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The Relationship between Taxation Levels and Economic Growth in Greece: Comparison with Selected Countries

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Abstract:

Purpose: *The purpose of this paper is to examine the effect of taxation levels on the economic growth of Greece over a period and compare the results with other European countries. A theoretical model connecting taxation rates, revenue and economic growth is difficult to apply because of the multitude of legislation acts, regulations, exemptions, and reforms regarding taxation.*
Design and Methodology: *In the paper the percentage of direct, indirect, and environmental taxes to GDP, as well as the implicit taxation rates for consumption and labor are examined as to how they affect the GDP and GDP per capita growth rate for Greece, Germany, Italy, and Portugal over the period from 1995 to 2018.*
Findings: *The results show that any increase or decrease in these taxation figures has a different effect on the economies of these countries because of the inherent differences in each economic environment.*
Practical implications: *The common conception that high tax rates have a negative effect on the economy seems to apply only for the steady and growing German economy. For the Greek and the Portuguese economies, depression, external debt and changes in legislation and reforms add more factors that influence the economic growth and sometimes reverse the result.*
Originality/Value: *While many studies have investigated the effect of taxation rates on the economic growth, the originality of this paper lies in the fact that it deals with the same subject specifically for Greece and compares the results with other European Union countries.*

Keywords*: Taxation, Indirect tax, Direct tax, Environmental tax, Implicit tax rate, Labor tax rate, Consumption tax rate, Gross Domestic Product (GDP), Gross Domestic Product (GDP) per Capita, Value Added Tax (VAT), Laffer curve.*

JEL codes: *A12, A13, A14, C02, C12, C13, C15, C51, C53, E01, E02, E21, F43, H23, H24.*

Paper type: *Research article.*

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1. Introduction

In recent years, many states face huge economic problems and deficits making the need for new sources of revenue more urgent than ever. Although an increase of tax rates is expected to have an immediate effect on state revenue, this increase is bad for business since it "scares off" investors, entrepreneurs, and corporations. It is generally accepted that (mostly) in free economies, taxation has a key role for the state to generate revenue to finance its services and social policy including the distribution of income. However, high tax rates deprive the economy of resources that could be channeled into the market and fuel the economic growth. The term "economic growth" is examined in terms of expanding the Gross Domestic Product (GDP) and the supply side of the economy. In general, while there is no doubt that tax policy can influence economic choices, it is by no means obvious, on an ex-ante basis, that tax rate cuts will ultimately lead to a larger economy in the long run. While rate cuts would raise the after-tax return to working, saving, and investing, they would also raise the after-tax income people receive from their current level of activities, which lessens their need to work, save, and invest (Gale and Samwick, 2016).

According to Therese McGuire (Calvert, 2019) (tax policy expert and professor of strategy at the Kellogg School of Management of Northwestern University), the best tax policies for state and local governments seeking to grow their economies are those that (1) offer long-term certainty to businesses and individuals, (2) are coupled with wise public investment, and (3) are designed with the principles of efficiency, simplicity, and equity in mind. Such policies—based on economic principles, not political whim—also have the best chance of promoting fairness across the board (Calvert, 2019).

In a simplified approach a policy maker could decide to cut as much of the tax rate as possible in order to direct these cuts to the real market by stimulating new consumer spending and/or new business investment (Gale *et al.*, 2001). At the same time, the effect of these cuts to state revenue, interest rates and in general the long-term impact of these cuts should be kept to a minimum by expanding the tax base. Expanding the tax base can eliminate the effect of tax rate cuts, but at the same time, they reduce the impact on labor supply, saving, and investment and thus reduce the direct impact on growth. They may also reallocate resources across sectors toward their highest value economic use, resulting in increased efficiency and potentially raising the overall size of the economy (Gale and Samwick, 2016).

The effect of tax cuts in long-term growth cannot be examined without taking into consideration the way these cuts are financed. If these cuts are balanced by cuts in unproductive government spending, they raise output and long-term growth. On the other hand, if tax cuts are balanced by reductions in government investments, they could reduce output. If tax cuts are not financed by spending cuts, they will lead to an increase in state borrowing, which in turn, will reduce long-term growth. The

historical evidence and simulation analyses suggest that tax cuts that are financed by debt for an extended period will have little positive impact on long-term growth and could reduce growth (Gale and Samwick, 2016).

The purpose of this paper is to derive an empirical relationship between taxes, tax reductions, state revenue and economic growth for Greece in comparison with other countries based on available data. The paper is organized as follows. In the next section the basics of Laffer curve are presented along with an attempt to use it for Greece. Based on available data for Greece, a form of the curve is computed but it does not resemble the theoretical shape since the economic environment and the data do not comply with the assumptions for the original Laffer curve. The methodology and analysis section presents the data for Greece over a period from 1995 to 2018 and empirical formulas derived from these data sets relating tax revenues (as percentage of GDP) with GDP and GDP per capital growth rates. Another set of empirical formulas are computed to relate the implicit tax rates for consumption and labor to the GDP and GDP per capital growth rates. For comparison, the same empirical formulas are computed for Germany, Italy, and Portugal. The last section summarizes the results for Greece and the other 3 countries.

2. Background

Greece, in the years between 1995 and 2018 went through complex economic changes from the (almost) independent economic policy of the 90s to the Euro era and the control of the European Central Bank. It experienced the pre-2004 economic growth fueled by the Athens Olympic Games, after that, an almost 12-year depression accompanied by economic control from the European Institutions and the IMF and a small economic growth in recent years, which might suggest that the depression era might be over. In this 23-year period various changes in taxation rates took place. Taking the VAT as an example, in mainland Greece it changed from 4 categories (up to 1992) to 3 (after 1992), and the rate increased by almost 50% for the normal, low, and reduced category, as in the following Table 1:

Table 1. *VAT rates in Greece from 1992 till Today*

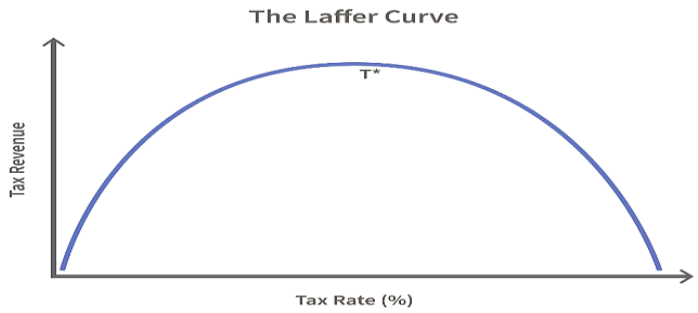
Period		**VAT Rate**		
From	**To**	**Normal**	**Low**	**Reduced**
8/8/1992	3/31/2005	18%	8%	4%
4/1/2005	3/14/2010	19%	9%	4.5%
3/15/2010	6/30/2010	21%	10%	5%
7/1/2010	12/31/2010	23%	11%	5.5%
1/1/2011	6/20/2015	23%	13%	6.5%
7/20/2015	5/31/2016	23%	13%	6%
6/1/2016	Today	24%	13%	6%

Source: *Greek Independent Public Revenue Authority (AADE, www.aade.gr)*

As if this was not complex enough, in these years various products and services changed VAT category more than one time, making meaningless any analysis simply based on VAT ratings. Another factor to be taken into consideration is the percentage of VAT collected by the tax authorities, since the inherent tax evasion increased in the years of depression.

