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Investigating the Relationship between Tax Rates and Tax Revenues in the Euro Area: The Effect of the Shadow Economy

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Dimitra Ntertsou[1], Konstantinos Liapis[2]

Abstract:

Purpose: *In the years that preceded the global economic and financial crisis in 2008 there was a trend of reducing both statutory corporate income tax rates and top personal income tax rates. With the outbreak of the crisis though, the need to raise revenues and perhaps introduce increases in the corporate income and personal income tax rates became pressing, especially for some countries. The purpose of this article is to investigate the relationship between the tax rate and the relevant tax revenue both for personal income and corporate income tax in the euro area, during years 2000 – 2018, taking into consideration the effect of the global economic crisis of 2008.*

Design/Methodology/Approach: *The analysis tests both the arithmetic effect of a tax rate increases on tax revenues as well as the economic effect, by incorporating in the analysis the size of shadow economy. Since the sample consists of a combination of cross section data and time series, where the same unit cross section is measured at different times, the methodology applied is Generalized Least Squares in EViews, with country fixed effects and a dummy variable to capture the effect of the global economic crisis.*

Findings: *The analysis confirmed that there are two different effects of a tax rate increase on respective tax revenues; the positive arithmetic effect of the tax rate increase and the negative economic effect of the tax base erosion, captured by the size of shadow economy.*

Practical implications: *Taking into consideration the definition of shadow economy, GDP is augmented with the size of the shadow economy to account for the total national income of the economy, both the reported and the hidden one.*

Originality/value: *The current paper contributes to the existing literature on the relationship between the tax rate and the relevant tax revenue in the field of corporate and personal income taxes, by incorporating in the analysis the size of shadow economy.*

Keywords: *Tax revenues, tax rates, shadow economy, economic crisis*.

JEL classification: *E62, E63, H200.*

Paper Type: *Research article.*

[1]*PHD Candidate, Panteion University of Social & Political Sciences, Faculty of Sciences of Economy & Public Administration, Economic & Regional Development Department, d.ntertsou@panteion.gr;*
[2]*Professor of Accounting and Business Administration, the same as in 1, konstantinos.liapis@panteion.gr;*

1. Introduction

In the years that preceded the global economic and financial crisis in 2008, there was a trend in Eurozone countries of reducing both statutory corporate income tax rates and top personal income tax rates. With the outbreak of the crisis, the need to raise revenues and perhaps introduce increases in the corporate income and personal income tax rates (both for revenue and distributional reasons) became pressing especially for some countries.

An increase of the tax rate is expected to increase the corresponding tax revenue. At the same time, an increase of the tax rate may distort economic agents' decisions and therefore may have a negative effect on the tax base. Existing literature has empirically proved that an increase in the tax rates leads to an increase in the size of shadow economy, as it creates incentives to individuals and companies to shift their activities to the unofficial sector. This means that the tax base is eroded leading to a reduction of corresponding tax revenue.

The current paper aims to investigate the relationship between tax rates and tax revenues both for personal income and corporate income tax in the euro area, during years 2000 – 2018, taking into consideration the effect of the global economic crisis of 2008. The analysis tests both the arithmetic effect of a tax rate increases on tax revenues as well as the economic effect, by incorporating in the analysis the size of shadow economy.

The paper is structured as follows; Section 2 provides a brief literature review on the relationship between tax revenues and relevant tax rates and the effect of tax rates on the size of the informal sector, section 3 describes the methodology used and the sources for our data, section 4 provides the empirical results for corporate income taxes and section 5 provides the empirical results for personal income taxes.

2. Literature Review

Arthur Laffer (2004) argued that the basic idea behind the relationship between tax rates and tax revenues is that there exists a trade-off between two effects on tax revenue – the arithmetic effect i.e., reduced tax rates yield reduced tax revenues and the economic effect i.e., tax cuts create incentives to increase output, employment and production. The arithmetic effect always works in the opposite direction from the economic effect and as a result the overall effect on tax revenues is rather ambiguous. The illustration of this relationship between tax rates and revenues in an inverted U shape curve, known as the 'Laffer curve'.

