Print ISSN: 2288-4637 / Online ISSN 2288-4645
doi:10.13106/jafeb.2022.vol9.no3.0355

The Effect of Technical Innovation on Producer Services Industry Development in China: Evidence from Fujian Province*

Chang Sheng LIAO[1]

Received: November 30, 2021 Revised: February 08, 2022 Accepted: February 15, 2022

Abstract

The effect of technological innovation on the high-quality development of the producer services industry depends on whether or not technical innovation efficiency plays a key role. This study looks at the impact of technological innovation and financial technology (fintech) on the development of high-quality producer services in Fujian Province from 2010 to 2019. The efficiency of technological innovation is measured using Data Envelopment Analysis (DEA) and the Malmquist productivity index. The mean overall innovation efficiency score is 0.639, meaning that Fujian accounts for 36.1% of resource utilization inefficiencies and that there are significant differences in technological innovation efficiency between cities. The findings show that high-quality producer services industries benefited from innovation efficiency, but that the influence of technological innovation efficiency is insignificant. This demonstrates that financial innovation has not been able to completely enhance the development level of the producer services industry. This may be due to the unreasonable output structure of technological innovation and the low industrial transformation rate of technological achievements. This study advocates that the R&D fund allocation structure be optimized. That technological innovation can improve the high-quality development of the producer services industry is a consensus within the academic community.

Keywords: Producer Services Industry, Financial Innovation, Technical Innovation, Financial Technology, Fintech, Data Envelopment Analysis Model

JEL Classification Code: C44, O14, O32

1. Introduction

The Chinese economy has experienced rapid development and economic reform since 1979, and the paradox of industrial structure imbalance has become more apparent during the previous four decades. The disadvantages of the Chinese economy illustrate these problems, including winning using a quantity-over-quality strategy, cheap marketing, building an empire, and being too big to fail. This is an important issue faced in China's economic development. In 2014, annual reports issued by the Chinese government noted that the producer services industry was at the height of global industrial competition. However, the Chinese producer services industry has problems, such as underdevelopment, poor quality, unreasonable structure, and inappropriate resource allocation. One approach to solve these problems is to continue to enhance the strength and scientific quality of innovation and development. This is particularly important to the process of economic development in developed countries. Meliciani (2002) suggested that technological innovation can increase a country's export trade volume and promote economic growth.

Producer services are intermediate inputs to further production activities that are sold to other firms, although households are also important consumers in some cases. They typically have high information content and often reflect a "contracting out" of support services that could be provided in-house. The share of the economy occupied by the

***Acknowledgements:**
This study is supported by a grant from the Fujian Association for Science and Technology, China. Fujian Provincial Science and Technology Innovation Strategy Research Joint Project (No. 2020R0166).

[1]First Author and Corresponding Author. Associate Professor, School of Internet Economics and Business, Fujian University of Technology, Fujian, China [Postal Address: No.999, Dongsanhuan Road, Fuzhou City, Fujian Province, 350014, China]
E-mail: sheng2009tw@gmail.com

service industry generally tends to increase during periods of economic growth, and the importance of the producer services industry will continue to rise and occupy a dominant position in the service industry overall. There is a regular trend in the development of the producer services industry, moving from non-market-oriented to market-oriented. When the level of economic development is low, producer services are usually provided by enterprises themselves. In contrast, when the economy matures, industries that provide specialized services, such as financial accounting, marketing planning, transportation, and logistics, begin to emerge in the economic system. Service demanders can purchase the required services through the market, and they do not need to provide them themselves. This new-normal economy promotes the deep integration and development of the high-value-added service industry and the advanced manufacturing industry and has become an important breakthrough in promoting high-quality production and in the economic transformation of the service industry. Sassen (1991) indicated, in general, that producer services can provide service guarantees for manufacturing production and the upgrading of industrial structure. Lundquist et al. (2008) pointed out that the renewal and transformation of producer services take place later than in the manufacturing sector.

