

On the Human Capital Factors to Evaluate the Efficiency of Tax Collection Using Data Envelopment Analysis Method

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Abstract: This study focuses on the investigation of the influence of human capital factors on the tax collection efficiency. Literature review indicated that although the efficiency evaluation of tax collection has been discussed in previous study, the influence of human capital factors on the tax collection efficiency has seldom been addressed. Hence, the Data Envelopment Analysis (DEA) method has been employed to address this issue in this study. The innovation of this study lays on that the human capital factors have been taken into account in the efficiency evaluation of tax collection. To measure performance of the human capital factors in the tax collection, a case study in Wuhan city, China has been carried out. The DEA analysis results demonstrate that the tax collection efficiency increases with the increase of the number and higher education level of the tax officers and the higher education level of the tax officers still has a large room to improve. Then, relative improvement strategies have been proposed to strengthen tax collection efficiency. Hence, the findings of this study contribute to the body of knowledge in the efficiency evaluation of tax collection and its improvement measurement, which can be referred by other cities over the world.

Keywords: Data envelopment analysis, human capital factors, tax collection, tax revenue

INTRODUCTION

Since the tax system reform, China's tax revenue has been maintaining a rapid growth and tax revenue growth rate since 1997 is more than 10%. At the same time, we found that the level of China's Gross Domestic Product (GDP) growth rate is slightly lagging behind the extraordinary growth of the tax effect. With this phenomenon, some scholars have explained as follows: the impact of economic factors, policies and special factors, management factors, tax virtual income factors. However, tax virtual income is an uncertainty issue and in fact is not easy to provide precise statistic. Economic factors include economic growth and the impact of 2 aspects of changes in industrial structure. Strengthening tax collection is the most direct cause of promoting the growth of tax revenue. The financial expenditure pressure caused by the implementation of proactive fiscal policy in the late 1990s and the system efficiency caused by tax system reform are two factors contributed to the strengthening of tax collection and the inner driving force. However, in the existing research on "Strengthening the collection and management to promote the growth of tax revenue for the collection and management efficiency estimation" it mostly uses qualitative research methods instead of quantitative study. Literature review indicated that limited work has

been done on this issue of quantitative study on tax collection and efficiency estimation in China. The reason is that the stripping factors and economic factors are difficult to determine in practice and it is difficult to make an accurate quantitative analysis. However, the quantitative study seems to be more important than the qualitative research in this case of tax collection and efficiency estimation because it provide specific description of the current situation of tax collection and hence could suggest direct solutions and maintenance to improve the tax revenue.

As for the quantitative study for the efficiency evaluation of tax collection, the Data Envelopment Analysis (DEA) has been proven to be very useful to address this issue. DEA was proposed by Charnes *et al.* (1978) and modified by Banker *et al.* (1984) and aims to deal with frontier analysis between inputs and outputs in a linear manner. Since DEA does not need priori information about the connection between inputs and outputs, it has been received a good deal of attention and has been used in a various applications. Kerstens (1996) has investigated the technical efficiency of French urban transit companies using DEA. Singer *et al.* (2002) have used the DEA to research the semi-autonomous planning for Chilean General Treasury. Kim and Kim (2005) have used DEA to discuss the technical efficiency factors in the use of

polluting inputs. Li (2008) has established the analysis model on the property right of mineral resources using DEA for trade market in China. Wu *et al.* (2009) have taken China Unicom as an example to evaluate the operation efficiency of firm's financial indexes and benchmark selection using DEA method. Whittaker *et al.* (2009) has adopted a hybrid genetic algorithm for multi-objective problems using DEA. Liu and Ren (2009) have proposed the improved DEA model to evaluate CPVVA model. These previous work has suggested that DEA is powerful for the efficiency evaluation in the real world. As a result, it is wise to use the DEA to evaluate the efficiency of tax collection.