Many studies for individual countries or groups of countries have examined empirically whether there is an inverse relationship between tax rates and tax revenues. Canto *et al.* (1981) examined the relationship between tax rates and tax revenues for the USA for the period 1951-1964, Stuart (1981) for Sweden in the

1970s, Van Ravestein and Vijlbrief (1988) for the Netherlands for the period 1960-1985, Hsing (1996) for the USA for the period 1959-1991, Karas (2012) for Czech Republic for the period 1993-2010, Sen *et al.* (2017) for Turkey for the period 1970-2015, Brill and Hassett (2007) for a panel of OECD countries over the period 1981-2005, Trabandt and Uhilg (2011) for the US, the EU-14 and several individual EU countries, Kawano and Slemrod (2015), Akgun et al. (2017) for a panel of 34 OECD countries, for the period 1978-2014.

There have been several studies which identified a negative relationship between tax rates and the size of the shadow economy. According to the definition provided by Schneider and Enste (2000), the shadow economy, (also called underground, informal, or parallel economy), includes not only illegal activities but also unreported income from the production of legal goods and services. Therefore, the shadow economy comprises all economic activities that would generally be taxable were they reported to the tax authorities. While tax evasion refers to the amount of foregone revenues, the term shadow economy encompasses the amount of production that escapes taxation (Kuehn, 2007).

Johnson, Kaufmann and Zoido-Lobaton (1998) examined the relationship between the tax burden (as perceived by businesses) and the size of the informal economy for 49 countries, including most OECD countries. They concluded that a higher tax burden, as evaluated by executives (taking into consideration marginal tax rates and the way the tax system is administered) leads to more unofficial activity.

Schneider and Enste (2000) also attributed the growth in the underground economy to the corresponding increase in effective tax rates in many countries. Davis and Henrekson (2005) found that for rich industrialized economies in the mid-1990s, taxes on labor income and consumption expenditures encourage households to substitute away from the legal market sector in favor of untaxed activities, i.e., to a bigger underground economy.

Heijman and van Ophem (2005) also argued that an alternative for economic agents to becoming inactive when tax rates become too high, is to become active in the black labor economy. They developed a model of optimum taxation that considered a possible shift to informal economy for several OECD countries for the period 1988-1996.

Similarly, Busato and Chiarini (2011) incorporated in a two-sector dynamic equilibrium model tax evasion and underground activities to derive Laffer Curves for personal income and corporate income taxation for the Italian economy. Vogel (2012) extended the QUEST III model by tax avoidance and found that in economies where the official and the informal sector are closer substitutes the so-called Laffer curve for labor and corporate taxation flattens.

The current paper contributes to the existing literature on the relationship between the tax rate and the relevant tax revenue in the field of corporate and personal income taxes, by incorporating in the analysis the size of shadow economy. Specifically, what is innovative in our approach, is that corporate income tax revenues, personal income tax revenues and shadow economy are expressed as a percentage of an augmented GDP, which considers the total national income of the economy, i.e., the reported one and the hidden one.

3. Methodology – Description of the Dataset

As described in Liapis *et al.* (2019) tax revenue can be linear correlated with the tax rate:

$$T=b_1*r \quad (1)$$

Each country has a different tax base, and it can be referred that the tax base is associated with the wealth levels of the country. The relationship between the tax rate, the wealth levels of the country and the tax base is summarized by the following identity, developed with the DuPont formula:

$$T/GDP=T/B*B/GDP \quad (2)$$

Tax revenue as a percentage of GDP is determined by two ratios: tax revenue T over the tax base B and tax base B over GDP. Isolating the first term of equation (2), equation (1) can be transformed in the following linear correlation function, where the tax revenue is expressed as a percentage of GDP and linear related with a tax rate, which shifts depending on each country's policy:

$$(T/GDP)\_it=b\_0i+b\_1*r\_it+\varepsilon\_it \quad (3)$$

Where:
the subscript i corresponds to country,
the subscript t corresponds to year,
r is the tax rate and
ε is the error term.

