

# A Study on Change and Difference of Provincial Fishery Efficiency in China

Bo LI\*

International College of Business and Technology,  
Tianjin University of Technology,  
Tianjin, 300384, China  
Institute of Geographic Sciences and Natural Resources  
Research, China Academy of Science,  
Beijing, 100101, China  
e-mail: mg2011818@126.com

Lin WANG

International College of Business and Technology,  
Tianjin University of Technology,  
Tianjin, 300384, China

Hui-ling QIAO

International College of Business and Technology,  
Tianjin University of Technology,  
Tianjin, 300384, China

**Abstract**—This paper uses Chinese provincial panel data, Data Envelopment Analysis (DEA) method, Malmquist index calculation method and Theil index decomposition method to study the efficiency of Chinese fishery and the structure of provincial fishery efficiency differences. The results show that in a large number of Chinese provinces, fisheries are in an inefficient state. In most provinces, fisheries have achieved efficiency gains, which is conducive to the improvement of fishery total factor productivity. The intra-regional differences within eastern, central, western and northeastern China are the major cause of the total provincial efficiency difference in fisheries, while the inter-regional difference is the minor cause. Based on the empirical results, this paper further discusses the relevant political implications.

**Keywords**-Fishery efficiency; Data Envelopment Analysis; Malmquist index; Theil index decomposition.

## I. INTRODUCTION

Fishery is an integral part of the issues of “Agriculture, Rural areas and Farmers” in China. It is also an important driving force of Chinese national economy. The improvement of fishery efficiency could strongly support the increase of revenue growth and development of fishery. However, there exist apparent regional differences in the allocation of Chinese fishery resources. Under this circumstance, to study the fishery efficiency difference is conducive to providing solutions for improving Chinese fishery economy.

An examination of technical efficiency can provide an understanding of the relationship between inputs and outputs (Duy & Flaaten 2016). Therefore, in the existing literature, Data Envelopment Analysis (DEA) method was widely used to study the efficiency of fishery production and resource utilization. Especially for Chinese fishery efficiency, previous studies adopted the DEA method (Gao & Ding, 2011; Li & Liu, 2014).

However, most of the existing literature paid less attention to the difference of Chinese fishery efficiency. Therefore, this paper measures and analyzes the provincial fishery efficiency and its changing trend using Chinese provincial panel data from 2002 to 2013, DEA method and Malmquist index method. Furthermore, based on the efficiency results, this paper measures provincial difference of fishery efficiency using Theil index, and decomposes the difference to further analyze the contributions of inter-regional and intra-regional efficiency difference to the total difference using Theil index decomposition method. The political implications of the study results will provide a reference for the coordinated development of Chinese fishery.

## II. METHODS AND DATA

### A. Methods

The method of DEA was first proposed by Charnes, Cooper and Rhodes (1978), according to which multiple input and output indicators and linear programming were applied to measure the technical efficiency of a production system. Then, in 1994, Fare et al. (1994) proposed the Malmquist index method based on DEA method to measure the total factor productivity change. The method has been widely used in the analysis of technical efficiency and total factor productivity change. Using Malmquist index method, the TFP change of the interested production system could be examined, and the change could be decomposed into technical efficiency change and production technological progress.

In this paper, the above methods are used to study the changing trend of fishery efficiency and the efficiency difference in China. Furthermore, Theil index calculation method is used as an index to measure regional differences, and Theil index decomposition method is used to analyze the structure of difference, which, based on regional groups, could decomposes the total Theil index into intra-regional Theil index and inter-regional Theil indices.

B. Data

In this paper, 28 provincial areas including provinces, autonomous regions and municipalities directly under the central government are treated as decision-making units for analysis. The input and output indicators include: (1) input indicators: the provincial total power of motor boats by the end of the year (kilowatts, kw), and fishery population and employees (person); (2) output indicator: total output of fishery products (tons). The data time span is from 2002 to 2013. The data is collected from "Chinese fishery statistical yearbook". The regional division is adopted from "China Statistical Yearbook 2010"<sup>b</sup>.