Schumpeter (1942) first pointed out that innovation theory starts from the perspective of the combination of technology and economy, and it emphasizes the important role of production technology innovation in the process of economic development. Numerous studies also suggest that research and development (R&D) investment has a significant impact on the output and efficiency of innovation activities. Sener and Saridogan (2011) explain that a technology-innovation-oriented global competitiveness strategy and the transmission mechanism of economic growth give countries more sustainable competitiveness and long-term growth potential than those without such a strategy. Ismanu et al. (2021) examine and analyze product innovation and process innovation as indicators that affect the performance of small and medium enterprises (SMEs). Thus, technology innovation plays a key role in economic growth and is even derived from different industries, such as the producer services industry. The main purpose of this paper is to expound on the role of technological innovation in the high-quality development of the producer services industry in China using panel data from nine prefecture-level cities in the Province of Fujian. This study analyses the direction and strength of the role of technological innovation in the structural upgrading of the producer services industry in Fujian from the micro-level.

In conclusion, this study offers three important contributions. First, previous studies focus on the inter-industry synergistic agglomeration effect and whether or not technological innovation is an internal motivator of industrial integration. Financial innovation plays a key role in economic growth and financial stability (Beck et al., 2016). However, the efficiency and productivity of financial innovation are difficult to measure accurately. This study uses data envelopment analysis (DEA) and the Malmquist productivity index to measure the efficiency of technological innovation in Fujian Province, China. Second, in accounting for both traditional R&D and financial technology (fintech) output while evaluating and analyzing the bank productivity change index, I assume that fintech outputs can be captured using the proxy of financial profitability efficiency. This approach compares results from perspectives that do or do not consider financial innovation output within the classical DEA analysis. Third, the fast growth and recovery in the last two decades have given China a key role in the world economy, and Fujian Province is a key example of China's producer services industry. Few studies have examined the impact of the producer services industry in Fujian. Thus, this study explores this issue.

2. Data and Methodology

2.1. Measuring the Efficiency of Technological Innovation

In this study, a non-parametric analytic technique is used to measure the efficiency of the producer services industry. Numerous studies, such as Naser and Afzal (2014), Naushad et al. (2020), and Liao (2020), adopt the DEA model to capture various industries' efficiency. Specifically, this study adopts Malmquist productivity change analysis, which is a non-static model that uses linear programming. Malmquist productivity change analysis is derived from DEA. Charnes et al. (1978) describe DEA as a non-parametric approach that uses a linear programming technique to construct an envelope for the observed input-output combinations of all market participants under the constraint that all best-practice decision-making units (DMU) support the envelope, whereas all inefficient firms are kept off the frontier.[1]

Banker et al. (1984) use Shephard's distance function to make assumptions about the production possibility set and to derive the same model as CCR (Charnes et al., 1978). Thus, pure technical efficiency and scale efficiency are derived by relaxing the constraints on the possible set of production. The BCC model (Banker et al., 1984) changes constant returns to scale to variable returns to scale to calculate the DMU efficiency score, the product of the pure efficiency value, and the scale efficiency value is the technical efficiency value of the BCC model. The variable return to scale input-oriented model is as follows:

$$\text{Min}_{h_k} = \theta_k - \varepsilon\left[\sum_{i=1}^{m} S_{jk}^{-} + \sum_{r=1}^{s} S_{rk}^{+}\right]$$

$$\begin{aligned} s.t. \sum_{k=1}^{n}\lambda_k x_{jk} - \theta x_{jk} + S_{jk}^{-} &= 0 \\ \sum_{k=1}^{n}\lambda_k y_{rk} - S_{rk}^{+} &= y_{rk} \\ \sum_{k=1}^{n}\lambda_k &= 1 \\ \lambda_k,\ S_{jk}^{-},\ S_{rk}^{+} \geq 0; r &= 1,\ 2,\ \ldots, s \\ j = 1,\ 2,\ \ldots, m \quad k &= 1,\ 2,\ \ldots, n \end{aligned} \tag{1}$$

Where S_{jk}^{-} and S_{rk}^{+} are the amount of the j^{th} input consumed and amount of the r^{th} output generated by the k^{th} DMU, respectively. The variable θ_k indicates that I must solve this linear program to obtain the efficiency results from the optimum value for each DMU. The value θ_k represents the overall technological efficiency for each DMU.

