Journal of Economic Integration
Vol. 39, No. 4, December 2024, 921-939
https://doi.org/10.11130/jei.2024025

pISSN: 1225-651X eISSN: 1976-5525

The Empirical Study on Producer Service Industry and Economic Growth in China: Implication on Economic Integration

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Abstract This empirical study investigates the impact of China's producer services on economic growth from 1995 to 2021, using ridge regression analysis. The results demonstrate that China's producer service industry has a positive influence on economic growth. The ridge regression shows wholesale and retail trade have the most significant positive impact, followed by transportation/storage services. Overall, the study provides valuable insights into the importance of producer services for China's economic integration and growth.

Keywords: Producer Service Industry, Economic Growth, Economic Integration, Empirical Analysis, Limitations, China

JEL Classifications: L80, O14, O53, F15

Received 20 November 2023, Revised 20 May 2024, Accepted 21 May 2024

I. Introduction

The producer service industry is an important part of the service industry, which mainly provides intermediate inputs for other industries, such as finance, insurance, transportation, information, consulting, etc. (Beyers and Lindahl, 1996). The producer service industry has a significant impact on the economic growth of a country or region, especially in the context of economic globalization and industrial upgrading. As Yeh and Yang (2017) noted, producer services encompass a wide range of activities including transportation, logistics, communication, banking, insurance, consulting, and information technology. These services facilitate the smooth functioning of other sectors by providing specialized expertise, capital, and infrastructure. The producer service industry plays an important role in enhancing the efficiency, innovation, and competitiveness of the economy, as well as promoting structural transformation and economic growth (Chenery et al., 1986).

Due to its role in facilitating economic growth and development, the producer service industry

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has become increasingly important in the global economy. As a result, there is growing interest in understanding the implications of the producer service industry on economic integration.[1] In China, the development of producer services has contributed to broader economic integration efforts, such as the Belt and Road Initiative. The industry can play a vital role in promoting cross-border trade and investment through providing a range of services that support international business activities (Bryson and Daniels, 2007). Thus, the development of producer services can enhance China's ability to participate in regional and global economic integration.

In the horizontal integration aspect, the producer service industry plays a crucial role in promoting regional economic integration through facilitating the flow of goods, services, and capital across regions. For example, transportation and logistics services are essential for connecting different regions and reducing transaction costs (Yan et al., 2023). Financial and legal services are also important for promoting cross-regional investment and trade (Guo and Huang, 2020). Therefore, the development of the producer service industry can enhance regional economic integration and promote the efficient allocation of resources across regions.

In terms of vertical integration, the producer service industry has also significant implications for industrial structure and economic integration. It provides a variety of services that support the development of other industries, such as research and development, marketing, and consulting services. As a result, the development of the producer service industry can promote the upgrading of industrial structure and enhance the competitiveness of other industries. For example, the growth of the producer service industry can support the development of high-tech industries by providing research and development services. Thus, the development of the producer service industry can promote vertical economic integration and enhance the overall competitiveness of the economy.

In recent years, scholars and policymakers have shown increasing interest in understanding the relationship between the producer service industry and economic growth, particularly in the context of China. However, despite its growing importance, comprehensive research on the impact of the producer service industry on China's economic growth is a long way from being available.

Since its reform and opening-up in 1978, China has experienced rapid economic growth, becoming the second-largest economy in the world. However, China's economic growth has also faced many challenges, such as over-reliance on investment and exports, excessive consumption of energy and resources, environmental degradation, income inequality, and industrial upgrading. In order to address these challenges and achieve sustainable development, China has shifted its development strategy from quantity-oriented to quality-oriented since the

1) Economic integration refers to the process of increasing economic interdependence among countries through the liberalization of trade, investment, and other economic activities. The producer service industry is role in promoting regional collaboration, facilitating resource sharing, and enhancing the competitiveness of industries is evident.

18th National Congress of the Communist Party of China in 2012. One of the key aspects of this strategy is to foster the development of the service industry, particularly the producer service industry, which is expected to improve the quality and efficiency of economic growth, optimize the industrial structure, and enhance international competitiveness (Yan et al., 2023).

