Economic Stimulus and Fiscal Revenue based on the DEA-HEM: Evidence from China

Yu Feng, Shi[1,a*], Wei, Wei[2,b]
[a*]e-mail: syf_nm@126.com, [b]e-mail: 20201011@gdufe.edu.cn

[1] School of Yueshang/MBA, Guangdong University of Finance & Economics, Guangzhou, China
[2]Institute of Talent Evaluation and Development in Greater Bay Area, Guangdong University of Finance & Economics, Guangzhou, China

Abstract*:* In order to effectively identify the high-quality level and clarify the sustainable development potential of China's urban fiscal revenue, this paper builds a High-quality Evaluation Model (HEM) based on the classic DEA. This model overcomes the "data smoothness" requirement of the DEA, settles the problem of quantitative evaluation of multiple objectives from a dynamic multi-dimensional perspective. Then, the consumption, investment, export, and fiscal revenue data from 21 cities in Guangdong province from 2012 to 2019 were imported into HEM for numerical determination. Empirical results: If the above 21 cities are taken the same scale of consumption, investment, export stimulus measures, Shaoguan, Shenzhen, Yangjiang obtain better performance of fiscal revenue. The result indicates that the above three cities are high-quality in fiscal revenue. Conclusion: During the ongoing global epidemic, the government should give priority to stimulating Shaoguan, Shenzhen, Yangjiang in order to obtain higher fiscal revenue. The research results are of practical significance to guide the government to implement the correct policies and effectively promote fiscal recovery.

Keywords: Fiscal revenue; Urban economy; High-quality development.

1. INTRODUCTION

At present, China's economy is facing multiple difficulties such as post-epidemic recovery and low-carbon development, and how to obtain high-quality economic development with limited economic stimulus has become an important subject for scholars [7, 8, 20,21]. It is since the above important background that Chinese scholars have carried out fruitful research work on the issue of high-quality fiscal.

According to the different understanding of different scholars on high-quality fiscal, the research results of high-quality fiscal aspects are sorted out as follows: Some scholars emphasize the accuracy of fiscal expenditure in consumption, investment, and export stimulus to further obtain significant and sustained fiscal revenue growth [25]; And scholars have also emphasized the leading role of fiscal policy in guiding environment-friendly investment [6, 9, 10, 23]; And then, some scholars emphasize the benign transformation of green finance itself in fiscal revenue and expenditure [4]; Also, some scholars even emphasize the feasibility of green finance in fiscal expenditure and low carbon emission reduction costs [22]. Overall, the relevant theories and practices on high-quality fiscal are still in the stage of development and discussion and have not yet formed well-known concepts and standards.

ICEMME 2022, November 18-20, Nanjing, People's Republic of China

DOI 10.4108/eai.18-11-2022.2326906

As an important material foundation of national governance and social development guarantee, fiscal resources play the role of economic lever regulation. Fiscal revenue is an important part of fiscal resources and plays a fundamental role. The high-quality level of fiscal revenue reflects the high-quality level of economic development and sustainable development ability to a certain extent.

Therefore, this paper focuses on the important economic indicator of fiscal revenue, proposes a high-quality evaluation model (HEM) to measure the conversion efficiency between investment, consumption, export stimulus variables, and fiscal revenue variables, and to determine high-quality fiscal revenue levels. Further, the provincial economy is selected for the research object, and the high-quality performance of fiscal revenue is revealed from the perspective of quantitative research.

The rest of this paper: The second chapter is the mechanism analysis part of fiscal revenue, mainly discusses the driving force of fiscal revenue to provide theoretical support for urban economic development. The third chapter is the construction part of the HEM based on the DEA. The single efficiency factor is extended to multiple efficiency factors, and then the multiple efficiency factors are constructed into the HEM. The model overcomes the data "smoothing requirements" of the DEA model [14] and realizes measuring multiple goals from a dynamic multi-dimensional perspective. The fourth chapter is the empirical test section, which measures HEM values in 21 cities in Guangdong Province from 2 012 to 2019 through the HEM to observe the high-quality level of fiscal revenue and development trends in different cities. The fifth chapter is the conclusion and policy recommendation part which are beneficial to the growth of fiscal revenue in the context of the post-epidemic.

The main innovation points of this paper: 1) This paper puts forward the fiscal revenue formation mechanism, which reveals that "urban fiscal revenue depends on the value-added ability of urban industry"; 2) The paper constructs HEM which measures the high-quality level of fiscal revenue. The mode has a clear and reasonable economic significance and roles a powerful tool for high-quality evaluation of fiscal revenue. It has the advantages of clear economic significance and simple calculation.

2. MECHANISM ANALYSIS

The following will discuss the transformation mechanism between the three stimulus measures (consumption, investment, and export) and the fiscal revenue.