The variable Φ indicates solving this linear programming to obtain the efficiency results from the optimum value for each non-life insurers.

Assume that returns to scale may be increasing or decreasing and that the inefficiency of the overall efficiency may partly come from the improper scale of operation. I must distinguish efficiency value under variable returns to scale to calculate pure technical efficiency. The relatively low input in other DMUs allows us to use resources efficiently, so the cause of inefficiency is managers' inappropriate decisions.

DEA is a static analysis, while the Malmquist productivity change index compares the relative efficiency of the rated units in different periods, making it a dynamic analysis that is used to understand the change in the observed value. The Malmquist index assumes that the production function is a distance function that expresses changes in total factor productivity between two periods. Inter-period changes in productivity may result from changes in production technology or changes in technical efficiency. Following Isik and Hassan (2003), and using Farrell's distance function and Fare et al.'s (1994) definition of productivity, the measurement of productivity change is based on a definition of a distance function. It assumes constant returns to scale, and the total factor productivity change (TFPCH) index can be decomposed into efficiency change (EFFCH) and technical change (TECHCH), such that TFPCH is equal to EFFCH × TECHCH. Under the assumption of variable returns to scale, efficiency change can be decomposed into pure technical efficiency change (PECH) and scale efficiency change (SECH). This assumes that the panel data can be described by period t and DMU i, as follows:

Output: $y_{nt} = (y_{1nt}, y_{2nt}, \ldots, y_{Mnt})$, $n = 1, 2, \ldots, N$.

Input: $x_{nt} = (x_{1nt}, x_{2nt}, \ldots, x_{Knt})$, $n = 1, 2, \ldots, T$.

This represents DMU i, an output-based Malmquist productivity change index as below:

$$M_0(y_{is}, x_{is}, y_{it}, x_{it}) = \left(\frac{D_{OC}^{S}(y_{it}, x_{it})}{D_{OC}^{S}(y_{is}, x_{is})} \times \frac{D_{OC}^{t}(y_{it}, x_{it})}{D_{OC}^{t}(y_{is}, x_{is})}\right)^{\frac{1}{2}} \tag{2}$$

Where $D_{OC}^{S}(y_{it}, x_{it})$ and $D_{OC}^{S}(y_{is}, x_{is})$ are the distance functions of the same period, and $D_{OC}^{t}(y_{it}, x_{it})$ and $D_{OC}^{t}(y_{is}, x_{is})$ are the intertemporal distance functions.

The scale and volume of each city are different before measuring the Malmquist productivity of regional technological innovation. This paper first standardizes the original data, which is calculated as follows:

$$x_{ij}^{x} = 0.1 + \frac{x_{ij} - \min(x_j)}{\max(x_j) - \min(x_j)} \times 0.9 \tag{3}$$

Where i indicates the city of the R&D input-output variables, and max (x_j) and (x_j) are the j^{th} input-output variables' maximum and minimum.

The input-output specification of the present study is based on Zhang et al. (2003), Chen et al. (2011), and Naser and Afzal (2014). The input variable is generally represented by R&D professional staff and R&D internal expenditures, and the output variable is coded as the number of patent applications. Few studies have measured the effects of financial innovation business on producer services industry production value. In exploring the effect of financial innovation on regional productivity change, this study understands financial innovation as the use of financial profitability efficiency. Naser and Afzal (2014) used domestic credit provided by the banking sector divided by GDP as a proxy for financial innovation input to measure national innovation efficiency. The added value of the financial industry contains much information about the business of various sectors of the financial industry, which can better represent the financial innovation capability and level of a city (Jiang & Jiang, 2013). This study uses the logarithm of the added value of loan businesses in the financial industry to measure financial innovation indicators in various cities in Fujian Province.

