%. The industrial collaborative agglomeration of manufacturing and producer services has brought about the demonstration effect, enabling enterprises to reduce industrial pollutant emissions when pursuing added value. Thereby, high-quality development can be achieved. The mediator effect of green technology innovation accounts for 57.85% in Models (6) and (7). The innovation interaction among industries can be boosted by industrial co-agglomeration, which is conducive to the coupling of green innovation elements.

5.4.2. The Moderating Effect of the Digital Economy

According to the theoretical analysis, the digital economy plays a moderating role between high-quality development and industrial co-agglomeration. The model is as follows:

$$\begin{aligned} HQE_{it} = {} & \alpha_3 + \rho W \times HQE_{it} + \beta_1 ICA_{it} + \beta_2 ICA_{it}^2 + \beta_3 DIG_{it} + \beta_4 IN_{it} \\ & + \varphi_1 W \times DIG_{it} + \varphi_2 W \times IN_{it} + \theta_1 W \times ICA_{it} + \theta_2 W \times ICA_{it}^2 \\ & + \gamma Control_{it} + \delta W \times Control_{it} + u_i + \sigma_t + \varepsilon_{it} \end{aligned} \quad (6)$$

After adding the variables of the digital economy and the interaction terms of the digital economy and industrial co-agglomeration to the benchmark model, the coefficients of the core explanatory variables are still significant. The coefficient of interaction term is positive and significant at the 1% level, indicating that the digital economy plays a positive moderating role between high-quality economic development and industrial co-agglomeration. Table 10 presents the results of the regression.

Table 10. The regression results of the moderating effect.

Variables	SDM	*HQE*	Effect Decomposition	
			Direct Effect	Indirect Effect
ICA	0.1129 ** (2.67)	0.1517 *** (3.37)	0.1659 *** (3.45)	0.5575 ** (2.31)
ICA^2	−0.0322 *** (−3.53)	−0.0596 *** (−4.22)	−0.064 *** (−4.21)	−0.1778 *** (−2.64)
DIG		0.6471 *** (8.43)	0.6734 *** (9.09)	0.8553 *** (3.21)
$CIA \times DIG$		0.1821 *** (4.39)	0.1935 *** (4.81)	0.3723 ** (2.38)
Control Variables	YES		YES	
ρ	0.2667 *** (3.08)		0.1964 *** (3.27)	
Sigma2_e	0.0002 *** (3.08)		0.0001 *** (13.58)	
Individual/Time Fixed	YES		YES	
R^2	0.432		0.807	
$LogL$	1059.09		1219.14	
Obs	372		372	

Note: ** and *** indicate a significance level of 5% and 1%, respectively. The values in parentheses represent *t*-statistics.

The digital economy can reduce the difficulty of industrial collaboration and the cost of agglomeration. Industrial digitalization and digital industrialization can both help improve the efficiency of enterprise cooperation and effectively improve the market environment. The higher the level of the digital economy, the more significant the role of the industrial collaborative agglomeration in promoting the quality of the economy. Hypothesis 3 was verified. The results of effect decomposition show that the positive moderating effect of the digital economy also has a significant spillover effect on the surrounding areas.

6. Discussion

6.1. Academic Implications

This paper enriches the research results of industrial collaborative agglomerations on promoting high-quality economic development from the perspective of spatial spillover. We explored the impact and mechanism of industrial co-agglomeration on high-quality development at the provincial level. The differences of influence in regions were determined, and the reasons were analyzed. Combined with the results of empirical research, we provided targeted policy insights and refined practical directions for improving China's economic development quality.

6.2. Management Significance

Based on the conclusions, in order to realize the potential and value of manufacturing and producer services, this paper provides specific insights for the improvement of the

quality and sustainability of China's economic development. It is hoped that China will make greater contributions to global sustainable development in the future.

First of all, the continuity and stability of the co-agglomeration can be maintained between the manufacturing industry and the producer service industry. It is quite important to create tough conditions and policy support for intra- and inter-regional industrial co-agglomerations. When attracting investment, local governments should pay attention to the factors of industrial collaborative agglomeration, provide relevant industrial supporting services, create a better business environment, and guide the development of producer service and manufacturing clusters.