This equation represents the arithmetic effect of tax rates on tax revenues; An additional explanatory variable is incorporated in our model, shadow economy, which is expected to capture the economic effect of a possible increase of a tax rate, i.e. the erosion of the tax base. As a result, the model transforms to:

$$(T/GDP)\_it=b\_0i+b\_1*r\_it+b\_2SHAD+\varepsilon\_it \quad (4)$$

Where:
SHAD = the size of shadow economy expressed as a percentage of GDP.

Tax revenues are expressed as a percentage of GDP, as these indicators provide a standard way to compare tax levels across countries and over time. The main source for the data on tax revenues is European Commission, DG Taxation and Customs Union, based on Eurostat data which provides detailed and internationally comparable tax data for all European Union countries.

Data on the corporate income tax rates are also extracted from DG Taxation and Customs Union database, where the central and sub central statutory tax rates are reported.

The personal income tax analysis in the paper does not use top statutory personal income tax rates, as these are not a sufficient indicator of the level or collected personal income tax revenues. Specifically, in most Eurozone countries, there is a progressive personal income tax schedule, meaning that the tax rate paid by individuals increases with higher incomes. Therefore, a question arises on which rate is considered as an appropriate explanatory variable in our model. Given that the top statutory personal income tax rate only applies to the share of income that falls into the highest tax bracket, it is not considered an appropriate explanatory variable.

The European Commission provides data on the implicit tax rate on labour, which measures the actual or effective average tax burden directly or indirectly levied on employed labour income. The implicit tax rate though incorporates compulsory actual social security contributions, which fall out the scope of the current research.

The European Commission also provides data on the tax wedge on labour income, which is a measure of the personal income tax and social security contributions (net of cash transfers) as a percentage of total labour cost. Again, since social security contributions are included, this measure is not considered appropriate for this model. Therefore, personal income tax revenues are examined in relation with the average personal income tax rates, as they are calculated in the OECD taxing wages database. Since this indicator focuses only on the burden imposed by personal income taxation, it is considered as a more appropriate explanatory variable in the above-mentioned model.

The annual OECD Taxing Wages publication shows average and marginal effective tax rates for eight different household types, which vary by income level and household composition (single persons, single parents, one or two earners, couples with or without children). In the current analysis and for the sake of simplicity, the average income tax rate as a percentage of gross labour income for the single person earning 100% of the average wage is used. Including families would not bring much information (Akgun *et al.*, 2017).

Data on shadow economy are derived by the work of Kelmanson *et al.* (2021), as included in the IMF's book entitled "The Global Informal Workforce Priorities for Inclusive Growth". Kelmanson et al. follow the definition of the shadow economy

used by Schneider (2014), as being mostly legal and productive economic activities deliberately hidden from official authorities, that, if recorded, would contribute to GDP. Therefore, illegal or criminal activities, do-it-yourself, or other household activities are excluded from the analysis. By using the multiple indicators – multiple causes (MIMIC) method they get macro-estimates of the size of the shadow economy for 47 European countries over the period 2000 - 2019.

Taking into consideration the definition used by Kelmanson et al. (2021), the model is transformed by augmenting GDP with the size of the shadow economy. Corporate income tax revenues, personal income tax revenues and shadow economy are therefore expressed as a percentage of an augmented GDP, which considers the total national income of the economy, i.e., the reported one and the hidden one.

$$TaxRev.adj.=b\_0i+b\_1*r\_it+b\_2SHADadj.+\varepsilon\_it \quad (5)$$

Where:
Tax Rev. adj. = adjusted corporate / personal income tax revenues
SHAD = the adjusted size of shadow economy

In order to isolate all other components, a search is conducted for an unknown unmeasured effect in the model, which is common between countries and affects revenues from income tax, besides shadow economy, which has already been included in the model as an explanatory variable. As a result, the model is changed to:

$$TaxRev.adj=b\_0i+b\_1*r\_it+b\_2SHADadj+CSFEi+\varepsilon\_it \quad (6)$$

Where:
CSFE = the Cross Section Fixed Effect per Country, which is a dummy variable for each country that differentiates the constant variable against the average constant variable of euro-area. In other words, the fixed effects assume that differences between individual countries (cross section) can be accommodated from different intercept.