2.2. Regression Design

I test whether technological innovation and financial innovation affect the development of the producer services industry. Following other studies, such as Naser and Afzal (2014), the present research establishes a regression equation to further investigate the determinants of the producer services industry's level of development. According to industry characteristics and official definition, and taking into account the availability of data, this study defines the producer services industry as including the following six sectors: wholesale and retail, information management and calculator services, finance, leasing and business services, scientific research and technical services, and transportation.

Following the literature, this study uses the logarithm of the production value of the service sector as a proxy for the level of development of the producer services industry. It is expressed in real terms and deflated by the consumer price index, indexed to 2010 in Fujian Province (2010 = 100). Thus, I construct the regression model as follows:

$$\text{LNPSD}_{it} = f(\text{TE}_{it}, \text{SE}_{it}, \text{TEF}_{it}, \text{SEF}_{it}, \sum_{h=1}^{3} X_{h,it} \quad (4)$$

Where LNPSD indicates the producer services industry's level of development, TE indicates technological innovation efficiency, SE represents innovation scale efficiency, FTE indicates technological innovation efficiency with the effect of financial innovation, FSE represents innovation scale efficiency the with the effect of financial innovation, and X_{it} stands for the control variables, including the indicators for science and education input (SSE), degree of industrialization (INDL), and industrial upgrading (INDUP).

Direct investment in education, according to Bloom et al. (2004), can greatly raise overall education levels, promote labor productivity, and increase human capital accumulation to stimulate long-term economic growth. According to Jorgenson et al. (2003), increased investment in information technology and higher education has been the primary driver of US economic development. As a result, the purpose of this research is to see if adding science and education to the producer services business improves product value. The logarithm of education and science technology spending is how I measure this. I adopt a one-period lag for education and science technology expenditures because science and education investments require time to influence the growth of producer services. The ratio of secondary industry product value to the GDP of the region measures the level of industrialization. Service-oriented economic growth is inevitable after large-scale industrialization, and the high-quality service industry determines the ability to improve efficiency in the conversion process. Will the higher level of industrialization have a positive impact on the producer services industry or not? This question deserves further discussion.

Finally, this study also considers the effect of industrial upgrading on the development of the producer services industry. I assign a value to the added value of the primary, secondary, and tertiary industries, selecting the industrial structure coefficient as an indicator to measure the degree of industrial upgrading as follows:

$$\text{INDUP} = \sum_{i=1}^{3}(I_v.v) = I_1 \times 1 + I_2 \times 2 + I_3 \times 3 \quad (5)$$

Where I_v indicates the v^{th} industry's added value divided by total GDP, and v is a value from 1 to 3, such that lower values represent lower levels of industrial structure growth.

This study uses balanced panel data collected for nine prefecture-level cities in Fujian Province. The China Statistical Yearbook, the China Urban Statistical Yearbook, the Fujian Statistical Yearbook, and the Yearbook in Fujian were the primary data sources for this study. To estimate and replace missing data for a few cities, this study employs the moving average method and mean value interpolation. Table 1 shows descriptive statistics for the output and input variables.

3. Empirical Results

3.1. Results of the DEA Efficiencies

The results of assessing technological innovation efficiency in Fujian Province using a DEA model are presented in this section (Table 2). From 2010 to 2019, the average total innovation efficiency score was 0.639. This means that 36.1 percent of resource utilization inefficiencies occur in Fujian, and that technological innovation efficiency varies greatly amongst cities. Clearly, there are serious allocative inefficiencies in the input-output combinations among cities in Fujian. The result for each year demonstrates a W-shaped trend in innovation efficiency. In particular, the efficiency of technological innovation peaked in 2011 and 2014, then fell slightly before rising to the apex in 2019. According to Sun and Wang (2020), the mean innovation efficiency in Chinese regions with high R&D efficiency is 0.445. In conclusion, Fujian Province has the second-highest technological innovation efficiency in the country; yet, approximately 40% of city R&D inputs are wasted when assuming the same output between samples, indicating a significant disparity in the use of R&D resources among cities.

