# The Impact of the Digital Economy on Regional Tax Administration Efficiency

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**Abstract:** Based on the DEA-Malmquist model, the regional tax administration efficiency of 31 provinces in China from 2011 to 2020 is measured and dynamically analyzed to further explore the impact of the digital economy on the regional tax administration efficiency. China's tax administration efficiency has relative efficiency differences among regions, and tax administration efficiency needs to be improved. Further, using the panel Tobit model, a multi-level empirical analysis was conducted on the impact of the digital economy on the efficiency of tax administration, and the regression results showed that the digital economy and fiscal level had a significant positive impact on the efficiency of tax administration. Based on this, we think about improving the efficiency of local tax administration by strengthening technological innovation in tax administration; rationally and effectively allocating the digital economy, and strengthening the use of digital taxation to govern taxes.

**Keywords:** the digital economy; regional tax administration efficiency; DEA-Malmquist model; Tobit panel model

## 1 Introduction

At present, with the rapid development of the digital economy and the establishment and improvement of infrastructure, the digital economy provides financial services with the characteristics of broad service scope, civilian service targets, and precise risk control. The construction of a modern economic system is inseparable from the development and application of big data. So, can the digital economy improve the efficiency of local tax collection and management and promote the modernization of tax collection and management? According to the state's clear goal of modernization of tax collection and management, the implementation and construction of the golden tax project, the merger of national land tax and smart taxation have provided new momentum for the reform of the tax collection and management model, so the analysis of the improvement of tax collection and management efficiency and the causes of impact in the new situation is crucial.

Some scholars in China have achieved a lot of research on the efficiency of tax collection and management, and some scholars have discussed the development of Internet technology and the integration of tax collection and management based on the theoretical level, and proposed to

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improve the ability to use data and reduce the cost of tax collection (Yang et al., 2020) and the analysis of the new interactive relationship between tax compliance and tax services (Ma, 2020) to improve the efficiency of tax collection and management; another group of scholars from the empirical perspective of regional tax collection and management efficiency under different evaluation methods, the mainstream research methods are analysis based on the quartile DEA-Malmquist (Zhang, 2018) and analysis methods based on the Malmquist index (Yang, 2010) based on the frontier analysis (SFA) technology of the machine (Wang et al., 2009), it is known that the efficiency of tax administration in various regions shows a scale difference.

In the research of digital economics, some scholars have studied economic growth and social security (Wang et al., 2020) affecting the gap between household consumption (Yi et al., 2018), individuals Entrepreneurship (Xie et al., 2019), real economy [1] and other perspectives impact of digital inclusion on it (Zhou et al.,2021) [7], few works of literature on the impact of the digital economy on the efficiency of local tax administration, some scholars from the following perspectives to explore digital universality impact of finance on taxation. For example, Zhong (2019) [6] believes that the tax incentives of China's digital inclusive finance rely on policy documents, lack systematic considerations, their content design is relatively rough, and the fairness and security of tax incentives are insufficient Criminals rely on the cloak of digital inclusive finance to evade taxes, evade taxes, and evade taxes. There is also a view that digital financial inclusion has achieved regional tax revenue growth through increased coverage and deepening of mobility and facilitation [5]. Combing the literature, it can be seen that there is little literature on the impact of the digital economy on the efficiency of local tax administration. Based on the above analysis, this paper proposes the following hypothesis:

Hypothesis 1: The development of the digital economy has promoted the efficiency of local government tax administration.

Hypothesis 2: The development of the digital economy has widened the gap in tax administration efficiency between regions.

Based on this, this paper empirically examines the impact of the digital economy on the efficiency of tax administration. The DEA-Malmquist model is used to measure and decompose the tax administration efficiency of 31 provinces in China, and the tax administration efficiency are analyzed from a dynamic perspective, and then the panel Tobit regression model is used for analysis the impact of the digital economy on the efficiency of tax administration will accelerate the overall improvement of tax administration, and put forward reasonable counter measures and suggestions for further strengthening the modernization of tax administration.