Since the sample consists of a combination of cross section data and time series, where the same unit cross section is measured at different times, the methodology applied to estimate the above-described model and test our hypothesis is Generalized Least Squares in Eviews, with country fixed effects. This method controls for time-invariant unobserved individual characteristics that can be correlated with the observed independent variables. This is different from a simple Ordinary Least Square Model in the intercept term.

By introducing Dummy variables (Cross-section Fixed Effects) a different intercept is calculated for each individual country. As a result, the estimation of an unknown constant effect in the model is enabled, which is unmeasured by the data. Also, the

Generalized Least Squares method with a cross section weighting in the sample is considered appropriate to fix heteroskedasticity, as subpopulation differences attributed to the wealth standard of each country are eliminated.

3.1 Empirical Estimation of the Effect of CIT Rate and Shadow Economy on Corporate Income Tax Revenues

For the estimation of the relationship between tax revenues and relevant tax rates, in the field of corporate income taxes, the current analysis covers 18 out of 19 Eurozone countries, as no data are available for Malta, regarding the size of shadow economy. The period covered is from 2000 to 2018 and a dummy variable is introduced to capture the effects of the economic crisis. The dummy variable takes the value of one (1) for years 2008 to 2015, to indicate the presence of the negative effects of the economic crisis. For years 2000 to 2007 and 2016 to 2018 it takes the value of zero (0) to indicate the absence of the (pronounced) negative effects of the economic crisis.

Since our sample consists of a combination of cross section data and time series, where the same unit cross section is measured at different times, the methodology applied is panel data regression with fixed effects. The results of the estimation of the adjusted regression are presented in the following table:

Table 1. *Empirical Estimation Results, Corporate Taxes*

Dependent Variable: Corporate Tax Revenue % of GDP	**(1)**	**(2)**
Independent Variables		
C	2.394***	2.531***
	(0.213)	(0.257)
Corporate Income Tax Rate	0.027***	0.020***
	(0.007)	(0.009)
Shadow Economy (as % of GDP)	-0.038	-0.038
	(0.002)	(0.006)
Dummy Variable	- 0.276***	- 0.191***
	(0.056)	(0.062)
AR (1)		0.561
		(0.044)
Method	Panel Least Squares	Panel Least Squares
Observations	341	322
Cross - sections included	18	18
R-squared	0.819	0.883
R-squared adjusted	0.808	0.875
F-Statistic	72.48191	108.6842
Country Fixed Effects	**Yes**	**Yes**
Year Fixed Effects	No	No

Standard Error	0.475	0.371
Durbin-Watson stat	0.824	2.006

Source: *Authors' estimations.*

The adjusted R-Squared is the magnitude of the influence or ability of predictor variables simultaneously in explaining the response variable by observing the standard error. The explanation is the same as the R- Squared but this value has been corrected with standard error.

In estimation output (1), the adjusted R-squared is high, indicating that approximately 81% of the total variation in CIT revenue is explained by the CIT statutory rate and the size of shadow economy. All coefficients have the expected signs and are statistically significant at 0,001 level. Our estimations though are auto correlated. To correct for auto-correlation, an auto-regression scheme of first order denoted as AR (1) is introduced.

By introducing the first order autoregression scheme, as depicted in the last column, the value of Durbin-Watson statistic is 2, therefore it can be assumed that there is no first-order autocorrelation either positive or negative. The adjusted R-squared is higher, indicating that approximately 88% of the total variation in CIT revenue is explained by the CIT statutory rate and the size of shadow economy. The coefficient of the CIT rate has the expected sign and is statistically significant at 0.001 level. This means that the corporate tax rate has a positive and significant relation with revenues from corporate tax. When the rate is increased by 1%, corporate tax revenues will increase by approximately 2%.