Second, government administrators can pay attention to the importance of industrial co-agglomeration, green innovation, and the digital economy. In particular, governors should make full use of the national strategy for the development of the western region to improve the development of manufacturing and producer services and enhance the endogenous driving force of development, crossing the inflection point of the U shape as soon as possible.

Last but not least, local governments can accelerate the construction of digital economy innovation platforms and provide technical, talent, and financial support for enterprises and industries. The government can also strengthen talent training for innovation platforms, improve the level of regional human capital, and exert the role of the digital economy in industrial collaborative agglomerations, empowering high-quality development. At the same time, government departments should accelerate the innovation of environmental regulations, form a multi-party environmental governance system, reduce dependence on polluting industries and resource industries, and continue to promote the green development and green innovation level of the regional economy.

6.3. Limitations

This research still has limitations regarding the industrial co-agglomeration's ability to promote high-quality development. Firstly, this research only conducts empirical analysis based on the provincial panel data of China. It needs to be further verified and discussed whether these conclusions can be extended to the practice guidance of other countries. Secondly, we utilized model regression and UTEST to find the inverted U-shaped relationship between industrial co-agglomeration and high-quality development and find the inflection point value. However, the causes of the reflection point need to be analyzed in more depth. Finally, the influencing mechanism between industrial co-agglomeration and high-quality economic development is complex. This research only discusses the impact mechanisms of green innovation and the digital economy. There is still a lack of comprehensive research results.

7. Conclusions

Based on the provincial panel data from 2010 to 2021 in China, this research evaluates the impact of co-agglomeration between manufacturing and producer services on high-quality economic development from the perspective of spatial spillover by using the double-fixed-effect spatial Durbin model. It also comprehensively examines the regional spatial heterogeneity. The mediating effect of green innovation and the moderating effect of the digital economy are both discussed. The following conclusions are drawn:

(1) Similar to the conclusions of Peng, Elahi, and Fan (2022) and Yang et al. (2021), the collaborative agglomeration of manufacturing and producer services has an inverted U-shaped impact on high-quality economic development [3,12]. There is an obvious positive spillover effect. This conclusion validated hypothesis 1. Based on the overall samples, most regions in China are still on the left side of the inverted U-shaped influence structure. The collaborative agglomeration of manufacturing and producer services can significantly promote high-quality economic development.

(2) In the impact effects of the co-agglomeration of manufacturing and producer services to promote high-quality development, some of them are realized by green innovation.

Hypothesis 2 was validated. The mediating effect of green product innovation is the most important. About 75.58% of the impact effect is achieved through green product innovation. The second-strongest effect is green technological innovation, and the weakest mediating effect is green process innovation.

(3) In the moderating effect test, the degree of regional digital economy plays a significant positive regulating role in promoting high-quality development. This conclusion validated hypothesis 3. With the continuous improvement of the digital economy, the role of industrial co-agglomeration in promoting high-quality development becomes more effective.

(4) In the spatial heterogeneity analysis, it was found that high-quality development has a positive spatial spillover effect in each area. The spillover of positive externalities in promoting high-quality development by the industrial co-agglomeration is obvious in the eastern area, which confirms the existence of the trickle-down effect. In the central area, industrial co-agglomeration, human capital level, and financial development have a "siphon effect" on the high-quality development of neighboring regions. The co-agglomeration can effectively promote the high-quality economic growth of the central region. However, it plays a restraining role in neighboring regions. Compared with the above, industrial collaborative agglomeration impacts high-quality development within a U shape in the western area, and it inhibits the high-quality development at present. These results differ greatly from the conclusions of Chen et al. (2023) [45]. The main reason is that Chen et al. (2023) used the cooperation network and believed that the central and western regions were at the edge of the cooperation network, and therefore the role of industrial co-agglomeration in promoting high-quality development was weaker [45]. In this research, we studied the impact of industrial co-agglomeration on high-quality development from the perspective of the spatial spillover effect, and economic geography theories were introduced. This can not only reflect the increasing return to scale of industrial co-agglomeration but also discuss the decomposition effect of spatial spillover. More richer and meaningful conclusions were obtained.