Under steady market conditions (perfect competition, full-employment output, increasing inflation), the Laffer Curve (developed by supply-side economist Arthur Laffer) describes the effect of tax rate changes to tax revenue (Soldatos, 2016). It assumes that the maximum tax revenue is raised having the tax rate somewhere between 0% and 100% while no tax revenue is raised at rates 0% and 100%. The shape of the curve is parabolic-like showing that revenue increases from tax rate 0% up to an intermediate rate and then as rate increases the revenue decreases until it reaches 0 at tax rate 100%. However, the shape of the curve as a function of taxable income elasticity is uncertain and disputed among economic scientists (Tucker, 2019). One use of the Laffer curve is to determine the taxation rate that raises the maximum revenue. This is not to be confused with the optimal tax rate that raises a given amount of revenue with the minimum economic distortions (Giertz, 2008).

Figure 1. *The Laffer curve*



Source: *Tucker 2019.*

For this paper, the Laffer curve proved inappropriate for two reasons: (1) between the years 1995 and 2018 the economic conditions in Greece are nowhere near to be considered steady and (2) the overall tax rates (implicit direct and indirect) are practically constant as shown in the following Table 2.

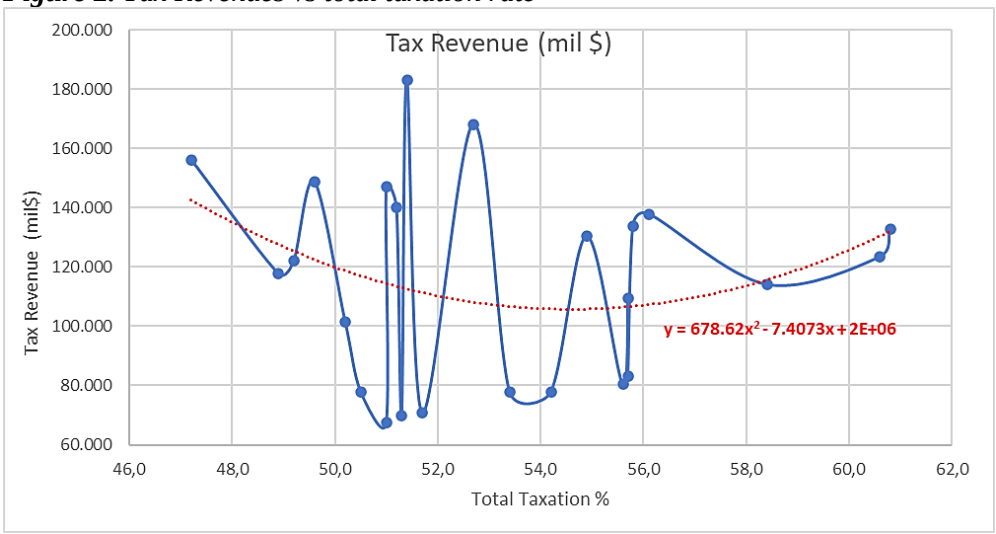
Table 2. *Total implicit Tax Rate and Revenue for Greece*

Year	Total Taxation %	Tax Revenue (mil $)
1995	51,7	70.799,0
1996	53,4	77.895,6
1997	54,2	77.682,7
1998	55,6	80.422,1

Year	Total Taxation %	Tax Revenue (mil $)
1999	55,7	83.222,5
2000	51,0	67.421,0
2001	51,3	69.927,0
2002	50,5	77.999,8
2003	50,2	101.564,6
2004	48,9	117.777,6
2005	49,2	122.021,9
2006	51,2	140.063,7
2007	52,7	168.081,9
2008	51,4	182.916,7
2009	47,2	156.207,9
2010	49,6	148.749,4
2011	51,0	146.943,2
2012	56,1	137.900,5
2013	55,8	133.882,6
2014	54,9	130.335,9
2015	55,7	109.556,3
2016	58,4	114.055,8
2017	60,6	123.331,3
2018	60,8	132.688,7

Source: *Own study.*

Figure 2. *Tax Revenues vs total taxation rate*



Source: *Own study.*

From Figure 2 and Table 2, the average tax rate is 53.2% (with standard deviation of 3.5%) and the average revenue is 115.477 mil$ (with standard deviation of 33,084.5 mil$).

Using Ordinary Least of Squares (OLS) methodology[i], a corresponding curve can be derived, similar to the simplified Laffer curve, in the form $\mathbf{y=ax^2 + bx + c}$.

The resulting formula is as follows:

Tax Revenue = 678.616*Tax%^{2} – 7,4073.367*Tax% + 2,127,082.37
(red dotted line in Figure 2)

where, obviously, a= 678.616, b= -74,073.367 and c=2,127,082.379

This formula gives an R^2 = 0.8677, F test statistic = 0.9978 and P-value = 0.386. With these values and since P>0.05, the H0 hypothesis that a=b=c=0 versus at least one of a, b or c being not equal to 0 cannot be rejected, at a significance level 0.05.

The first and second derivatives show that a tax rate of 54.58% gives the minimum tax revenue (105,740 mil$), whereas smaller and larger tax rates increase the revenue. The shape of the curve can be seen in the chart and it can be easily understood that this curve does not resemble the normal Laffer Curve for the reasons previously mentioned. Therefore, the examination of the Laffer curve is abandoned for the rest of the paper.

3. Methodology and Analysis

In theory, there is a connection between tax rates, tax revenue and growth rates which can be approximated by formulas derived from data covering a relatively big period. In practice, this is very difficult to achieve because even for a single tax, like the VAT, there is no one single rate applied to all products and services (Table 1. VAT *rates in Greece from 1992 till Today* Another problem is that for the same tax category (like the income tax) there are different tax rates for different income categories, and there are various tax deductions and surcharges based on (mostly) social criteria. These deductions and exceptions apply mostly to direct taxes but some of them apply to indirect taxes as well (Table 3, numbers 1, 3, 4 and 15, 16, 19). Finally, the legislation which defines tax rates, deductions and surcharges changes almost every year. The following Table 3 contains 20 legislation changes in 6 tax categories for only 2018.

Table 3. *Legislation changes in Greece in 2018.*

Description of measure	**Change**
Personal income tax: Earned income	
1. Tax credit reduced to €1,250 for a taxpayer without children and with a taxable income up to €20,000, €1 300 for a taxpayer with one child, €1,350 for a taxpayer with two children, and €1,450 for taxpayers with 3 or more children. This brings the average tax-free threshold to around €6,500. The maximum allowable offset of the tax credit is the sum of employment, pension, and farm income multiplied by the basic tax rate. Tax credit more	Base increase

