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An Exploratory Study of Efficiency in Tax Jurisdictions

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Abstract. This study explores how the efficiency of collecting national tax in tax jurisdictions has been changed in Korea over the period 1998-2011. Using data envelopment analysis, we estimate the aggregate efficiency scores of six tax jurisdictions for each of the 14 years from 1998 to 2011. The mean of the aggregate efficiency scores is 0.62 for our pooled sample of 84 observations, suggesting that there exist a significant level of waste in national tax collection activity. Furthermore, trend analysis indicates that the aggregate efficiency for tax jurisdictions has declined steadily over time since the currency crisis of 1997, which sheds light on tax administration policy in Korea.

1 Research Motivation

This study explores how the efficiency of collecting national tax in tax jurisdictions has been changed in Korea over the period 1998-2011. Since the financial crisis of 1997 in Korea, national tax administration has made the effort to improve its tax system from the standpoint of tax payers. At the same time, many tax system reforms have been implemented to enhance fair taxation. Although these regulatory changes have taken place in rapidly changing economic environments, there has been very little research on the efficiency of collecting national tax in tax jurisdictions in Korea.

Tax jurisdictions for national tax collection in Korea are composed of the following six regions: Seoul, Jungbu, Daejeon, Gwangju, Daegu, and Busan. Thus, to estimate the efficiency of tax collection activity by region, we can use empirical data on six regional tax jurisdictions in Korea. Park and Ryu (2012) use data envelopment analysis (DEA) and examine the efficiency and productivity changes in Korean six regional tax offices. In contrast to Park and Ryu (2012) that evaluate the efficiency of six regional tax offices in Korea, this study concentrates on analyzing the efficiency of national tax collection activity in each regional tax jurisdiction.

2 Research Design

The efficiency of an efficiency evaluation unit is defined as its success in producing as large as possible outputs from a given set of inputs (Farrell 1957). This study applies data envelopment analysis (DEA) in estimating efficiency scores. The

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advantage of using DEA is that it can consider multiple inputs and multiple outputs simultaneously. Further, it can produce relative efficiency scores for each tax jurisdiction-year observation.

Specifically, this study employs an input-oriented DEA model based on Charnes et al. (1978). For each observation (j, t) for regional tax jurisdiction j=1,…, J, and year t=1,...., T, y_{jt} is a vector of R outputs and x_{jt} is a vector of I inputs, while for the whole sample there is a I×J input matrix, X, and a R× J output matrix, Y. The efficiency envelopment form of the programming problem determines an efficiency score for each observation (j, t). The problem is

$$\text{Min } \theta$$
$$\text{s.t. } Y\lambda \geq y_{jt},\ X\lambda \leq \theta x_{jt},\ \lambda \geq 0 \quad (1)$$

where, for each jurisdiction-year (j, t), θ is a scalar ($0 \leq \theta \leq 1$), with $\theta=1$ indicating an efficient jurisdiction-year that is on the production frontier and $\theta < 1$ indicating an inefficient jurisdiction-year that is below the production frontier (Farrell 1957). Based on (1) that is a constant return to scale model, we estimate an efficiency score for each jurisdiction-year and define it as aggregate efficiency (Charnes et al. 1978).

3 Empirical Results

3.1 Data and Descriptive Statistics

We consider 6 regional tax jurisdictions for each of 14 years from 1998 to 2011, resulting in a total of 84 (=6×14) jurisdiction-year observations.

Prior studies use total amount of tax collected by regional tax office in tax jurisdictions as one of outputs (Barros 2007; Park and Ryu 2012; Thirtle et al. 2000; Jha et al. 1999). In this study, based on previous literature, we decompose national tax collection into direct tax and other taxes exclusive of direct tax and use the following two types of national tax collection: (i) direct tax and (ii) other taxes. In a general production function, labor and capital are included as inputs. However, in this study, our efficiency evaluation unit is not a firm that is engaged in production activity but a regional tax jurisdiction. In a similar context, Barros (2007) uses the number of regional taxpayers as an input and assesses the technical and allocative efficiency of tax offices. Thirtle el al. (2001) include state gross domestic product as an input in estimating efficiency and analyze tax efficiency of Indian 15 state tax jurisdictions. In this study, taking into account the existing literature and availability of data, we include the number of taxpayers in each regional tax jurisdiction and regional gross domestic product (RGDP) as inputs. Further, the total number of tax payers is broken down into the number of direct tax payers and the number of indirect tax payers. Therefore, we use two outputs (direct tax, other taxes) and three inputs (direct tax payers, indirect tax payers, RGDP) in estimating the efficiency for each jurisdiction-year observation.