The city fiscal revenue in China mainly comes from taxation, and the main part of taxation is value-added tax from the production & trading links. And the production & trading links are driven by consumption, investment, and export. Thus, Fiscal revenue ultimately depends on the action of the three stimulus measures: consumption, investment, and export. The intensity of the action depends on the ability to create added value in the local industry. In short, the city fiscal revenue depends on the "value-added capacity" of the region.

3. METHODS AND DATA

3.1 The expression of HEM

The HEM is the equivalent form of RCI [18], a measurement model built by Yufeng Shi et al. based on the classic DEA [1-3, 5,11-13,15-17,19, 24] in 2021.

$$I_{\beta,s,t} = E_{\beta,s,t} \sum_{\alpha=1}^{m} E_{\alpha,s,t} \tag{1}$$

Note： $min \sum_{t=1}^{T}\left(\sum_{\alpha=1}^{m} E_{\alpha,s,t} + \sum_{\beta=1}^{n} E_{\beta,s,t}\right)$; $E_{\alpha,s,t} = \sum_{k=1}^{K-1} u_{\alpha,k,t} w_{k,t}^{s} / u_{\alpha,s,t}$; $E_{\beta,s,t} = v_{\beta,s,t} / \sum_{k=1}^{K-1} v_{\beta,k,t} w_{k,t}^{s}$.And the economic significance of all the above parameters is shown in TABLE 1.

TABLE 1. THE DESCRIPTION OF THE PARAMETER

Variable	Paraphrase	Variable	Paraphrase
α	Input variable	β	Output variable
s	Evaluated department	t	Evaluated period
n	The number of input variables	m	The number of output variables
k	Any department	K	The total number of departments
ξ	The equilibrium factor under strict	ε	The equilibrium factor under loose
$u_{\alpha,k,t}$	The value of the input variable αf department k in period t	$v_{\beta,k,t}$	The value of the output variableβ of department k in period t
$w_{k,t}^{s}$	The variable weights, and $\sum_{k=1}^{K-1} w_{k,t}^{s} = 1$	λ	Evaluation index value

3.2 The economics signification of HEM

$$I_{\beta,s,t} = \sum_{\alpha=1}^{n} \frac{v_{\beta,s,t}/u_{\alpha,s,t}}{\sum_{k=1}^{K-1} w_{k,t}^{s} v_{\beta,k,t} / \sum_{k=1}^{K-1} w_{k,t}^{s} u_{\alpha,k,t}} \tag{2}$$

Among them, $v_{\beta,s,t}/u_{\alpha,s,t}$ represent the conversion ratio; $\sum_{k=1}^{K-1} w_{k,t}^{s} v_{\beta,k,t} / \sum_{k=1}^{K-1} w_{k,t}^{s} u_{\alpha,k,t}$ represent the weighted conversion ratio;$(v_{\beta,s,t}/u_{\alpha,s,t}) / (\sum_{k=1}^{K-1} w_{k,t}^{s} v_{\beta,k,t} / \sum_{k=1}^{K-1} w_{k,t}^{s} u_{\alpha,k,t})$ represents a conversion-rate substitution factor between a single department and a weighted department; $\sum_{\alpha=1}^{n} \frac{v_{\beta,s,t}/u_{\alpha,s,t}}{\sum_{k=1}^{K-1} w_{k,t}^{s} v_{\beta,k,t} / \sum_{k=1}^{K-1} w_{k,t}^{s} u_{\alpha,k,t}}$ represents the overall substitution factor between a single department and a weighted department.

When

$$\left(v_{\beta,s,t}/u_{\alpha,s,t}\right) \Big/ \left(\sum_{k=1}^{K-1} w_{k,t}^{s} v_{\beta,k,t} \Big/ \sum_{k=1}^{K-1} w_{k,t}^{s} u_{\alpha,k,t}\right) \geq 1 \tag{3}$$

is established, it means that the single department has the highest conversion rate (any α to any β); when $\sum_{\alpha=1}^{n} \frac{v_{\beta,s,t}/u_{\alpha,s,t}}{\sum_{k=1}^{K-1} w_{k,t}^{s} v_{\beta,k,t} / \sum_{k=1}^{K-1} w_{k,t}^{s} u_{\alpha,k,t}} \geq n$, it means that the single department has the highest conversion rate(n to any β)

3.3 The test data of HEM

This paper selects five-panel data, namely, the Total Retail Sales of Consumer Goods, the Investment in Fixed Assets, the Foreign Export Trade, and General Public Fiscal Budget Revenue of 21 cities in Guangdong Province from 2012 to 2020 as the alternative indicators of consumption, investment, export, and fiscal revenue. (The data is from the statistical yearbook of Guangdong Province from 2012 to 2020)