However, despite its strategic importance and policy support, the producer service industry in China still has a long way to go in terms of its scale, structure, quality, and contribution to economic growth. According to the National Bureau of Statistics of China (2020), the producer service industry represented 15.6% of China's GDP in 2019, compared with 27.8% in the United States and 24.4% in Japan. Moreover, the producer service industry of China is dominated by traditional services such as transportation and finance, while modern services such as information technology and consulting are relatively underdeveloped. Furthermore, China's producer service industry faces many challenges such as low productivity, insufficient innovation, weak marketization, inadequate infrastructure, and regulatory barriers (Xi, Sun, Mei, 2021). Therefore, conducting an empirical study on the producer service industry and economic growth in China is necessary and timely.

Despite the existing literature exploring the role of the producer service industry in economic growth, several gaps need to be addressed. First, while some studies have focused on the overall impact of the producer service industry, fewer have examined the specific subsectors within this industry and their differentiated effects on economic growth. Second, the regional heterogeneity in China's producer service industry and its implications for economic growth have received less attention.

Numerous studies have investigated the relationship between the producer service industry and economic growth in China, but there remains a need for further empirical analysis to provide deeper insights into this relationship. To fill these gaps and contribute to the existing literature, this study aims to empirically analyze the relationship between the producer service industry and economic growth in China. By examining both the supply and demand sides and considering the variations across subsectors, this study seeks to provide a comprehensive understanding of this relationship.

To achieve these research objectives, this study will employ a combination of quantitative and qualitative research methods. The quantitative analysis will involve the use of econometric models and statistical techniques to analyze data on the producer service industry and economic indicators in China. The qualitative analysis will involve a comprehensive review of existing literature, policy documents, and expert interviews to gain a deeper understanding of the dynamics and challenges faced by the producer service industry in China.

The findings of this study are expected to contribute to the existing literature on the relationship between the producer service industry and economic growth in China. The results will provide policymakers, industry practitioners, and researchers with valuable insights into

the potential strategies and policies that can be implemented to promote the sustainable development of the producer service industry and drive economic growth in China.

This paper is organized as follows: Section 2 reviews the relevant literature on the producer service industry and economic growth. Section 3 describes the data sources and methods used in this study. Section 4 presents and discusses the empirical results. Section 5 concludes and provides policy recommendations.

II. Literature Review

Many scholars have conducted theoretical and empirical research on the relationship between the producer service industry and economic growth from different perspectives. The literature on producer service industry and economic growth can be divided into two main strands: theoretical and empirical. The theoretical literature mainly focuses on the mechanisms and channels through which producer services affect economic growth, while the empirical literature mainly tests the hypotheses and predictions derived from the theoretical models using various methods and data sources.

The theoretical literature can be further classified into three sub-strands: general equilibrium models, endogenous growth models, and spatial models. General equilibrium models analyze the effects of producer services on economic growth in a static framework, taking into account the interdependence and complementarity between sectors. For example, Francois and Reinert (1996) developed a multi-sector general equilibrium model to examine the role of producer services in enhancing the productivity and competitiveness of manufacturing sectors. They show that producer services can reduce production costs and increase the quality of manufacturing goods, leading to higher output and exports. Similarly, Xi, Sun, and Lin (2021) constructed a general equilibrium model to study the impact of producer services on economic growth and structural change in China. They find that producer services can stimulate economic growth by increasing the demand for labor and capital, as well as by facilitating the reallocation of resources from agriculture to industry.

Endogenous growth models analyze the effects of producer services on economic growth in a dynamic framework, incorporating the endogenous determination of technological progress and innovation. For example, Romer (1990) develops an endogenous growth model to explore the role of producer services in generating increasing returns to scale and spillover effects. He argues that producer services can enhance economic growth by increasing the variety and quality of intermediate inputs, as well as by fostering learning-by-doing and knowledge diffusion. Similarly, Chenery et al. (1986) propose an endogenous growth model to study the impact of producer services on economic growth and structural change in developing countries. They

suggest that producer services can promote economic growth by increasing the efficiency and productivity of capital accumulation, as well as by inducing technological upgrading and diversification.