## 2 Research methods and data sources

### 2.1 DEA Model Building

Data envelopment analysis (DEA) is an effective tool for evaluating input-output efficiency by comparing it with the production frontier. Therefore, this paper draws on the practices of scholars such as Guan (2020) [3] to evaluate the efficiency of tax collection in each region of China using data envelopment analysis, the expression of which is:

$$\min\left[\theta-\varepsilon\left(\sum_{i=1}^{m} si^{-}+\sum_{r=1}^{n} s\,r^{+}\right)\right]$$

$$\sum_{j=1}^{I} x_{ij}\lambda_j+si^{-}=\theta_{xi}k\,,\sum_{j=1}^{I} y_{rj}\lambda_j-sr^{+}=y_rk$$

$$\textstyle\sum_{j=1}^{I}\lambda_j=1\ ,\lambda_j,si^{-},sr^{+}\geq 0,j=1,2,\dots n \tag{1}$$

In equation (1): Assume that the BBC model has multiple decision making units (DMU), wherein the input value $x_{ij}$for $DMU_j$the ith, $x_{ij}\geq 0$the $y_{rj}$ output value $DMU_j$ of the rth item$y_{rj}\geq 0,\theta$, which is the target value, $\lambda_j$ is the planning decision variable, $\varepsilon$is the non-Archimedean infinitesimal, $si^{-},sr^{+}$is the relaxation variable vector; if $\theta$= $1s^{-}=0,s^{+}=0$, then the decision unit DEA is valid; if $\theta$< 1, the decision unit DEA is invalid·

**Malmquist Productivity Index:** Malmquist (1953) first introduced the Malmquist index in the process of consumption analysis. This paper draws on the Malmquist productivity index proposed by Caves et al (1982), which can be decomposed into the product of efficiency changes and technological progress and can be expressed as:

$$\boldsymbol{M(x^{t+1},y^{t+1},x^{t}y^{t})}=\sqrt{\frac{\boldsymbol{D^{t}(x^{t+1},y^{t+1})}}{\boldsymbol{D^{t}(x^{t},y^{t})}}\times\frac{\boldsymbol{D^{t+1}(x^{t+1},y^{t+1})}}{\boldsymbol{D^{t+1}(x^{t},y^{t})}}}$$

$$Effch=[\tfrac{D^{t}(x^{t+1},y^{t+1})}{D^{t}(x^{t},y^{t})}] \tag{2}$$

$$Tech=[\frac{D^{t}(x^{t+1},y^{t+1})}{D^{t+1}(x^{t+1},y^{t+1})}\times\frac{D^{t}(x^{t},y^{t})}{D^{t+1}(x^{t},y^{t})}]$$

$$Tfpch=Effch\times Tech=(Pech\times Sech)\times Tech$$

In equation (2), $Effch$ represents the change in efficiency, $Tech$represents technological progress. If $Effch$>1, it indicates that an improvement in efficiency; if $Effch$< 1, it indicates no improvement in efficiency; and $Tech$ indicates the degree of change in production technology. If $Tech$ >1, it means that the production technology has improved, and vice versa, it means that there is no trend of improvement in the production technology.

### 2.2 The Tobit Regression Model

The Tobit regression model was constructed to examine the impact of the digital economy on tax administration efficiency by regressing the DEA-measured regional tax administration efficiency values. The specific model is:

$$Y_{it} = \begin{cases} \beta X_{it} + \beta_1 Z_{it} + u_i + \varepsilon_{it}, & \beta X_{it} + \beta_1 Z_{it} + u_i + \varepsilon_{it} > 0 \\ 0, otherwise \end{cases} \quad (3)$$

In equation (3), the $Y_{it}$ is the DEA-measured regional tax collection efficiency value; the $X_{it}$ is the matrix of explanatory variables; the $Z_{it}$ is the matrix of control variables; $\beta$ and $\beta_1$ are the regression parameter vectors; $i$ and $t$ are province and year respectively, $u_i$ denotes individual effects and $\varepsilon_{it}$ is the error term.

