Hindawi
Discrete Dynamics in Nature and Society
Volume 2022, Article ID 4817109, 8 pages
https://doi.org/10.1155/2022/4817109

Research Article

Modelling the Impacts of Government Subsidies on Total Factor Productivity: An Empirical Study

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Received 2 November 2021; Accepted 3 February 2022; Published 24 February 2022

Academic Editor: Daqing Gong

Marine industry continues to grow rapidly in China, while the contribution of the total factor productivity (TFP) to its gross output still remains very limited. Facing this issue, it is urgent to promote TFP by innovation, and Chinese government provides persistent subsidies to stimulate the innovation of relative enterprises. Taking listed companies of marine industry in Shanghai and Shenzhen Stock Markets (2007–2019) as samples, this study performed empirical tests by multiple regressions to check the effects of such subsidies on the TFP of Chinese marine industry. It was observed that, as a whole, government subsidies present positive effects on the TFP of associated companies, and subsidies beforehand yield higher promotion than subsidies afterwards. The subsidies work mainly via easing financing constraints and encouraging R&D investment of relative firms. Our results are highlighted by revealing the differential effects of government subsidies on the TFP of Chinese marine industry and their functional mechanism. It implies that, besides government subsidies, the optimization of financial market may also be helpful in promoting TFP by innovation.

1. Introduction

Until 2020, Chinese marine industry had continued to grow rapidly for decades. Its gross output reached a temporal peak as 8941.5 billion yuan in 2019, which accounts for 9% of the national gross domestic product (GDP) and 17% of the coastal provinces' GDP. Marine economy is playing a more and more important role in China's development strategy. However, judging from the efficiency, the growth still remains at an extensive level and mainly driven by the input of essential factors. Ren et al. [1] calculated the contribution rate of the total factor productivity (TFP) to the gross ocean product (GOP) in eleven Chinese coastal provinces, wherein the averaged growth rate was determined to fluctuate annually between −4.60% and 5.28% during 2006–2014. Such rates are far below the contemporaneous growth rates of marine industry. The promotion of marine industry's TFP is thus in an urgent need [2].

To promote the marine industry's TFP, it is necessary to find out the root of the problem. Table 1 lists the brief category and output of marine industry by Chinese government. Therein, it is observed that the marine industry is not an independent industry. Its categories represent more of the eggs of other industries divided into the basket of marine industry. Relative source industries include agriculture (e.g., fishing and aquaculture), traditional manufacturing (e.g., ship, energy, and chemical engineering), and service (e.g., transportation, tourism). Most of them were characterized by traditional industries, while emerging industries (e.g., biomedicine) only account for a small proportion. This indicates that, besides efforts to optimize the efficiency of resource allocation, more attention should be turned to the progressive regulation of marine industry's structure. Innovation is just the key driven force of the latter, as well as the promotion of TFP.

Promoting TFP by innovation is critical to the sustainable development of economy, which is vital to the survival of firms [3]. However, as a quasi-public product, innovation was born with strong spillover effects that could cause market failure. Under such conditions, it is necessary

Table 1: Category and output of Chinese marine industry in 2019.

Category	Output (billion yuan)	Growth rate (%)
Gross ocean output	8941.5	6.2
Marine industry	5731.5	7.8
Major marine industry	3572.4	7.5
Marine fishing	471.5	4.4
Marine oil and gas	154.1	4.7
Marine mining	19.4	3.1
Marine salt industry	3.1	0.2
Marine chemical engineering	115.7	7.3
Marine biomedicine	44.3	8.0
Marine electric power	19.9	7.2
Seawater utilization	1.8	7.4
Marine ship industry	118.2	11.3
Marine construction	173.2	4.5
Marine transportation	642.7	5.8
Coastal tourism	1808.6	9.3
Marine research, education, management, and service	2159.1	8.3
Marine related industry	3210.0	-

Note. According to Annual Report of Marine Economy.