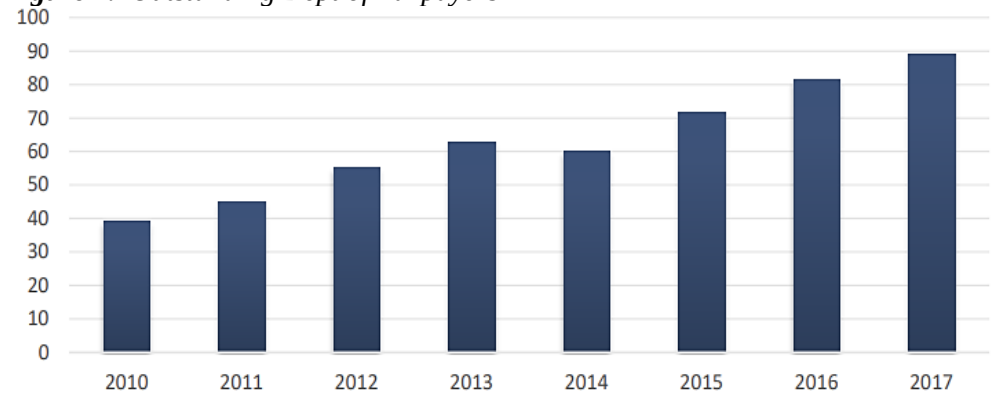
Description of measure	Change
Personal income tax: Earned income	
than this eligible amount cannot be offset.	
2. The tax rate for the first bracket will be reduced to 20% (from 22%). Therefore, the tax schedule applying to pooled business and employment income, as well as farming income, is: 20% for up to €20,000; 29% for €20,001 to €30,000; 37% for €30,001 to €40,000; 45% for above €40,000.	Rate decrease
3. The solidarity surcharge will be imposed on income of more than €30,000 (instead of €12,000). It is levied on all income, whether subject to Personal income tax or not, including salaries, pensions, income from business activity, capital, capital gains and transfers, whether real or presumed. The tax rate will vary from 2% for income between €30,000 and €40,000, rising progressively to 10% for income over €220,000.	Rate decrease
4. Abolition of medical expenses tax allowance (1/1/2017) and of the 1.5% reduction in income tax withheld on employment income and pension income (1/1/2018).	Base increase
5. 1-year suspension of tax imposed on any income arising from capital gains from the transfer of immovable property which does not constitute a business activity.	Neutral
6. Tax will be imposed on income derived from short term property lease. This income is income from business activity, when additional services (apart from sheet cleaning) are provided.	New tax
7. Abolition of the deduction from the taxable amount of the parliamentary allowance of the members of the Parliament.	Base increase
Social security contributions: Self-employed	
8. Insurance contribution for self - employed (insured persons in former OAEE), free lancers (insured in former ETAA) and farmers (insured in former OGA) will be calculated as the sum of the monthly taxable income of the self-employed and payable social security contributions. For the year 2018, the insurance contribution is calculated at 85% of the above taxable income.	Base increase
Corporate income tax	
9. The CIT rate for all companies (regardless of whether the companies are single bookkeeping or double bookkeeping) will be 26% except for credit institutions for which the CIT rate is 29%.	Rate decrease
Value-added tax	
10. A 6-month extension was granted, until 6/30/2018, for the reduced tax rates for the islands of Leros, Lesbos, Kos, Samos, and Chios.	N/A
11. Reduced VAT rate of 13% for farm supplies (from 1/1/2017) and for services of retirement homes (from 1/1/2018)	Rate decrease
Other excise duties	
12. Fuel excises: from 1/6/2016, natural gas used for electricity production is exempt from excise duty, from 1st of January 2017 Reduce Excise Duty on Natural Gas for households and production	Rate decrease; base decrease
13. Fuel excises: from January 2017, increase in excise duty on petrol from €670 to €700 per 1,000 litres; on diesel from €330 to €410 per 1,000 litres, on kerosene from €330 to €410 per 1,000 litres, and on motor LPG	Rate increase; base

Description of measure	Change
Personal income tax: Earned income	
from €330 to €430 per 1,000 Kg. From 1st January 2017, reduced excise duty on natural gas for heating in non-businesses (i.e., residential) from €5.4/MWh (€1.5/GJ) to €1.07/MWh (€0.3/GJ).	increase
14. Effective 1 January 2017: revision of the excise tax rates on natural gas for industrial/commercial (non-heating) use, with the new rates (€/MWh) based on consumption.	N/A
15. Excise tax rates on cigarettes and tobacco: the excise tax regime on cigarettes was restructured from 1st January 2017 by increasing the ad valorem excise from 20% to 26% of the retail selling price. The specific tax on fine cut smoking tobacco was increased from €156.70 to €170 per kg.	Rate increase; base increase
16. Consumption tax on e-cigarettes: a new tax of 10 cents/ml introduced on electronic cigarettes from 1st January 2017.	New tax
17. Consumption tax on coffee: new tax on coffee introduced from 1st January 2017 at €2 per kilo on raw (non-roasted) coffee, €3 on roasted coffee, and €4 on instant coffee and other coffee products.	New tax
18. Abolition of excise duty imposed on isopropyl alcohol, which is used in medicine, cosmetics production.	N/A
Other taxes	
19. Communication levies: a new 5% levy on landline and broadband subscriptions introduced from 1st January 2017.	New tax
20. Tax rate on dividends increased from 10% to 15%.	Rate increase

Source: *(European Commission Taxation Database, n.d.).*

Another problem has to do with tax collection. To legislate and define tax rates is relatively easy. To collect tax revenue is a quite different and more difficult task. The following Figure 3 shows the outstanding debt of taxpayers in billions of Euros at the end of 2017.

Figure 1. *Outstanding Dept of Taxpayers*



Source: *Angerer, 2018.*

All these factors add "noise" to the data, making the attempt to derive a simple formula or apply a theoretical model (such as the Laffer curve) impossible and unrealistic. Under these circumstances it was decided to examine two main taxation figures, tax revenue (as a percentage of GDP) and implicit taxation rate and their relationship with GDP growth and GDP per capital growth.

Tax revenue is analyzed into the percentage over GDP of all indirect, direct, and environmental taxes collected for the 1995-2018 period. For example, in Greece in 2002 total taxation revenue was 34% of the GDP (52,514 mil$). Indirect taxes totaled 14.5% of the GDP (22,396 mil$), direct taxes 9.7% (14982 mil$) and environmental taxes 2.5% of the GDP (3,861 mil$). The GDP for 2002 was 154,455 mil$ with a growth rate of 3.9% and the GDP per capita was 14,185 mil$ with a growth rate of 12.8%. [ii]

There is a positive correlation between Indirect and Environmental percentages (coefficient=0.849) and a weaker positive one between Indirect and Direct percentages (coefficient=0.551) while there is no correlation (coefficient=0.362) between Direct and Environmental percentages. Taxation percentage is analyzed into the implicit tax percentage for Consumption and Labor.

Consumption tax rate is largely affected by the VAT, but it also contains taxes on energy, tobacco, alcohol etc. which are not negligible at all. Labor tax rate is composed mainly of all forms of personal income tax and social security contributions. For example, in Greece in 2002 the implicit tax rate on Consumption was 16.1% and on Labor 34.4%[3]. There is no correlation (coefficient=0.225) between Labor and Consumption tax rates.

4. Tax Percentage over GDP and GDP Growth Rate

GDP Growth rate is correlated neither with Indirect tax percentage (coefficient= 0.163) nor with Direct tax percentage (coefficient= -0.185) nor with Environmental (coefficient= -0.123).

In order to derive a linear function of the form **y= ax + bz +ck + d** that connects GDP growth rate (y) with the indirect (x), direct (z) and environmental (k) taxes as percentages over GDP, Ordinary Least of Squares was used (the L matrix contains a column of GDP growth rates, the x matrix the unknown coefficients and the A matrix contains the values of indirect, direct, environmental taxes and a column with 1s) to compute the best values of the a, b, c and d coefficients from data from Greece over a period from 1995 to 2018. The resulting formula is as follows:

GDP growth rate = 3.847*Ind – 2.473*Dir - 7.487* Env – 9.594

The formula gives an $R^2 = 0.4993$, adjusted $R^2 = 0.4242$, F test statistic = 6.6490 and P-value = 0.003. From these values and, since the P-Value is less than 0.05, the null

hypothesis H0 can be rejected (H0: a=b=c=d=0, versus H1:at least one of a, b, c or d being not equal to 0) at a significance level 0.05.