### 2.3 Selection of Indicators and Data Processing

**Construction of Input-output Indicators:** Regional tax administration efficiency is measured using DEA, an output-oriented data envelopment analysis commonly used by scholars, and the construction of an input-output index system is an important part of measuring tax administration efficiency. Referring to the practice of Cui et al. (2006) [2], the total tax revenue of each region is used as the output indicator. Input indicators :(1) The sum of the added value of the secondary and tertiary industries. Most of China's tax sources are concentrated in the secondary and tertiary industries, and the added value of the secondary and tertiary industries can reflect the impact of factors such as a region's taxable capacity and tax business environment. (2) The number of tax personnel. Used as a measure of the cost of tax collection and administration, the quality of tax personnel and their behavior directly or indirectly affect the cost of tax collection (Guo et al.,2021) [4]. See Table 1 for details.

**Index construction of the Impact of the Digital Economy on Regional Tax Administration Efficiency:** The following explanatory variables were selected as indicators for the evaluation of regional tax collection efficiency factors: (1) Explained variables. the results of the tax administration efficiency data measured in the previous section. (2) Explanatory variables. The digital economy index was selected as the core explanatory variable, which draws on the level of digital economy measured by Zhang et al. (2020). The annual average index and ranking of digital economy of 31 provinces in China are calculated by using the principal component analysis method. (3) Control variables: economic level: regional economic level will affect the quality of tax sources and thus affect the efficiency of tax collection and management; and urbanization level reflect factors such as the level of talents in a region and the degree of urban intelligence, which in turn affects the efficiency of tax administration public infrastructure: infrastructure construction will affect the taxpayer's tax payment convenience and thus affect the efficiency of tax administration; fiscal level: the improvement of the level of finance will increase the ability of local taxation departments to use local resources, and the efficiency of tax collection and administration needs local financial support to some extent, so it is believed that the level of finance will have an impact on the efficiency of tax administration. The variables detailed in Table 2.

Table 1: Input-output indicators of regional tax administration efficiency

| variable | Functional indicators | Working with data |
|---|---|---|
| **Input variables** | Contribution of secondary and tertiary industries | Value added of secondary and tertiary sectors (billion) |
| | Human capital | Number of tax staff (persons) |
| **Output variables** | Tax revenue | Tax revenue (million) |

Table 2: Indicators influencing regional tax administration efficiency

| variable | Functional indicators | Working with data |
|---|---|---|
| **Core explanatory variables** | Digital economy | Data measured by principal component analysis |
| **Control variables** | Economic level | GDP per capita (yuan/person). |
| | Level of urbanization | The urban population accounts for the total regional population (%). |
| | Public infrastructure | Level of Internet development (number of ports). |
| | Fiscal level | General budget income (million) |

**Data Sources:** This paper selects panel data from 31 provinces in China from 2011 to 2020, and the tax-related data are mainly from the China Statistical Yearbook and the China Tax Yearbook to facilitate comparison and mitigate the effect of heteroscedasticity on the results, all data are logarithmic.

# 3 Measurement and regression analysis of regional tax administration

## 3.1 Dynamic Analysis of the DEA-Malmquist Index

This paper uses DEAP2.1 software to measure the Malmquist productivity index of the annual tax revenue of 31 regions in China from 2011 to 2020 and its decomposition of technical efficiency and technical progress. The Malmquist productivity index of tax administration efficiency and its decomposition values were derived (Table 3).

