

Research on the improvement of tax collection and management efficiency based on DEA model

—Taking Yiwu Taxation Bureau as an example

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ABSTRACT

The three-stage DEA model is used to measure and compare the tax collection and administration efficiency of 12 sample county-level cities in Zhejiang Province, and concludes that the overall level of tax collection and administration efficiency is not high. At the same time, combining with the general overview of tax collection and management in Yiwu City, it is concluded that the tax collection and management in Yiwu City has problems such as unreasonable organizational structure, excessive growth rate of tax sources, complex types of managed households and collection and management technology to be improved, and countermeasure suggestions such as optimizing tax organizational structure, strengthening tax source management, improving tax service system and accelerating tax informatization construction are put forward.

KEYWORDS

Tax collection and management efficiency; DEA model; Grassroots tax collection and management

1 Introduction

On July 20, 2018, the General Office of the State Council, PRC promulgated the Reform Program of the National Taxation and Local Taxation Collection and Administration System, but it has been five years since then, does the new collection and administration model brought by the reform of the collection and administration system play a role in optimizing the allocation of resources and improving the efficiency of collection and administration? Academics and tax collection practice have not yet given a definite answer. Over the years, with the increase of tax revenue, the new round of structural tax reduction has brought new problems and challenges to tax collection and administration, that is, we should not only focus on the expansion of tax collection scale, but also on the improvement of tax collection quality.

Based on the above background, this paper measures and analyzes the tax administration efficiency of taxation departments, and because most of the existing literature studies the tax administration efficiency at the national and provincial levels, the research on regional grassroots taxation bureaus is very limited, therefore, this paper selects the grassroots taxation bureaus, i.e., Yiwu Taxation Bureau, as the research object, and uses the three-stage DEA model to measure the tax administration efficiency of 12 cities in Zhejiang Province from 2017 to 2021, to objectively measure and comparatively analyze the tax collection and administration efficiency of the sample county-level cities, and analyze the causes of their problems in the light of the actual tax collection and administration in Yiwu City, in order to suggest and contribute to the next step of improving the tax collection and administration efficiency of the taxation department in Yiwu City, as well as to

make a small contribution to the enrichment of tax administration theory and the improvement of regionalized tax collection and administration efficiency.

2 Model construction and variable selection

2.1 The idea of constructing the empirical model

2.1.1 Initial efficiency analysis of DEA in the first stage.

Based on existing studies, the input-oriented BBC model is chosen, which can be expressed as

$$\begin{aligned} \min \theta - \varepsilon(e^T S^- + e^T S^+) \\ \text{s.t.} \begin{cases} \sum_{j=1}^n X_j \lambda_j - S^+ = \theta X_0 \\ \sum_{j=1}^n X_j \lambda_j - S^- = Y_0 \\ \lambda_j \geq 0, S^-, S^+ \geq 0 \end{cases} \end{aligned} \quad (1)$$

Where, $j = 1, 2, \dots, n$ denotes the decision unit, X, Y are the input and output variables respectively.

2.1.2 SFA regression analysis in the second stage.

In the second stage, with the help of SFA (stochastic frontier analysis) regression, the slack variables in the first stage are decomposed into management inefficiency, environmental factors, and statistical noise, and such slack variables can reflect the initial inefficiency. Thus the following SFA-like regression function is constructed (with input orientation as an example):

$$S_{ni} = f(Z_i; \beta_n) + v_{ni} + \mu_{ni}; i = 1, 2, \dots, I; n = 1, 2, \dots, N \quad (2)$$

Where S_{ni} is the slack value of the n^{th} input of the i^{th} decision unit; Z_i is the environmental variable, which β_n is the coefficient of the environmental variable; $v_{ni} + \mu_{ni}$ is the mixed error term, which v_{ni} denotes random disturbance, and μ_{ni} denotes management inefficiency. where $v \sim N(0, \sigma_v^2)$ is the random error term, indicating the effect of random disturbances on the input slack variables; μ is the management inefficiency, indicating the effect of management factors on the input slack variables, which are assumed to obey a normal distribution truncated at the zero point, i.e. $\mu \sim N^+(0, \sigma_\mu^2)$.