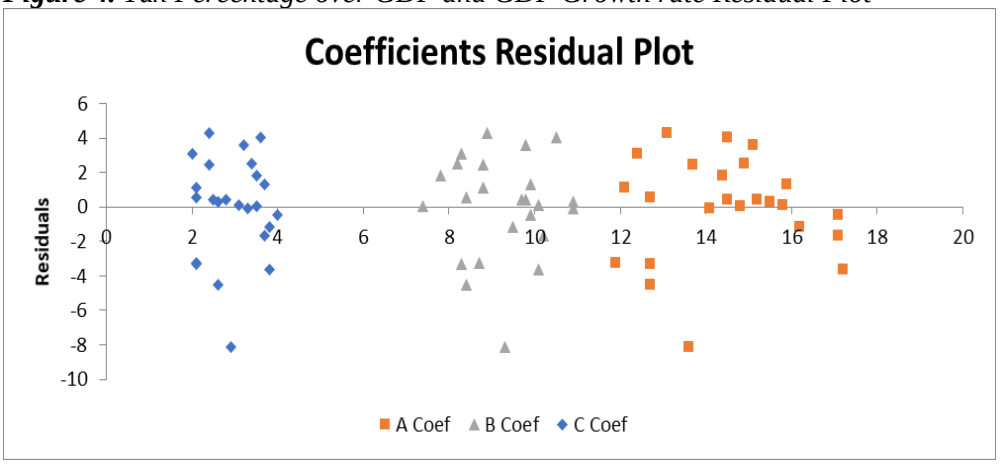
Table 4. *Tax Percentage over GDP and GDP Growth rate Statistical Significance*

Hypothesis testing of Zero Coefficients (Statistical Significance)			
Coefficient	**P-Value**	**P<0.05**	**Significance at a=0.05 Level**
Indirect %(a)	0.000	True	Statistically Significant
Direct % (b)	0.008	True	Statistically Significant
Environmental % (c)	0.002	True	Statistically Significant
Constant (d)	0.225	False	Statistically Insignificant

Source: *Own study.*

The Breusch-Pagan test for heteroscedasticity gives a P-value= 0.987. Because this value is not less than 0.05, the null hypothesis that heteroscedasticity is present in the model cannot be rejected.

Figure 4. *Tax Percentage over GDP and GDP Growth rate Residual Plot*



Source: *Own study.*

From the above formula raising the percentage of indirect taxes in the GDP has a positive effect on the GDP growth rate, while raising the percentage of direct and environmental taxes in the GDP, lowers the GDP growth rate. For comparison purposes the same formula for Germany, Italy, and Portugal was computed, using the same data for the same period of time and the same OLS methodology. The results are as follows:

GDP growth rate $_{DE}$ = - 0.336*Ind $_{DE}$ - 0.132*Dir $_{DE}$ - 1.621* Env $_{DE}$ + 10.443

GDP growth rate $_{IT}$ = - 0.453*Ind $_{IT}$ – 1.330*Dir $_{IT}$ + 2.377* Env $_{IT}$ + 19.169

GDP growth rate $_{PT}$ = 0.260*Ind $_{PT}$ + 1.109*Dir $_{PT}$ + 4.36* Env $_{PT}$ – 24.851

According to the above formulas, in Germany raising the percentage in the GDP for any tax, has a negative impact on the GDP growth rate. In Italy raising either the Indirect or the Direct tax percentage in the GDP lowers the GDP growth rate, while raising the Environmental tax percentage in the GDP increases the GDP growth rate. In Portugal, every increase in the percentage of the Indirect, Direct or Environmental taxes in the GDP appears to have a positive impact on the GDP growth rate.

5. Tax Percentage over GDP and GDP per Capita Growth Rate

GDP per capita growth rate is correlated neither with indirect tax percentage (coefficient= -0.203) nor with direct tax percentage (coefficient= -0.432) nor with environmental (coefficient= -0.317).

In order to derive a linear function of the form **y= ax + bz +ck + d** that connects GDP growth rate (y) with the indirect (x), direct (z) and environmental (k) taxes as percentages over GDP, Ordinary Least of Squares was used (the L matrix contains a column of GDP per capita growth rates, the x matrix the unknown coefficients and the A matrix contains the values of indirect, direct, environmental taxes and a column with 1s) to compute the best values of the a, b, c and d coefficients from data from Greece over the period between 1995 and 2018. The resulting formula is as follows:

GDP per Capita growth rate = 5.184*Ind – 6.650*Dir – 12.642* Env + 27.310

The formula gives an $R^2 = 0.3315$, adjusted $R^2 = 0.2313$, F test statistic = 3.3064 and P-value = 0.041. From these values and, since the P-Value is less than 0.05, the null hypothesis H0 can be rejected (H0: a=b=c=d=0, versus H1:at least one of a, b, c or d being not equal to 0) at a significance level 0.05.

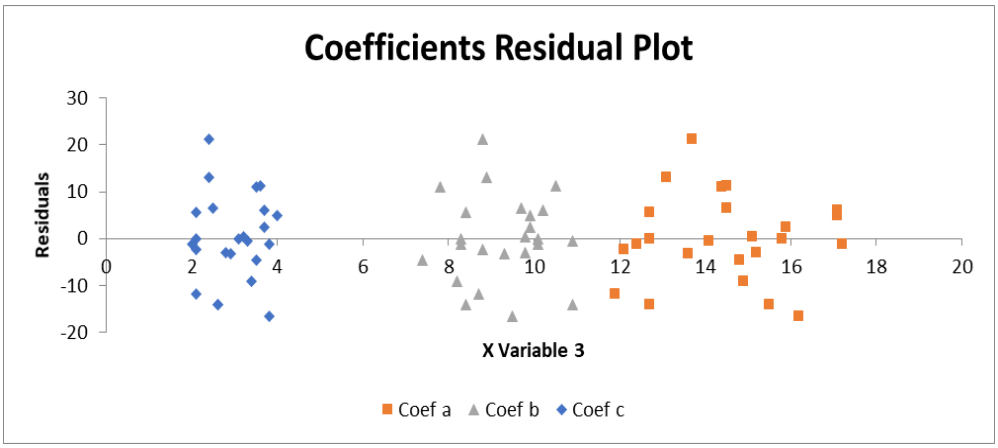
Table 5. *Tax Percentage over GDP and GDP per Capita Growth rate Statistical Significance*

Hypothesis testing of Zero Coefficients (Statistical Significance)			
Coefficient	**P-Value**	**P<0.05**	**Significance at a=0.05 Level**
Indirect %(a)	0.078	False	Statistically Insignificant
Direct % (b)	0.020	True	Statistically Significant
Environmental % (c)	0.052	False	Statistically Insignificant
Constant (d)	0.266	False	Statistically Insignificant

Source: *Own study.*

The Breusch-Pagan test for heteroscedasticity gives a P-value= 0.999. Because this value is not less than 0.05, the null hypothesis that heteroscedasticity is present in the model cannot be rejected.

Figure 5. *Tax Percentage over GDP and GDP per Capita Growth rate Residual Plot*



Source: *Own study.*

From the above formula raising the percentage of indirect, direct, and environmental taxes in the GDP has a negative effect on the GDP per Capita growth rate. Using the same data for the same period and the same OLS methodology, the results for Germany, Italy and Portugal are as follows:

GDP per Capita growth rate$_{DE}$ = - 6.361*Ind$_{DE}$ - 1.132*Dir $_{DE}$ + 17.267* Env $_{DE}$ + 50.906

GDP per Capita growth rate$_{IT}$ = - 3.995*Ind $_{IT}$ - 5.378*Dir $_{IT}$ - 1.767* Env $_{I}$ + 144.575

GDP per Capita growth rate$_{PT}$ = 5.545*Ind $_{PT}$ - 2.081*Dir $_{PT}$ + 4.565* Env $_{P}$ – 68.630

According to the above formulas, in Germany raising the percentage in the GDP for direct and indirect taxes has a negative impact on the GDP per capita growth rate. Raising the percentage of the environmental tax has a positive effect on the GDP per Capita. In Italy raising any tax percentage in the GDP lowers the GDP per capita growth rate. In Portugal increasing the percentage of the indirect or environmental taxes in the GDP appears to have a positive impact on the GDP per capita growth rate, while raising the direct tax percentage lowers the GDP per capita growth rate.