Table 3 Malmquist productivity index of tax management capabilities and its decomposition values

| year | Technical efficiency | Technological advancements | Purely technical efficiency | Efficiency of scale | Malmquist - Wikipedia |
|---|---|---|---|---|---|
| 2011-2012 | 1.05 | 1.02 | 1.023 | 1.026 | 1.07 |
| 2012-2013 | 0.976 | 1.005 | 1.028 | 0.949 | 0.981 |
| 2013-2014 | 0.963 | 1.027 | 0.944 | 1.02 | 0.989 |
| 2014-2015 | 0.931 | 1.036 | 0.946 | 0.984 | 0.964 |
| 2015-2016 | 1.003 | 0.944 | 0.986 | 1.018 | 0.947 |
| 2016-2017 | 1.008 | 1.005 | 0.995 | 1.013 | 1.012 |
| 2017-2018 | 1.028 | 0.974 | 1.02 | 1.008 | 1.002 |
| 2018-2019 | 1.017 | 0.925 | 1.026 | 0.991 | 0.94 |

| | | | | | |
|---|---|---|---|---|---|
| 2019-2020 | 1 | 0.929 | 1.022 | 0.979 | 0.929 |
| average | 0.997 | 0.984 | 0.998 | 0.998 | 0.981 |

From Table 3, it can be concluded that the tax administration efficiency index is 1.07 from 2011 to 2012, indicating a certain degree of increase in tax administration efficiency, and overall, the tax productivity index is in a state of decline from 2012 to 2020, with an average value of 0.981. From the perspective of the reasons for the change in the efficiency of tax administration, the main reason for the increase in tax administration efficiency comes from the improvement of technological progress. The rise in technical efficiency is not significant, which is the reason for the insignificant rise in the tax administration efficiency index.

### 3.2 The Impact of the Digital Economy on Regional Tax Administration Efficiency

Using the LLC method for the panel unit root test, the variables are tested by the significance level, so the variables were stationary and zero-order singular. A further panel cointegration test using the Westerlund method showed a p-value of 0.000 for the statistic, indicating a cointegrating relationship between the variables and allowing for regression analysis.

Using tax administration efficiency rate as the explained variable and the digital economic index as the core explanatory variable, plus control variables for regression, the impact of the digital economy on tax administration efficiency is explored using panel Tobit model, fixed effects and other econometric methods. For the hypothesis 1 of this paper, the final regression results are as shown in Table 4. There are four models in the table, and the regression results of each model show that the digital economy has a positive impact on the efficiency of tax administration.

Table 4: Estimated results of the impact of the digital economy index on regional tax administration efficiency

| variable | Fixed-effect model | Hybrid Tobit model | CLAD model | Panel Tobit model |
|---|---|---|---|---|
| Digital economy index | 0.366** | 0.442*** | 0.160** | 0.403** |
| | (2.339) | (3.042) | (2.082) | (2.004) |
| Infrastructure construction | -0.421** | -0.491*** | -0.164* | -0.450** |
| | (-2.372) | (-2.957) | (-1.870) | (-1.965) |
| Level of urbanization | 0.00840** | -0.00590*** | -0.00788*** | 0.000530 |
| | (2.435) | (-4.935) | (-12.71) | (0.138) |
| Fiscal level | 0.209*** | 0.0218* | 0.0251*** | 0.167*** |
| | (5.467) | (1.900) | (4.353) | (3.300) |
| GDP per capita | -0.155* | 0.182*** | 0.227*** | -0.00674 |
| | (-1.656) | (3.837) | (9.045) | (-0.0636) |
| Constant term | 0.537 | -0.893** | -1.361*** | -0.286 |
| | (0.699) | (-2.069) | (-5.822) | (-0.345) |
| Observations | 310 | 310 | 310 | 310 |

Note: The factors in parentheses are standard errors, and *, **, and *** are expressed at 10%, 5%, and 1% levels that passed the significance test respectively.

Based on the consideration of the difference in the level of development between the three parts of China, hypothesis 2 was tested to further empirically analyze the impact of the digital economy on tax administration efficiency in the eastern, middle and western regions, resulting in a comparative analysis, the results of which are shown in Table 5.