Furthermore, the fundamental causes of technical inefficiency are investigated in this study. Because mean

Table 1: Descriptive Statistics for the Variables Employed in this Study

Variables	Variable Meaning	Average	Std. Dev.
LNPSD	Producer services industry, level of development	4.675	0.976
TE	Technological innovation efficiency	0.639	0.2737
SE	Innovation scale efficiency	0.8667	0.1405
FTE	Technological innovation efficiency with the effect of financial innovation	0.6953	0.106
FSE	Scale efficiency innovation with the effect of financial innovation	0.8462	0.085
SSE	Science and education input	0.2273	0.042
INDL	Degree of industrialisation	0.4981	0.0596
INDUP	Industrial upgrading indicators	2.399	0.333

Table 2: Technological Innovation Efficiency

	OTE	PTE	SE
2010	0.570	0.706	0.801
2011	0.720	0.848	0.842
2012	0.606	0.722	0.836
2013	0.655	0.768	0.856
2014	0.725	0.794	0.915
2015	0.606	0.689	0.877
2016	0.592	0.669	0.884
2017	0.602	0.688	0.873
2018	0.576	0.706	0.822
2019	0.739	0.756	0.961
Mean	0.639	0.735	0.867

Note: OTE: Overall technological efficiency; PTE: Pure technological efficiency; SE: scale efficiency. The “mean” is the average for the entire sample over the period 2010 to 2019.

Table 3: Technological Innovation Efficiency with Financial Innovation

	OTE	PTE	SE
2010	0.577	0.733	0.755
2011	0.526	0.742	0.686
2012	0.857	0.893	0.957
2013	0.68	0.797	0.859
2014	0.769	0.868	0.892
2015	0.603	0.743	0.812
2016	0.706	0.819	0.868
2017	0.803	0.856	0.942
2018	0.77	0.86	0.9
2019	0.662	0.849	0.791
Mean	0.6953	0.816	0.8462

Note: OTE: Overall technological efficiency; PTE: Pure technological efficiency; SE: scale efficiency. The “mean” is the average for the entire sample over the period 2010 to 2019.

scale efficiency (0.867) is higher than pure technological efficiency (0.735), pure technological inefficiency is a primary driver of innovation inefficiency. This suggests that the inefficiency of Fujian Province’s innovation can be attributed to the underutilization of inputs or incorrect input combination selection.

The outcomes for each city’s[2] technological innovation efficiency. They demonstrate that Quangzhou, Putian, and Ningde are the best-ranked cities in Fujian Province. This shows that Quanzhou is rated first because a big number of patent applications means that the manufacturing and service industries in Fujian Province have more product value and are of higher quality. The lowest innovation efficiency value is found in Xiamen, with a mean technical innovation efficiency score of 0.224. One probable explanation is that Xiamen City has made huge investments in terms of supporting scholars and providing research funds, however, there are only 15,271 patent applications. This is significantly less than the 49,492 and 29,035, respectively, of patent applications filed in Quanzhou and Fuzhou. The amount submitted in Xiamen City is only marginally more than the 13,982 in Zhangzhou. The number of professional employees and capital investments, on the other hand, are more than double those of Zhangzhou. This finding is in line with the findings, which suggest that a poor allocation of resources for R&D and inefficient innovation are the primary causes of resource waste. To summarise, the efficiency of technological innovation in Fujian Province is dependent on the increase of scale to realize efficiency gains.

The findings of innovation efficiency values evaluated with and without financial innovation outputs are compared in this study. According to the findings, the OTE, PTE, and SE values are 0.6953, 0.8161, and 0.8433, respectively, which is consistent with Chen et al. (2011). The results demonstrate that the estimated innovation efficiency value with financial innovation outputs was somewhat greater than the value without. Although the results were the same, the overall technical efficiency and pure technical efficiency were very different. This shows that the level of financial innovation has a significant and positive impact on the efficiency of innovation.

3.2. Results of Productivity Change

The Malmquist total factor productivity index is used in this section to calculate total factor productivity changes for nine prefecture-level cities in Fujian Province from 2010 to 2019. I measure the TFPCH index, efficiency change, and technical change under the assumption of constant returns to scale. Table 4 shows Malmquist indices from 2010 to 2019 along with a brief model explanation of the means.