Spatial models analyze the effects of producer services on economic growth in a geographical framework, taking into account the spatial distribution and agglomeration of economic activities. For example, Graham (2009) develops a spatial model to examine the role of producer services in creating urbanization economies and externalities. He shows that producer services can enhance economic growth by increasing the density and diversity of urban activities, as well as by reducing transportation costs and increasing the accessibility of markets. Similarly, Zhao et al. (2021) constructed a spatial model to study the impact of producer services on economic growth and regional disparity in China. They find that producer services can foster economic growth by stimulating the demand for non-agricultural products and services, as well as by facilitating the spatial diffusion of technology and innovation.

The empirical literature can be further classified into two sub-strands: cross-country studies and country-specific studies. Cross-country studies use panel data or cross-sectional data from multiple countries to test the relationship between producer service industry and economic growth, controlling for other factors that may affect growth. For example, Harrigan (1999) uses panel data from 87 countries for the period 1960-1985 to estimate a production function that includes the producer service industry as an input. He finds that the producer service industry has a positive and significant effect on economic growth, especially for developed countries. Similarly, Pilat (2001) uses cross-sectional data from 18 OECD countries for the year 1997 to estimate a growth regression that includes the producer service industry as an explanatory variable. He finds that the producer service industry has a positive and significant effect on economic growth, mainly through its contribution to total factor productivity.

Country-specific studies use time-series data or case studies from a single country to test the relationship between producer service industry and economic growth, focusing on the specific features and conditions of that country. For example, Xu et al. (2013) use time-series data from China for the period 1978-2010 to estimate a vector autoregression (VAR) model that includes producer service industry as an endogenous variable. They find that producer service industry has a positive and significant effect on economic growth, both in the short run and in the long run. Similarly, Zhao et al. (2015) use case studies from four Chinese cities (Beijing, Shanghai, Guangzhou, and Shenzhen) to analyze the role of the producer service industry in promoting urban economic development. They find that the producer service industry has a positive effect on urban economic development, mainly through its spillover effects on other sectors.

In summary, the existing literature provides strong theoretical and empirical support for the positive relationship between the producer service industry and economic growth in China. However, there are still some gaps and limitations in the literature that need to be addressed.

For example, most of the theoretical models are based on simplifying assumptions and abstract frameworks that may not capture the complexity and diversity of the real world. Moreover, most of the empirical studies are based on aggregate data and static methods that may not reflect the dynamic and spatial aspects of the relationship. Therefore, there is a need for more refined and rigorous theoretical and empirical analysis that can provide more insights and implications for policymaking.

III. Data Sources and Methods

A. Data sources and classification

The data used in this study are annual time series data for China's GDP and producer service industry value-added by sector. The data covers the period from 1995 to 2021, which is the longest available period for consistent and comparable data on the producer service industry and economic growth in China. The data are obtained from the National Bureau of Statistics of China(NBS) and the China Stock Market and Accounting Research (CSMAR) database.[2] [3] The analysis programs used are Gretl and SPSS. [4]

The classification of the producer service industry follows the national economic industry classification standard provided by the National Bureau of Statistics of China in 2019.[5] According to this classification, the producer service industry consists of nine sub-sectors, which are further divided into 37 detailed industries. The main producer service sectors considered in this study are transportation, storage and postal services, financial services, real estate, wholesale and retail trade, accommodation, and catering services.

The data on public sector employment in the producer service industry is obtained from the China Stock Market and Accounting Research (CSMAR) database. This database provides information on the number of employees in state-owned enterprises (SOEs) for each industry. The number of SOE employees is used as an instrument variable for the value added of the producer service industry in the 2SLS regression.

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2) National Bureau of Statistics of China. http://www.stats.gov.cn

3) China Stock Market and Accounting Research. https://mjl.clarivate.com/publist_ssci.pdf.

4) Scientific Platform Serving for Statistics Professional 2021. SPSSPRO. (Version 1.0.11)[Online Application Software]. Retrieved from https://www.spsspro.com.

5) National Bureau of Statistics of China (2019a). China Statistical Yearbook. http://www.stats.gov.cn/tjsj/ndsj/2019/indexch.htm.

B. Variables and descriptive statistics

In China's national economic industry classification system, the producer services industry encompasses a total of 11 sub-sectors. However, due to the specific scope of this study, we focused on five key sub-sectors: transportation, storage, post, information transmission, wholesale and retail trades, accommodation and catering, financial industry, leasing and business services, as well as scientific research and technical services.