In the future, further research can be conducted on collaborative agglomeration at the city level and within industries, and we can deeply explore the effect of industrial collaborative agglomeration and its impact on the high-quality development of the regional economy at the city scale. Also, the research may combine the industrial co-agglomeration with new quality productive forces.

Author Contributions: Conceptualization, X.L. and Y.L.; methodology, X.L. and Y.L.; software, X.L.; validation, X.L. and Y.L.; investigation, X.L. and Y.L.; writing—original draft preparation, X.L.; writing—review and editing, X.L. and Y.L.; funding acquisition, X.L. and Y.L. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the National Natural Science Fund (No. 72334006 and No. 72272140), China, and the Colleges and Universities Outstanding Young Talents Fund (No. YQYB2023016), Department of Education, Anhui Province, China.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data are contained within the article.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Hao, X.; Li, Y.; Ren, S.; Wu, H.; Hao, Y. The role of digitalization on green economic growth: Does industrial structure optimization and green innovation matter? *J. Environ. Manag.* **2023**, *325*, 116504. [CrossRef] [PubMed]
2. Zhai, X.; An, Y. Analyzing influencing factors of green transformation in China's manufacturing industry under environmental regulation: A structural equation model. *J. Clean. Prod.* **2020**, *251*, 119760. [CrossRef]