These results show that the mean values of EFFCH, PECH, and SECH are all greater than one, showing that innovative activities have positive scale efficiency growth and advancement, as well as the ability to manage their own resources. TFPCH and TECHCH have mean values less than one, indicating that they have technological issues. We can track efficiency changes over time using the Malmquist index method. As indicated in Table 5, the TFPCH mean is less than one (0.930), showing that innovation productivity has scarcely improved. TFPCH reached its lowest point in 2011–2012 when it was only 0.372. In Fujian Province, the shift in TFPCH is erratic.

This study shows that as the value of innovation efficiency falls, organizations try to improve it by increasing productivity. In addition, I investigated the increased productivity factor structure. Over this time span, the mean of TECHCH is 0.899, showing a 1.01 percent average technological regression. The catch-up effect (EFFCH) and the frontier-shift effect are deconstructed in this paper (TECHCH). The observed decline in output was primarily attributable to the frontier-shift effect rather than the catch-up impact, indicating that Fujian Province experienced slow and stagnant innovation during our research period and that the change in production is primarily due to technological factors.

One probable explanation for this outcome is that innovation involves a lot of money and a lot of risks, as well as a lot of help from the government, the financial industry, and commercial and intermediate services. In comparison to other locations on China's eastern coast, Fujian Province's resources are limited, and there is insufficient money to support institutions and businesses' innovation efforts. This shows that technology-based SMEs excel at invention and production but struggle with finance and have significant long-term costs. As a result, private businesses are having a tough time obtaining finance for innovation. Finally, this tendency is causing Fujian Province's technical advancement to stagnate. The fact that the mean value of SECH is more than one (1.027) is further proof of this, showing that the city innovation activities scale has gradually approached its optimal size.

The Malmquist indices for each city are shown below, and the mean TFPCH for eight cities[3] is less than one. This reveals that, except for Sanming, whose productivity remained

Table 4: Total Factor Productivity Changes without Financial Innovation

	EFFCH	TECHCH	PECH	SECH	TFPCH
2010–2011	1.357	0.853	1.110	1.222	1.157
2011–2012	0.771	0.483	0.881	0.875	0.372
2012–2013	1.140	1.159	1.087	1.049	1.322
2013–2014	1.117	0.956	1.065	1.049	1.068
2014–2015	0.791	1.102	0.813	0.973	0.872
2015–2016	0.967	0.919	0.953	1.015	0.889
2016–2017	1.047	1.033	1.063	0.984	1.081
2017–2018	0.947	0.974	0.969	0.977	0.922
2018–2019	1.341	0.825	1.181	1.136	1.106
Mean	1.034	0.899	1.007	1.027	0.930

Note: The "mean" is the average for the entire sample over the period 2010 to 2019. TFPCH: the total factor productivity index; EFFCH: the catch-up indicates the insurer's efficiency change, Frontier-shift indicates the technology change; THCHCH, and PECH: pure technical efficiency changes; and SECH: the scale efficiency change.

Table 5: Total Factor Productivity Changes with Financial Innovation

	EFFCH	TECHCH	PECH	SECH	TFPCH
2010–2011	0.898	0.804	0.978	0.917	0.722
2011–2012	1.851	0.525	1.282	1.444	0.972
2012–2013	0.757	1.095	0.861	0.879	0.829
2013–2014	1.167	0.823	1.113	1.049	0.961
2014–2015	0.747	1.545	0.825	0.906	1.155
2015–2016	1.214	0.811	1.124	1.080	0.984
2016–2017	1.187	0.788	1.097	1.082	0.935
2017–2018	0.961	0.879	1.001	0.960	0.845
2018–2019	0.840	1.141	0.980	0.857	0.959
Mean	1.027	0.897	1.020	1.007	0.922

TFPCH: the total factor productivity index; EFFCH: the catch-up indicates the insurer's efficiency change, Frontier-shift indicates the technology change; THCHCH, and PECH: pure technical efficiency changes; and SECH: the scale efficiency change.

steady, other cities' production decreased. Furthermore, the disparity in technological innovation efficiency narrowed with time. This supports the conclusion reached for the time-varying sample. The reduction in productivity is primarily attributable to a lack of innovation (TECHCH), rather than efficiency gains (EFFCH).