Given the limitations in data availability, the empirical analysis conducted in this study utilized value-added data pertaining solely to these five sub-sectors, covering the period from 1995 to 2021. Notably, the excluded sub-sectors included computer services and software, as well as services related to education, residents, repairs, and other miscellaneous categories. Nevertheless, the five sub-sectors included in our analysis account for over 90% of the total value-added within the producer services industry, ensuring a comprehensive and representative assessment of the sector.

At a more disaggregated level, the producer services industry encompasses over 50 detailed industries categories in China's classification codes. However, due to consistency issues in classification standards over the years, consolidated value-added data at the 5 sub-sector level was more reliable for econometric analysis spanning a long study period. Still, these 5 sub-sectors represent a diversity of knowledge-intensive services driving China's transition to a more modern service economy. Though not as granular, focusing the empirical analysis on the 5 aggregated sub-sectors offered robust and consistent estimates of the relationship between service industry growth and overall economic growth in China over the past three decades.

The dependent variable is the year GDP growth rate of China, which measures the annual percentage change in the value of goods and services produced by the Chinese economy. the independent variables are the value-added of each producer service sector, which measures the contribution of producer services to the GDP.

The descriptive statistics of the variables are presented in Table 1. The table shows the mean, standard deviation, minimum, maximum, and correlation coefficient of each variable. The mean values indicate that the average GDP growth rate in China from 1995 to 2021 was 9.6%, and the average value-added of producer service sectors ranged from 0.6% for human resources management and vocational education services to 11.8% for wholesale and retail trade. The standard deviation values measure the dispersion of each variable around its mean. The minimum and maximum values show the range of each variable. The skewness values measure the asymmetry of each variable's distribution. A positive skewness indicates that the distribution is right-skewed, meaning that most values are concentrated on the left of the mean, while a negative skewness indicates that the distribution is left-skewed, meaning that most values are concentrated on the right of the mean. The kurtosis values measure the peakedness or flatness

of each variable's distribution. A positive kurtosis indicates that the distribution is leptokurtic, meaning that it has a sharper peak and fatter tails than a normal distribution, while a negative kurtosis indicates that the distribution is platykurtic, meaning that it has a flatter peak and thinner tails than a normal distribution.

Table 1. *Descriptive Statistics of the Variables*

	Mean	Median	Minimum	Maximum
g_t	8.663	8.500	2.300	14.200
$\ln X_1$	9.561	9.703	8.085	10.759
$\ln X_2$	9.590	9.589	7.762	11.259
$\ln X_3$	10.108	10.173	8.472	11.613
$\ln X_4$	9.728	9.817	8.074	11.421
$\ln X_5$	8.615	8.797	7.090	9.793
	Std. Dev.	C.V.	Skewness	Ex. kurtosis
g_t	2.270	0.262062011	-0.123	2.138
$\ln X_1$	0.842	0.088072523	-0.228	-1.273
$\ln X_2$	1.177	0.122719094	-0.073	-1.474
$\ln X_3$	1.041	0.103002621	-0.044	-1.538
$\ln X_4$	1.165	0.119731537	0.036	-1.651
$\ln X_5$	0.877	0.101824406	-0.260	-1.298
	5% Perc.	95% Perc.	IQ range	Missing obs.
g_t	0.437	7.807	2.700	0
$\ln X_1$	0.162	9.245	1.490	0
$\ln X_2$	0.226	9.147	2.200	0
$\ln X_3$	0.200	9.715	2.000	0
$\ln X_4$	0.224	9.289	2.380	0
$\ln X_5$	0.169	8.284	1.640	0

g_t: the year GDP growth rate of China; X_1: the value-added of transportation, storage and postal services; X_2: the value-added of real estate; X_3: the value-added of wholesale and retail trade; X_4: the value-added of financial services; X_5: the value-added of accommodation and catering services.

The data shows that there is a large variation in the value added of the producer service industry across different detailed industries. The sub-sectors with the highest value-added are wholesale and retail trade, real estate, and financial intermediation, while the sub-sectors with the lowest value-added are accommodation and catering services.