6. Tax Rate and GDP Growth Rate

GDP growth rate is correlated neither with labor tax rate (coefficient= -0.209) nor with consumption tax rate (coefficient= 0.309). In order to derive a linear function of the form **y= ax + bz +c** that connects GDP growth rate (y) with the consumption tax rate(x) and labor tax rate (z), Ordinary Least of Squares is used (the L matrix

contains a column of GDP growth rates, the x matrix the unknown coefficients and the A matrix contains the values of labor and consumption implicit tax rates and a column with 1s) to compute the best values of the a, b, and c coefficients from data from Greece over the same period. The resulting formula is as follows:

GDP growth rate = 1.282*Cons – 0.441* Lab - 3.294

The formula gives an $R^2 = 0.2449$, adjusted $R^2 = 0.1730$, F test statistic = 3.4056 and P-value = 0.052. Since the P-Value is greater than 0.05, the null hypothesis H0 cannot be rejected (H0: a=b=c=0, versus H1: at least one of a, b or c being not equal to 0) at a significance level 0.05. The conclusion is that the three parameters are jointly statistically insignificant at significance level 0.05.

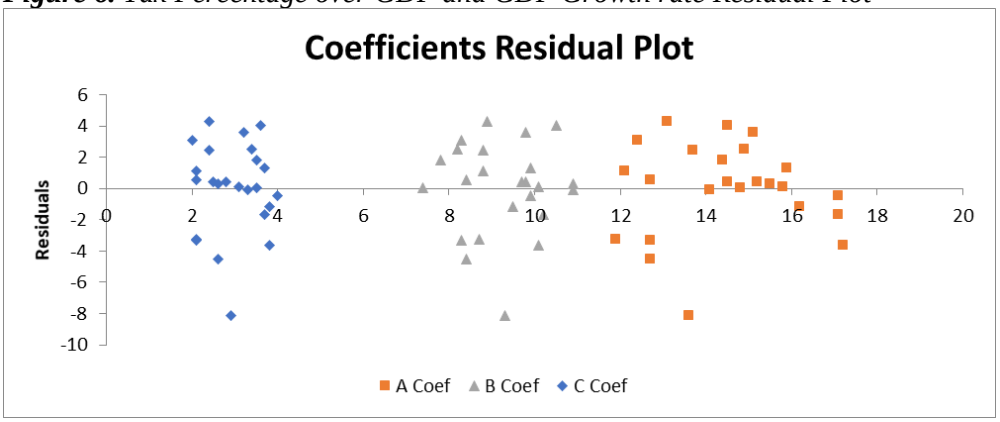
Table 6. *Tax Rate and GDP Growth rate Statistical Significance (linear)*

Hypothesis testing of Zero Coefficients (Statistical Significance)			
Coefficient	**P-Value**	**P<0.05**	**Significance at a=0.05 Level**
Consumption rate (a)	0.028	True	Statistically Significant
Labor rate (b)	0.124	False	Statistically Insignificant
Constant (c)	0.784	False	Statistically Insignificant

Source: *Own study.*

The Breusch-Pagan test for heteroscedasticity gives a P-value= 0.936. Because this value is not less than 0.05, the null hypothesis that heteroscedasticity is present in the model cannot be rejected.

Figure 6. *Tax Percentage over GDP and GDP Growth rate Residual Plot*



Source: *Own study.*

From the above formula raising the percentage of indirect taxes in the GDP has a positive effect on the GDP growth rate, while raising the percentage of direct and environmental taxes in the GDP, lowers the GDP growth rate.

For comparison purposes the same formula for Germany, Italy and Portugal was computed, using the same data for the same period and the same OLS methodology. The results are as follows:

GDP growth rate $_{DE}$ = - 0.336*Ind $_{DE}$ - 0.132*Dir $_{DE}$ - 1.621* Env $_{DE}$ + 10.443

GDP growth rate $_{IT}$ = - 0.453*Ind $_{IT}$ – 1.330*Dir $_{IT}$ + 2.377* Env $_{IT}$ + 19.169

GDP growth rate $_{PT}$ = 0.260*Ind $_{PT}$ + 1.109*Dir $_{PT}$ + 4.36* Env $_{PT}$ – 24.851

According to the above formulas, in Germany raising the percentage in the GDP for any tax, has a negative impact on the GDP growth rate. In Italy raising either the indirect or the direct tax percentage in the GDP lowers the GDP growth rate, while raising the environmental tax percentage in the GDP increases the GDP growth rate. In Portugal, every increase in the percentage of the indirect, direct, or environmental taxes in the GDP appears to have a positive impact on the GDP growth rate.

7. Tax Percentage over GDP and GDP per Capita Growth Rate

GDP per capita growth rate is correlated neither with Indirect tax percentage (coefficient= -0.203) nor with Direct tax percentage (coefficient= -0.432) nor with Environmental (coefficient= -0.317).

In order to derive a linear function of the form **y= ax + bz +ck + d** that connects GDP growth rate (y) with the Indirect (x), Direct (z) and Environmental (k) taxes as percentages over GDP, Ordinary Least of Squares was used (the L matrix contains a column of GDP per Capita growth rates, the x matrix the unknown coefficients and the A matrix contains the values of indirect, direct, environmental taxes and a column with 1s) to compute the best values of the a, b, c and d coefficients from data from Greece over the period between 1995 and 2018. The resulting formula is as follows:

GDP per Capita growth rate = 5.184*Ind – 6.650*Dir – 12.642* Env + 27.310

The formula gives an $R^2 = 0.3315$, adjusted $R^2 = 0.2313$, F test statistic = 3.3064 and P-value = 0.041. From these values and, since the P-Value is less than 0.05, the null hypothesis H0 can be rejected (H0: a=b=c=d=0, versus H1:at least one of a, b, c, or d being not equal to 0) at a significance level 0.05.

Table 7. *Tax Percentage over GDP and GDP per Capita Growth rate Statistical Significance*

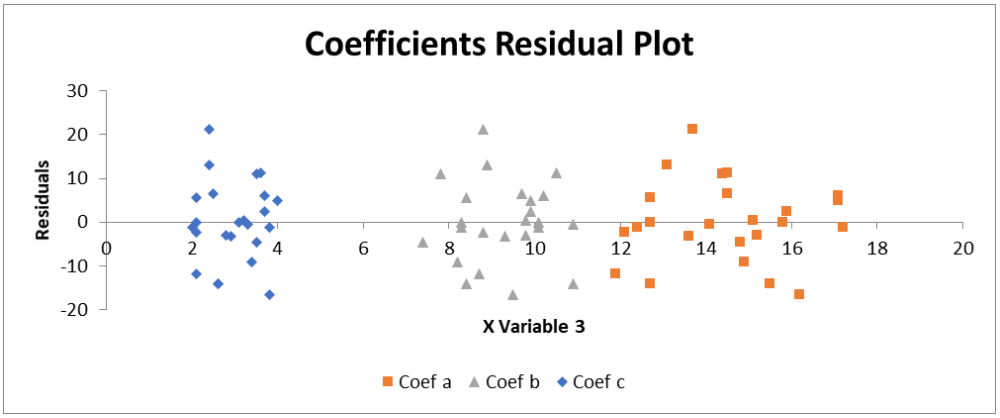
Hypothesis testing of Zero Coefficients (Statistical Significance)			
Coefficient	**P-Value**	**P<0.05**	**Significance at a=0.05 Level**
Indirect %(a)	0.078	False	Statistically Insignificant

Hypothesis testing of Zero Coefficients (Statistical Significance)			
Coefficient	**P-Value**	**P<0.05**	**Significance at a=0.05 Level**
Direct % (b)	0.020	True	Statistically Significant
Environmental % (c)	0.052	False	Statistically Insignificant
Constant (d)	0.266	False	Statistically Insignificant

Source: *Own study.*

The Breusch-Pagan test for heteroscedasticity gives a P-value= 0.999. Because this value is not less than 0.05, the null hypothesis that heteroscedasticity is present in the model cannot be rejected.