The purpose of the SFA regression is to remove the effects of environmental and stochastic factors on the efficiency measures in order to adjust all decision units in the same external environment. The adjusted input variables i.e., the effects of environmental variables and statistical noise are removed. The adjustment formula is:

$$\begin{aligned} X_{ni}^A = X_{ni} + \left[\max(f(Z_i; \hat{\beta}_n)) - f(Z_i; \hat{\beta}_n) \right] + \left[\max(v_{ni}) - v_{ni} \right] \\ i = 1, 2, \dots, I; n = 1, 2, \dots, N \end{aligned} \quad (3)$$

Where X_m^A is the adjusted input; X_{ni} is the input at the time of adjustment; $\left[\max(f(Z_i; \hat{\beta}_n)) - f(Z_i; \hat{\beta}_n) \right]$ is the adjustment for external environmental factors; and $\left[\max(v_{ni}) - v_{ni} \right]$ is to place all decision units under the same level of luck.

According to Fried et al. the formula for separating the management inefficiency term is as follows:

$$E(\mu|\varepsilon) = \sigma \cdot \left[\frac{\phi(\lambda \frac{\varepsilon}{\sigma})}{\phi(\frac{\lambda \varepsilon}{\sigma})} + \frac{\lambda \varepsilon}{\sigma} \right], \text{其中, } \sigma = \frac{\sigma_\mu \sigma_v}{\sigma}, \sigma = \sqrt{\sigma_\mu^2 + \sigma_v^2}, \lambda = \sigma_\mu / \sigma_v \quad (4)$$

The final calculation computes the random error term v , which is calculated as follows:

$$E[v_{ni}|v_{ni} + \mu_{ni}] = s_{ni} - f(z_i; \beta_n) - E[\mu_{ni}|v_{ni} + \mu_{ni}] \quad (5)$$

2.1.3 The third stage of adjusted DEA analysis.

By bringing the adjusted input variables into the BBC model of the first stage again, the calculated efficiency values exclude the effects of environmental variables and statistical noise, and the empirical results are more objective.

2.2 Selection of variables for the empirical model

Taxation authority is a special production sector. According to the characteristics of tax generation process and with reference to the existing literature, this paper takes tax revenue as the output and the number of tax practitioners, value added of secondary and tertiary industries, the degree of concentration of tax sources and gross regional product as the input indicators. According to the characteristics of tax collection and existing theoretical analysis, this paper mainly considers the following factors as environmental variables: disposable income per capita, GDP per capita, degree of external openness and the density of population (Table 1).

Table 1 Analysis indicators of tax collection efficiency

Indicator classification		Name of the indicator	Description of the indicator
Output Indicators		Tax revenue	Tax revenue realized by counties and cities (million yuan)
		Number of tax practitioners	Measuring the cost of tax collection (people)
		Value added of secondary and tertiary industries	Number of tax sources measured (million yuan)
Input Indicators		Concentration of tax sources	Total taxpayers / total tax revenue (%)
		Regional GDP	Measure of regional economic level (million yuan)
		Disposable income per capita	Reflecting willingness and ability to pay taxes (yuan)
Environment Variables		GDP per capita	Gross production value/total household population (yuan/person)
		Degree of external openness	Total imports and exports/GDP (%)
		Density of population	Population per unit area (persons/km2)

This study selects data from 12 sample counties and cities within Zhejiang Province from 2017-2021, where tax-related data come from the Statistical Yearbook and the Statistical Bulletin of National Economic and Social Development of each region, and other data come from regional government portals, as well as information public channels to obtain.

3 Empirical analysis

3.1 Traditional DEA empirical result in the first stage

Using DEAP 2.1 software, the initial efficiency analysis of the first stage was conducted using the tax revenue from 2017-2021 as the output variable (Table 2).