3. Yang, H.; Zhang, F.; He, Y. Exploring the effect of producer services and manufacturing industrial co-agglomeration on the ecological environment pollution control in China. *Environ. Dev. Sustain.* **2021**, *23*, 16119–16144. [CrossRef]
4. Ellison, G.; Glaeser, E.L. Geographic concentration in US manufacturing industries: A dartboard approach. *J. Political Econ.* **1997**, *105*, 889–927. [CrossRef]
5. Howard, E.; Newman, C.; Tarp, F. Measuring industry coagglomeration and identifying the driving forces. *J. Econ. Geogr.* **2016**, *16*, 1055–1078. [CrossRef]
6. Jacobs, W.; Koster, H.R.; van Oort, F. Co-agglomeration of knowledge-intensive business services and multinational enterprises. *J. Econ. Geogr.* **2014**, *14*, 443–475. [CrossRef]
7. De Blasio, G.; Di Addario, S. Do workers benefit from industrial agglomeration? *J. Reg. Sci.* **2005**, *45*, 797–827. [CrossRef]
8. Zheng, H.; He, Y. How does industrial co-agglomeration affect high-quality economic development? Evidence from Chengdu-Chongqing Economic Circle in China. *J. Clean. Prod.* **2022**, *371*, 133485. [CrossRef]
9. Liu, Y.; He, Z. Synergistic Industrial Agglomeration, New Quality Productive Forces and High-quality Development of the Manufacturing Industry. *Int. Rev. Econ. Financ.* **2024**, *94*, 103373. [CrossRef]
10. Zhang, W.; Cheng, J.; Liu, X.; Zhu, Z. Heterogeneous industrial agglomeration, its coordinated development and total factor energy efficiency. *Environ. Dev. Sustain.* **2023**, *25*, 5511–5537. [CrossRef]
11. Yang, H.; Xu, X.; Zhang, F. Industrial co-agglomeration, green technological innovation, and total factor energy efficiency. *Environ. Sci. Pollut. Res.* **2022**, *29*, 62475–62494. [CrossRef] [PubMed]
12. Peng, C.; Elahi, E.; Fan, B.; Li, Z. Effect of high-tech manufacturing co-agglomeration and producer service industry on regional innovation efficiency. *Front. Environ. Sci.* **2022**, *10*, 942057. [CrossRef]
13. Zhou, Y. Human capital, institutional quality and industrial upgrading: Global insights from industrial data. *Econ. Change Restruct.* **2018**, *51*, 1–27. [CrossRef]
14. Chang, K.; Zhang, H.; Li, B. The impact of digital economy and industrial agglomeration on the changes of industrial structure in the Yangtze River Delta. *J. Knowl. Econ.* **2023**, 1–21. [CrossRef]
15. Fan, W.; Wang, F.; Liu, S.; Chen, T.; Bai, X.; Zhang, Y. How does financial and manufacturing co-agglomeration affect environmental pollution? Evidence from China. *J. Environ. Manag.* **2023**, *325*, 116544. [CrossRef] [PubMed]
16. Zhu, K.; Sun, W. Collaborative agglomeration level and spatial correlation of intercity manufacturing industry: An empirical study based on the cities of the Yangtze River Delta. *PLoS ONE* **2023**, *18*, e0293645. [CrossRef] [PubMed]
17. Lu, P.; Liu, J.; Wang, Y.; Ruan, L. Can industrial agglomeration improve regional green total factor productivity in China? An empirical analysis based on spatial econometrics. *Growth Change* **2021**, *52*, 1011–1039. [CrossRef]
18. Ye, C.; Zhu, J.; Li, S.; Yang, S.; Chen, M. Assessment and analysis of regional economic collaborative development within an urban agglomeration: Yangtze River Delta as a case study. *Habitat Int.* **2019**, *83*, 20–29. [CrossRef]
19. Shen, Q.; Pan, Y.; Feng, Y. Identifying impacts of industrial co-agglomeration on carbon emissions: Evidence from China. *Front. Public Health* **2023**, *11*, 1154729. [CrossRef] [PubMed]
20. Meng, X.N.; Xu, S.C. Can industrial collaborative agglomeration reduce carbon intensity? Empirical evidence based on Chinese provincial panel data. *Environ. Sci. Pollut. Res.* **2022**, *29*, 61012–61026. [CrossRef] [PubMed]
21. Yuan, H.; Liu, J.; Li, X.; Zhong, S. The impact of industrial collaborative agglomeration on total factor carbon emission efficiency in China. *Sci. Rep.* **2023**, *13*, 12347. [CrossRef] [PubMed]
22. Liu, B.; Luo, J.; Zheng, K.; Wu, F.; Zhao, X. How will industrial collaborative agglomeration affect the efficiency of regional green development? *Front. Ecol. Evol.* **2023**, *11*, 1179004. [CrossRef]
23. Lin, S.; Chen, Z.; He, Z. Rapid transportation and green technology innovation in cities—From the view of the industrial collaborative agglomeration. *Appl. Sci.* **2021**, *11*, 8110. [CrossRef]
24. Peng, H.; Shen, N.; Ying, H.; Wang, Q. Can environmental regulation directly promote green innovation behavior?—Based on situation of industrial agglomeration. *J. Clean. Prod.* **2021**, *314*, 128044. [CrossRef]
25. He, W.; Li, Y.; Meng, X.; Song, M.; Ramsey, T.S.; An, M. Will green technological progress help industrial collaborative agglomeration increase regional carbon productivity: Evidence from Yangtze River Delta urban agglomerations. *Environ. Dev. Sustain.* **2023**, 1–28. [CrossRef]
26. Carlsson, B. The Digital Economy: What is new and what is not? *Struct. Change Econ. Dyn.* **2004**, *15*, 245–264. [CrossRef]
27. Bin, H.; Yuanyuan, W. Network Infrastructure Construction, Industrial Co-agglomeration, and Urban Industrial Upgrading: Based on the Elements of "People" and "Land". *J. Financ. Econ.* **2023**, *49*, 95–109.
28. Li, X.; Wu, Q. The impact of digital economy on high-quality economic development: Research based on the consumption expansion. *PLoS ONE* **2023**, *18*, e0292925. [CrossRef] [PubMed]
29. Vyas, V.; Jain, P. Role of digital economy and technology adoption for financial inclusion in India. *Indian Growth Dev. Rev.* **2021**, *14*, 302–324. [CrossRef]
30. Liang, S.; Tan, Q. Can the digital economy accelerates China's export technology upgrading? Based on the perspective of export technology complexity. *Technol. Forecast. Soc. Change* **2024**, *199*, 123052. [CrossRef]
31. Bresnahan, T.F.; Brynjolfsson, E.; Hitt, L.M. Information technology, workplace organization, and the demand for skilled labor: Firm-level evidence. *Q. J. Econ.* **2002**, *117*, 339–376. [CrossRef]
32. Chen, Y.; Zhu, M.; Lu, J.; Zhou, Q.; Ma, W. Evaluation of ecological city and analysis of obstacle factors under the background of high-quality development: Taking cities in the Yellow River Basin as examples. *Ecol. Indic.* **2020**, *118*, 106771. [CrossRef]