Figure 7. *Tax Percentage over GDP and GDP per Capita Growth rate Residual Plot*



Source: *Own study.*

From the above formula raising the percentage of indirect, direct and environmental taxes in the GDP has a negative effect on the GDP per capita growth rate. Using the same data for the same period of time and the same OLS methodology, the results for Germany, Italy and Portugal are as follows:

GDP per Capita growth rate$_{DE}$ = - 6.361*Ind$_{DE}$ - 1.132*Dir $_{DE}$ + 17.267* Env $_{DE}$ + 50.906

GDP per Capita growth rate$_{IT}$ = - 3.995*Ind$_{IT}$ - 5.378*Dir$_{IT}$ - 1.767* Env $_{I}$ + 144.575

GDP per Capita growth rate $_{PT}$ = 5.545*Ind $_{PT}$ - 2.081*Dir $_{PT}$ + 4.565* Env $_{P}$ – 68.630

According to the above formulas, in Germany raising the percentage in the GDP for direct and indirect taxes has a negative impact on the GDP per capita growth rate. Raising the percentage of the environmental tax has a positive effect on the GDP per capita. In Italy raising any tax percentage in the GDP lowers the GDP per capita growth rate. In Portugal increasing the percentage of the indirect or environmental taxes in the GDP appears to have a positive impact on the GDP per capita growth rate, while raising the direct tax percentage lowers the GDP per capita growth rate.

8. Tax Rate and GDP Growth Rate

GDP growth rate is correlated neither with Labor tax rate (coefficient= -0.209) nor with Consumption tax rate (coefficient= 0.309). In order to derive a linear function of the form **y= ax + bz +c** that connects GDP growth rate (y) with the Consumption tax rate(x) and Labor tax rate (z), Ordinary Least of Squares is used (the L matrix contains a column of GDP growth rates, the x matrix the unknown coefficients and the A matrix contains the values of Labor and Consumption implicit tax rates and a column with 1s) to compute the best values of the a, b, and c coefficients from data from Greece over the same period. The resulting formula is as follows:

GDP growth rate = 1.282*Cons – 0.441* Lab - 3.294

The formula gives an R^2 = 0.2449, adjusted R^2 = 0.1730, F test statistic = 3.4056 and P-value = 0.052. Since the P-Value is greater than 0.05, the null hypothesis H0 cannot be rejected (H0: a=b=c=0, versus H1: at least one of a, b or c being not equal to 0) at a significance level 0.05. The conclusion is that the three parameters are jointly statistically insignificant at significance level 0.05.

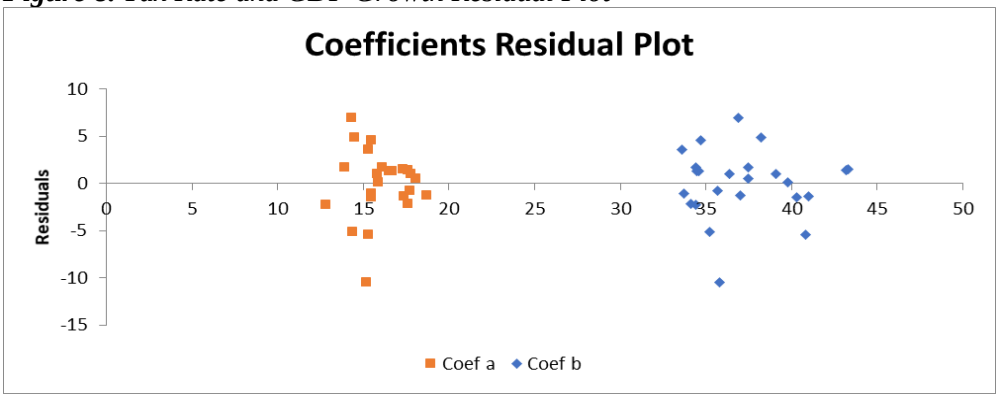
Table 8. *Tax Rate and GDP Growth rate Statistical Significance (linear)*

Hypothesis testing of Zero Coefficients (Statistical Significance)			
Coefficient	**P-Value**	**P<0.05**	**Significance at a=0.05 Level**
Consumption rate (a)	0.028	True	Statistically Significant
Labor rate (b)	0.124	False	Statistically Insignificant
Constant (c)	0.784	False	Statistically Insignificant

Source: *Own study.*

The Breusch-Pagan test for heteroscedasticity gives a P-value= 0.936. Because this value is not less than 0.05, the null hypothesis that heteroscedasticity is present in the model cannot be rejected.

Figure 8. *Tax Rate and GDP Growth Residual Plot*



Source: *Own study.*

From the above formula, raising the Consumption tax rate increases the GDP Growth rate and raising the Labor tax rate decreases the GDP growth rate. Using the same data for the same period and the same OLS methodology, the results for Germany, Italy and Portugal are as follows:

GDP growth rate $_{DE}$ = - 0.408*Cons $_{DE}$ + 0.144*Lab $_{DE}$ + 2.973

GDP growth rate $_{IT}$ = 0.903*Cons $_{IT}$ - 0.370*Lab $_{IT}$ + 2.046

GDP growth rate $_{PT}$ = 0.567*Cons $_{PT}$ + 0.155*Lab $_{PT}$ – 12.776

According to the above formulas, in Germany raising the Consumption tax rate has a negative impact to the GDP growth rate but raising the Labor tax rate increases the GDP growth rate. Italy presents the opposite effect: increasing the Consumption tax rate increases the GDP growth rate, while increasing Labor tax rate decreases it. In Portugal, an increase in the Labor and/or Consumption tax rate increases the GDP growth rate.

Instead of a linear, a second-degree polynomial function of the form $\mathbf{y= ax^2 + bz^2 + cx + dz + exz + f}$ can be derived that connects GDP growth rate (y) with the Consumption tax rate(x) and Labor tax rate (z). Ordinary Least of Squares can be used again to compute the best values of the a, b, c, d, e and f coefficients from data from Greece over the same period. The resulting formula is as follows:

GDP growth rate = -0.080 *Cons^2 + 0.010 *Lab^2 + 3.454 * Cons – 1.338 * Lab + 0.010*Cons*Lab – 3.348

This formula gives an R^2 = 0.2477021, adjusted R^2=0.0387609, F test statistic = 1.1854901 and P-value = 0.3549003. Since the P-Value is greater than 0.05, the null hypothesis H0 cannot be rejected (H0: a=b=c=d=e=0, versus H1: at least one of a, b, c, d, or e being not equal to 0) at a significance level 0.05. The conclusion is that the five parameters are jointly statistically insignificant at significance level 0.05.