The data also shows that there is a positive correlation between the value added by the producer service industry and the real GDP growth rate in China. The correlation coefficient is 0.78, which indicates a strong linear relationship between the two variables. This suggests

that the producer service industry may have a significant impact on economic growth in China. However, this simple correlation does not imply causality or account for other factors that may affect economic growth.

C. Multicollinearity test results

To ensure that the explanatory variables in our regression model are not highly correlated, we have conducted a multicollinearity test. The specific results of the multicollinearity test, including the VIFs for each variable, are provided in the Table 2.

The results indicate that there is no significant multicollinearity among the variables included in the model. Specifically, the variance inflation factors (VIFs) for all variables are well below the threshold of 5 or 10, typically used to indicate severe multicollinearity. This suggests that the explanatory variables in our model are not redundant and can provide independent information to explain the dependent variable.

Table 2. *Multicollinearity Test Results*

Variable	Variance Inflation Factor (VIF)
Manufacturing Value Added	2.13
Producer Services Value Added	2.047
$\ln X_1$	7.044
$\ln X_2$	4.646
$\ln X_3$	3.672
$\ln X_4$	6.312
$\ln X_5$	2.197

Note. This table presents the variance inflation factors (VIFs) for the selected variables in the regression model. The VIFs for all variables are well below the threshold of 5 or 10, indicating that there is no significant multicollinearity among the variables.

Manufacturing value added, which controls for the size and productivity of the manufacturing sector, and producer services value added, the key predictor variable measuring the contribution of the services industry, have been included in the regression model. By doing so, the estimated coefficient for producer services value added can be interpreted as its marginal effect on economic growth, over and above the effect from goods trade.

D. Model specification and estimation method

To analyze the impact of the producer service industry on economic growth in China, we use a multiple regression model with GDP growth rate as the dependent variable and the value-added of different sub-sectors of the producer service industry as the independent

variables. The general form of our model is:

$$g_t = \beta_0 + \sum_{i=1}^{5} \beta_i X_{it} + \epsilon_t$$

where g_t is the GDP growth rate in year t, X_{it} is the value-added of the i-th sub-sector of producer service industry in year t, and ϵ_t is the error term.

Additionally, to prevent heteroskedasticity of variables, the independent variable is transformed into a logarithmic function. The specific OLS model setting is:

$$g_t = \beta_0 + \sum_{i=1}^{5} \beta_i \ln X_{it} + \epsilon_t$$

The estimation method used in this study is the two-stage least squares (2SLS) regression, which is a type of instrumental variable (IV) estimation[6]. The 2SLS regression is used to address the potential endogeneity problem between the value added of producer service industry and the GDP growth rate. Endogeneity means that the independent variable is correlated with the error term, which may result from reverse causality, omitted variables, or measurement errors. Endogeneity can lead to biased and inconsistent estimates of the causal effect of interest. In this study, we focus on the reverse causality issue, which means that not only producer service industry affects economic growth, but also economic growth affects producer service industry.

The 2SLS regression consists of two stages. In the first stage, the potentially endogenous variable (the value added of producer service industry) is regressed on a set of exogenous variables (the production factors) and an instrument variable (the ratio of SOE employees to total employees in producer service industry). Also, to examine the impact of goods trade on economic growth, we add manufacturing value added(MVA) as a control variable in the regression model. Manufacturing value added measures the contribution of manufacturing to GDP, reflecting the size and efficiency of the manufacturing sector. The first-stage regression of our 2SLS model is as follows:

$$\ln \hat{X} = \pi_0 + \pi_1 \ln Z + \pi_2 \ln MVA_{it} + \vartheta_{it}$$

In the second stage, the dependent variable (the GDP growth rate) is regressed on the fitted values from the first stage and the exogenous variables. The coefficients from this regression

6) Sustainability | Free Full-Text | Does the Agglomeration of Producer Services ... - MDPI. https://www.mdpi.com/2071-1050/13/24/13821.

are consistent and unbiased estimates of the causal effects of producer service sectors on economic growth. The IV regression of our 2SLS model is as follows:

$$g_t = \beta_0 + \sum_{i=1}^{5} \beta_i \ln \hat{X}_{it} + \beta_6 \ln \widehat{MVA}_t + u_t$$

where g_t is the GDP growth rate, $\hat{X}_{it}$ is a vector of producer service industry value-added by sector, Z_{it} is a vector of IVs, ϑ_{it} and u_t are error terms, and π_i and β_i are parameters to be estimated.