In this study, the DEA method is adopted to deal with the efficiency evaluation of tax collection. The innovation of this study is that the human capital factors have been taken as the inputs of the DEA to investigate the efficiency of tax collection. These factors include the levels of education and numbers of the tax staffs, etc. A case study has been carried out by the use of historical data of Wuhan City of China. The analysis results show that the levels of education play a critical role in the efficiency of tax collection in Wuhan, China. Hence, some strategies have been proposed to strengthen efficiency of tax collection according to the DEA results.

THE PROPOSED ANALYSIS METHOD BASED ON DEA MODEL

DEA algorithm: Data envelopment analysis model (DEA model) is a statistical analysis method, which is based on a set of observed values on the input-output to estimate the efficient production frontier. In economics and econometrics, it is estimated that production frontier is commonly used statistical regression and other statistical methods. These methods estimate the production function which did not show the actual frontier, so the function is actually non-effective. This is because the estimation is confused with effective decision-making unit and non-effective decision-making unit. In addition to the DEA method, there are other methods in the evaluation of the effectiveness of those methods which are exclusively limited to a single output. In contrast, DEA method can handle multi-input; in particular DEA has an absolute advantage in the ability of handling multi-output (Sun and Lu, 2005; Sexton *et al.*, 1986; Jahanshahloo *et al.*, 2011). Wong and Wong (2008) and Mahdiloo *et al.* (2011) have listed some features of DEA as follows:

- DEA is very effective to evaluate the relative efficiency of Decision Making Units (DMUs) under multiple inputs and outputs
- Performance evaluation can be done by DEA with the use of the concept of efficient frontier

- DEA is able to work without prior information on the inputs and outputs
- Subjective estimation can be well avoided by DEA

People's productive activities and social activities often encounter this problem: after a period of time, departments or units with the same type (i.e., DMUs) to evaluate the basis for the assessment of decision-making unit "input data" and "output data". Input data is some amount of decision-making unit need to be consumed in certain activities, such as the total amount of capital invested, number of total labor input, floor area and so on; while the output data is the decision-making unit after a certain input, that the effectiveness of the activities of certain amount of information, such as the number of different types of products, quality of the products, economic efficiency and so on. For example, in evaluating a city's colleges and universities, the input can be the school's annual funding, the total number of faculty members, the total area of the teaching space, all kinds of titles, the number of teachers, etc. The output can be the number of training doctoral students, the number of post-graduate students, the number of graduate students, the teaching load of teachers, scientific research (quantity and quality) and so on.

When using Charnes *et al.* (1978) DEA method (i.e., the scale of production of DMU is a constant) to study the efficiency of tax collection, the output is the tax revenues described as tax output vector Y^t ; the input is the elements that affect the tax revenue described as tax input variables X^t . The relationship of tax output variables and the tax input variables constitutes the efficiency of tax collection, which can get:

$$S^t = u^T Y^t / v^T X^t \quad (1)$$

where, u and v are the weighting coefficients of the input and output, respectively.

Then select the appropriate weighting coefficients to satisfy the maximization of the efficiency of tax collection:

$$\max (S^t) = v_p \quad (2)$$

where, v_p subjects to the following constrains:

$$\begin{cases} h_i = \frac{u^T Y_i^t}{v^T X_i^t} \leq 1, (i = 1, 2, \dots, N) \\ v \geq 0, u \geq 0 \end{cases} \quad (3)$$

If we add the following constrain in Eq. (3):

$$\sum v = 1 \quad \text{and} \quad \sum u = 1 \quad (4)$$

then, Banker *et al.* (1984) DEA (the scale of production of DMU is variable) is obtained.

The proposed DEA model: In this study, the human capital factors are introduced as the inputs of DEA and a new analysis model is established. The new model is presented as below.

Tax revenue is involved with the quantity and quality of the tax input sources, input of the tax authorities, including investment in human capital, as well as tax services and tax advocacy. Tax services and tax advocacy cannot be reflected in the data. Human capital factors can be reflected by the quantity and quality level of the tax officials.