4. EMPIRICAL TEST

4.1 Empirical explanation

Thus, formula (1) can be used to measure the value of city revenue high-quality level driven by consumption, investment, and export. Among, the values 1, 2, and 3 of α respectively represent the consumption, the investment, the export, and the values 1 of β respectively represent the fiscal revenue. Then formula (1) can be transformed into the following expression:

$$I_{1,s,t} = E_{1,s,t} \sum_{\alpha=1}^{3} E_{\alpha,s,t} \tag{4}$$

Note: $min \sum_{t=1}^{9} \left(\sum_{\alpha=1}^{3} E_{\alpha,s,t} + E_{1,s,t} \right)$; $E_{\alpha,s,t} = \sum_{k=1}^{20} u_{\alpha,k,t} w_{k,t}^{s} / u_{\alpha,s,t}$; $E_{1,s,t} = v_{1,s,t} / \sum_{k=1}^{20} v_{1,k,t} w_{k,t}^{s}$.

Among, $I_{1,s,t}$ denotes the value of HEM driven by consumption, investment, and export in s city at t (The value of s is 1-21, and the value of t is 1-9). The greater the value of $I_{1,s,t}$ is, the higher the quality level is.

The first step is to solve equations (4) with the help of programming software based on the optimal solution idea; The second step is to calculate the value of HEM of 21 cities from 2012 to 2019 according to equation (4) (the calculation results are shown in Table 2); The third step is to select cities according to the trend value (TABLE 2) of HEM and analysis the difference.

4.2 The measurement results of HEM

TABLE 2. THE HEM VALUE OF 21 CITIES IN GUANGDONG PROVINCE

City	2012	2013	2014	2015	2016	2017	2018	2019	Growth rate
Shaoguan	3.23	3.48	3.56	3.61	3.56	3.95	4.46	4.47	0.18
Shenzhen	4.50	5.19	5.89	7.12	7.44	6.64	6.07	5.27	0.11
Yangjiang	1.59	1.78	1.88	2.06	2.58	2.02	1.98	1.76	0.02
Jiangmen	2.18	2.18	2.27	2.18	1.88	1.86	1.96	2.07	-0.02
Zhuhai	2.56	2.67	2.31	2.18	2.03	2.03	2.10	2.34	-0.03

Chaozhou	1.57	1.57	1.56	1.91	1.98	1.87	1.56	1.32	-0.04
Foshan	2.32	2.42	2.56	2.16	1.83	1.94	1.86	2.04	-0.04
Huizhou	2.40	2.70	2.34	2.08	1.95	1.93	1.95	2.02	-0.05
Zhanjiang	2.45	2.47	2.40	2.32	2.00	2.27	1.94	1.95	-0.07
Dongguan	2.09	1.92	1.79	1.55	1.47	1.56	1.62	1.54	-0.08
Yunfu	2.67	2.56	2.56	2.64	2.66	2.43	1.37	2.10	-0.08
Shantou	2.06	2.13	2.04	1.96	2.04	2.04	1.67	1.48	-0.08
Shanwei	1.78	1.75	1.72	1.40	1.40	1.59	1.33	1.17	-0.09
Zhongshan	2.66	2.78	2.56	2.27	2.03	2.01	2.10	1.98	-0.10
Jieyang	1.71	1.64	1.44	1.24	1.24	1.19	1.26	0.94	-0.11
Qingyuan	3.32	3.22	3.18	3.03	3.16	2.86	2.79	2.45	-0.12
Heyuan	2.65	1.89	1.96	2.27	2.35	2.08	1.96	1.76	-0.13
Zhaoqing	3.01	2.81	3.00	2.83	1.99	1.98	2.04	1.62	-0.20
Meizhou	3.92	3.84	3.40	3.33	3.47	3.11	2.64	2.14	-0.25
Maoming	4.10	3.45	3.37	3.51	3.47	2.93	2.65	2.19	-0.27
Guangzhou	4.46	4.03	3.33	2.61	2.04	2.09	2.24	2.40	-0.29

