An Empirical Study on Industry Convergence in an Underdeveloped Area: Shanwei, Guangdong, China

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Abstract

The present paper studies the convergence of industry in Shanwei, a coastal city in Guandong province, China. The data originated from the Shanwei Statistical Yearbook 1990-2021. The Herfindahl-Hirschman Index is used to evaluate industry convergence. The Grey relational analysis assesses the contributions of the three industries' added values to local GDP. The regression model verifies if the industry convergence is conducive to economic growth. The results first indicate that Shanwei City's economy shows a significant increase in the proportions of the manufacturing and service sectors and a sharp decline in the ratio of the agricultural sector. Second, the service sector contributes the most to GDP, followed by the agricultural sector, with the manufacturing sector contributing the least. Third, industrial convergence is driving regional economic growth. This study's theoretical contribution outlines the relationship between Shanwei City's industrial convergence and regional economic development. The proposed policy recommendations are valuable for adjusting its industrial framework and promoting high-quality development.

Keywords: Convergence of the Three Industries, Underdeveloped Area, Herfindahl-Hirschman Index, Grey Relational Analysis, Regional Economic Development

1. Introduction

Industrial convergence is an inevitable result of industry development reaching a particular stage. It enhances industry competitiveness and fosters the development of emerging economies, injecting new vitality into optimizing and upgrading industrial structures (Chen et al., 2019).

As an economically powerful province, Guangdong is promoting supply-side reform, with

agriculture, industry, and services all developing steadily and the industry infrastructure constantly upgrading. Since 2001, the service sector's output has surpassed that of the manufacturing sector, forming a 'three-two-one' pattern, ranking among the top in the country. However, there are still weaknesses in agricultural modernization; the secondary industry's ability to drive the primary sector is limited, and the service efficiency of the tertiary industry has not been fully realized. Pushing the convergence of the three sectors and transforming the economic development engine is conducive to promoting economic resilience in Guangdong Province (Zhou et al., 2023).

Previous literature has yet to study the convergence of the three industries at the prefecture-level cities in Guangdong Province. Shanwei City, an important coastal city in Guangdong, has formed a distinctive pattern of the three major industries after economic structure adjustments: the primary sector is dominated by fisheries, with a focus on agriculture, but its proportion is decreasing year by year; the secondary industry focuses on light industry, machinery, and electronics, and urgently needs transformation and development; the tertiary industry is mainly based on tourism and high-tech services, with its proportion increasing, becoming the key to driving economic transformation and upgrading.

According to data from the 1990-2021 Shanwei Statistical Yearbook, the present study employs the Herfindahl-Hirschman Index to evaluate industry convergence, employs Grey relational analysis to measure how much the added values of the three sectors contribute to gross domestic product respectively, and applies a regression model to examine whether industrial convergence influences economic growth. The findings reveal three key points: first, the manufacturing and service industries in Shanwei City are expanding, while the primary industry is declining, indicating a trend towards a diversified and modernized economy. Second, the effective convergence of industries is bolstering stable regional economic growth. Third, all industries demonstrate a close relationship with GDP, with the tertiary industry making the most significant contribution, followed by the primary sector, while the secondary sector remains relatively weaker. Furthermore, industrial convergence is positively related to economic growth. Consequently, Shanwei City needs to consolidate the development of the primary and service sectors while enhancing support for the secondary industry to adapt to new labor force trends and promote economic structure optimization and upgrading.

The present paper's theoretical value lies in its in-depth exploration of the convergence of Shanwei City's three industries, its effect on economic growth, and the correlation between their added values and GDP. Its practical contribution is the policy recommendations for adjusting Shanwei's industrial framework and achieving high-quality development.

2. Theoretical Frameworks

Industry convergence blurs boundaries between different segments as their knowledge, technologies, markets, and value chains combine (Stezano, 2021). This leads to collaboration across scientific disciplines (Sick et al., 2019), strategic innovation (Lee et al., 2010), and improved productivity (Dong & Li, 2024). We categorize related papers into theoretical foundations, empirical analyses, and measures.