Table 5: Regional heterogeneity analysis results

| variable | Western region | Middle region | Eastern region |
|---|---|---|---|
| Digital economy index | -0.142 | -0.648* | 0.0213 |
| | (-0.412) | (-1.952) | (0.0637) |
| Infrastructure construction | 0.213 | 0.850** | -0.0540 |
| | (0.545) | (2.184) | (-0.140) |
| Level of urbanization | -0.0161*** | 0.00765* | 0.0152*** |
| | (-4.972) | (1.729) | (2.746) |
| General budget income | -0.0339 | 0.384*** | 0.187*** |
| | (-1.242) | (5.340) | (3.221) |
| GDP per capita | 0.330*** | -0.441*** | -0.167 |
| | (2.705) | (-3.252) | (-0.978) |
| Constant term | -1.808 | 1.692* | 0.481 |
| | (-1.629) | (1.934) | (0.327) |
| Observations | 100 | 100 | 110 |

Note: The factors in parentheses are standard errors, and *, **, and *** are expressed at 10%, 5%, and 1% levels that passed the significance test respectively.

The results show that the digital economy in the middle region has a significant hindering effect on the efficiency of regional tax administration, specifically, the digital economy index in the middle region increased by 1%, and the efficiency of tax collection and management decreased by 64.8%. At the same time, the impact of the digital economy in the western region on the efficiency of tax administration is not as obvious as that in the middle region, while the digital economy in the eastern region has a catalytic effect on regional tax administration efficiency, probably because the secondary and tertiary industries account for a high proportion of GDP in the average value of industries in the eastern region, and the industrial, service, knowledge and technology-intensive industries are well developed, and the renewal of the industrial structure can largely promote regional tax administration efficiency. The renewal of the industrial structure can, to a large extent, promote the improvement of regional tax administration efficiency. The improvement of the level of urbanization has a significant positive effect on the efficiency of tax administration, and its role in the eastern region is particularly prominent, for every 1% increase in the level of urbanization, the efficiency of tax administration is increased by 1.52 The reason may be that the eastern region itself has relatively high resource endowments, and the ability to greatly enhance the efficiency of tax administration can be greatly enhanced through the improvement of the level of urbanization and the introduction of talents. Similar influencing factors are per capita GDP, which has the most prominent role in promoting the western region, which is manifested in the increase of GDP per capita by 1 %, and the efficiency of regional tax administration will be increased by 33%.

## 4 Conclusions and implications

In this paper, the DEA-Malmquist model is used to measure and analyze the efficiency of tax management in all regions of the country, and then the panel Tobit model is used to empirically test the digital economy on the efficiency of tax administration. The empirical results show that: (1) There are differences in the efficiency of tax output in different regions, and the tax technology capabilities of local tax departments need to be improved. (2) The improvement of local tax technology in the context of the digital economy has played an expected positive role. (3) There are differences in the degree of improvement in the technical efficiency of taxation in different regions. Accordingly, the following optimization measures can be taken to improve the efficiency of tax collection and management.

Firstly, it is important to improve the accuracy of tax incentives geared towards the core industries of the digital economy. The tax incentives for SMEs in different industrial sectors should be tailored to improve their own operating conditions in order to obtain higher operating surpluses and to promote the improvement of tax administration efficiency.

Secondly, for different regions, the manpower, material, and financial resources of the tax authorities should be effectively allocated according to local conditions and the allocation structure should be optimized. It is recommended that all regions should effectively allocate the level of economic development and the number of tax personnel in their respective regions to reduce the negative impact of administrative inefficiency on the efficiency of tax collection and management.

Thirdly, there are fewer laws and regulations on the digital economy in China. Combined with the current actual tax collection and management situation in China, the relevant content is revised, especially for the construction system of digital information platforms, and there must be clear legal provisions.

Finally, increase the strength of tax administration with digital taxation. The tax administration department should establish a strong risk control system, scientifically use big data technology, improve the efficiency of data processing, and establish a tax risk management platform for dynamic monitoring of the whole process.

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