According to Table 2, we can see that: Cixi has an annual tax collection efficiency mean value of 1, which ranks first among the 12 county-level cities and occupies a very obvious advantage; Cixi, Dongyang and Yongkang have technical efficiency values between 0.8 and 1.0, and the DEA results are relatively effective; Yiwu, Haining and Tongxiang have technical efficiency values between 0.5

Table 2 The comparison of technical efficiency between 12 counties and cities

DUM	2017	2018	2019	2020	2021	Average	Ranking
Cixi	1.000	1.000	1.000	1.000	1.000	1.000	1
Yiwu	0.755	0.838	0.802	0.809	0.791	0.799	4
Yuyao	0.546	0.482	0.480	0.488	0.482	0.4956	7
Zhuji	0.511	0.463	0.446	0.414	0.370	0.4408	9
Yueqing	0.525	0.456	0.448	0.393	0.357	0.4358	10
Haining	0.750	0.681	0.708	0.692	0.653	0.6968	5
Tongxiang	0.515	0.478	0.490	0.591	0.513	0.5174	6
Ruian	0.540	0.479	0.485	0.436	0.392	0.4664	8
Yuhuan	0.476	0.461	0.398	0.337	0.336	0.4016	12
Wenling	0.494	0.446	0.403	0.358	0.332	0.4066	11
Dongyang	0.787	1.000	1.000	1.000	1.000	0.9574	2
Yongkang	1.000	0.874	0.783	0.742	0.774	0.8346	3
Average	0.658	0.638	0.620	0.605	0.583	/	/

The technical efficiency value of 0.8-1.0 is relatively effective; 0.5-0.8 is more effective; below 0.5 is relatively ineffective

and 0.8, and the DEA results are more effective; Yuyao, Rui'an, Zhuji, Yueqing, Wenling, Yuhuan's technical efficiency value is lower than 0.5, and there is a big gap with the efficiency effective county-level cities. It can be concluded that among the 12 county-level cities, the difference of technical efficiency is still more obvious.

3.2 SFA regression result in the second stage

Using Frontier 4.1 software, regression analysis was performed on the input slack variables calculated in the first stage using data from 2021, and the results are shown in Table 3.

The above data show that disposable income per capita, GDP per capita and population density have significant effects on the slack variables, indicating that their environmental variables have a greater impact on the efficiency evaluation, so it is necessary to remove the effects of environmental variables.

3.3 DEA empirical results after adjusting input in the third stage

Taking the data of 2021 as an example, the technical efficiency, pure technical efficiency and scale efficiency of the first stage and the third stage are compared and analyzed, which leads to Table 4.

According to Table 4, it can be seen that most of the county-level cities have changed in terms of ranking and efficiency values, among which Cixi and Dongyang have always remained relatively effective; In terms of changes in technical efficiency value and pure technical efficiency value, most counties saw an increase in technical and pure technical efficiency values after adjustment, while only Yuhuan and Yongkang cities' efficiency values decreased. The number of counties that reached effective technical efficiency increased after the adjustment, and it can be said that these counties were influenced by the poorer economic environment in the first stage, which yielded lower technical efficiency results, not because of differences in their technical management level with other regions.

3.4 The main conclusions of the model measurement.

First, the overall level of tax collection and management efficiency is not high. The average value of the technical efficiency of these 12 county-level cities in 2017-2021 is 0.73, which is in the more

Table 3 SFA regression results

	Coefficient value	SD	T test value
Number of tax practitioners lack variable			
Constant value	-55.06***	1.00	-55.06
Disposable income per capita	0.16*	0.00	1.66
GDP per capita	-0.08*	0.00	-1.64
Degree of external openness	0.40*	0.52	1.78
Density of population	0.16	0.25	0.64
sigma-squared	10156.01***	1.00	10156.01
gamma	1.00***	0.00	2017.87
Value added of secondary and tertiary lack variable			
Constant value	-4625061.50***	1.00	-4625061.50
Disposable income per capita	149.95***	1.43	105.14
GDP per capita	-47.42***	0.91	-52.00
Degree of external openness	10742.64***	1.00	10742.36
Density of population	150.68***	0.99	151.66
sigma-squared	16321493000000.00***	1.00	16321493000000.00
gamma	1.00***	0.00	2052036.30
Concentration of tax sources lack variable			
Constant value	-10.3235***	2.9060	-3.5524
Disposable income per capita	0.0001	0.0001	0.5937
GDP per capita	0.0000	0.0001	-0.9829
Degree of external openness	0.0128	0.0205	0.6256
Density of population	0.0140*	0.0087	1.6551
sigma-squared	69.0407***	1.0226	67.5133
gamma	1.0000***	0.0000	10136529.0000
GDP lack variable			
Constant value	-4446163.90***	1.00	-4446186.40
Disposable income per capita	148.68***	33.51	4.44
GDP per capita	-50.52*	47.67	-1.66
Degree of external openness	11231.60***	0.83	13596.74
Density of population	427.46***	1.22	349.41
sigma-squared	17777817000000.00***	1.00	17777817000000.00
gamma	1.00***	0.00	17893.23

T is the indicator to test if explaining variable has significant impact on explained variable; *** represents the test with 1% significance level; ** represents the test with 5% significance level; * represents the test with 10% significance level.