The theoretical foundation of industry convergence builds the corresponding core theories or principles (Baskerville & Dulipovici, 2006). Figure 1 illuminates the drivers and consequences of industry convergence. Some authors argued that those drivers include technology advancement, policy environment, and market needs (Geum et al., 2016). First, emerging technologies such as ICT (Jung et al., 2021), nanotechnology (Bainbridge & Roco, 2016), and health-promoting foods (Bröring et al., 2006) bring value across various applications and are adopted by multiple industries. This fosters technology convergence, creating new product-market combinations and ultimately driving industrial convergence (Curran et al., 2010; Sick et al., 2019). Second, policies influence industrial convergence; for example, integration policies can foster tourism industrial convergence by improving governance efficiency, enhancing the allocation of public resources, and expanding market size (Tang, 2021). Economic policy uncertainty significantly hinders industrial convergence, with the effect being most pronounced in non-state enterprises (He & Wang, 2023). Industrial upgrading mediates the relationship between China's telecommunications networks, Internet policy, and energy transition (He et al., 2024). Third, market need is another key driver of industry convergence (Geum et al., 2016). As interdisciplinary innovation grows, customers increasingly seek more diverse and innovative products and services (Raja et al., 2013), which can be achieved through convergence (Chin et al., 2020). It prompts enterprises to explore different ways of innovation (Pallant et al., 2020), such as ideas from different industries, which drives industrial convergence.
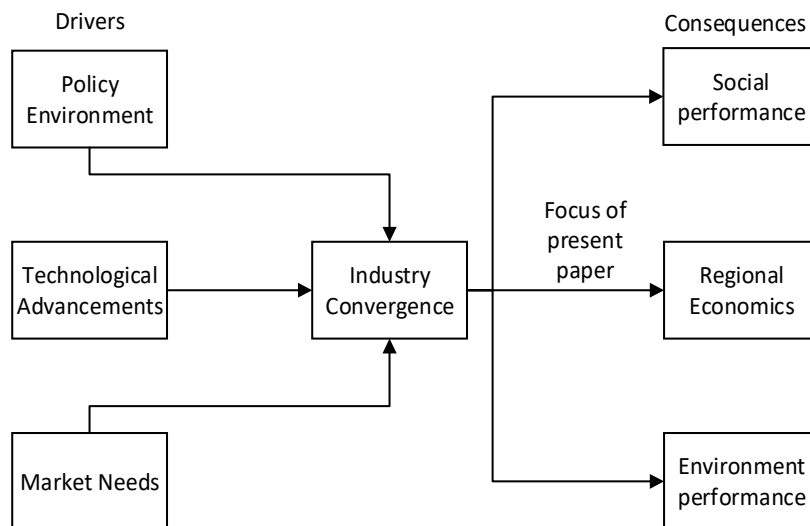

Figure 1. The diagram of the theoretical framework

Other researchers claimed that the outcomes of industry convergence include environmental performance, social performance, and regional economic growth, which could be understood as the "triple bottom line" (Elkington & Rowlands, 1999; Khan et al., 2021). Relevant empirical research revealed important insights into how industry convergence generates these results. As for environmental performance, Gu et al. (2022) find that ecological coordination will enhance the progress of industry convergence in rural areas; Dong et al. (2021) argue

that industry convergence contributes to Eco-development efficiency, mediated by green innovation; Chen et al. (2020) studied the development of an agricultural complex in China. It illustrates how converging different industries can benefit sustainable development. As for social performance, Neuwirth (2015) finds that a paradoxical relationship between industry convergence and regulatory divergence exists because, as a consequence, laws and regulations fail to keep pace with industry convergence, which calls for innovative regulatory solutions to narrow the gap; Yang et al. (2023) investigated how farming and related industries can collaborate to reduce poverty in China's rural areas. They report that combining agriculture with tourism, processing industries, and the Internet could ease poverty. The findings emphasize the socio-economic benefits of converging different industries in less-developed areas. As for regional economic growth, Cao et al. (2020) report that industry fusion can significantly boost China's metabolic efficiency, especially during its initial phase; Dong & Li (2024) report that industrial convergence is conducive to high-quality development in terms of economic output and labor efficiency; Shen et al. (2019) looked into rural tourism in Yunjia village, China. This study emphasized the crucial role of local involvement and government support in converging sectors. Their findings imply the capability of industrial convergence to increase economic output and deliver societal benefits.