III. EFFICIENCY CHANGE AND DIFFERENCE ANALYSIS

A. Efficiency and Efficiency Change Measurement

TABLE I. MEASUREMENT RESULT OF CHINESE PROVINCIAL FISHERY EFFICIENCY

Province	2002	2013	Avg	Province	2002	2013	Avg
Beijing	1.00	0.57	0.78	Shandong	0.83	0.6	0.74
Tianjin	0.93	1.00	0.91	Henan	0.53	0.6	0.45
Hebei	0.72	0.50	0.58	Hubei	0.69	0.6	0.63
Shanxi	0.89	1.00	0.88	Hunan	0.59	0.4	0.61
Neimengu	1.00	0.59	0.65	Guangdong	0.58	0.6	0.58
Liaoning	1.00	0.82	0.81	Guangxi	0.56	0.4	0.51
Jilin	0.55	0.31	0.48	Hainan	0.56	0.7	0.61
Heilongjiang	0.42	0.44	0.42	Chongqing	0.20	0.3	0.21
Shanghai	0.82	1.00	0.98	Sichuan	0.84	0.7	0.58
Jiangsu	0.36	0.42	0.39	Guizhou	0.17	0.1	0.16
Zhejiang	0.69	0.64	0.60	Yunnan	0.41	0.9	0.51
Anhui	0.52	0.39	0.45	Shanxi	1.00	0.2	0.46
Fujian	0.75	0.65	0.70	Gansu	0.81	1.0	0.85
Jiangxi	0.61	0.35	0.53	Xinjiang	0.89	0.9	0.93
	0	7	5		2	91	0

Using DEA method, the results are shown in Table 1, in which only the efficiencies of 2002, 2013, and average from 2002 to 2013 are listed due to space limitation. As can be seen from the table, there exist obvious provincial differences in the fishery efficiency of the 28 provincial areas. Among them, Shanghai has the highest provincial

<sup>b</sup> The provinces in eastern region include: Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan; the provinces in central region includes: Shanxi, Anhui, Jiangxi, Henan, Hubei and Hunan; the provinces in western region include: Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, and Xinjiang; the provinces in northeastern region include: Liaoning, Jilin and Heilongjiang.

fishery efficiency, with the average efficiency level of 0.984. Meanwhile, Guizhou has the lowest provincial fishery efficiency, with the average efficiency level of only 0.164.

Using Malmquist index method, the changes of efficiency and total factor productivity of Chinese provincial fishery are shown in Table 2. The technical provincial fishery efficiency increased from 0.851 in 2003 to 0.917 in 2013 with fluctuations. In most years, technical efficiency change and technological change played an active role alternately in promoting the total factor productivity of provincial fishery in China.

B. Measurement and Decomposition of Efficiency Difference

The regional differences in Chinese fishing efficiencies will definitely hinder the enhancement of the overall efficiency of Chinese fishery. Therefore, it is necessary to accurately measure the inter-regional difference and intra-regional differences. In this paper, the four-region-division method is used to divide the provinces into four regional groups including eastern, central, western and northeastern region of China, so as to examine regional differences of fishery efficiency in China.

TABLE II. CALCULATION RESULTS OF MALMQUIST INDEX

Year	EFF CH	TECH CH	TFP CH	Year	EFF CH	TECH CH	TFP CH
2003	0.851	1.132	0.963	2009	1.065	0.968	1.032
2004	1.205	0.814	0.981	2010	1.011	1.885	1.906
2005	0.439	2.322	1.029	2011	0.68	1.091	0.742
2006	2.031	0.464	0.942	2012	1.525	0.617	0.94
2007	1.023	0.752	0.769	2013	0.917	1.163	1.066
2008	0.937	0.981	0.919	Avg	0.990	1.004	0.994

Note: (1) EFFCH denotes technical efficiency change; (2) TECHCH denotes technological change; (3) TFPCH denotes total factor productivity change.

In Table 3, the changing trend of Theil index of Chinese provincial fishery efficiency reflects the variation tendency of regional differences of fishery efficiencies in 28 mainland provinces of China from 2002 to 2013. From the table, it is clear that the differences of Chinese provincial fishery efficiency fluctuated strongly, which is obviously not conducive to the enhancement of overall fishery efficiency of China.