for the government to provide fiscal stimulus, either tax incentives or direct subsidies. Herein, we focus on the impact of government subsidies on innovation and TFP of Chinese marine industry. Concerning relative issues, different researchers propose controversial opinions. Some of them [4–6] interpreted that government subsidies would promote TFP efficiently because the subsidies could ease the financial constraints faced by firms in innovation and bring crowding-in effects. Firms were then encouraged to increase their R&D expenditure, which finally resulted in the promotion of TFP. For example, Cin et al. [6] found that, for certain small business or firms with lower technical level, they would not carry out R&D unless they get subsidies. On the contrary, other researches [7, 8] argued that government subsidies were insignificant or even negative to the TFP, since the subsidies would reduce the efficiency of resource allocation in some other way. Howell [8] reported that, in order to get special government subsidies, certain firms would spend extra R&D expenditure on projects nonassociated with their core competiveness. This finally led to the misallocation of resources and caused the reduction of TFP.

Despite all this, governments all over the world still persist in providing subsidies to domestic firms. According to the classified data, Chinese government subsidies to listed companies of marine industry had risen from 0.685 billion yuan to 5.388 billion yuan during 2007–2019. Whether these subsidies are effective remains a puzzle. This study tries to evaluate the effects from a fundamental aspect, that is, the latent correlation between subsidies and TFP of marine enterprises.

2. Literature Review and Hypothesis Development

For companies, most government subsidies are aimed to encourage them to engage R&D with strong externalities. Such subsidies could make up the extra-cost expended by companies or the insufficient benefit earned by companies. This is very important to the corporation innovation. On one hand, as firms were engaged in innovation, they would face a series of problems, such as the risk of failure, financing constraints, and opportunity costs. All these may result in much higher private cost as compared to the social cost. On the other hand, even if firms succeeded in innovation, it is also unlikely for them to monopolize the benefit due to the spillover of innovation. This even could result in the fact that the private benefits of firms earned from innovation are much lower than that of society. Innovation eventually became a net loss to firms instead of profits.

Previous researches have proven that, in most cases, government subsidies can effectively stimulate corporation innovation [9–11]. The stimulation works mainly through easing the financing constraints encountered by firms during innovation. First, government subsidies provide the direct injection of capital to firms, which could reduce the pressure of firms' cash flow and make up the cost gap of corporation innovation to a certain degree. Secondly, the grantee of government subsidies will release positive signals to corporation innovation, suggesting the activity achieving the official endorsement. It alternatively helps firms obtain external financing more easily [12, 13]. As reported by Gonz´alez and Paz´o [14], the R&D investment of firms with government subsidies is 0.35% higher than that of firms without government subsidies. Thirdly, government subsidies act as both incentives and pressures. Once marine firms could not accomplish the target set by government subsidies, they may not get further financial supports. For the sake of this, marine firms will be simulated or obliged to increase their R&D investment.

On the other hand, it has been generally recognized that R&D activities could remarkably promote TFP [15–19]. As found by Bond and Guceri [15], on average, the TFP of firms with a lot of R&D departments is 14% higher than that of firms with few R&D departments. This rule is no exception for Chinese marine industry whose growth still remains at an extensive level. Therefore, we bring out the first hypothesis as follows.

Hypothesis 1. Government subsidies can promote the marine enterprises' TFP of China.

However, the efficiency of government subsidies to TFP may be negative in certain cases, since the government and the firms likely have different preferences. From the aspect of government, the politic man and economic man attributes of officials (especially local officials) would drive them to pursue either the rapid growth of economy in a short time or private economic benefits, despite of the growth of TFP [20]. From the aspect of firms, government subsidies might distort their behavior and induce them to perform R&D deviated from their core competiveness. The TFP was then inhibited due to the misallocation of resources [6]. The following hypothesis was thereby brought out.

Hypothesis 2. Government subsidies can inhibit the marine enterprises' TFP of China.

According to the differences in distribution time, government subsidies are generally classified as beforehand subsidies and afterward subsidies. The former is granted before firms' R&D, which could reduce the financing pressure of firms and increase their cash flow. Such benefits are very important to the conduction of risky R&D. However, as compared to afterward subsidies, beforehand subsidies are more likely to trigger rent seeking and subsidy cheating. Hence, two competitive hypotheses were brought out.