The coefficient of the shadow economy has the expected negative sign and is also statistically significant at 0.001 level. This means that when shadow economy increases by 1%, revenues from corporate tax will fall by approximately 4%. The coefficient on the dummy variable has the expected negative sign and is statistically significant at 0.001 level. This means that when the dummy variable takes the value of 1 (i.e., for years 2008 – 2015), there is a statistically significant negative effect of the economic crisis on corporate tax revenues. Finally, the constant term is significant, suggesting that there is an unmeasured common effect, not explained by the data that has positive overall effect on tax revenues.

In Table 2, the Cross-section Fixed Effects, which is the quantitative index which distinguishes countries measuring imbalances, are summarized. These fixed effects are cross-section deviations from the overall intercept mean and they capture time-invariant heterogeneity. Countries with a positive fixed effect are clustered together, while countries with a negative fixed effect are clustered together. Countries are ranked from the highest value to the lowest value.

Out of the eighteen Eurozone countries included in our sample, seven countries have a positive fixed effect. The countries with the higher fixed effect are Luxembourg

and Cyprus which are considered as tax heavens and attract investment flows. Luxembourg has a lenient tax regime on financial institutions, attracting as a result a large portion of EU funds and investors and Cyprus has a very low corporate tax regime. Ireland which also has a competitive corporate tax regime also has relatively high fixed effect.

Table 2. *Cross-section Fixed Effects, Corporate Taxes*

Luxembourg	2,284015	Finland	-0,134744
Cyprus	1,919721	Spain	-0,200872
Ireland	0,333771	France	-0,396981
Belgium	0,240595	Italy	-0,417389
Slovakia	0,190854	Greece	-0,443968
Portugal	0,120035	Slovenia	-0,482213
Netherlands	0,007604	Austria	-0,48253
		Latvia	-0,489908
		Lithuania	-0,554016
		Germany	-0,560125
		Estonia	-0,720548

Source: *Authors' estimations.*

Eleven countries have a negative fixed effect. It could be assumed that in these countries there are inefficiencies in tax administration or tax audits. It could also be assumed that there are many multi-national companies which possibly engage in base erosion and profit shifting activities, and as a result the corporate tax revenue is being affected by the volume of the tax base. Spain has the largest negative effect, followed by Greece.

3.2 Empirical Estimation of the Effect of PIT Rate and Shadow Economy on Personal Income Tax Revenues

For the estimation of the relationship between tax revenues and relevant tax rates, in the field of personal income taxes, the analysis covers 17 out of 19 Eurozone countries, as no data are available for Cyprus and Malta in the OECD taxing wages database regarding the average personal income tax rate. Also, as already mentioned, there are no data for Malta regarding the size of shadow economy.

For consistency purposes, GDP is augmented by the size of the shadow economy and the time period covered is from 2000 to 2018, with a dummy variable to capture the effects of the economic crisis. The results are presented in the following table.

In estimation output (1) the adjusted R-squared is very high and the coefficient on the average PIT rate and the shadow economy have the expected signs and are statistically significant at the 0,001 level. Our estimations though are auto correlated.

To correct for autocorrelation, an auto-regression scheme of first order AR (1) is introduced.

Table 3. *Empirical Estimation Results, Personal Taxes*

Dependent Variable: Personal Income Tax Revenue % of GDP	**(1)**	**(2)**	**(3)**
Independent Variables			
C	0.038***	0.041***	0.042***
	(0.002)	(0.003)	(0.003)
Average Personal Income Tax Rate	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)
Shadow Economy (as % of GDP)	-0.056***	-0.059***	-0.059***
	(0.003)	(0.001)	(0.001)
Dummy Variable	0.000***	0.001***	
	(0.049)	(0.003)	
AR (1)		0.828***	0.818***
		(0.036)	(0.036)
Method	Panel Least Squares	Panel Least Squares	Panel Least Squares
Observations	323	306	306
Cross - sections included	17	17	17
R-squared	0.985	0.994	0.994
R-squared adjusted	0.984	0.994	0.994
F-Statistic	1077.399	2560.51	2726.331
Country Fixed Effects	**Yes**	**Yes**	**Yes**
Year Fixed Effects	No	No	No
Standard Error	0.004	0.003	0.003
Durbin Watson Stat	0.55	1.802	1.804

Source: *Authors' estimations*

In estimation output (2) autocorrelation is corrected, given that the Durbin-Watson statistics approximates the value of 2. The adjusted R-squared is high, indicating that over 99% of the variation in personal income tax revenues is explained by the model. The coefficients on the average PIT rate and the shadow economy have the expected signs and are statistically significant at the 0,001 level. What strikes us is that the coefficient on the dummy variable does not have the expected negative sign but is though statistically significant at the 0,001 level.

