Sectoral GDP and Tax Revenue: a Panel Data Analysis

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Abstract

To analyze tax revenue from its relationship with the sectoral gross domestic product (GDP) becomes essential. Sectoral GDP plays a role in achieving sectoral tax revenue and, in turn, obtaining tax revenue in total. This paper aims to reveal this relationship using empirical evidence. Using a dataset from 34 provinces in Indonesia, the researchers found that industrial, mining, accommodation, and financial sectors positively correlated with tax revenue. On the other hand, agriculture, transportation, and communication correlated negatively with tax revenue. These results have a meaningful implication for the government, particularly for the Directorate General of Taxes (DGT). DGT may apply this result to predict and to establish strategy to boost tax revenue based on the sectoral GDP.

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1. Introduction

Gross Domestic Product (GDP) highly correlates with tax revenue, particularly between sectoral GDP and sectoral tax revenue. The share of different industries in the economy captures the differences in the ability of those sectors to generate tax revenue. For instance, agriculture does not contribute much to tax revenue, even though this sector has a large portion of Indonesia's GDP. On the other hand, the mining sector and industrial sector have similar characteristics; both sectors contribute to a large proportion of Indonesia's tax revenue and Indonesia's GDP. Thus, various branches of industry have different contributions to tax revenue. Therefore, it is interesting to understand the relationship between a particular sector and tax revenue in total.

To date, several papers have investigated this issue with mixed results. Baiardi et al. (2019) found a negative relationship between tax revenue and GDP per capita. Arnold et al. (2011) also revealed this negative relationship from a dataset of 21 OECD countries. Karagoz (2013) investigated this issue in Turkey, where he found that agricultural and industrial

sectors affected tax revenue in Turkey. Those results showed no similar conclusion for this relationship. Thus, it is essential to analyze the correlation between tax revenue and GDP using sectoral GDP, particularly in Indonesia as a developing country.

This article contributes to the tax revenue prediction by incorporating the relationship between GRDP and tax revenue. Until now, no study undertakes the information on GRDP and tax revenue, mainly due to confidentiality issues of the tax revenue dataset.

Panel data analysis has revealed that industrial, mining, accommodation, and financial sectors positively influenced tax revenue in 34 provinces. On the other hand, transportation, agricultural, and information and communication sectors negatively contributed to tax revenue. In addition, the trade and construction sector did not significantly influence tax revenue.

These results have considerable insights that improving each sectoral GDP will not automatically increase tax revenue performance. Several sectors are less contributing or contribute negatively to tax revenue. It implies that the government may need to maintain several sectors to generate tax revenue. In addition, the government should evaluate several policies to improve sectors that contribute negatively or are less likely to improve tax revenue performance.

In this paper, the data and calculation model that the researchers have formulated, will be presented in the following section. The third section will illustrate the results of this study, while the fifth section will conclude the discussion of this study.

2. Data and Model

The unit analysis used in this paper is either province or regional tax office, resulting in 115 observations. This modification is required since the GRDP is not available for the regional tax office level. [1] The researchers consider the GRDP for 34 provinces as the independent variable and tax revenue as the dependent variable.[2]

The primary model is as follows:

$$TR_{it} = \alpha + \beta_{1\,it} GRDP_{it} + \lambda + \varepsilon$$

- TR_{it} : Tax revenue unit *i* years *t*
- $GRDP_{it}$: Gross Regional Domestic Bruto unit *i* years *t*
- Λ : set of fixed effects
- ε : error term

In this study, other economic variables, including inflation, tax rate, and central bank rate, were excluded since these variables are homogeneous for all provinces. In addition, inflation is available only for a particular city/town and not for specific province.

Then, before conducting a panel data analysis, the researchers performed several required tests to confirm that the model was appropriate.[3] As this data may have issues with autocorrelation, cross-sectional dependence, and heteroskedasticity, the researchers ran a specially-designed panel data analysis considering these conditions. In addition, the researchers took the possibility of a time-fixed effect in this model into consideration as well.[4] The Fixed Effect model was considered more appropriate for this analysis after the Hausman test was performed.

3. Analysis

The main results show the coefficients and their standard error, presented in Table 1. Then, the results between the OLS regression and the FE model were analyzed, where the OLS results (column 1) indicated overestimation (Adj R-Squared is 0.90). The coefficients and the signs differed from the FE model, where only trade, agriculture, finance, and the information sector significantly influenced tax revenue. Intuitively, the GRDP of the industrial and mining sector should contribute to tax revenue significantly, as shown in column 2 and 3. Therefore, it can be concluded that the OLS provides bias estimation.