Since the association between industry development and increase in economic output is the concentration of the present paper, the measures are vital to guide the analysis and interpretation of the results. The Herfindah-Hirschman Index is widely used to measure the convergence of industries. For example, Lu et al. (2017) used it to assess the extent of convergence of Beijing's cultural and finance industries; Bhattarai & Qin (2022) employed it to represent the size of industrial concentration. In addition, GDP is an indicator to assess regional economic growth (Liang et al., 2020; Muringani & Rodríguez-Pose, 2021). Furthermore, the Grey relation model helps detect the relevance of three industries to GDP (Dong et al., 2020).

To sum up, the existing studies outline a literature stream that constructs a theoretical foundation, documents empirical evidence, and proposes practical measures for studying industry development and the increase of the economy. However, few studies have explored this topic in an underdeveloped area. Shanwei, located in Guangdong Province, China, faces distinct challenges due to its less advanced economy than nearby coastal cities. Despite this, industrial convergence presents a feasible way for Shanwei to attain constant economic growth. With the advantages of proximity to the Pearl River Delta and rich natural resources, Shanwei can promote convergence among its key industries. This paper aims to assess the convergence of the city's three main sectors, test how their added value relates to regional GDP, and verify whether industry convergence influences regional economic growth. It offers recommendations for a balanced sector development to help Shanwei restructure its economy and achieve high-quality growth.

3. Material and Methods

3.1 Herfindahl-Hirschman Index Analysis Method

The Herfindahl-Hirschman Index is now widely employed to determine the degree of

industrial convergence (Lu et al., 2017), calculated by the sum of the squared market shares for each company in the sector (Gambardella & Torris, 1998). The fundamental equation is:

$$HHI = \sum_{i=1}^{n} \left(\frac{x_i}{x}\right)^2 \tag{1}$$

Where x represents the GDP of an administrative region, x_i represents the added value of the ith industry within the region, and n represents the number of industries. The Herfindahl-Hirschman Index ranges from 0 to 1. When this index is closer to 0, it indicates a higher overall level of industrial convergence; conversely, if the index is closer to 1, it implies a low level of convergence. Details are provided in Table 1 according to Gambardella & Torris (1998).

Table 1. Levels of Industrial Convergence

Convergence level	High	Medium-High	Medium	Medium-Low	Low
Range	0.2-0.36	0.36-0.52	0.52-0.68	0.68-0.84	0.84-1

3.2 Grey Relational Analysis

The Grey relational model is an efficient multi-factor statistical analysis tool that accurately assesses the strength of correlation between different factors (Silva et al., 2023). In other words, it assesses the relational degree between discrete data sequences. Unlike traditional statistical analysis, Grey relational analysis requires less data, handles multiple factors, and is not restricted by typical data distribution. It overcomes limitations such as needing large datasets and predefined functional relationships between variables (Tsai et al., 2003).

The present paper uses this model to measure the extent of association between the value contributed by the agricultural, manufacturing, and service industries and Shanwei's Gross Domestic Product. The particular procedures are shown below:

Step 1: Determine the reference series and the comparative series. This paper uses the regional GDP of Shanwei City as the reference series $X_0 = (x_{01}, x_{02}, x_{03}, \ldots \ldots x_{0k})$ and the added values of the agricultural, manufacturing, and service sectors are the comparative series $X_i = (x_{i1}, x_{i2}, x_{i3}, \ldots \ldots x_{ik})$, to investigate the association between industry expansion and local economic growth. Here, $i = 1, 2, 3$ represents agriculture, manufacturing, and service sectors, respectively; $k = 1, 2, 3, ..., n$ represents the number of years.

Step 2: Standard processing to achieve non-dimension, scaling, and polarization for the reference and comparative series to be comparable (Mor á n et al., 2006). In this research, the initial value approach is applied, resulting in $X_i' = \frac{X_i}{x_{i1}} = (x_{i1}', x_{i2}', ..., x_{ik}')$, where $i = 1, 2, 3$.

Step 3: Calculate the difference series, the maximum disparity, and the minimum disparity,

which are $s = |x'_{0k} - x'_{ik}|$, $m = \min\limits_{i} \min\limits_{k} |x'_{0k} - x'_{ik}|$, and $M = \max\limits_{i} \max\limits_{k} |x'_{0k} - x'_{ik}|$.