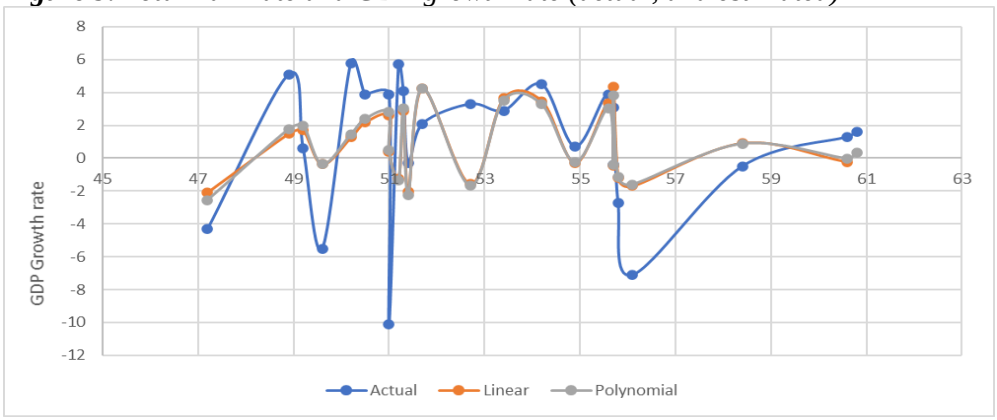
Table 9. *Tax Rate and GDP Growth rate Statistical Significance (polynomial)*

Hypothesis testing of Zero Coefficients (Statistical Significance)			
Coefficient	**P-Value**	**P<0.05**	**Significance at a=0.05 Level**
Consumption rate ^2 (a)	0.859	False	Statistically Insignificant
Labor rate ^2 (b)	0.954	False	Statistically Insignificant
Consumption rate (c)	0.792	False	Statistically Insignificant
Labor rate (d)	0.878	False	Statistically Insignificant
Consumption*Labor (e)	0.981	False	Statistically Insignificant
Constant (f)	0.986	False	Statistically Insignificant

Source: *Own study.*

The Breusch-Pagan test for heteroscedasticity gives a P-value= 0.996. Because this value is not less than 0.05, the null hypothesis that heteroscedasticity is present in the model cannot be rejected. Although it would be expected that the polynomial formula fits more accurately to the actual data, the following graph shows that both the linear and the polynomial formulas similarly represent the effect of total taxation rate (combined Consumption + Labor) to the GDP growth rate. Therefore, the linear formula is preferred due to its simplicity.

Figure 9. *Total Tax Rate and GDP growth rate (actual, and estimated)*



Source: *Own study.*

9. Tax Rate and GDP per Capita Growth Rate

GDP per Capita growth rate is correlated neither with Labor tax rate (coefficient= -0.245) nor with Consumption tax rate (coefficient= 0.030). In order to derive a linear function of the form **y= ax + bz +c** that connects GDP per capita growth rate (y) with the Consumption tax rate(x) and Labor tax rate (z), Ordinary Least of Squares is used (the L matrix contains a column of GDP per capita growth rates, the x matrix the unknown coefficients and the A matrix contains the values of Labor and Consumption implicit tax rates and a column with 1s) to compute the best values of the a, b, and c coefficients from data from Greece over the same period. The resulting formula is as follows:

GDP per Capita growth rate = 0.673*Cons – 1.012* Lab + 29.917

The formula gives an R^2 = 0.0678, adjusted R^2 = 0.0210, F test statistic = 0.7634 and P-value = 0.479. From these values and since the P-Value is greater than 0.05 the null hypothesis H0 cannot be rejected (H0: a=b=c=0, versus H1: at least one of a, b or c being not equal to 0) at a significance level 0.05. The conclusion is that the three parameters are jointly statistically insignificant at significance level 0.05.

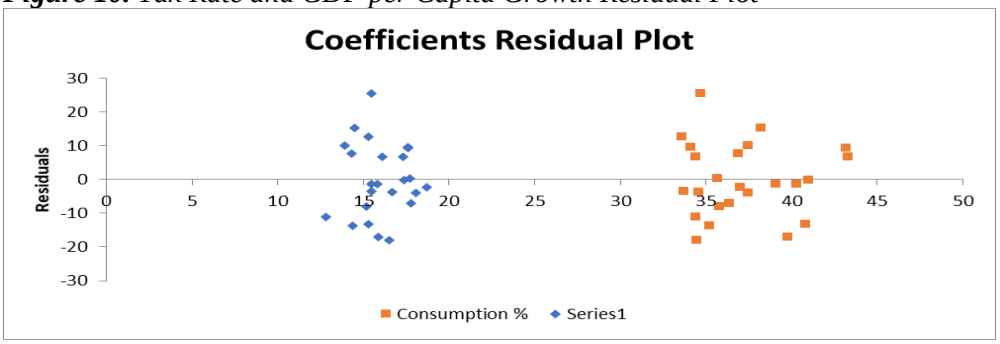
Table 10. *Tax Rate and GDP per Capita Growth rate Statistical Significance (linear)*

Hypothesis testing of Zero Coefficients (Statistical Significance)			
Coefficient	**P-Value**	**P<0.05**	**Significance at a=0.05 Level**
Consumption rate (a)	0.682	True	Statistically Significant
Labor rate (b)	0.233	False	Statistically Insignificant
Constant (c)	0.409	False	Statistically Insignificant

Source: *Own study.*

The Breusch-Pagan test for heteroscedasticity gives a P-value= 0.9512057. Because this value is not less than 0.05, the null hypothesis that heteroscedasticity is present in the model cannot be rejected.

Figure 10. *Tax Rate and GDP per Capita Growth Residual Plot*



Source: *Own study.*

From the above formula, raising the Consumption tax rate increases the GDP per Capita Growth rate and raising the Labor tax rate decreases the GDP growth rate. Using the same data for the same period and the same OLS methodology, the results for Germany, Italy and Portugal are as follows:

GDP growth rate $_{DE}$ = 3.089*Cons $_{DE}$ – 2.166*Lab $_{DE}$ + 32.469

GDP growth rate $_{IT}$ = 0.346*Cons $_{IT}$ – 1.635*Lab $_{IT}$ + 67.607

GDP growth rate $_{PT}$ = 0.147*Cons $_{PT}$ + 0.269*Lab $_{PT}$ – 29.330

According to the above formulas, in Germany and Italy, raising the Consumption tax rate has a positive impact on the GDP per Capita growth rate but raising the Labor tax rate decreases the GDP per Capita growth rate. In Portugal, an increase in the Labor and/or Consumption tax rate increases the GDP per Capita growth rate.

Instead of a linear, a second-degree polynomial function of the form **$y= ax^2 + bz^2 + cx + dz + exz + f$** can be derived that connects GDP growth rate (y)

with the Consumption tax rate(x) and Labor tax rate (z). Ordinary Least of Squares can be used again to compute the best values of the a, b, c, d, e, and f coefficients from data from Greece over the same period. The resulting formula is as follows:

GDP growth rate = 0.019 *Cons^2 + 0.371 *Lab^2 + 12.970 * Cons – 23.360 * Lab – 0.359*Cons*Lab + 357.014

This formula gives an R^2 = 0.1125, adjusted R^2=0.1340, F test statistic = 0.4563 and P-value = 0.380. Since the P-Value is greater than 0.05, the null hypothesis H0 cannot be rejected (H0: a=b=c=d=e=0, versus H1:at least one of a, b, c, d, or e being not equal to 0) at a significance level 0.05. The conclusion is that the five parameters are jointly statistically insignificant at significance level 0.05.