In the actual tax collection, tax officials are often in-depth enterprise to impose, or to accept the taxpayer's consulting and pay taxes directly in the tax lobby. At this point, it requires an appropriate number of tax officers. If the tax is relatively small, then each tax officials needs to share a greater number of enterprises. The workload for them is relatively large, then the work efficiency will be affected and the quality of service and accuracy of the tax will also have adverse consequences. On the contrary, if the tax is too much, it is easy to form the redundancy of the job and could easily lead to overstaffing situation, also hinder the collection and management of efficiency improvements. In view of the uncertainty of tax collection efficiency, we propose the following hypothesis:

Assumption 1: The number of tax officers is proportional to the efficiency of tax collection.

The quality of tax officials has a major impact on the efficiency of tax collection. When taxpayers are in the tax hall to face the tax staff, if tax staff service attitude is not good enough, or professionalism is not high enough, then the taxpayer will feel more irritable. As a result, collection and management efficiency will be greatly reduced. If the tax officials are able to maintain service with a smile and resolve taxpayers' questions in time and professionally, it will reduce the taxpayers' tax time, then the efficiency will be greatly increased. The degree of tax culture can better reflect their professionalism and in this point, we propose the second assumption:

Assumption 2: The higher education level of the tax officers will help improve the efficiency of tax collection.

This study selects the output indicators of tax revenue as tax DEA model. Taking into account the basic situation in Wuhan City, the tax input costs such as office funds invested for tax authorities and taxpayers' compliance costs are not easy to measure. Therefore, in addition to the human capital factors of the number and educational level of the tax officials, we

also selected some other control variables as shown below:

- **Gross Domestic Product (GDP):** GDP reflects the overall size of a regional economy. There is no doubt that it has an important influence on the size of the tax. GDP is an important indicator of the region's economic vitality and economic size. The higher the GDP is, the more sources of revenue quality are. As a result, it has a positive impact for the region's tax revenues.
- **The share of GDP of secondary industry and tertiary industry:** According to the theory of development economics, economic growth can be understood as a comprehensive upgrade of industrial structure. The process of economic growth is the process of industrial structure developing from low to high level. In general, along with economic development, the evolution of industrial structure from industry, the proportion of dominant to the second, the direction of the dominant proportion of tertiary industry evolution. As tax sources mostly concentrate in the second and tertiary industries, in the case of certain economies of scale, the higher of the two industries share of GDP, the more developed of the region's economy, the greater of the potential tax revenue.
- **The operating surplus to GDP ratio:** Regional Gross Domestic Product (GDP) consists of workers' compensation, depreciation of fixed assets, net taxes on production and operating surplus of composition. The operating surplus is equivalent to a regional enterprise operating profit plus subsidies on production, but deduces wages, benefits and net of expenses from the profits and so on. Operating surplus share of GDP can be approximated to describe the level of economic benefit of the region and it has an important impact on the tax, especially the corporate income tax.

CASE STUDY

Up to date, an increasing number of local governments of China have begun adopting and employing new indicators to evaluate the tax collection efficiency. These years China's tax revenue has been kept a high increase tendency. In 2008, China's tax revenue was 5,420 billion CNY. During 1994 to 2008, the increase rate of China's tax revenue is 16.5%, which is far larger than the increase rate of China's GDP. So, how the role of tax collection efficiency plays in China's tax revenue and how to measure this effect have been recognized and broadly adopted by many local governments of China in the procedure of their tax collection reports. For example, in July 2011, more than 20 local governments of China discuss the common

guideline of how to construct new indicators to regular the tax collection.