TABLE III. THEIL INDEX OF CHINESE PROVINCIAL FISHERY EFFICIENCY

Year	Theil	Year	Theil	Year	Theil	Year	Theil
2002	0.064	2005	0.27	2008	0.08	2011	0.174
2003	0.096	2006	0.07	2009	0.07	2012	0.062
2004	0.058	2007	0.06	2010	0.08	2013	0.080
	9	7	82		48		7

Based on the results, Theil index decomposition method is used to quantifiably decompose the difference, so as to find effective ways of reducing regional differences of Chinese provincial fishery efficiency. The decomposition results are shown in Table 4. As can be seen from the table, the following results are obtained:

(1) Intra-regional difference is the main cause of the overall provincial difference in fishery efficiency of China, while the inter-regional difference is the minor or secondary cause. In 2002, the proportion of intra-regional differences in the overall difference was 97.67%, while the proportion of the inter-regional difference was 2.33%. Despite the subsequent minor fluctuations, the proportions remain generally stable. In 2013, the proportion of intra-regional differences in the overall difference was 96.04%, while the proportion of the inter-regional difference was 3.96%.

(2) The changing trends of intra-regional differences within eastern (E), central (C), western (W) and northeastern (NE) China are different as the time changes. Among them, the proportion of intra-regional difference in western China in the overall difference decreased from 62.15% in 2002 to 54.74% in 2013. In most years, it is the highest among regions. The proportion of intra-regional difference in eastern China increased from 18.97% in 2002 to 56.00% in 2005. Then it began to decrease to 16.15% in 2013 with fluctuations. The proportion of intra-regional difference in central China increased from 5.81% in 2002 to 16.23% in 2013. In most years, the proportion of intra-regional difference in central China was lower than that in eastern China. The proportion of intra-regional difference in northeastern China decreased from 10.74% in 2002 to 8.93% in 2013. Generally, it is the lowest among regions.

TABLE IV. CONTRIBUTION DECOMPOSITION OF THEIL INDEX

Year	Intra-regional				Sum	Inter-regional
	E	C	W	NE		
2002	18.97%	5.81%	62.15%	10.74%	97.67%	2.33%
2003	14.61%	13.72%	39.71%	11.41%	79.45%	20.55%
2004	19.07%	10.84%	52.63%	7.72%	90.26%	9.74%
2005	56.00%	8.22%	20.36%	2.28%	86.85%	13.15%
2006	19.39%	18.49%	42.23%	7.47%	87.59%	12.41%
2007	20.27%	26.42%	39.78%	6.80%	93.27%	6.73%
2008	21.85%	17.89%	51.56%	1.40%	92.71%	7.29%
2009	14.63%	19.60%	51.82%	4.36%	90.41%	9.59%
2010	10.74%	9.53%	49.98%	6.03%	76.28%	23.72%
2011	11.59%	7.00%	54.32%	3.34%	76.25%	23.75%
2012	16.22%	12.12%	57.67%	9.14%	95.15%	4.85%
2013	16.15%	16.23%	54.74%	8.93%	96.04%	3.96%

#### IV. CONCLUSIONS AND POLITICAL IMPLICATIONS

Based on the empirical results of this paper, the following conclusions and political recommendations could be obtained.

(1) Local government departments should continue to increase investment to strengthen the fishery infrastructure. In addition, policies should be formulated focusing on the promotion of fisheries layout adjustment and the implementation of moratorium system in key fishery areas. Furthermore, it is necessary for local governments in backward provinces to focus on the improvement of fishery efficiency in order to shrink the overall efficiency difference and improve overall fishery total factor productivity. At the same time, the fishery technology promotion and transfer should not be ignored.

(2) Emphasis should be put on the shrinkage of intra-regional difference of provincial fishery efficiency. Local government departments in the relatively backward regions should strive to increase fishery scientific research, technology promotion and investment, in order to upgrade the level of fisheries. Furthermore, adequate training and guidance for fishery practitioners should be provided, and effective management and operation system should be implemented in backward provinces to improve the level of fishery development.

(3) The shrinkage of inter-regional difference in provincial fishery efficiency should not be ignored. Relevant government departments should strengthen the regional fishery coordination and activate regional positive interactions through exchange of regional fishery management and operation experience. Furthermore, fishery development strategies should be developed based on local conditions and characteristics, so as to guide the realistic and comprehensive development of Chinese fishery.

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