Step 4: Computing the Grey relational coefficient between the reference and comparative series. The distinguishing coefficient δ is implemented to expand the span of the Grey relational coefficient, which is proposed in the literature to have a value of 0.5 (Ertuğrul et al., 2016; Canbulut et al., 2022), particularly when data is insufficient and the formula is outlined below:

$$\rho(k) = \frac{m + \delta M}{s + \delta M} \qquad (2)$$

Step 5: Calculate the Grey relational grade. It indicates how much comparability sequences influence the reference sequence. If a comparability sequence is more critical than others to the reference sequence, its Grey relational grade will be higher (Tosun, 2006). Therefore, in this paper, as one Grey rational grade increases, the contribution of value-added from the corresponding sector to regional economic growth increases as well:

$$r_{0i} = \frac{1}{n} \sum_{k=1}^{n} \rho_i(k) \qquad (3)$$

3.3 Regression Model

The regression model is a predictive model that studies the link between response and explanatory variables (Uyanık & Güler, 2013). Using regression analysis, it is expected to verify whether industrial convergence influences economic growth in terms of GDP. After the stationary test, the regression model can be established as below:

$$LnGDP = \beta_1 HHI + \mu \qquad (4)$$

LnGDP is a logarithmic form of GDP, offering several advantages, such as reducing data skewness and stabilizing data variance. *HHI* is the Herfindahl-Hirschman Index, which indicates the level of industrial convergence. After regressing, the Breusch-Godfrey test (Davidson & MacKinnon, 1993) should be implemented to test for higher-order serial correlation in the disturbance.

3.4 Data Sources

The study selects data from the 'Shanwei Statistical Yearbook,' including Shanwei City's regional GDP and the added values of the agriculture, manufacturing, and service sectors from 1990 to 2021, with all units in ten thousand yuan. Shanwei City's traditional advantage industries are the marine, jewelry, hardware, and textile and clothing sectors. During the 14th Five-Year Plan, Shanwei City focuses on developing electronic information, new energy vehicles, and green petrochemical industries.

4. Results

4.1 Current Status of Industrial Convergence in Shanwei City

Shanwei is located near the Greater Bay Area, with Shenzhen and Huizhou to the west and

the Shantou-Jieyang-Chaozhou metropolitan area to the east. Strategically, it is a crucial hub along Guangdong Province's eastern coast, highlighting its significant geographical importance, as illustrated in Figure 2.

The modern industrial system is the cornerstone of building a modern economic system (Gong, 2023), which optimizes the internal structure of industries and drives transformation and upgrades through endogenous motivation (Zheng et al., 2023). Simultaneously, breaking down the boundaries and barriers between industries to enhance industrial convergence is critical to cultivating new economic growth points (Xu et al., 2024). Shanwei City should build on its actual conditions, promote informatization, coordinate the three industries, and explore innovative business structures and forms. Although the structural characteristics of the three sectors are different, they can achieve mutual benefit through complementarity (Chen et al., 2023). Shanwei City needs to cultivate high-level talents in various fields to ensure the development of industrial convergence. Talents support scientific and technological progress, economic growth, and social development, and the reserve of high-level talent is essential for converging the three sectors (Li & Yao, 2024).
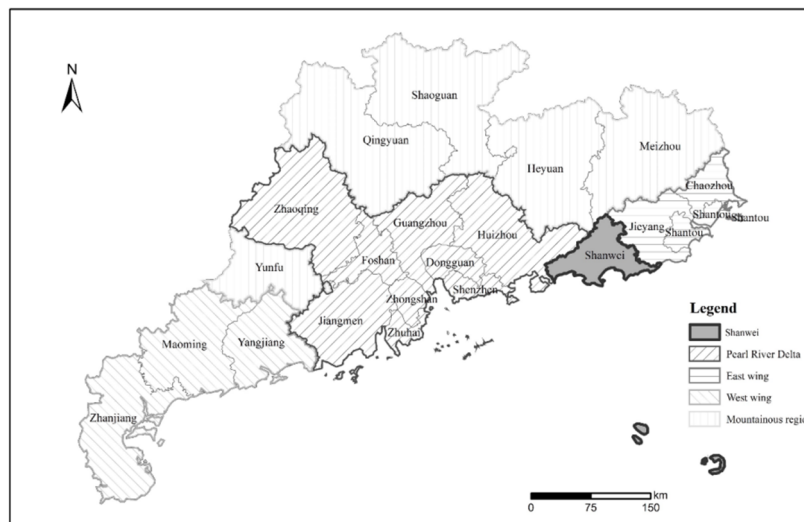