There is substantial body of literature that discusses efficiency evaluation of tax collection. Earlier researches adopted somewhat less systematically investigations due to the difference between theoretic and practice (Wang and Li, 2009; Yang *et al.*, 2006). For example, Yang *et al.* (2006) calculated the tax collection efficiency using the data of 29 provinces in China. However, their calculation results and conclusions cannot be verified by other small cities. Wang and Li (2009) investigated the relationship of the tax revenue and GDP and pointed out that the improvement of tax revenue is determined by the increase rate of GDP. The problem in their work is still that no extra data can be used to verify this conclusion. Han (2008) discussed the relationship between the human resource and individual tax income. However, the human capital factors involved with the tax collection have not taken into account in his study. In order to evaluate tax collection efficiency, it is critical to identify and understand the human capital factors valuation. In addition, the analysis shall start in a small city because a city case study always behaves as a specific case in a province case study. The analysis data in a city is more precise and abundant than a province. As a result, the analysis of a city is more reliable than a province and the generalization of the analysis results is better. Hence, in this study, the efficiency evaluation of tax collection in Wuhan city of China has been taken as the research objective. The proposed DEA model has been employed to analyze the statistical data of Wuhan city taking human capital factors into account.

The statistical data on the tax revenue of Wuhan city from 2008 to 2011 has been adopted in the tax collection efficiency analysis in this study. Table 1 shows the tax revenue of Wuhan from 2008 to 2011.

As mentioned in Section 2, the human capital factors of the tax officers will influence the efficiency of tax collection greatly. Hence, in this study the higher education level and total number of tax officers in Wuhan city have been introduced into the efficiency evaluation of tax collection. Table 2 shows the distribution of these two parameters in the statistical data on the tax revenue of Wuhan city from 2008 to 2011.

It can be seen in Tables 1 and 2 that with the increase of the number and higher education level of the tax officers, the tax revenue of Wuhan city increases year by year. It is also noticeable in Table 1 that the share of GDP of secondary industry and tertiary industry increases every year. It suggests that the industrial structure of Wuhan city becomes better and better. As a result, the influence of the human capital factors of the tax officers and the share of GDP of secondary industry and tertiary industry has mixed with each other and it is difficult to evaluate them

Table 1: Tax revenue of Wuhan from 2006 to 2011

Year		Amount (billions: CNY) (%)
2008	Tax revenue	23.3
	Operating surplus to GDP ratio	22.7
	Secondary industry and tertiary industry	17.6
2009	Tax revenue	38.2
	Operating surplus to GDP ratio	28.1
	Secondary industry and tertiary industry	22.5
2010	Tax revenue	59.5
	Operating surplus to GDP ratio	29.2
	Secondary industry and tertiary industry	33.7
2011	Tax revenue	71.2
	Operating surplus to GDP ratio	32.8
	Secondary industry and tertiary industry	45.3

Table 2: Human capital factors of the tax officers in Wuhan from 2008 to 2011

Year	Number	Higher education level (%)
2008	5987	44.3
2009	6230	50.6
2010	6503	55.7
2011	6702	62.3

accordingly. Therefore, it is crucial to evaluate the impact of human capital factors of the tax officers in the efficiency of tax collection.

In this study, the DEA has been employed to deal with the efficiency evaluation of tax collection in Wuhan city. The analysis results will provide reference to the efficiency evaluation of tax collection in other places in China. Herein, the DEA method has been used to analyze the input and output of the tax data of Wuhan city during 2008 to 2011. The inputs are the mentioned five items (i.e., tax revenue, operating surplus to GDP ratio, secondary industry and tertiary industry, number and higher education level of the tax officers), as well as the GDP. The output of the DEA model is the tax collection efficiency. In the DEA processing, we have analyzed the inputs and output under different assumptions. These conditions include envelopment analysis and multipliers analysis. In addition to Charnes *et al.* (1978) DEA method, Banker *et al.* (1984) DEA (the scale of production of DMU is variable) has also been employed to compare with the DMUs with constant scale of production. Figure 1 to 4 show the DEA analysis results, where the 1st to 6th DMU indicate the inputs of GDP, tax revenue, operating surplus to GDP ratio, secondary industry and tertiary industry, tax officers number, higher education level of the tax officers.