Therefore, the regression is re-estimated, by omitting the dummy variable, i.e., by omitting the effect of the economic crisis.

In estimation output (3) the adjusted R-squared is very high, indicating again that over 99% of the variation in personal tax revenues is explained by the model. The coefficients of both explanatory variables have the expected signs and are

statistically significant at the 0,001 level. The coefficients on the explanatory variables remain unchanged which confirms that the dummy variable, does not provide additional predictive power in the model.

According to the estimation results, when the shadow economy increases by 1% then, the personal income tax revenues fall by 5%. The constant term is significant, suggesting that there is an unmeasured common effect, not explained by the data that has positive overall effect on tax revenues.

Finally, when the average PIT rate increases by 1%, personal income tax revenues increase marginally, by only 0.2%. This would mean that the level of the average PIT rate is not the main driving force behind the level of the tax revenues. This makes sense since in most countries, the PIT system has a progressive tax schedule.

A progressive tax schedule can be transformed significantly and in many ways. For example, the number and the level of the tax rates may change or/and the number and the breadth of income tax brackets or/and the tax credits and tax allowances. These changes may cause a significant increase or decrease in overall personal income tax revenues depending on the income distribution in the economy, though they will not necessarily alter the average personal income tax rate imposed on an individual earning the 100% of the average wage.

This could explain why the coefficient on the average wage in our estimation results is very low. In the following Table 4 the country fixed effects are presented.

Table 4. *Cross-section fixed effects – Personal Income Taxation*

Spain	0.000979	Netherlands	-0.001197
Germany	0.004625	Ireland	-0.003104
Luxembourg	0.010688	Greece	-0.004310
France	0.011640	Portugal	-0.007808
Belgium	0.015071	Slovenia	-0.008986
Italy	0.018692	Estonia	-0.017535
Austria	0.022455	Latvia	-0.019820
Finland	0.028425	Lithuania	-0.024498
		Slovak Republic	-0.025317

Source: *Authors' estimations.*

It is noticed that the strong European economies have a positive fixed effect which means that there are some country-specific attributes that do not vary across time, which increase the personal income tax revenues. Among them, Finland and Austria have the highest positive fixed effects. The newer members of the EU, together with the Netherlands, Ireland, Greece and Portugal have a negative fixed effect on tax revenues.

4. Conclusions

The current paper investigated the relationship between tax revenues and corresponding tax rates in the field of personal income tax and corporate income tax in the euro area, during years 2000 – 2018. Apart from the arithmetic effect of a change of tax rates on tax revenues, the analysis incorporated also the economic effect on tax revenue, i.e., the effect of a change of the tax base. The economic effect in our analysis was examined through the size of the shadow economy.

Given that the shadow economy comprises all economic activities that would generally be taxable if they were reported to the tax authorities, our analysis expressed corporate income tax revenues, personal income tax revenues and shadow economy as a percentage of an augmented GDP, which considered the total national income of the economy, i.e., the reported one and the hidden one.

The estimation output confirmed the positive relationship between tax revenues and corresponding tax rates as well as the negative effect of the size of the shadow economy on tax revenues. We should be cautious though when interpreting the results in the field of personal income taxation, given that in most countries the personal income tax systems are progressive and therefore the level of the average tax rate does not always mirror changes in the income tax schedule that may have a considerable effect on revenues.

Finally, cross section fixed effects were included in the analysis, confirming that there are time-invariant, country specific characteristics, that may have a significant effect on the amount of tax revenues collected.

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