Figure 2. Shanwei and other cities in Guangdong Province

Shanwei has acted to develop convergence between the three sectors and attract talent, yielding positive results. First, it has promoted industrial convergence, focusing on the entire industrial chain, strengthening the construction of weak and critical links in agricultural industrial parks, and improving the convergence level of the three sectors. Second, it has strengthened policy support and financial guidance, such as enacting regulations to recognize and manage high-quality agricultural products, implementing a plan to reform the subsidy policy for mandatory animal disease vaccination, upgrading the rural consumption quality, and so on. Shanwei supports leading enterprises in various industries, farmers' cooperatives, and other business entities, increases farmers' enthusiasm for participating in the

development of the entire supply chain, enhances the industry chain's connection, and shares the fruits of economic growth.

In the marine economy, Shanwei City issued the 'Shanwei City Marine Aquaculture Development Plan (2021-2030)' in 2021, planning the use of marine areas for aquaculture and reserving space for developing marine ranches. In 2023, it claimed financial support for marine ranching's high-quality development and upgrading. Particular implements include establishing a sub-fund to support marine ranching growth, building a complete economic system for the industrial supply chain, and supporting marine financing and leasing business development. They provide financing channels for companies participating in marine ranching construction.

Shanwei has consistently emphasized the growth of the manufacturing sector. In 2023, it enacted a policy called 'Several Measures to Promote High-Quality Development of the Industrial Economy in Shanwei City.' For chain-leading enterprises that introduced new compliant projects in the previous year, a reward of up to 50 million RMB is offered based on 5% of the fixed investment. Newly cultivated enterprises that become above-designated industrial enterprises receive 0.1 million RMB cultivation support; enterprises that meet output and growth standards can receive rewards of up to 1 million RMB.

The culture and tourism sector in Shanwei City has developed well. In 2021, it was awarded the title of 'China's Excellent Coastal Leisure Tourism Destination.' Shanwei City insists on cultural and tourism convergence, strengthening the supply of cultural and tourism products, improving tourism facilities, and improving tourism consumers' experience. In 2023, the 'Shanwei City Cultural Tourism Development Promotion Ordinance' was enacted to safeguard the cultural and tourism sector's growth through legal means.

In terms of talent attraction, Shanwei City has implemented the 'Shanwei City Red Sea Sailing Plan' since 2021 (renamed the 'Shanmei Talent Plan' in 2023). This plan supports high-level talents to start businesses and find employment in Shanwei, providing generous economic rewards, good living conditions, and favorable policies for children' education.

4.2 Assessment of Shanwei City's Three Industries

Figure 3 illustrates the shifts in the proportions of the three industries in Shanwei City from 1990 to 2021. The share of the agricultural sector gradually diminished, from 49.29% in 1990 to 13.59% in 2021. The share of the manufacturing sector indicated an oscillating rise, from 20.78% in 1990 to 38.74% in 2021, with a peak in 2007 (46.51%). The share of the service sector also showed a fluctuating upward trend, with a significant increase between 2018 and 2021, rising from 29.93% in 1990 to 47.67% in 2021.