After considering time FE and id FE, several signs were similar to the FE model, including industry, mining, agriculture, finance, and information sector. The OLS results with time FE and id FE improved significantly. Yet, the OLS results (Column 2) were still over-estimated (Adj R-Squared is 0.99). The results, after controlling the possibility of heteroskedasticity, autocorrelation, and cross-sectional dependence, are shown in column 3. Meanwhile, the coefficient of transportation, accommodation, and the government sector, changed significantly.

Table 1. The results of OLS and FE Regressions of the GRDP on Tax Revenue

DV: Tax revenue	**OLS**	**OLS**	**FE**
Industry	0.00 (0.04)	0.18** (0.08)	0.10*** (0.04)
Mining	0.05 (0.05)	0.10*** (0.04)	0.09* (0.04)
Trade	0.47** (0.18)	-0.43* (0.22)	0.21 (0.16)
Transportation	-0.11 (0.21)	-0.32 (0.32)	-0.56** (0.22)
Agriculture	-0.18** (0.08)	-0.45** (0.17)	-0.29*** (0.09)

Construction	-0.36 (0.27)	0.01 (0.19)	-0.23 (0.21)
Accommodation	0.07 (0.23)	0.68 (0.43)	0.39** (0.17)
Finance	1.89*** (0.29)	2.12*** (0.54)	1.67*** (0.32)
Information	-0.93*** (0.24)	-1.07*** (0.36)	-1.02*** (0.16)
Government	-0.70* (0.39)	1.09** (0.42)	0.17 (0.42)
Cons	23996.48*** (3250.81)	12337.95** (7166.79)	21411.82*** (2603.87)
N	115	115	115
Model	OLS	OLS	FE
R Squared	0.90	0.99	0.86
Time FE	No	Yes	Yes
Province FE	No	Yes	Yes
Heteroskedasticity/autocorrelation/Cross-sectional dependence	No	No	Yes

**** p<0.01, **p<0.05, *p<0.1*

The dependent variable is tax revenue.

The researchers compared these results with tax revenue from every five dominant sectors. Table 2 shows the contribution of tax revenue from the five dominant sectors. First, the industrial sector significantly contributes to tax revenue, as these findings support this statement. 1 Billion Rupiah GRDP in the industrial sector will contribute to tax revenue by 0.1 Billion Rupiah. Second, although the trade sector is the second largest sector that contributes to tax revenue, the results of this study show otherwise, where this sector did not influence tax revenue. Third, in this study, the mining sector, the third-largest sector that contributes to tax revenue, shows a positive influence on tax revenue. However, the researchers did not observe any statistical differences in contribution between the industrial and mining sector (Figure 1). Fourth, the financial sector is the fourth largest sector contributing to tax revenue. The results of this

study intuitively show that this coefficient was significantly the largest among other sectors (1.67 points). Fifth, the accommodation sector also contributed to tax revenue positively (0.39 points), even though this sector is out of the five primary sectors in tax revenue contribution. The informal economy may be less likely to work in this sector.