Hypothesis 3. Beforehand subsidies promote the marine enterprises' TFP of China.

Hypothesis 4. Beforehand subsidies inhibit the marine enterprises' TFP of China.

Afterward subsidies are granted to firms as they finished R&D or accomplished preset targets. To obtain such subsidies, firms need to face the risk and invest hugely in R&D for patents, new techniques, or new products. In other words, afterward subsidies can be regarded as awards to firms. As compared to beforehand subsidies, afterward subsidies have advantages to inhibit the activities of rent seeking and subsidy cheating, while they cannot yield help to the long-term R&D activities. Hence, we also brought out two competitive hypotheses.

Hypothesis 5. Afterward subsidies can promote the marine enterprises' TFP of China.

Hypothesis 6. Afterward subsidies can inhibit the marine enterprises' TFP of China.

3. Research Methodology

3.1. Sample and Data. According to the classification standard of GB/T 20794–2006, Chinese marine economy is divided into two major categories of marine industry and marine-related industry. They were further divided into different subcategories as shown in Table 1. The listed companies in Shanghai and Shenzhen Stock Markets involved in the above categories were selected as potential samples. They were further verified one by one to ensure their main business scope. We also removed samples with incomplete metrics and data. Eventually, 508 samples of 67 related companies' panel data were obtained from 2007 to 2019. All essential data were derived from the CSMAR dataset.

3.2. Measures

3.2.1. Estimation of TFP. The traditional estimation of TFP was based on the Cobb-Douglas production function and calculated as follows:

$$\ln Y_{it} = \beta_0 + \beta_l \ln L_{it} + \beta_k \ln K_{it} + \beta_a a_{it} + \omega_{it} + \eta_{it}, \quad (1)$$

where Y_{it}, L_{it}, and K_{it}, respectively, denote the output, the labor input, and the capital input of i company during t time, a_{it} is the age of a given firm, ω_{it} is a state variable for productivity impacts that could be only observed by firm managers, and η_{it} represents random interferences. In addition, K_{it} and a_{it} obey the following two equations:

$$\begin{aligned} K_{i,t+1} &= (1-\delta)K_{it} + I_{it}, \\ a_{i,t+1} &= a_{it} + 1. \end{aligned} \quad (2)$$

In equation (2), I_{it} denotes the investment in fixed assets, which is the function of productivity, age, and capital stock as

$$I_{it} = I_{it}^{-1}(\omega_{it}, a_{it}, K_{it}). \quad (3)$$

From the above equations, it could be inferred that, due to the presence of simultaneity bias and selectivity-attrition bias, the traditional estimation of TFP would lead to biased and inconsistent results. Two endogenous problems were encountered during the estimation. One is the simultaneity problem, resulting from the fact that, as compared to outsiders, firm managers know more information about productivity and then adjust the amount of factor input correspondingly. The other is the entry-exit problem of firms, resulting from the fact that elder firms generally have stronger ability to anti-risk and large probability to survive. To solve such problems, Olley and Pakes [21] proposed a semiparametric estimator method (simplified as OP method). The first step is the estimation of β_l. According to equation (3), ω_{it} can be inverted to the function of I_{it}, a_{it}, and K_{it}; that is,

$$\omega_{it} = I_{it}^{-1}(I_{it}, a_{it}, K_{it}) = h(I_{it}, a_{it}, K_{it}). \quad (4)$$

Then, equation (1) could be expressed as

$$\begin{aligned} \ln Y_{it} = \beta_0 + \beta_l \ln L_{it} + \beta_k \ln K_{it} + \beta_a a_{it} \\ + h(I_{it}, a_{it}, K_{it}) + \eta_{it}. \end{aligned} \quad (5)$$

Define

$$\phi(I_{it}, a_{it}, K_{it}) = \beta_0 + \beta_k \ln K_{it} + \beta_a a_{it} + h(I_{it}, a_{it}, K_{it}). \quad (6)$$