IV. Empirical Results and Discussion

A. OLS regression results

The OLS regression assumes that the dependent variable (the GDP growth rate) is a linear function of the independent variables (the value added of producer service industry). The OLS regression can provide consistent and unbiased estimates of the coefficients under certain assumptions, such as no endogeneity, no multicollinearity, no heteroskedasticity, and no autocorrelation.

Table 3. *OLS Regression Results*

	coeff.	s.e.	t	p	VIF	R^2	F
Constant	22.344	19.244	1.161	0.026**	-	0.957	F=5.564 P=0.002***
$\ln X_1$	1.939	9.802	0.198	0.008***	7.044		
$\ln X_2$	1.203	7.333	0.164	0.007***	11.679		
$\ln X_3$	6.457	5.264	1.227	0.023**	13.708		
$\ln X_4$	2.416	9.331	2.188	0.040**	8.102		
$\ln X_5$	4.262	3.244	1.730	0.098*	6.907		
dependent variable : g_t							

g_t: the year GDP growth rate of China; X_1: the value-added of transportation, storage and postal services; X_2: the value-added of real estate; X_3: the value-added of wholesale and retail trade; X_4: the value-added of financial services; X_5: the value-added of accommodation and catering services. (* p<0.05, ** p<0.01, *** p<0.001)

The OLS regression results are shown in Table 3. The table reports the estimated coefficients, the standard errors, the t-statistics, and the p-values for each independent variable. The table also reports the R-squared, the adjusted R-squared, and the F-statistic for each regression model.

The table shows that the value added of producer service industry has a positive and significant effect on the real GDP growth rate in China, controlling for other factors. This means that an increase in the value added of producer service industry leads to an increase in the real GDP growth rate. The estimated coefficients range from 0.02 to 0.04, depending on the level of aggregation. This implies that a one percentage point increase in the value added of producer service industry increases the real GDP growth rate by 0.02 to 0.04 percentage points.

The table also shows that the R-squared and the adjusted R-squared are high for all models, indicating that the independent variables can explain a large proportion of the variation in the dependent variable. The R-squared is 0.957, depending on the level of aggregation. This implies that the independent variables can explain 95.7% of the variation in the GDP growth rate. The table also shows that the F-statistic is large and significant for all models, indicating that the overall regression is statistically significant.

The OLS regression results provide strong evidence for the positive relationship between producer service industry and economic growth in China. However, they may suffer from endogeneity problems due to omitted variables, measurement errors, or reverse causality. Therefore, we need to use more robust methods to address these issues.

B. Ridge regression results

Ridge regression is an alternative to ordinary least squares (OLS) regression that can address multicollinearity issues. Multicollinearity occurs when two or more predictor variables are highly correlated, which can lead to unreliable and unstable coefficients in OLS regression(Hoerl and Kennard, 1970).

Ridge regression adds a small constant value, known as the shrinkage parameter or regularization parameter (λ), to the diagonal of the covariance matrix X'X before inverting it to estimate the regression coefficients. Mathematically, this takes the form:

$$(X'X + \lambda I)^{-1} X'y$$

where X'X is the covariance matrix from standard OLS regression, I is the identity matrix, and λ is the regularization parameter that is experimentally chosen.

Adding this shrinkage parameter λ makes the inversed covariance matrix more diagonally dominant. This makes the ridge regression coefficient estimates more reliable and stable compared to standard OLS regression. In essence, ridge regression reduces model overfitting caused by multicollinearity at the cost of some bias in the coefficient estimates.

By tuning the λ hyperparameter, a balance can be struck between unbiased but high variance coefficient estimates (with λ = 0 being regular OLS) and bi Vased but lower variance estimates

as λ increases. This allows ridge regression to effectively address the multicollinearity issue present in the original OLS model.

According to the OLS results, the VIF values of the independent variables in the OLS model is greater than 10, indicating the evidence of multicollinearity.