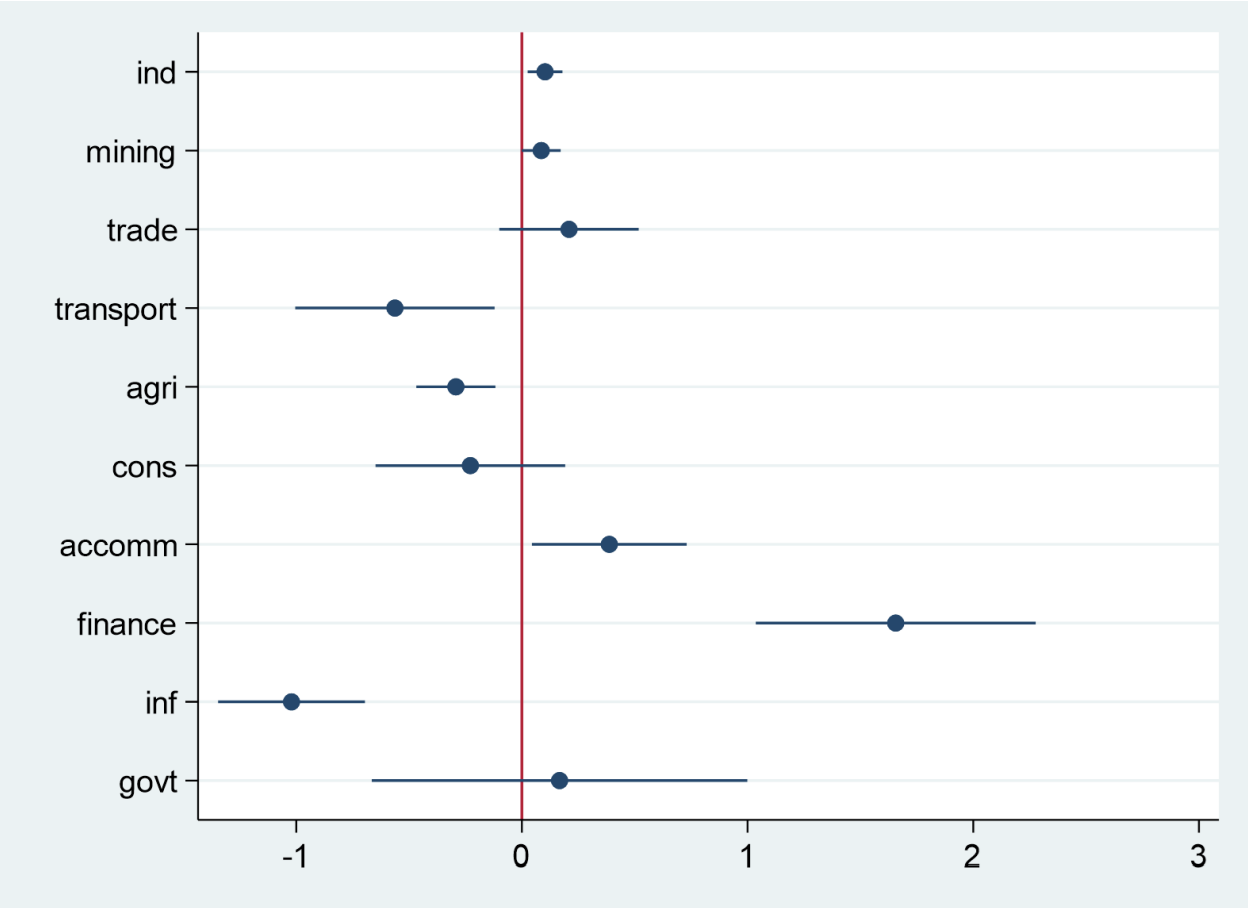

Figure 1. Coefficient plot with 95% CI for GRDP from column 3 Table 1.

Three sectors correlated negatively with tax revenue (transportation, agriculture, and information). First, the agriculture sector is exempted from tax and difficult to tax; thus, if this sector increases, it will not affect tax revenue. Instead, it will reduce tax revenue based on these results (Agbeyegbe et al. 2004). Since this data is based on the provincial level, thus, if the vital economic sector in a particular province is agriculture, its tax revenue is deemed lower than other provinces. Meanwhile, it is possible that various informal economy plays a role in the sector of transportation and information, or that there is a lot of tax exemption concerning these sectors. However, it will need lots of analysis to reveal why these sectors and tax revenue show negative correlations.

Table 2. Contribution of Five Largest Sectors in Tax Revenue

Sector	Contribution (%)
Industry	27.8
Trade	21.8
Mining	14.8
Finance	11.2
Other Services	3.32

Source: Directorate General of Taxes.

Robustness check

The researchers expanded the analysis for each region.[5] The researchers analyzed the correlation between each region with sectoral GDP; the results are presented in Table 2. First, the industrial sector was robust to the regional clustering. The GDP of the industrial sector in Sumatera, Java, Bali, and Nusa Tenggara (column 2) positively correlated with tax revenue in these regions. These five regions are the main islands in Indonesia, so they represent the overall condition of Indonesia. Therefore, the coefficient was similar to the regression of GDP on national tax revenues, as seen in column 1. Second, similarly to column 1, the GDP of the mining sector in the main islands were less meaningful for regional tax revenue. The mining sector did not contribute much to national or regional tax revenues. Third, the trade sector did not significantly contribute to national tax revenues. However, using regional data, the trade sector remarkably influenced tax revenue at the regional level, although the significance level was only 10%. Fourth, the transportation sector was more convincing to affect tax revenue negatively. The correlation was even closer at the regional level. Fifth, analyzing the agriculture sector is intriguing for some reasons. The correlation for the regional level was negative, and this situation was contradictory to its correlation for the national level. This sector is mainly located in the main islands, particularly Java and Sumatera, because of geographical conditions. This sector in the non-main islands is way more conventional and thus is hard to tax due to informality. The agriculture sector on the main island is more sophisticated using modern technology, and perhaps, its multiplier effect is much higher.[6] Sixth, the contribution of the construction sector in the main islands is significantly different from that in the non-main islands. This sector was negatively contributing to tax revenue. The negative sign is reflected in the withholding tax system in Indonesia. Seventh, accommodation, information, and government sectors were robust in the regression at the regional level, while the financial sector was less contributing to tax revenue at the regional level.

We then analyzed the effect of GRDP growth on tax revenue as in column 3 table 2.[7] The results now captures whether the increasing of GRDP from the previous year has a correlation on tax revenue. It is shown that several sectors change significantly. The trade sector and finance sector have negative correlation with tax revenue. Meanwhile, the transportation has a positive correlation with tax revenue. The construction sector, accommodation sector, and information sector are now become less meaningfull to tax revenue. Only Industry sector and agriculture sector are robust in all analysis.