The results of productivity change estimates with and without financial innovation are also compared in this study. Table 5 shows that the TPFCH with financial innovation has a mean of less than one and is almost unaltered when compared to the model without financial innovation. As a result, the impact of financial innovation on productivity in Fujian is insignificant. One possible explanation is that fintech spillovers have a dynamic effect that benefits "static" innovation efficiency but does not improve processing, resulting in productivity changes.

3.3. The Determinants of the Producer Services Industry

This section summarises the findings of the factors that influence the level of development of the producer services business. I investigate whether the efficiency of innovation and financial innovation have an impact on the product values in this industry. According to the findings of a Hausman test, a random-effects model is better for Panel A, whereas a fixed-effects model is better for Panel B[4]

As demonstrated in Table 6, the TE coefficient is negative and significant, meaning that technical innovation efficiency does not boost producer services industry growth. In all columns, the coefficient on SE is positive and significant, showing that improving innovation scale efficiency can boost product values in the producer services industry. The disparities in R&D investments among Fujian cities could be one cause for this result. The local government is the primary source of R&D financing. Because of the large urban-rural divide, the majority of money is concentrated in Fuzhou, Quangzhou, and Xiamen. The findings reveal that R&D funds and resources have been inefficiently distributed, with resources concentrated in a few towns with substantial economic and commercial operations. Xiamen, for example, has an annual average of 9,173.22 million RMB in internal R&D funds, whereas Nanping City, which has the lowest R&D spending, has only 1,274.96 million. In addition, Zhangzhou, which is in the middle, only has 3,361.21 million RMB in investments. The amount of money spent on research and development differs significantly between cities. As a result, innovation scale efficiency has a positive impact on the high-quality development of the producer services industry, and the government might boost innovation efficiency by increasing R&D inputs. Managerial inefficiency in the use of resources, on the other hand, stifles the growth of the producer services industry.

The FTE and FSE coefficients are both positive and nonsignificant, showing that financial innovation has not been effective in advancing the producer services industry's development. This could be related to technological innovation's irrational output structure and poor rate of industrial transformation of technological advances. It also demonstrates how the separation of the R&D and business application markets makes innovation be translated into products that boost productivity.

The SSE coefficient indicates that there is a negative and significant relationship between science and education expenditures and producer services industry development. Increased education spending, in general, helps R&D activity

Table 6: The Determinants of Producer Services Industry Development

	Panel A		Panel B		VIF
	FE	RE	FE	RE	
TE	−0.889 (−3.858)***	−0.278 (−0.825)	−1.101 (−3.625)***	−0.399 (6.617)***	2.436
SE	2.887 (7,34)***	1.022 (1.964)*	2.578 (5.974)***	−0.399 (−1.049)	1.454
FTE			0.482 (1.29)	0.019 (0.058)	2.953
FSE			0.463 (1.027)	−0.264 (−0.66)	2.271
SSE	−5.314 (−2.72)***	−8,152 (−4.82)***	−5.849 (−2.94)***	−7.859 (−4.609)***	1.785
INDL	4.762 (4.024)***	−4.834 (−2.722)***	4.499 (3.74)***	−4.323 (−2.506)**	1.825
INDUP	0.635 (8.914)***	0.479 (10.94)***	0.599 (7.65)***	0.485 (11.104)***	1.059
R^2	0.5143	0.7169	0.6409	0.7063	
Hausman Test					
Chi-χ^2	5.626 (0.3443)		15.016 (0.0358)		

Notes: FE: fixed-effects model; RE: random-effects model. **p*-value < 1, significant at the 10% level. ***p*-value < 0.05, significant at the 5% level; ****p*-value < 0.001, significant at the 1% level.

at universities, commercial businesses, and fundamental research organizations, as well as builds knowledge stock. The objective of industrial upgrading is finally attained thanks to the intermediary role of technical innovation. This could be due to the concentration of education spending in government agencies, state-owned universities, and state-owned businesses. Furthermore, it implies that research institute R&D outcomes cannot be related to company market activity. As a result, academics and practitioners should pay closer attention to how funds (resources) for science and education are allocated.