In summary, Shanwei City's economic structure has undergone a positive transformation, particularly in the manufacturing and service industries, which have experienced significant increases in their proportions by 17.96% and 17.74%, respectively. At the same time, the agricultural sector's fraction in the overall economic structure has decreased significantly, with a decline of 35.70%. This change indicates that Shanwei City's economy is moving towards greater diversification and modernization.
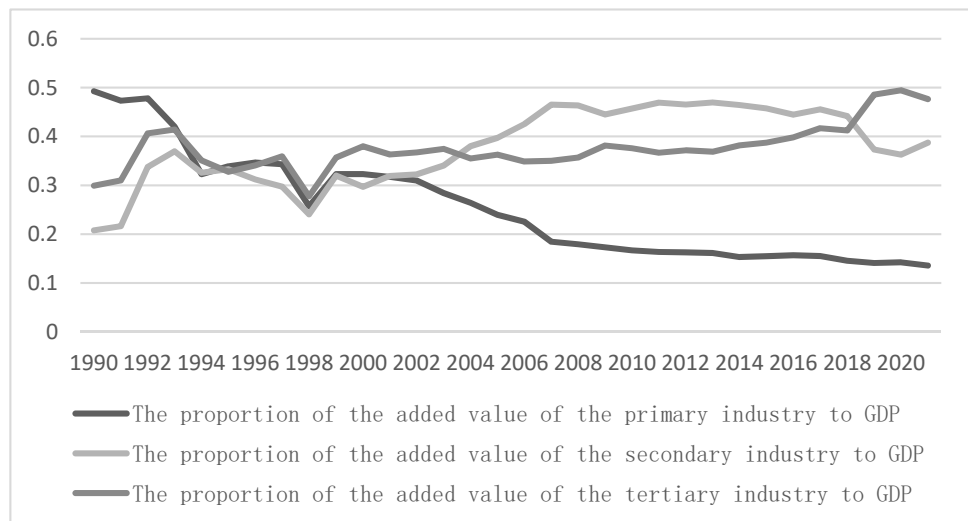
Figure 3. Changes in the percentages of the agricultural, manufacturing, and service sectors in Shanwei City

4.3 Analysis of Industrial Convergence in Shanwei City Using the Herfindahl-Hirschman Index (HHI)

Based on the HHI value, the degree of convergence among three industries in Shanwei City was analyzed, with detailed results shown in Figure 4. It can be observed that before and including 1998, the HHI value for Shanwei City's three industries showed a significant fluctuating downward trend. Specifically, the HHI value decreased from 0.375 in 1990 to 0.201 in 1998. However, after 1998, Shanwei's HHI value stabilized and slowly increased to 0.396 by 2021, presenting that the degree of industry convergence has entered a mid-to-high convergence stage. It expects stable growth of the local economy.
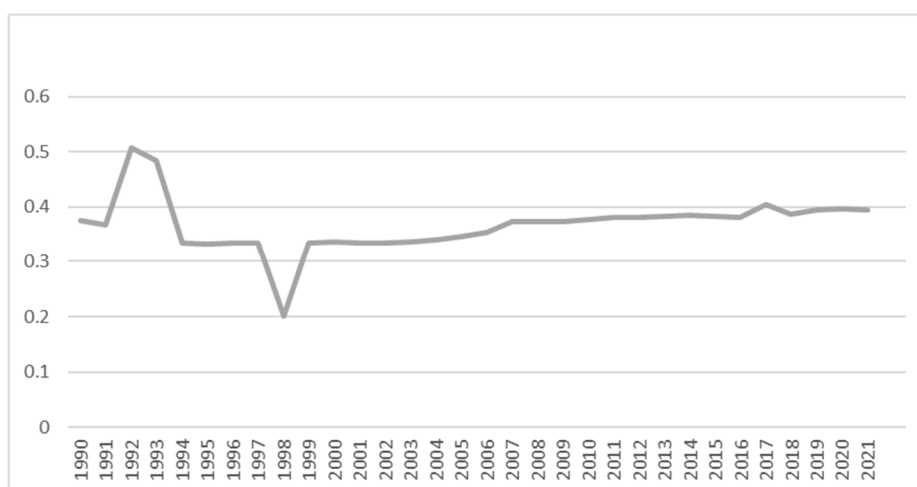
Figure 4. Measurement of the convergence level among the agricultural, manufacturing, and service sectors in Shanwei City

4.4 Grey Relational Analysis of Economic Growth and Industrial Structure in Shanwei City

The article uses Shanwei City's regional GDP as the reference series and the added values of the agricultural, manufacturing, and service sectors as the comparative series to explore the extent of connections between them (Liu et al., 2022).

First, the regional GDP and the added values of the agricultural, manufacturing, and service sectors in Shanwei City from 1990 to 2021 are dimensionless processed. Second, the difference series is calculated to obtain the maximum difference = 49.4241, the minimum difference = 0, and the distinguishing coefficient of 0.5 is employed to compute the Grey relational coefficients. After averaging, the Grey relational grade is derived, as presented in Table 2.