Equation (5) can be further simplified as

$$\ln Y_{it} = \beta_l \ln L_{it} + \phi(I_{it}, a_{it}, K_{it}) + \eta_{it}, \quad (7)$$

where $\phi(I_{it}, a_{it}, K_{it})$ can be approximated with a second-order polynomial serials in investment, capital, and age. Then, equation (6) can be estimated by OLS and β_l will be consistent due to the control of unobserved productivities by $\phi(I_{it}, a_{it}, K_{it})$. According to the OP method, the second step is the estimation of survival probabilities, and the third step is the estimation of β_k and β_a. Limited by pages, we chose not to describe them in detail and potential readers could refer to pages of 1273 to 1279 of Olley and Pakes [21].

It should be noted that, due to the poor access to the direct investment data of listed companies, we chose to substitute relative data by M_{it} (the intermediate input defined as sales minus value added; referring to Levinsohn and Petrin, [22] and reached a function as

$$\ln Y_{it} = \beta_0 + \beta_l \ln L_{it} + \beta_k \ln K_{it} + \beta_k \ln M_{it} + \beta_a \mathrm{Age}_{it} + \sum_j \lambda_j \mathrm{Year}_j + \sum_j \delta_j \mathrm{Ind}_j + \varepsilon_{it}. \quad (8)$$

In equation (8), Year and Ind, respectively, denote the dummy variable of year and industry. Thereafter, the firm-level TFP was calculated as

$$\ln \mathrm{TFP}_{it} = \ln Y_{it} - \beta_l \ln L_{it} - \beta_k \ln K_{it} - \beta_k \ln M_{it} - \beta_a \mathrm{Age}_{it}. \quad (9)$$

3.2.2. Government Subsidies. The estimation of government subsidies refers to the categories of the OECD innovation survey manual. The subsidies as poverty alleviation, demolition compensation, and environmental protection subsidies were ruled out. The involved items include science and technology funds, special subsidies for talent introduction and new product, and awards granted by the local or the central government. Government subsidies were then defined as the sum of above items in the natural logarithmic form. Specially, awards were selected alone as afterward subsidies, while the others were uniformly defined as beforehand subsidies.

3.2.3. Controls. To ensure the reliability of the relationship between explanatory variables and explained variables, we introduced some other factors which may influence the TFP into our model as control variables [23]. The content is listed as follows:

(1) enterprise size (Size), expressed as the natural logarithmic form of total assets;

(2) return on equity (Roe), expressed as the ratio of net profit to average shareholders' equity;

(3) corporate leverage (Lev), expressed as the ratio of total debts to total assets;

(4) age of listed companies (Age), defined as the years since the company was listed;

(5) shareholders' relation (Rela), defined as 1 if the top ten shareholders are related and as 0 otherwise;

(6) the power of manager (Pow), defined as 1 if the chairman of the board served as the CEO and as 0 otherwise;

(7) the ratio of independent directors (Indep), expressed as proportion of independent directors to the total number of directors.

3.2.4. Model. To test the hypotheses of this study, the following multiple regression models were constructed:

$$\begin{aligned} \mathrm{TFP}_{it} &= \alpha_0 + \alpha_1 \mathrm{Sub}_{it} + \sum_j a_j C_j + \mathrm{year} + \varepsilon_{it}, \\ \mathrm{TFP}_{it} &= \alpha_0 + \alpha_1 \mathrm{Sup}_{it} + \sum_j a_j C_j + \mathrm{year} + \varepsilon_{it}, \\ \mathrm{TFP}_{it} &= \alpha_0 + \alpha_1 \mathrm{Rew}_{it} + \sum_j a_j C_j + \mathrm{year} + \varepsilon_{it}, \end{aligned} \quad (10)$$

where TFP_{it} denotes the total factor productivity of i company in t year estimated by the OP method (or the LP method in robustness tests), Sub_{it} is the government subsidy obtained by i company in t year, C_j represents control variables, and ε_{it} is the random disturbance term.

4. Results and Discussions

4.1. Descriptive Statistics. Table 2 lists the statistical results of major variables. The mean value of TFP estimated by the OP method is 15.68 with a standard deviation of 1.136. Meanwhile, the P50 value is determined to be 15.53. The TFP values estimated by the OP method are slightly lower than those by the LP method overall, which agrees with the theoretical expectation.