It can be seen in Fig. 1 and 2 that the efficiency curves of DEA with Constant Returns to Scale (CRS) changes obviously while the efficiency curves using DEA with Variable Returns to Scale (VRS) do not change much. It demonstrates that the human capital factors influence significantly in the tax collection and hence these factors cannot be regarded as equal as other inputs, such as GDP, etc. As a result, the Charnes

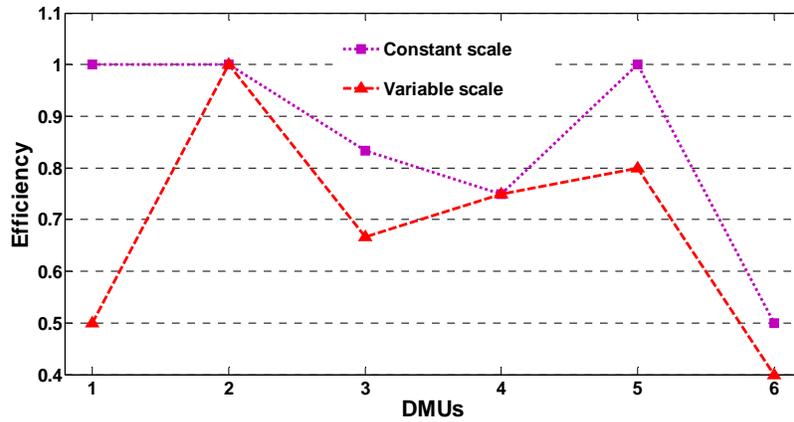


Fig. 1: Input analysis of tax collection efficiency using envelopment analysis

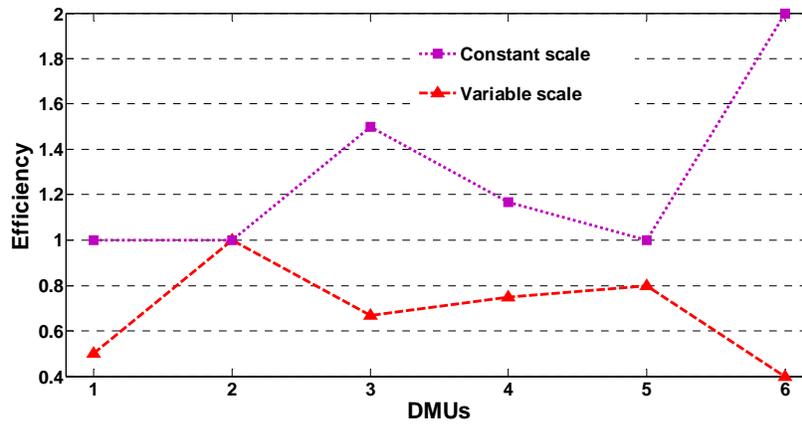


Fig. 2: Output analysis of tax collection efficiency using envelopment analysis

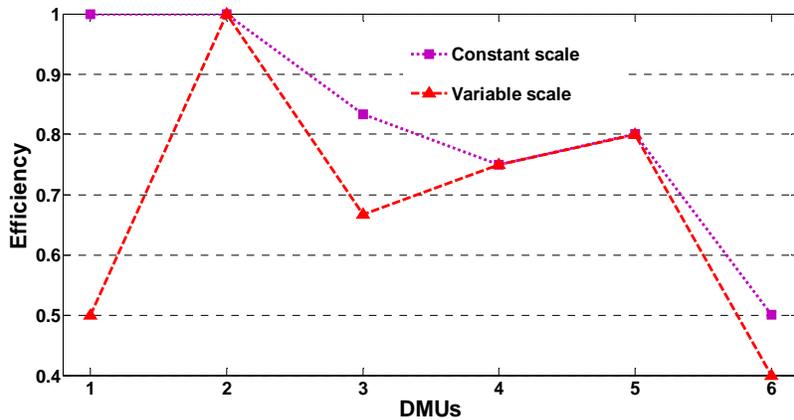


Fig. 3: Input analysis of tax collection efficiency using multipliers analysis

et al. (1978) DEA method is not suitable for this situation and the Banker *et al.* (1984) DEA seems to be more effective. The same observations can also be found in Fig. 3 and 4.