Table 2. Grey relational grade between Shanwei City's regional GDP and the added values of the agricultural, manufacturing, and service sectors

Evaluation Item	Relational Grade	Ranking
The primary industry added value (x_1)	0.7479	2
The secondary industry added value (x_2)	0.6735	3
The tertiary industry added value (x_3)	0.8390	1

It can be seen that $r(x_0, x_1)=0.7479$，$r(x_0, x_2)=0.6735$，$r(x_0, x_3)=0.8390$, indicating that $r(x_0, x_3)>r(x_0, x_1)>r(x_0, x_2)$. The degree of connections between Shanwei's agricultural, manufacturing, and service sectors and its regional GDP is large, with the tertiary industry-added value playing a dominant role in Shanwei's GDP, contributing the most. In comparison, the contribution of the agricultural sector's added value ranks second, while the contribution of the manufacturing sector's added value is relatively minor. This phenomenon not only reveals the varying impacts of different industries on Shanwei's economic development but also indicates that the growth of the service sector is strongly related to the overall economic prosperity of Shanwei City, serving as a critical factor in driving urban economic development.

Shanwei City's primary industry has demonstrated a robust production trend, with the production of core products showing stable growth and achieving satisfactory harvests. To further enhance the city's appearance, improve living conditions, and strengthen green ecological construction, Shanwei City has actively launched an initiative named 'Pearl No. 1' starting in 2023. Through this initiative, Shanwei has deeply implemented the rural revitalization strategy, striving to create a prosperous, beautiful, and affluent rural landscape.

In the secondary industry sector, Shanwei City focuses on the real economy and manufacturing, building a modern industrial system by constructing comprehensive sectors, platforms with broad coverage, large projects, innovative enterprises, and a supportive environment. The city is developing a large-scale industrial park and promoting the growth of advanced manufacturing. In the High-Quality Development Project for 100 Counties, 1 000 Towns, and 10 000 Villages, Shanwei has deepened its cooperation with Shenzhen, newly undertaking 43 projects, with the leading platform receiving provincial support.

The tertiary industry in Shanwei also shows a positive development trend, becoming a vital force driving local economic and social development. Specifically, Shanwei has optimized proxy services through the Greater Bay Area·Video Office, realized mutual handling of government affairs with Shenzhen, implemented policies to assist businesses, addressed employment issues, and created brand activities like the 'Pin Qing Lake Forum' for small and micro enterprises to improve the business environment and enhance market vitality.

As per the Petty-Clark theorem, economic growth and rising per capita income result in the labor force shift from the agricultural sector to the manufacturing and service sectors (Wang et al., 2021). Therefore, Shanwei City should focus on strengthening the growth of the manufacturing sector while maintaining the stable development of the agricultural and service sectors to align with labor migration trends and enhance economic structure optimization.

4.5 The Influence of Industry Convergence on Economic Growth in Shanwei City

Testing whether all variables are stationary is essential before conducting regression analysis on time series data. The Augmented Dickey-Fuller (ADF) Test (Paparoditis & Politis, 2018) is applied to examine the first-order differenced stationarity of both *LnGDP* and *HHI*. The null hypothesis asserts that the sequence exhibits a non-stationary unit root. The results are as follows in Table 3. The first-order differenced stationarity of both *LnGDP* and *HHI* are *dLnGDP* and *dHHI*. They are significant at the 1% level, representing no unit root and these variables are stationary.

Table 3. The stationary test

Variables	P value	ADF value	1% Critical value	5% Critical value	10% Critical value
LnGDP	0.085	-2.642	-3.709	-2.983	-2.623
dLnGDP	0.001	-4.681	-3.716	-2.986	-2.624
HHI	0.023	-3.159	-3.709	-2.983	-2.623
dHHI	0.001	-6.734	-3.716	-2.986	-2.624

Note: *dLnGDP* is the first-ordered differenced *LnGDP*. *dHHI* is the first-order differenced

HHI.

To examine if the development of industrial convergence benefits economy's growth, the present paper regresses *dLnGDP* on *dHHI* and the results are detailed as Table 4 shows. Precisely, the coefficient of *dHHI* is -1.348 at a 5% significance level, which means that a one-unit increase in *dHHI* will produce an expected reduction in *dLnGDP* of -1.348 units. There is a negative association between *dLnGDP* and *dHHI*. This result is in line with the expectation that industrial convergence is conducive to economic development.

The Breusch-Godfrey test is conducted to test for higher-order serial correlation in the disturbance. The p-value is 0.0516, which is larger than 0.05, so the null hypothesis of no serial correlation cannot be rejected.