Data on outputs and inputs is obtained from yearly statistics data disclosed annually on the homepage of National Tax Service in Korea. All monetary value items have been deflated to 2010 Korean won using the index of consumer prices

published by the Bank of Korea. Table 1 provides descriptive statistics of outputs and inputs.

Table 1. Descriptive statistics

		Mean	Std. dev.	25%	Median	75%
Outputs	Direct tax	10,600	12,860	2,550	4,295	13,975
	Other taxes	6,877	4,154	4,925	6,487	9,350
Inputs	Direct tax payers	1,005	620	528	695	1,281
	Indirect tax payers	714	380	412	533	974
	RGDP	163,174	72,518	101,546	140,847	224,488

Note: All monetary value items are expressed in billion Korean won and have been deflated to 2010 Korean won using the index of consumer prices. Headcount is expressed in 1,000 persons. RGDP: Regional gross domestic product

3.2 Trend Analysis of Efficiency

Table 2 presents the average DEA efficiency scores for each of 14 years from 1998 to 2011. The average DEA efficiency score for each year shows the highest 0.68 in 1999, and since then has shown a downward trend and recorded the lowest 0.51 in 2011. This trend analysis indicates that since the currency crisis of 1997, the average DEA efficiency score for each year has declined steadily until 2011.

Table 2. Summary of DEA efficiency for 1998-2011

Year	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Mean	0.61	0.68	0.65	0.67	0.65	0.66	0.65
Std. dev.	0.33	0.29	0.33	0.32	0.29	0.29	0.32
Max.	1.00	0.99	1.00	1.00	0.96	0.92	1.00
Min.	0.17	0.20	0.23	0.20	0.21	0.21	0.21
Year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Mean	0.64	0.61	0.63	0.56	0.55	0.56	0.51
Std. dev.	0.28	0.26	0.29	0.27	0.20	0.26	0.26
Max.	0.91	0.90	1.00	0.98	0.86	0.88	0.98
Min.	0.26	0.28	0.24	0.22	0.30	0.21	0.24

3.3 Efficiency Analysis by Regional Tax Jurisdiction

Table 3 reports the DEA efficiency scores for each of tax jurisdictions for the whole sample period.

The average efficiency scores for six tax jurisdiction range from 0.23 to 0.93 with a higher score indicating greater efficiency. The mean of the DEA efficiency scores for our pooled data is 0.62. Seoul and Gwangju report very high average efficiency scores, 0.93 and 0.84 respectively. In contrast, Jungbu and Daegu report very low average efficiency scores, 0.36 and 0.23 respectively.

Table 3. Summary of DEA efficiency for tax jurisdictions

Statistics	**Seoul**	**Jungbu**	**Daejeon**	**Gwangju**	**Daegu**	**Busan**	**Total**
Mean	0.93	0.36	0.60	0.84	0.23	0.74	0.62
Std. dev.	0.06	0.05	0.09	0.13	0.03	0.14	0.27
Max.	1.00	0.48	0.72	1.00	0.30	0.95	1.00
Min.	0.85	0.29	0.43	0.57	0.17	0.46	0.17

4 Conclusions

In this study, we explore how the efficiency of collecting national tax in six tax jurisdictions has been changed in Korea over the period 1998-2011. Using data envelopment analysis (DEA), we estimate the aggregate DEA efficiency of tax jurisdictions using the number of direct tax payers, the number of indirect tax payers and regional gross domestic product as three inputs and the amount of direct tax collected and the amount of other taxes collected as two outputs. Empirical results are summarized as follows.

First, efficiency analysis for tax jurisdictions indicates that Seoul and Gwangju have higher aggregate DEA efficiency. Jungbu and Daegu are shown to have very low aggregate DEA efficiency. In addition, the average of the DEA efficiency scores for our pooled data is 0.62, which suggests that there exist a significant level of waste or inefficiency in national tax collection activity.

Second, trend analysis demonstrates that the aggregate DEA efficiency for all tax jurisdictions has declined steadily over time since the currency crisis of 1997.

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