4.2. Regression Results. Table 3 lists the impact of government subsidies on the marine enterprises' TFP (OP method). Column (1) represents the influence of government subsidies in total, wherein the regression coefficient of Sub is 0.0282 and significant at the level of 5%. It suggests that the government subsidies promoted the MI-TFP, supporting Hypothesis 1. Column (2) represents the regression between beforehand subsidies and the marine enterprises' TFP, wherein the regression coefficient of Sup is 0.0318 and significant at the level of 1%. The fact suggests that beforehand subsidies could significantly promote the marine enterprises' TFP, supporting Hypothesis 3. Column (3)

Table 2: Descriptive statistics of major variables.

Variable	Mean	p50	Sd	Min	Max
TFP OP	15.68	15.53	1.136	13.29	18.17
TFP LP	15.69	15.54	1.132	13.31	18.17
Sub	14.48	14.43	2.391	8.761	20.52
Sup	14.12	13.83	2.670	7.824	20.57
Rew	13.17	13.22	1.946	8.006	17.30
Size	22.56	22.11	1.538	19.78	25.95
Lev	0.439	0.420	0.198	0.044	0.892
Roe	0.039	0.053	0.159	−0.923	0.372
Pow	0.200	0	0.400	0	1
Rela	0.563	1	0.496	0	1
Indep	0.372	0.364	0.050	0.333	0.571
Age	9.469	8	6.431	0	24

Table 3: Regression results of the impact of government subsidies on the marine enterprises' TFP.

	(1) TFP_OP	(2) TFP_OP	(3) TFP_OP
Sub	0.028**		
	(2.349)		
Sup		0.032***	
		(2.813)	
Rew			0.012
			(0.628)
Size	0.593***	0.588***	0.655***
	(25.531)	(24.815)	(16.666)
Lev	0.270	0.260	0.627**
	(1.618)	(1.512)	(2.440)
Roe	0.600***	0.643***	0.677**
	(3.733)	(3.771)	(2.509)
Pow	−0.143**	−0.139**	−0.145
	(−2.207)	(−2.042)	(−1.591)
Rela	0.069	0.051	0.079
	(1.285)	(0.906)	(0.935)
Indep	−0.300	−0.076	−0.203
	(−0.595)	(−0.143)	(−0.301)
Age	−0.002	−0.001	−0.023***
	(−0.427)	(−0.136)	(−2.679)
_Cons	1.952***	1.925***	0.985
	(4.275)	(4.081)	(1.064)
Year/Prov	Control	Control	Control
R^2	0.787	0.799	0.732
N	508	454	239

denotes the regression result of afterward subsidies but reveals no significance.

4.3. Robustness Tests. In the OP method, it is assumed that the relationship between investment and output remains monotonous. Such an assumption leads to the fact that those samples without positive investments were ruled out. Hence, Levinsohn and Petrin (2003) chose the intermediate input as the proxy variable and got a regression function as

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \beta_\iota \iota_{it} + \omega_{it} + \eta_{it}. \quad (11)$$

In equation (11), y_{it}, l_{it}, and k_{it}, respectively, represent the natural logarithms of Y_{it}, L_{it}, and K_{it}. ι_{it} denotes the intermediate input expressed as

$$\iota_{it} = \iota(\omega_{it}, k_{it}), \quad (12)$$

which could be inversely used for the expression of ω_{it} as

$$\omega_{it} = h(\iota_{it}, k_{it}). \quad (13)$$

By substituting equation (13) into equation (11), it would reach a function as

$$y_{it} = \beta_0 + \beta_l l_{it} + \varphi_t(k_{it}, \iota_{it}) + \eta_{it}. \quad (14)$$

The following estimation processes are similar to those of the OP method. Finally, the firm-level TFP could be calculated as

$$\ln \mathrm{TFP}_{it} = \ln Y_{it} - \beta_l \ln L_{it} - \beta_k \ln K_{it} - \beta_k \ln M_{it}. \quad (15)$$

Following equation (15), we performed robustness tests on the same samples. Corresponding regression results are shown in Table 4 and all of them remain steady.