In fixed-effect models, the coefficient of INDL is positive and significant, but in random-effects models, it is negative and significant. These findings are contradictory, indicating that the impact of industrialization on the development of the producer services industry remains a mystery. The INDUP coefficient, on the other hand, is positive and significant, indicating that industrial upgrading improves the producer services industry. At present, GDP in Fujian is dominated by manufacturing; the average of the manufacturing and service industries was 139.39 billion and 118.23 billion RMB, respectively, from 2010 to 2019. Manufacturing earns profits mainly through machining and assembly processes, but profit margins are lower at this stage. This suggests that the degree of industrialization is a negative influence, but industry upgrading benefits the development of the producer services industry. It does so by fostering the growth of the high-value-added producer services industry because Fujian is still dominated by manufacturing. Traditional manufacturing industries or low-end service sectors attract workers. To drive the high-quality development of the producer services industry, this study advises that the flow of labor to high-end service sectors or producer services be increased.

4. Conclusion

This paper presents an interesting case study of the producer services industry and a basic problem concerning financial innovation output. It adds to the literature on the level of development of the producer services industry by incorporating financial innovation output as a measure of efficiency rather than omitting it in DEA and the Malmquist model. Fintech innovation has the potential to pursue high profits in high-tech businesses or businesses with high added value in the real economy. It will attract additional financial resources for investment, as well as create a large amount of room for fintech innovation.

This shows that in the producer services business, innovation scale efficiency has a positive impact on high-quality development, and the government can increase their innovation efficiency by increasing R&D investments. Managerial inefficiency, on the other hand, stifles the growth of the producer services business. This is evidenced by the fact that the estimated innovation efficiency value with financial innovation outputs was somewhat greater than the value without. It appears that the amount of financial innovation has a positive and considerable impact on the efficiency of innovation.

TFPCH has a mean value of less than one (0.930), showing that innovation productivity has scarcely improved. The mean value of TECHCH throughout this time period is 0.899, indicating that the average technological regress is 1.01 percent. This study divides productivity into two categories: catch-up and frontier-shift effects, with the frontier-shift effect accounting for the majority of the drop in output. Furthermore, the level of R&D investment varies significantly between cities. As a result, innovation scale efficiency has a positive impact on the high-quality development of the producer services industry. The government can increase its innovation efficiency by increasing R&D inputs. The development of the producer services industry, on the other hand, is hampered by resource management inefficiencies. This data shows that financial innovation has not fully improved the producer services industry's development level. This could be attributed to technological innovation's irrational output structure, as well as the poor rate of industrial transformation of technological advances.

Based on the empirical results and the regional status of Fujian, this study provides policy recommendations for attaining high-quality development of the producer services industry. First and foremost, I believe that the R&D fund allocation structure should be optimized. The academic community agrees that technological innovation can enhance the high-quality development of the producer services industry. This conversion process may have negative consequences, but they can be mitigated by improving the efficiency of capital allocation and the industrial conversion rate. Second, I advocate for the establishment of a market-driven, modern industry-university R&D framework. When the market fails, the government just helps to alter the market system. Finally, more efficient allocation of scientific and education expenditures, as well as increased investment in infrastructure and public services, would be beneficial.

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Endnotes

[1]See Liao (2020) for more details.

[2]Briefly, I do not show the estimated table in this study, but data available on request from the authors.

[3]Briefly, I do not show the estimated table in this study, but data available on request from the authors.

[4]The variance inflation factor (VIF) was implemented to test whether or not there is significant collinearity. As can be seen in Table 8, the VIF was less than ten for all variables, which implies that collinearity problems do not exist.