Table 4. The effect of industrial convergence on economic growth

Dependent variable: *dLnGDP*	Regression model			
	The coefficient	Robust SE	t-statistic	*p*-Value
dHHI	-1.348**	0.499	-2.700	0.011
Constant	0.131***	0.014	9.440	0.000
F	7.29			
R-squared	0.452			
Number of observations	31			

Notes. ** and *** indicate significance at the 5% and 1%, respectively. Robust standard errors are applied. After implementing the VIF test, no multicollinearity was detected.

5. Conclusion and suggestions

5.1 Conclusion

The present paper concentrates on the convergence of the three sectors in Shanwei City. It applies the Herfindahl-Hirschman Index to assess industry convergence, uses Grey relational analysis to measure the connection between added values of the three industries, and employs a regression model to detect whether industry convergence influences economic growth. The data is from the Shanwei Statistical Yearbook (1990-2021). The findings indicate that:

Shanwei City's economic structure is developing, with significant growth in the ratios of manufacturing and service sectors. In contrast, the ratio of the agricultural sector has dramatically decreased, reflecting a move towards diversification and modernization. This

finding is similar to Li & Huang (1999), who report that the proportion of the primary sector decreases as the shares of the secondary and tertiary sectors rise in the major cities in China, which is conducive to structure optimization and regional coordinated development (Yuan et al., 2024).

Significant connections exist between the three industries and economic growth. The tertiary industry's added value contributes the most to economic growth, followed by the agricultural and manufacturing sectors, which contribute the least.

The convergence of industries in Shanwei is effective, and the regional economy is developing steadily. The development of industrial convergence is positively associated with the growth of the economy, which is similar to the finding of Dong & Li (2024) in China's 30 provinces, and they suggest the mechanisms may include labor efficiency, innovation capacity, and enhanced industrial competitiveness.

5.2 Suggestions

By integrating the detailed quantitative and numerical analysis of Shanwei's industry convergence, the values added of three sectors, and GDP, specific policy recommendations can be proposed to maximize industry structure optimization and regional economic development. The following are some recommendations based on the findings:

Given that Shanwei's economic structure is constantly evolving, the authorities could establish practical policies to strengthen the synergy of the industrial chain and promote deep convergence of the three industries. They can work on integrating agriculture with manufacturing and tourism to create a closed industrial chain.

Considering the tertiary industry's added value contributes most to economic growth, followed by the primary and secondary industries, Shanwei first could develop productive service industries such as modern finance and intelligent logistics, as well as life service industries like cultural tourism and health preservation, to create a brand for Shanwei's service industry. Second, for the agricultural sector, Shanwei could establish agricultural product processing centers, create an e-commerce system for counties and villages, develop a delivery logistics system, and develop a platform for connecting agricultural resources in the Great Bay area. Third, in terms of secondary industry, it is feasible to accelerate the growth of leading local industries such as electronic information, power energy, automobile manufacturing, marine engineering equipment, and clothing and jewelry.

Industry convergence is conducive to economic development. Shanwei is a coastal city, and promoting the convergence of land and marine industries would benefit its economic growth. First, Shanwei could converge marine fisheries and tourism and develop leisure agricultural tourism that provides cultural entertainment and sightseeing experience. Second, offshore wind and ocean ranching would be an innovative mode of industry convergence, which has already progressed. For instance, the world's largest anti-typhoon offshore wind and fishing integrated net platform, China General Nuclear Power Group 'Fuxi No. 1,' has officially commenced operations in Shanwei.

Given that Shanwei is proximity to Shenzhen and has an excellent ecological environment, other policy recommendations that aim to increase the regional economy in Shanwei are as follows: first, it should enhance regional cooperation by strengthening industrial collaboration and resource sharing between Shanwei City and Shenzhen, in terms of developing an integrated regional development pattern by optimizing spatial layout, reasonably planning industrial development areas, and guiding industries to cluster in areas with strong ecological carrying capacity and convenient transportation and logistics. Second, it should focus on ecological construction and strengthen the green foundation. For example, with abundant forest resources and consistently good air quality in Shanwei City, the forestry carbon benefit projects could generate income for villagers.

Finally, it needs to establish a comprehensive talent service platform in the city and use the 'Shanwei Talent Plan' to attract and keep high-quality human capital to service local economy development.

Acknowledgments

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