33. Jia, H.; Zhang, W.; Pan, Y. Scientific and Technological Innovation, Industrial Structure Upgrading, and High-Quality Economic Development. *China Econ. Transit.* **2022**, *5*, 388–407.
34. Zeng, W.; Li, L.; Huang, Y. Industrial collaborative agglomeration, marketization, and green innovation: Evidence from China's provincial panel data. *J. Clean. Prod.* **2021**, *279*, 123598. [CrossRef]
35. Liu, L. Green innovation, firm performance, and risk mitigation: Evidence from the USA. *Environ. Dev. Sustain.* **2023**, 1–22. [CrossRef]
36. Li, G.; Li, X.; Huo, L. Digital economy, spatial spillover and industrial green innovation efficiency: Empirical evidence from China. *Heliyon* **2023**, *9*, e12875. [CrossRef] [PubMed]
37. Shahbaz, M.; Wang, J.; Dong, K.; Zhao, J. The impact of digital economy on energy transition across the globe: The mediating role of government governance. *Renew. Sustain. Energy Rev.* **2022**, *166*, 112620. [CrossRef]
38. Fan, C.C.; Scott, A.J. Industrial agglomeration and development: A survey of spatial economic issues in East Asia and a statistical analysis of Chinese regions. *Econ. Geogr.* **2003**, *79*, 295–319. [CrossRef]
39. Li, X.; Guo, Z.; Hu, Y.; Liu, X.; Wan, Y.; Luo, R.; Sun, Y.; Che, M. High-quality development of ultra-deep large gas fields in China: Challenges, strategies and proposals. *Nat. Gas Ind. B* **2020**, *7*, 505–513. [CrossRef]
40. Zhao, H.; Cheng, Y.; Liu, Y. Can industrial co-agglomeration improve carbon emission efficiency? Empirical evidence based on the eastern coastal areas of China. *Environ. Sci. Pollut. Res.* **2024**, *11*, 1–20. [CrossRef] [PubMed]
41. Lind, J.T.; Mehlum, H. With or without U? The appropriate test for a U-shaped relationship. *Oxf. Bull. Econ. Stat.* **2010**, *72*, 109–118. [CrossRef]
42. Shen, N.; Peng, H. Can industrial agglomeration achieve the emission-reduction effect? *Socio-Econ. Plan. Sci.* **2021**, *75*, 100867. [CrossRef]
43. Cheng, Z.; Hu, X. The effects of urbanization and urban sprawl on CO_2 emissions in China. *Environ. Dev. Sustain.* **2023**, *25*, 1792–1808. [CrossRef]
44. Chen, D.; Hu, W.; Li, Y.; Zhang, C.; Lu, X.; Cheng, H. Exploring the temporal and spatial effects of city size on regional economic integration: Evidence from the Yangtze River Economic Belt in China. *Land Use Policy* **2023**, *132*, 106770. [CrossRef]
45. Chen, M.; Li, Q.; Zhang, B.; Xie, L.; Liu, J.; Geng, Y.; Liu, Z. The Spatial Correlation Network of China's High-Quality Development and Its Driving Factors. *Sustainability* **2023**, *15*, 15738. [CrossRef]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.