Minerva Research Institute

Empirical Analysis

Debt, investments in education, and tax rates in Greece and Estonia: an empirical analysis

10th April 2024

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Abstract

Government debt is closely associated with tax revenues in the long run period. All else constant, higher tax rates imply higher tax revenues, reduction of budget deficit and less need for external borrowing, hence lower government debt. Investments in productivity-enhancing projects, like education or R&D, in turn, correspond to higher output. Since the tax base is higher than before, all else constant, tax revenues also should increase and hence debt should decrease. This theoretical framework can be analyzed empirically to show whether there is relationship between these three variables. We use data on two countries with radically different debt-to-GDP ratios to show how investments in education and tax rates affect debt-to-GDP. We found a presence of correlation between investments in education and tax rates, and debt, but weak explanatory power of joint variation of two former variables in explaining variation of the latter one.

Keywords: government debt, tax revenues, tax rates, budget deficit, external borrowing, education

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1. Introduction

Taxes are the primary source of government income, which can then be used for the realisation of different investment projects to drive up the country's total output. However, tax incomes are also used by governments worldwide to repay their debt to institutions, foreign governments, private investors, and other agents. Classical macroeconomics textbook theory suggests that higher tax rates are associated with low public debt because then the country can cover its expenses without external financial support. It is under the assumption that the tax income and/or borrowed financial resources are spent efficiently, i.e., with the highest possible return. Again, referring to the conventional theory, the most efficient way of spending money is with the aim to increase productivity, which implies that within the same time range, the input factors produce more than before and, therefore, bring higher income if the price level remains the same. If the output increases, income increases, tax revenues increase, and borrowing potentially decreases. These two factors – taxes and investments in productivity – are two of many determinants that affect public debt. The answer to the question of which of these two factors dominate in shaping public debt and whether they must change simultaneously in order to sustain public debt is the question of interest of this paper. This simplified model intends to give one more perspective on the formation of public debt with a combination of tax rates and investments in productivity as a manipulated variable.

More specifically, we examine the long-run relationship between public debt, tax rates, and investment in education on the example of Greece and Estonia.

The structure of the paper is the follows: Section 1 provides a literature review regarding the topic, Section 2 sets up the empirical model, Section 3 gives an overview of the data used in the study, Section 4 summarizes and analyzes results, and Section 5 concludes.

2. Literature review

A lot of research studies have been performed on the relationship between different fiscal policy regimes and macroeconomic variables both in advanced and emerging markets. Makau et al. (2018) found that the dynamics of the output gap is related to the fiscal policy regime chosen by the government. They provide a qualitative analysis of the path of public debt in Kenya indicating that it is kept unexceptionally high due to prolonged expansionary fiscal policy despite high output growth. This places these countries at a risk of financial crisis which drives the price of future borrowed money up, by chain reaction abstains private investments, which in turn forces these countries to accept loans for a higher price and therefore drives the whole economy into debt hole. A study by Daniel et al. (2003) who use a broad range of cross-sectional data from various developing countries shows that the reasons developing countries keep public debt high are low revenue basis and weak control over finances during sharp economic growth. Ferreira de Mendonça and Pereira Duarte Nunes (2011) come to a similar conclusion, pointing out factors like primary surplus, departures from inflation target, and output gap being the main in determining the risk premium of the cost of borrowing. The analysis of public debt was also done on such economies as Brazil (de Mendonça & Machado, 2013), Argentina (López & Nahón, 2017), and Turkey (Altaylıgil & Akkay, 2013; Gürbüz et al., 2007).

Unlike emerging markets, where the primary goal for sustaining public debt in most cases is, roughly speaking, to bring government finances in order, economies with high income per capita draw higher attention to debt revenue and its role in sustaining high public debt. More specifically, the national revenue extracted from the utilization of public debt undermines how trustworthy the government is, how high the interest rate will be, and how likely it is that it will repay its debt in the future (Blanchard, 2019; Reis, 2022). This minor role of the relationship between high public debt and the cost of future borrowing could be explained by tighter financial integration of industrial countries (Claeys et al., 2012). In simple words, initially, members of financial unions have broader access to "cheap" credits with which they can finance projects with higher returns on investment. This is a typical example of institutional changes that lead countries to international financial markets. The primary role, in turn, is played by *how* the borrowed money is spent. Vanlaer et al. (2021) show that a higher public debt restrains private investors from financing private projects. The same is true with regard to public investments: the higher the public debt, the lower the public investment (Marinescu et al., 2019). Petrović et al. (2021) use the data on emerging EU countries and find that the increased deficit-financed public investment does not increase the debt-to-GDP ratio. But the opposite seems true: the higher debt-to-GDP, the narrower the room for investing in productivity-enhancing projects, primarily education (Bacchiocchi et al., 2011).