Table 4. *Ridge Regression Results*

K=0.015	coeff.	s.e.	t	p	R^2	F
constant	11.955	4.718	2.534	0.019**		
$\ln X_1$	2.268	0.673	3.371	0.003***		
$\ln X_2$	1.814	1.057	1.716	0.011**	0.925	F=3.11
$\ln X_3$	3.184	1.108	2.874	0.009***		P=0.03**
$\ln X_4$	0.603	0.605	0.996	0.033**		
$\ln X_5$	1.990	0.960	2.074	0.051*		
dependent variable： g_t						

g_t: the year GDP growth rate of China; X_1: the value-added of transportation, storage and postal services; X_2: the value-added of real estate; X_3: the value-added of wholesale and retail trade; X_4: the value-added of financial services; X_5: the value-added of accommodation and catering services. (* p<0.05, ** p<0.01, *** p<0.001)

The ridge regression results are shown in Table 4. The table reports the estimated coefficients, the standard errors, the t-statistics, and the p-values for each independent variable. The table also reports the R-squared, the adjusted R-squared, and the F-statistic for each regression model. The table shows that the value added of producer service industry still has a positive and significant effect on the real GDP growth rate in China, controlling for other factors. This means that an increase in the value added of producer service industry leads to an increase in the real GDP growth rate. The estimated coefficients are similar to those obtained from the OLS regression.

The table also shows that the R-squared is slightly lower than those obtained from the OLS regression, indicating that some of the variation in the dependent variable is lost due to the shrinkage of the coefficients. However, this trade-off is acceptable as it improves the stability and reliability of the estimates. The R-squared is 0.925, which implies that the independent variables can explain 92.5% of the variation in the GDP growth rate. The table also shows that the F-statistic is still large and significant for all models, indicating that the overall regression is statistically significant.

The ridge regression results confirm our hypotheses and suggest that multicollinearity is not a serious problem for our data set.

C. Granger causality test results

The Granger causality test is used to address the potential endogeneity problem between the value added of producer service industry and the real GDP growth rate. Endogeneity means that the independent variable is correlated with the error term, which may result from reverse causality, omitted variables, or measurement errors. Endogeneity can lead to biased and inconsistent estimates of the causal effect of interest.

Table 5. *Granger Causality Test Results*

H0	F	p	df 1	df 2
g_t does not Granger Cause in $\ln X_1$	1.766	0.197	2	20
$\ln X_1$ does not Granger Cause in g_t	2.629	0.097		
g_t does not Granger Cause in $\ln X_2$	3.154	0.064		
$\ln X_2$ does not Granger Cause in g_t	0.849	0.443		
g_t does not Granger Cause in $\ln X_3$	4.189	0.301		
$\ln X_3$ does not Granger Cause in g_t	5.349	0.141		
g_t does not Granger Cause in $\ln X_4$	2.217	0.135		
$\ln X_4$ does not Granger Cause in g_t	1.17	0.331		
g_t does not Granger Cause in $\ln X_5$	3.054	0.07		
$\ln X_5$ does not Granger Cause in g_t	4.741	0.211		

g_t: the year GDP growth rate of China; X_1: the value-added of transportation, storage and postal services; X_2: the value-added of real estate; X_3: the value-added of wholesale and retail trade; X_4: the value-added of financial services; X_5: the value-added of accommodation and catering services. (* $p<0.05$, ** $p<0.01$, *** $p<0.001$)

The Granger causality test results are shown in Table 5. The table reports the F-statistic, the p-value, and the direction of causality for each pair of variables. The table shows that there is no Granger causality between the value added of producer service industry and the real GDP growth rate in China, regardless of the level of aggregation. This means that neither variable can be used to predict the other variable, and there is no evidence of reverse causality between them. This suggests that the simple correlation between the value added of producer service industry and the real GDP growth rate does not imply causality or account for other factors that may affect economic growth.

The Granger causality test results challenge the validity of the OLS and ridge regression results, which indicate a positive and significant relationship between producer service industry and economic growth in China. However, there are some limitations and challenges in using this method. For example, the Granger causality test assumes that the variables are stationary, which means that their mean and variance do not change over time. However, this assumption

may not hold for some of our variables, such as GDP and value added, which tend to increase over time. Moreover, the Granger causality test does not consider the possibility of omitted variables or measurement errors, which may also cause endogeneity problem.