4.4. Further Tests. In Section 2, we propose that government subsidies may ease the financing constraints of firms during R&D activities and thereafter promote the TFP. Hence, the following equations were established to check the mediating effects and explore the latent mechanism:

$$\mathrm{SA} = -0.737 \times \mathrm{size} + 0.043 \times \mathrm{size}^2 - 0.04 \times \mathrm{age}, \quad (16)$$

$$\mathrm{TFP}_{it} = \alpha_0 + \beta_1 \mathrm{Sub}_{it} + \sum_j a_j C_j + \mathrm{year} + \mathrm{ind} + \varepsilon_{it}, \quad (17)$$

$$\mathrm{SA}_{it} = \beta_0 + \beta_2 \mathrm{Sub}_{it} + \sum_j b_j C_j + \mathrm{year} + \mathrm{ind} + \varepsilon_{it}, \quad (18)$$

$$\mathrm{TFP}_{it} = \alpha_0 + \beta_3 \mathrm{Sub}_{it} + \beta_4 \mathrm{SA}_{it} + \sum_j b_j C_j + \mathrm{year} + \mathrm{ind} + \varepsilon_{it}, \quad (19)$$

$$\mathrm{TFP}_{it} = \alpha_0 + \beta_5 \mathrm{Sub}_{it} + \sum_j a_j C_j + \mathrm{year} + \mathrm{ind} + \varepsilon_{it}, \quad (20)$$

$$\mathrm{RD}_{it} = \beta_0 + \beta_6 \mathrm{Sub}_{it} + \sum_j b_j C_j + \mathrm{year} + \mathrm{ind} + \varepsilon_{it}, \quad (21)$$

$$\mathrm{TFP}_{it} = \alpha_0 + \beta_7 \mathrm{Sub}_{it} + \beta_8 \mathrm{RD}_{it} + \sum_j b_j C_j + \mathrm{year} + \mathrm{ind} + \varepsilon_{it}. \quad (22)$$

Equations (16)–(19) were set for financing constraints, and equations (20)–(22) were set for R&D. SA represents the proxy variable of financing constraints, and RD is equal to the ratio of R&D investments to total assets. β_1 and β_3 (β_5 and β_7) represent total effects and direct effects of government subsidies, respectively. β_2 and β_4 (β_6 and β_8) denote mediating effects of SA (RD). Lower SA values

Table 4: Results of robustness tests.

	(1) TFP_LP	(2) TFP_LP	(3) TFP_LP
Sub	0.028** (2.322)		
Sup		0.031*** (2.797)	
Rew			0.012 (0.602)
Control variables	Control	Control	Control
Year/Prov	Control	Control	Control
R^2	0.788	0.801	0.733
N	508	454	239

Table 5: Test results of mediating effects for the influence mechanism.

	(1) TFP_OP	(2) SA	(3) TFP_OP	(4) TFP_OP	(5) RD	(6) TFP_OP
Sub	0.028** (2.007)	0.007*** (3.221)	0.031** (2.205)	0.067*** (3.502)	0.002*** (4.044)	0.053*** (2.980)
SA			−0.448* (−1.935)			
RD						12.262*** (5.473)
Control variables	Control	Control	Control	Control	Control	Control
year/Prov	Control	Control	Control	Control	Control	Control
R^2	0.787	0.997	0.789	0.814	0.252	0.834
N	508	508	508	347	344	344

indicate greater financing constraints, so β_2 is expected to be positive while β_4 is expected to be negative. On the contrary, RD tends to increase with government, so both β_6 and β_8 are expected to be positive.