It is evident in Fig. 1 to 4 that the Banker *et al.* (1984) DEA provides consistent results in the

input/output analysis for the tax data of Wuhan city. In addition, the envelopment analysis and multipliers analysis provide similar results. It can be seen in Fig. 1 to 4 that the efficiency of the DMU of tax revenue is relatively highest to the other five DMUs. The efficiency index reaches to 1.0, which suggests that the

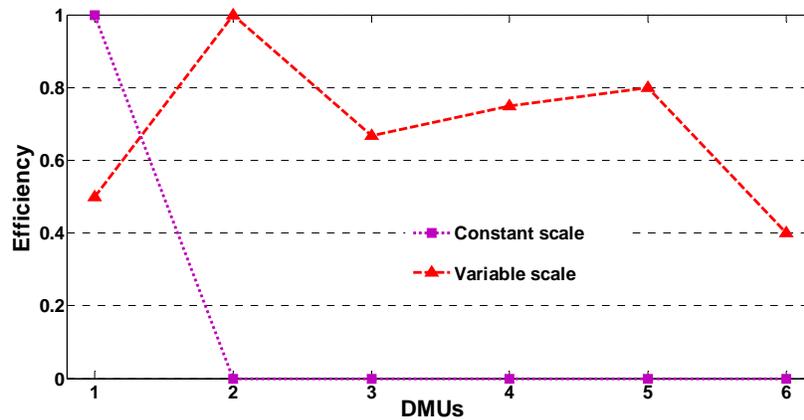


Fig. 4: Output analysis of tax collection efficiency using multipliers analysis

tax revenue structure in Wuhan is very reasonable and VRS usefulness. Although the efficiency index of DMU of tax officers number is not equal to 1.0, it presents a very high level and hence the tax officers number in Wuhan is in a reasonable position and there is no need to increase the tax officers number. However, the efficiency indexes of DMUs of operating surplus to GDP ratio, secondary industry and tertiary industry and higher education level of the tax officers are not as good as desired. Especially for the higher education level of the tax officers, the efficiency index presents a worst one among the 5 DMUs. This means the higher education level of the tax officers still has a large room to improve. Moreover, since the improvement of the higher education level of the tax officers has positive role in the increase of tax revenue, it is imperative to promote the whole higher education level of the tax officers in Wuhan city. By doing so, not only the efficiency of human factors can be improved, but the tax collection and the local economy.

CONCLUSION AND STRATEGIES

The human capital factors are considered to contribute in the tax collection. However, limited work has been done to address this problem. To deal with this problem, the DEA has been adopted to investigate the influence of human capital factors on the tax collection efficiency. A case study has been implemented in Wuhan city of China. Both the DEA with CRS and VRS have been used in the tax data analysis. The DEA analysis results show that the Banker *et al.* (1984) DEA model with VRS structure is more suitable than Charnes *et al.* (1978) DEA in the efficiency evaluation of tax collection by taking human capital factors into account. It finds from this case study that the tax collection efficiency increases with the increase of the number and higher education level of the tax officers and the higher education level of the tax officers still has a large room to improve. Hence, to improve the tax

collection efficiency, it is believed that the following strategies can be adopted:

- Provide opportunities for tax officers to promote their higher education level
- Enhance the secondary industry and tertiary industry to achieve a better industrial structure
- Put forward strict polices to maintain the tax officers number in the best situation

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