Table 4 The comparison of stage 1 and stage 3 efficiencies in 2021

DUM	The first stage efficiency value				The third stage efficiency value			
	TE	PTE	SE	TE Rankings	TE	PTE	SE	TE Rankings
Cixi	1.000	1.000	1.000	1	1.000	1.000	1.000	1
Yiwu	0.791	1.000	0.791	3	0.920	1.000	0.920	3
Yuyao	0.482	0.619	0.780	7	0.684	0.838	0.816	6
Zhuji	0.370	0.670	0.553	9	0.373	0.673	0.554	11
Yueqing	0.357	0.619	0.577	10	0.439	0.759	0.578	9
Haining	0.653	0.882	0.740	5	0.807	1.000	0.807	4
Tongxiang	0.513	0.769	0.666	6	0.609	0.913	0.666	7
Ruian	0.392	0.795	0.493	8	0.494	1.000	0.494	8
Yuhuan	0.336	1.000	0.336	11	0.286	0.904	0.317	12
Wenling	0.332	0.685	0.484	12	0.425	0.879	0.484	10
Dongyang	1.000	1.000	1.000	1	1.000	1.000	1.000	1
Yongkang	0.774	1.000	0.774	4	0.693	0.905	0.765	5

TE is technical efficiency; PTE is pure technical efficiency; SE is scale efficiency; $TE=PTE \times SE$;

effective range of 0.5-0.8. The overall efficiency level is not high, and the polarization is serious. For example, Zhuji and Yuhuan are in the relatively ineffective range of 0.5, while Cixi and Dongyang are in the relatively effective range of 1.0. It can be seen that the efficiency level of tax collection and management has room for improvement.

Secondly, the level of tax administration efficiency is not always positively correlated with the regional economic strength. The tax collection and administration efficiency of Cixi City, which ranks first in terms of comprehensive strength, is 1.0, which is absolutely superior, while the tax collection and administration efficiency of Zhuji City, which ranks fourth in terms of comprehensive strength, ranks eleventh among 12 county-level cities. It can be seen that many county-level cities with strong economic strength still have more room for improvement, which is worthy of our research and improvement.

4 Analysis of the problems of tax collection and management efficiency of Yiwu Taxation Bureau

4.1 General overview of tax collection and management

Yiwu Taxation Bureau was officially listed in 2018, marking the official merger of state and local taxes in Yiwu. Yiwu Tax Bureau has 7 branch bureaus (offices), which are responsible for the collection and management of central tax, shared tax, local tax and other related taxes and fees in the jurisdiction. Tax revenues and growth rates for 2017-2022 are shown in Figure 1:

4.2 General characteristics of tax collection and management in Yiwu

In this context, the pain points and blockages of tax collection and management in Yiwu are: First, Yiwu market-oriented, many small and micro enterprises, tax compliance is not high, and many do not issue invoices, in the current mode of tax control by ticket, the tax authorities are difficult to effectively access the actual transaction data of taxpayers, tax collection and management is difficult. Secondly, some of the individual households with online goods adopt virtual registration, cluster registration and other modes without regular offline business address, and at the same time, online goods are usually traded through e-commerce platforms, which are mostly concentrated in big cities such as Hangzhou and Shenzhen, so there is a lack of effective grasp for tax collection and