Table 2. Sectoral GDP for Each Regional

DV: Tax revenue	FE	FE - regional	GRDP growth
Industry	0.10***	0.11***	0.41***
	(0.04)	(0.03)	(0.05)
Mining	0.09*	0.02	0.05
	(0.04)	(0.04)	(0.02)
Trade	0.21	0.40*	-0.28***
	(0.16)	(0.23)	(0.10)
Transportation	-0.56**	-1.14***	0.32**
	(0.22)	(0.28)	(0.16)
Agriculture	-0.29***	0.20**	0.23**
	(0.09)	(0.10)	(0.10)
Construction	-0.23	-0.36**	-0.03
	(0.21)	(0.15)	(0.22)
Accommodation	0.39**	4.66***	0.15
	(0.17)	(0.52)	(0.23)
Finance	1.67***	0.42	-1.50***
	(0.32)	(0.45)	(0.38)
Information	-1.02***	-2.07***	0.41
	(0.16)	(0.54)	(0.45)
Government	0.17	-0.37	0.68*
	(0.42)	(0.44)	(0.38)
Cons	21411.82***	21034.22**	22223.05***
	(2603.87)	(1663.94)	(1104.51)
N	115	115	92
Model	FE	FE	FE
R-Squared	0.86	0.91	0.89

Time FE	Yes	Yes	Yes
Province FE	Yes	Yes	Yes
Heteroskedasticity/autocorrelation/Cross-sectional dependence	Yes	Yes	Yes
Interaction GDP x Regional	No	Yes	No

*** p<0.01, **p<0.05, *p<0.1

Note. The dependent variable is tax revenue.

The coefficients in the column 2 are the coefficients for the first group (Sumatera, Java, Bali, and Nusa Tenggara)

4. Conclusion

Sectoral GDP and tax revenue are closely correlated because the sectoral economy has a distinct feature that may influence a particular tax revenue. Therefore, the researchers analyzed the relationship between sectoral GRDP and tax revenue in Indonesia from 2016 to 2020.

By utilizing a panel data set from a statistical agency and DGT, the researchers confirmed that tax revenue is positively influenced by sectoral GRDP, particularly by the five primary economic sectors, industry, mining, and finance. Several economic sectors, such as transportation, information, and agriculture, affect tax revenue negatively, and the latter may need further analysis to reveal the story behind this argument.

However, these results have several limitations. First, this paper used tax payment instead of tax due. While the benefit of using tax payment in this study is the reliability of the dataset, there are also drawbacks to using a tax payment dataset. One of them is that the tax payment system in Indonesia uses a withholding tax system, where the payment is collected and paid by the other party and not by the taxpayers themselves. This system is reflected in a negative correlation between GDP and tax payment.

Despite the limitations, these results may have policy implications for the government. To be precise, the government needs to improve economic sectors with a large portion of tax revenue to boost tax revenue and to monitor extensively on the sectors that less contribute to tax revenue. In addition, tax authorities need to analyze the negative relationship between tax revenue and GRDP to predict tax revenue using the GDP dataset.

Footnotes

[1] Data from each province and regional tax office were combined. For provinces with more than one regional tax office, the unit analysis was at provincial level. For a particular regional tax office covered several provinces, the unit analysis was that particular tax office. This combination yielded 23 cross section data for five years. Large Tax Office and Special Tax Office covering all large companies and specific companies in Indonesia were considered two units of analysis.

[2] GRDP (Billion Rupiah) was drawn from Stastical Agency in Indonesia (BPS), while tax revenue (Billion Rupiah) was collected from Directorate General of Taxes (DGT) payment monitoring system. The dataset collected was from 2016 to 2020 (5 years).

[3] First, the researchers checked the existence of serial correlation between variables. The F-stat of Wooldridge test was significant, meaning that there was serial correlation among them. Second, the researchers checked the possibility of cross-sectional dependence/contemporaneous correlation. The F-stat of the Pesaran test was found significant, meaning that cross-sectional dependence/contemporaneous correlation existed in the dataset. Third, the researchers analyzed the possibility of heteroskedasticity in the dataset. The F-stat of the Wald test was significant, meaning that the dataset suffered from heteroskedasticity.

[4] The diagnostics show that there was a time fixed effect in the dataset.

[5] The regional level was clustered into two groups by islands: 1) Sumatera, Java, Bali, Nusa tenggara; and 2) Kalimantan, Sulawesi, Papua, and Maluku. The LTO, Special tax office, and Jakarta are categorized as the first group.

[6] Agriculture sector is non-taxable goods. Therefore, the researchers suggest that the effect of this sector to tax revenue is due to its multiplier effect to other taxes or sectors.

[7] The independent variables are the amount of the increasing of GRDP in a particular year from previous year within particular sectors.

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