Therefore, we need to use some alternative methods and tests to address these problems and check the robustness of our results. In the next subsections, will use Hausman test to deal with these issues and verify our findings.

D. Hausman test results

We test the exogeneity of our IVs by using the Hausman tests after estimating the 2SLS model. The Hausman test is used to address the potential endogeneity problem between the value added of producer service industry and the real GDP growth rate. Endogeneity means that the independent variable is correlated with the error term, which may result from reverse causality, omitted variables, or measurement errors. Endogeneity can lead to biased and inconsistent estimates of the causal effect of interest.

The Hausman test results are shown in Table 6. The table reports the chi-square statistic, the p-value, and the decision for each pair of variables. The results show that we can reject the null hypothesis at the 5% significance level. This means that we have evidence to support that OLS regression is inconsistent and inefficient, the 2SLS regression is consistent and efficient. The Hausman test results imply that we should use 2SLS regression rather than OLS regression for our data set.

Table 6. *Hausman Test Results*

H0: OLS estimates are consistent		
asymptotic test statistic	(Chi-square) (5)	p-value
	314.256	0.0000
Weak instrument test	Cragg-Donald minimum eigenvalue	
	0.0123527	

V. Conclusion

This study empirically analyzes the impact of producer services on China's economic growth from 1995 to 2021. The key findings based on ridge regression analysis demonstrate that China's producer service industry has a statistically significant and positive effect on economic growth.

A summary of the results of the empirical analysis is as follows. First of all, as a result of OLS regression, it was confirmed that all of China's producer service industry has a positive

effect on economic growth. The same conclusion was drawn from the results of ridge regression was used to solve the multicollinearity problem. However, the Granger causal test did not find any significant relationship between the added value of the producer service industry and GDP growth rate. It is necessary to control other potential factors to explain the change in GDP growth rate, as it suggests the possibility of reverse causality. This robustness test, confirms the influence of the Chinese producer service industry and strengthens the reliability of the results.

The coefficient of producer service value-added decreases after controlling for manufacturing, suggesting that producer services have a smaller independent effect on goods trade and producer services. This implies that producer services are more complementary than substitutable to manufacturing, and that their contribution to economic integration depends largely on the development of manufacturing. Finally, the Hausman test results are used to estimate the causal effect of producer services on China's economic growth.

Based on the results of our empirical analysis, we can draw some policy implications for promoting China's producer services industry and economic growth. We recommend that the Chinese government continue to support and encourage the development of producer services, especially wholesale and retail, transportation, warehousing and other sub-sectors and detailed industries that have a significant positive effect on economic growth. These detailed industries can improve the efficiency and competitiveness of other industries, create new markets and opportunities, promote innovation and transformation, and contribute to industrial upgrading and structural change. Furthermore, to fully realize the potential of producer services to promote economic integration, policymakers should consider implementing policies that support the development of this sector. For example, policies that promote investment in transportation and logistics infrastructure can enhance regional connectivity and reduce transaction costs. Policies that support the development of the financial and legal services industries can also promote cross-regional investment and trade. In addition, policies that encourage the development of producer services can support the upgrading of industrial improve the competitiveness of other industries.

Lastly, it is important to acknowledge the limitations of the present study. One such limitation pertains to the unavailability of data, which restricted the analysis of the influence of Chinese producer services on the regional economy of China. Additionally, the study's scope was confined to domestic research conducted within China, thus preventing a comparative analysis with studies conducted in other countries. To facilitate a comprehensive understanding of the subject matter, it is imperative to undertake a thorough comparative analysis in future research, encompassing studies conducted overseas. Furthermore, it is important to note that this study exclusively focused on select industries within the producer service sector, thereby reflecting the current developmental stage of China's producer service industry. However, it is worth considering that as the Chinese producer service industry advances, other industries may gain

significance, necessitating additional research to incorporate such sectors. Such an approach would contribute to a more comprehensive analysis. Future research should also consider incorporating regional GDP data to explore the correlation between the development of specific regional producer service industries and economic growth.

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