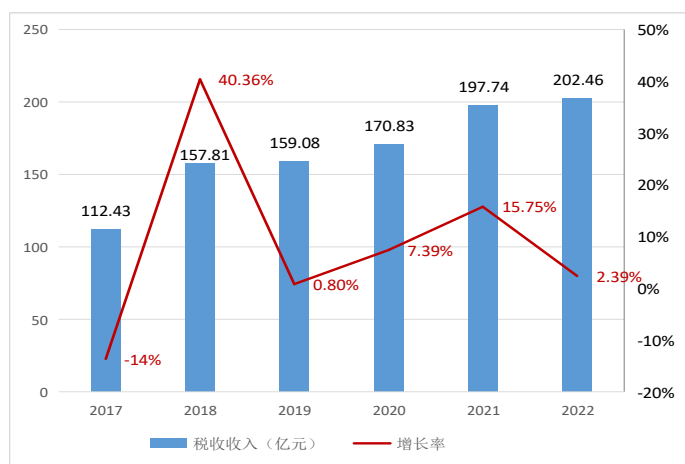


Figure 1 Tax Revenue and Growth Rate of Yiwu, 2017-2022

management. Thirdly, there are still some domestic areas of personal tax business income approved levy, such as Yiwu for individual households for strict levy control, it may lead to the loss of a large number of individual households, the development of Yiwu market for small and medium-sized enterprises as the main cause of adverse effects.

4.3 Analysis of the problem of tax collection and management efficiency of Yiwu Taxation Bureau

From the above empirical analysis data, it can be obtained that the average value of technical efficiency of tax collection and administration in Yiwu in the past five years is 0.881, which still has a large room for improvement. By comparing with Cixi and Dongyang, which have higher overall efficiency values, we can analyze the following problems in tax collection and management efficiency in Yiwu.

First, the allocation of tax administration resources is uneven and the organizational structure is unreasonable. The empirical results show that there is a negative correlation between tax collection and administration efficiency and tax practitioners, which to a certain extent manifests the current redundancy of tax practitioners' input. As a direct input cost of tax collection and management activities, tax practitioners reflect the reality that Yiwu Taxation Bureau is facing high tax collection and management costs. However, compared with the county-level cities such as Cixi and Dongyang, the per capita volume of tax practitioners in Yiwu Taxation Bureau is much larger, and simply reducing the number of tax practitioners not only cannot alleviate the current problem of inefficient tax collection and administration, but also will cause a further decrease in efficiency. The reason for this phenomenon may be that the organizational structure of Yiwu Taxation Bureau is not reasonable enough.

Secondly, the tax source growth rate is too fast, the collection and management force is weak. Yiwu has a total of 898,000 market entities in 2022, an increase of 137%. Compared with Cixi City, which ranked first in Zhejiang Province in terms of economic output during the same period, the average annual growth rate was only 37.2%, and Dongyang City's average annual growth rate was only 13.9%. It can be seen that the excessive growth rate of tax sources has brought certain obstacles to the improvement of tax collection and management efficiency in Yiwu. The main reason for this problem is the weak tax collection and management force. On the one hand, Yiwu Taxation Bureau has nearly 1,000 households per capita, which is three times more than the average

of the province, inevitably resulting in the phenomenon of levy leakage, omission or inappropriate management of enterprises; on the other hand, the age of tax collection personnel in Yiwu is polarized, and the phenomenon of aging of personnel is very serious, which seems to be insufficient energy under the huge pressure of household management and cannot adapt to the modern way of household management.

Thirdly, the type of controlled households is complicated and the tax compliance is not high. Yiwu enterprises are mainly foreign trade export, small processing and labor-intensive enterprises, and most of the taxpayers are individual industrial and commercial households. Due to various reasons, individual industrial and commercial taxpayers often cannot establish sound books of accounts, which makes it very difficult for the levy administrators to manage their declarations, and this part of taxpayers creates tax revenue of about 276 million per year, accounting for only 2.4% of tax revenue, but needs to invest about 30% of levy administration resources for management services, which to a certain extent causes waste, and to some extent also shows that taxpayers in this industry The general tax law compliance is not high, and the quality and efficiency of declaration is low.

Fourth, the cost of collection is too high, and the collection and management techniques need to be improved. Specifically, one is that the tax collection and administration in Yiwu relies more on the traditional forms of field visits, SMS and telephone reminders and reminders to issue notices such as reminder and order to make changes, which are not effective and costly. Secondly, individual taxpayers in Yiwu choose to deal with tax-related affairs at home more often than relying on the network taxation platform such as electronic tax bureau, which leads to the slow promotion of the informationization level of tax collection and management. For taxation authorities, the more taxpayers visit their homes to deal with tax-related matters, the higher the cost of collection will be.