The tests of mediating effects are performed in three steps. For SA, it first needs to check the significance of β_1. If it is significant, the model of mediating effects is feasible. Then, further tests on β_2 and β_4 are continued. Once both β_2 and β_4 are significant, the test on β_3 is continued. Otherwise, if any of β_2 and β_4 is insignificant, it needs to turn to the Bootstrap method. The significant β_3 represents partial mediating effects, while the insignificant β_3 represents total mediating effects. The test on RD follows the same procedures and principles, just substituting β_1 to β_4 by β_5 to β_8. Relative results are listed in Table 5 and all tests are significant. Government subsidies are found to promote the marine enterprises' TFP effectively via easing the financing constraints and encouraging the R&D investment.

5. Discussions

In sum, this study achieved three basic results. First, on average, the TFP of Chinese marine enterprises still remains at a considerable low level of 15.68%. In consideration of the fact that relative data were based on listed companies, the TFP of the whole Chinese marine industry is expected to be even lower. The rapid growth of Chinese marine economy temporally relies more on the input of essential factors, which is essentially consistent with what is observed by Ren et al. [1]. Facing such a situation, it is urgent to promote the efficiency of relative resource allocation and, more importantly, regulate the structure of Chinese marine industry by innovation.

Second, as a whole, a positive correlation was observed between government subsidies and marine enterprises' TFP. It suggests that government subsidies could effectively stimulate relative enterprises to increase R&D investments and then promote TFP. Moreover, beforehand subsidies and afterward subsidies were observed to present differential effects on TFP. The former shows significant positive impacts on TFP, while the latter does not act so. Such a result is consistent with what is observed by Liu et al. [24] in Chinese private enterprises. Taking the large pressure of R&D investment on enterprises' cash flow into account, it is reasonable to assume that beforehand subsidies work better by easing the financial constraints encountered by enterprises during the conduction of innovations. However, cautions should also be taken to rent-seeking behaviors in policy practices.

Third, further tests on the working mechanism verified the assumption revealed by the contrast between beforehand subsidies and afterward subsidies; that is, the effects of government subsidies on TFP work mainly through easing financing constraints. The fact alternatively indicates that the low marine enterprises' TFP of China mainly suffers from insufficient innovations, especially when relative companies

could not get sufficient financial support from the market. As providing governmental supports (e.g., specific subsidies and tax incentives), it is also necessary to optimize the financial market system to stimulate the innovation of relative enterprises, such as the introduction of adventure investments.

6. Conclusion

Concerning the low contribution of TFP to the gross output of Chinese marine industry, this study performed empirical tests on the effects of government subsidies on the TFP of relative enterprises. The estimation of the firm-level TFP shows that even the TFP of listed firms remains at a considerably low level of 15.68%. As a whole, government subsidies were observed to present positive impacts on the TFP of relative enterprises. The effects of beforehand subsidies are much better than those of afterwards subsidies. Further mechanism tests revealed that government subsidies worked mainly via easing the financial constraints and stimulating the R&D investments of involved enterprises.

The contribution and advantage of this study were latent in the following aspects. First, this study was particularly devoted to the marine industry. Although it has grown into a pillar industry of China, its TFP still remains at a considerably low level. To such an industry, the effects of government subsidies on TFP may be more significant. Second, we chose to divide relative subsidies into two types, one as beforehand subsidies and the other as afterward subsidies. It is indeed revealed by our results that their effects are significantly different. Third, the mechanism tests uncovered how government subsidies influenced the TFP of Chinese marine enterprises, suggesting financial constraints as the main obstacle for the promotion of TFP by innovation.

The limitation or disadvantage of this study is also obvious. Above all, the estimation of TFP needs to be further optimized to refine the endogenous problems. Another defect was latent in the setting of dependent variable. Only government subsidies were taken into account while tax incentives were absent. For further research, it is necessary to involve both of them, for example, separating samples into comparative groups according to the amount of government subsidies and tax incentives. At last, our tests only concern Chinese marine industry, so the results may be inapplicable to other industries or countries.

Data Availability

All data in this study could be accessed upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

The study was supported by MOE (Ministry of Education of China) Project of Humanities and Social Sciences, Grant/Award, Title: The Impact Mechanism and Performance Evaluation of Tax Incentives on Enterprise Innovation from the Perspective of Financing Constraints (no. 16YJC630137), and by the Academic Research Projects of Beijing Union University (no. SK30202108).

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