4.3 The fiscal revenue quality trend analysis

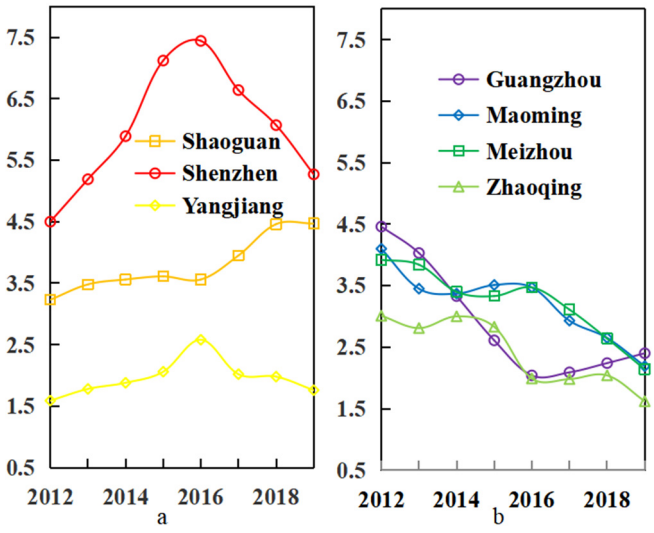

Figure 1. The HEM value trend

According to $I_{1,s,2019} - I_{1,s,2012} \geq 0$ and $I_{1,s,2019} - I_{1,s,2012} \leq -1$, the 21 cities are divided into upward trend group, downward trend group, and no obvious change group. As shown in Figure 1, t The HEM value of Shaoguan, Shenzhen, and Yangjiang shows an increasing trend, reflecting the obvious improvement of local industrial competitiveness and profitability. The HEM value of Guangzhou, Maoming, Meizhou, and Zhaoqing shows an obvious downward

trend, reflecting the current situation that the local industrial structure is not ideal, and the industrial transformation was not rapid enough. Among, Guangzhou shows a rapid decline overall, reflecting the "pain phenomenon" in the process of industrial transformation and upgrading, although it has rebounded in recent years.

4.4 Accuracy testing of HEM

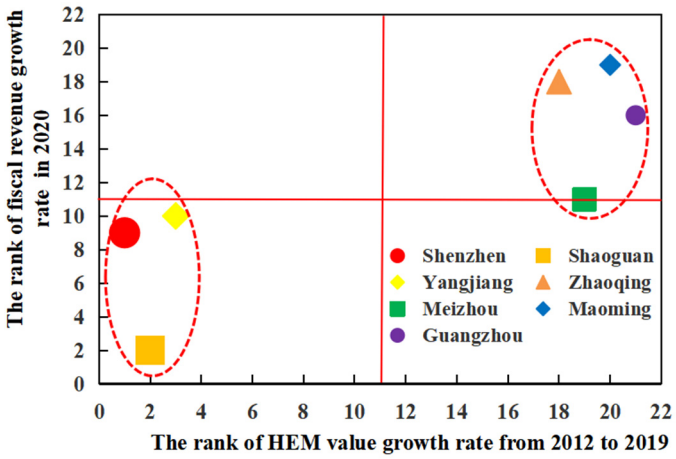

Figure 2. the inspection of HEM measurement function

Figure 1a shows that, from 2012 to 2019, the HEM values in Shaoguan, Shenzhen, and Yangjiang show an upward trend, While Figure 2 also shows that, in 2020, the tax growth rate of the above three cities is in the middle-upper level (2nd, 9th, and 10th) of 21 cities. On the contrary, Figure 1b shows that the HEM values of Guangzhou, Maoming, Meizhou, and Zhaoqing show a downward trend, and Figure 2 also shows that, the tax growth rate of the above four cities is at the middle-lower level (16th, 19th, 18th, and 11th).

The above situation shows that the HEM values are consistent with the actual value, proving that the HEM has a certain predictive power. Among, the tax growth rate of the 7 cities (Shaoguan, Shenzhen, Yangjiang, Guangzhou, Maoming, Meizhou, and Zhaoqing) is respectively -1.8%, 5.1%, -1.98%, -3.9%, -6.5%, -2.3% and-5.9% in 2020, ranking 9th, 2nd, 10th, 16th, 19th, 11th, and 18th.

5. CONCLUSION

Through mechanism analysis, model construction, and empirical testing, the high-quality evaluation of fiscal revenue is solved. Among them, the mechanism analysis and HEM measurement results are in line with the actual situation, which shows that the logic of this paper is reasonable, and the argument is proper.

In the context of effectively promoting economic recovery and implementing high-quality development, this paper makes the following summary and recommendations:

First, the generation mechanism of the fiscal revenue proposed in this paper can fully reveal the stimulus path, and “value-added creativity” can explain the heterogeneous performance of different cities in fiscal revenue.

Second, the mechanism shows that modern industries with a strong foundation and strong competitiveness are the prerequisite for the high-quality development of fiscal revenue. Therefore, local governments should give priority to Shenzhen, Shaoguan, Yangjiang to take effective measures to achieve an effective recovery of fiscal revenue.

Third, Shenzhen's fiscal revenue is far ahead of other cities in terms of high quality, and Chinese cities should learn from the Shenzhen model, develop modern industries and high-tech industries, build core competitiveness, and enhance profitability.

ACKNOWLEDGMENTS

Fund Projects: Project of Guangdong Local Public Finance Research Center of Guangdong University of Finance & Economics (20190007). Guangdong Education Science Planning Project (2018GXJK053).

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