5 Suggestions to improve the efficiency of tax collection and administration of Yiwu Taxation Bureau

5.1 Optimize the tax organization structure

The empirical results show that there is a negative relationship between tax administration efficiency and the number of tax practitioners, and the more the number of tax practitioners, the lower the tax administration efficiency. Yiwu Taxation Bureau is facing the problems of high cost of tax collection and administration and large amount of taxation personnel per capita, which cannot be solved only by increasing or decreasing the number of taxation personnel, but should optimize the taxation organization structure. Firstly, it should reasonably control the number of tax practitioners, actively introduce and outsource social specialized tax talents through the way of government purchasing services, enhance the accuracy and target of personnel expenses, and reduce unnecessary personnel costs so as to improve the efficiency of tax collection and administration. Secondly, the tax service industry should be actively developed. It should learn from the practice of the United States and other countries to give full play to the professional tax service industry, which can not only greatly improve the accuracy of the daily tax-related business of enterprises such as tax declaration, but also enable the taxation department to hand over a large amount of transactional work to tax intermediaries, thus enhancing the efficiency of tax collection and administration.

5.2 Strengthen the management of tax sources

The main body of taxpayers in Yiwu is scattered and the number of tax sources is huge. On the

one hand, the management mode of managing households has not been able to adapt to the tax collection and management of such a huge volume of taxpayers in Yiwu, and on the other hand, the uneven distribution of current tax collection and management resources by each branch (institute) of Yiwu Taxation Bureau has resulted in inefficient tax collection and management. To this end, a risk-oriented tax source classification and management system should be established. Combining with the actual situation of Yiwu, according to the industry characteristics and scale level of taxpayers, the city's taxpayers can be divided into key tax source enterprises, general tax source enterprises and individual double-determined tax sources. The key tax source enterprises implement specialized management, general tax source enterprises implement standardized management, and individual industrial and commercial households implement socialized management to improve the efficiency of tax collection and management in a targeted manner.

5.3 Sound tax service system

Broaden the way of tax service. By shifting the focus to the construction of information platform, we do a good job of tax service through various ways, for example, combining 12366 tax service platform, official WeChat public number, electronic tax bureau, short video app and other channels to realize multiple ways of tax service. First, to use the channels to innovate business. Through the form of multimedia, we implement the appointment system or provide taxpayers with the nearest tax processing organizations and the current number of people waiting for tax processing for reference, while the process, information submission and progress of tax processing are disclosed to taxpayers through the channels to improve taxpayers' trust. Secondly, the identity of taxpayers is differentiated and screened. For taxpayers with high tax compliance, when accepting tax matters, it can simplify part of the tax processing process or tax processing information, adopt fault-tolerant tax processing experience, handle instantly and reduce manual participation. For taxpayers with low tax compliance or special risk reminders, they are handled in accordance with relevant norms.

5.4 Accelerate the construction of tax information technology

This paper analyzes the technical efficiency of tax collection, and after three stages of revision the results conclude that the pure technical efficiency of Yiwu Taxation Bureau has reached DEA validity. This indicates that the pure technical efficiency of tax collection in Yiwu Taxation Bureau is roughly the same, but there is still room for improvement. Reforming the existing technology, innovating new technology of tax collection and giving full play to the effective combination of labor and technology can effectively improve the efficiency of tax collection and administration.

First, to improve the data collection and application capability. Through technical means, we strengthen the communication between various departments on tax data, actively innovate on the ways and means of data collection, and focus on obtaining tax-related information on turnover tax to better supervise the work of turnover tax. Secondly, it strengthens the management of basic tax collection and management information. On the one hand, it comprehensively optimizes and promotes the construction of electronic tax bureau, deeply integrates the innovative achievements of the Internet with taxation work, expands the application fields of information technology, and strives to solve the outstanding problems and deep-rooted conflicts in the current tax collection and administration. On the other hand, improve the basic information maintenance function of the cloud taxation service hall, which can update and maintain the basic levy management information in real time through joint high-tech enterprises.

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