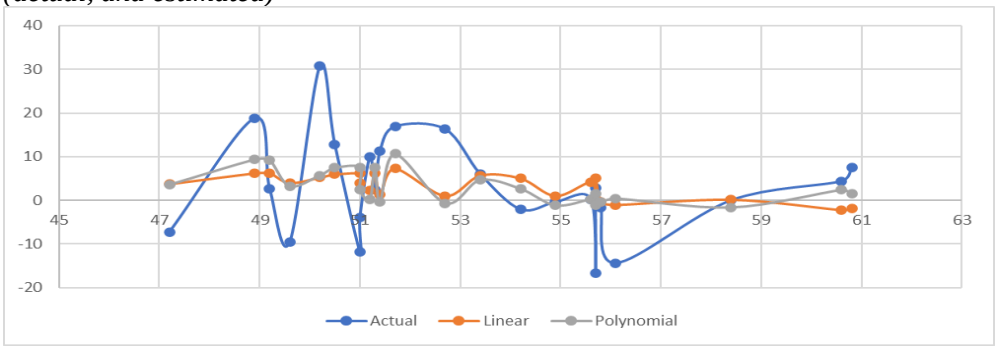
Table 11. *Tax Rate and GDP Growth rate Statistical Significance (polynomial)*

Hypothesis testing of Zero Coefficients (Statistical Significance)			
Coefficient	**P-Value**	**P<0.05**	**Significance at a=0.05 Level**
Consumption rate ^2 (a)	0.988	False	Statistically Insignificant
Labor rate ^2 (b)	0.449	False	Statistically Insignificant
Consumption rate (c)	0.735	False	Statistically Insignificant
Labor rate (d)	0.366	False	Statistically Insignificant
Consumption*Labor (e)	0.771	False	Statistically Insignificant
Constant (f)	0.532	False	Statistically Insignificant

Source: *Own study.*

The Breusch-Pagan test for heteroscedasticity gives a P-value= 0.999. Because this value is not less than 0.05, the null hypothesis that heteroscedasticity is present in the model cannot be rejected. As expected, the polynomial formula fits slightly better to the actual data than the linear one, as the following graph shows. However, this match is not good enough to compensate for the complexity of the polynomial formula so, the linear formula is preferred again due to its simplicity.

Figure 11. *Total Tax Rate (Consumption + Labor) and GDP per Capita growth rate (actual, and estimated)*



Source: *Own study.*

10. Conclusion

The purpose of this paper is to examine how the taxation figures influence growth rates in Greece and compare these findings with other European Countries. For this purpose, data for Greece, Germany, Italy, and Portugal were collected and analyzed to derive formulas to define:

1. How GDP growth rate is affected by the percentage of Direct, Indirect and Environmental tax revenues into the total GDP of each country. For Greece, GDP growth rate increases when indirect taxes increase and direct and environmental taxes decrease. For Germany, the GDP growth rate increases when any of these taxes decrease. The same applies to Italy apart from environmental taxes which raise the GDP growth rate. In Portugal, the GDP rate increases when any type of tax increases.
2. How GDP per capita growth rate is affected by the percentage of Direct, Indirect and Environmental tax revenues into the total GDP of each country. For Greece, GDP per capita growth rate increases when indirect taxes increase and direct and environmental taxes decrease. For Italy, the GDP growth rate increases when any of these taxes decrease. The same applies to Germany, apart from environmental taxes which raise the GDP per capita growth rate. In Portugal, the GDP rate increases when indirect and environmental taxes increase and direct taxes decrease.
3. How GDP Growth rate is affected by the implicit tax rates on Consumption and Labor for each country. For Greece, GDP growth rate increases when the taxation rate for consumption increases and for labor decreases. For Germany, the GDP growth rate increases when the taxation rate for consumption decreases and for labor increases. For Italy, GDP growth rate increases when the taxation rate for consumption increases and for labor decreases. In Portugal, the GDP rate increases when any rate for consumption or labor increases.
4. How GDP per Capita Growth rate is affected by the implicit tax rates on Consumption and Labor for each country. For Greece, GDP per Capita growth rate increases when the taxation rate for consumption increases and for labor decreases. For Germany, the GDP per Capita growth rate increases when the taxation rate for consumption increases and for labor decreases. For Italy, GDP per Capita growth rate increases when the taxation rate for consumption increases and for labor decreases. In Portugal, the GDP per Capita rate increases when any rate for consumption or labor increases.

As a general conclusion, it can be stated that the conception that high tax rates have a negative effect on the economy, seems to apply only for steady and growing economies, such as the German economy. The results show that an increase or decrease of any of these taxation figures has a different effect on the economies of the examined countries because of the inherent differences in each general economic environment. When more problematic economies are examined such as the Greek and the Portuguese ones, the economic problems, depression, changes in legislation

and reforms to deal with the economic and social difficulties add more factors that influence and sometimes reverse the result.

References:

Amadeo, K. 2020. What is the Laffer Curve [Online] Available at: https://www.thebalance.com/what-is-the-laffer-curve-explanation-3305566.

Angerer, J. 2018. Tax collection in Greece: State of play - June 2018. s.l., Economic Governance Support Unit / Directorate General for Internal Policies.

Anon., n.d. Greece GDP - Gross Domestic Product. [Online] Available at: https://countryeconomy.com/gdp/greece.

Boria, P. 2017. Taxation in European Union. Springer.

Calvert, D. 2019. Do High Local Taxes Really Hurt Economic Growth? [Online] Available at: https://insight.kellogg.northwestern.edu//article/local-tax-policy-economic-growth.

Congressional Budget Office. 2014. How CBO Analyzes the Effects of Changes in Federal Fiscal Policies on the Economy. Washington, DC: Congressional Budget Office.

Dekking, F.M., Kraaikamp, C., Lopuhaä, H.P., Meester, L.E. 2005. A modern introduction to probability and statistics: Understanding why and how. Springer.

Directorate General for Taxation and Customs Union, 2018. Tax Policies in the European Union: 2018 Survey. s.l., European Commision.

Directorate-General for Taxation and Customs Union, 2018. Taxation Trends in the European Union. Luxembourg: Publications Office of the European Union.

Directorate-General for Taxation and Customs Union, 2020. Taxation Trends in the European Union. Luxembourg: Publications Office of the European Union.

European Commision Taxation Database, n.d. Taxes in Europe Database. [Online] Available at: https://ec.europa.eu/taxation_customs/tedb/splSearchForm.html

European Union, n.d. Taxation. [Online] Available at: https://europa.eu/european-union/topics/taxation_en.

Gale, W.G., Samwick, A.A. 2016. Effects of Income Tax Changes on Economic Growth. Dartmouth College.

Gale, W., Orszag, P., Sperling, G. 2001. Stimulating the Economy Through Tax Policy: Principles and Applications. Brookings.

Giertz, S.H. 2008. How Does the Elasticity of Taxable Income Affect Economic Efficiency and Tax Revenues and What Implications Does this have for Tax Policy Moving Forward? American Enterprise Institute.

Hallerberg, M. 2012. Explaining European Patterns of Taxation: From the Introduction of the Euro to the Euro-Crisis. Inter-American Development Bank.

Meussen, G. 1999. The Principle of Equality in European Taxation. Wolters Kluwer.

OECD. Stat, n.d. Details of Tax Revenue - Greece. [Online] Available at: https://stats.oecd.org/Index.aspx?DataSetCode=REVGRC.

OECD/European Union 1998. Value-Added Taxes in Central and Eastern European Countries: A Comparative Survey and Evaluation. OECD Publishing.

Panayi, C.H., Haslehner, W., Traversa, E. 2020. Research Handbook on European Union Taxation Law. Edward Elgar Publishing.

Soldatos, G.T. 2016. The Laffer Curve, Efficiency, and Tax Policy: A Note. Review of Economics, De Gruyter, vol. 67(3).

Radaelli, C. 1997. The politics of Corporate Taxation in the European Union. Routledge.

Tucker, I.B. 2019. Survey of Economics. Cengage Learning.
Vellutini, C., Casamatta, G., Bousquet, L., Poniatowski, G. 2019. Estimating International Tax Evasion by Individuals. Luxembourg: Publications Office of the EU.

[i] The coefficients for the formula are the solution of the system Ax=L (in matrix form, where L is a single column matrix with the tax revenues, x is the unknown coefficients matrix and A is a matrix containing a column of taxation total rates and a column with 1s). Since the A matrix is not rectangular, the solution is $x=(A_T*A)^{-1}*A_T*L$.

[ii] (Directorate-General for Taxation and Customs Union, 2018), (OECD.Stat, n.d.), (Directorate-General for Taxation and Customs Union, 2020).