3. Data and variables used

The data were extracted either from Eurostat or IMF's World Economic Outlook databases. More specifically, we use the annualized general government gross debt as a percentage of GDP. As a proxy for expenditures related to an increase in productivity, we chose general government expenditure on education as a percentage of GDP. Finally, we include the social security tax rate variable as a proxy for the personal income tax rate. This type of tax was chosen due to two reasons: (i) it is one which fluctuates relatively often throughout the period and (ii) its tax contribution comprises more than 30 percent of total tax revenues in both countries. It is a tax that makes the most substantial contribution to the total tax revenue after VAT. All three variables are tracked from 2000 till 2021. A detailed description of variables can be found in Table A.1.

3.1. Variable transformations, identifying and eliminating potential issues of the model

We do not convert any of our variables into log-transformed form. This is because all our variables are expressed as a ratio and will not deliver meaningful intuition in the final result and will be hard to interpret.

To check for autocorrelation, we start by running AR(1) models for each variable, and each country, both in normal form and difference form. Table A.2 depicts coefficients and adjusted R-squared values of regressions. It can be seen that variables in normal form exhibit autocorrelation and, therefore cannot be included in the final version of the model. Only if there is a deterministic trend present in any of the variables, we could include the time variable in the final model, otherwise only variables in difference form will be included. To check for the type of unit root in variables, we run a set of formal Dickey-Fuller tests.

When conducting the DF test, the selection of determinants involves an examination of the time-series patterns exhibited by variables. The objective is to discern the presence or absence of trends within these variables, thereby informing the decision on which determinants should be incorporated into the test. By our judgment, neither of the variables analyzed in this article exhibits some persistent trend. Therefore, we include only constant in the DF tests of variables in their initial form. The null hypothesis is rejected only for *investments in education* variables of both countries. This implies that the majority of variables have unit roots, and we stick to the model comprised of variables in their difference form, i.e., the difference between values at time *t* and *t-1*. After running the DF test on variables in difference forms, the obtained result in terms of stationarity of variables is not the best but better: 3 out of 5 variables are stationary in difference forms. A detailed output of the set of tests is summarized in Table A.3.

4. Empirical model

4.1. Visual inspection

Figure A.1 depicts the debt to GDP of both countries. We can see that this indicator is extremely low in the case of Estonia, with no major fluctuations for almost two decades, while extremely high in the case of Greece. According to the EU's Maastricht criteria, a member state is not allowed to keep its debt higher than 60 percent of GDP. Traditionally, Baltic states are one among those who have kept that obligation since they joined the EU. In turn, more southern-located countries, including Greece, often break that commitment. Moreover, in this particular case, this lack of commitment almost caused a default of the country. Throughout the whole period since 1995, Greece's debt-to-GDP ratio was higher than 1, meaning that it kept its total obligations at the level of its total output. Until the financial crisis of 2008, it was more or less stable, but the economic turbulence caused its sharp increase. This is normal practice when in light of major economic crises, the government borrows more to boost production and financial support for their citizens. In just a few years after the crisis hit its debt reached 150 percent of GDP and it continued to rise due to the Greek sovereign debt crisis.

Turning to the investments in education, we can have a first clue about the reasons for differences in debt-to-GDP rations of both countries. Specifically, the ratio of public investments in education to GDP is significantly higher over the whole period in Estonia than in Greece. In Estonia, it was never lower than 5 percent while in Greece it varied around 4 percent. However, we can see a slight downward trend in Estonia's government investments in education while it is fairly constant in Greece though with some deviations from around 4 percent. The most recent data show that Greece's debt crossed the mark of 200 percent of GDP.

Finally, quite surprisingly, both tax rates in Estonia are lower than that in Greece. Standard macroeconomic theory suggests that low tax rates – expansionary fiscal policy – cause higher borrowings and consequently unstable debt. Greece's average tax rates are almost twice as high as in Estonia although its debt-to-GDP is much higher. Therefore, to explain this difference, we may look at some other variables different from tax rates that would be equally important for determining the government's debt. Namely, it is investments in education and that's what follows in the next section.

4.2. Granger causality

The evidence summarized in the literature review suggests that the effect of these two factors is quite ambiguous. On one side, a higher tax rate reduces debt-to-GDP, but on the other, the latter could decrease in subsequent periods due to higher prices, lower output, and lower income. The effect of higher investment in education is more straightforward: the output should increase in the following periods due to increased

productivity (under the assumption of sticky prices), which tends to decrease debt-to-GDP directly and indirectly, since the tax revenue increases due to increased tax base. However, Granger causality could be present also in this second case but works in opposite directions. To make a preliminary summary, it is necessary to perform a test for Granger causality for both sets of variables.

The Granger causality test is performed when there is a possibility that the past values of one of the series can be used to predict future values of the other series better than just using the past values of the other series. In our case, we would like to test if past values of tax rates alone can better predict future values of debt to GDP than just past values of debt to GDP. We perform this test for both countries and the output can be seen in Table A.4.

Several notable observations can be made. First, we see relatively weak predictive power of taxes on debt in the case of Estonia and no such power in the case of Greece. Second, the significance of Granger causality between taxes and debt and vice versa is reversed for Estonia and Greece. In the latter case, debt is a better variable for predicting tax rates than the debt itself alone, but in the former case, as mentioned, taxes are a good indicator for predicting future values of debt than past values of debt alone. Given the severe financial crisis in Greece, the statistical evidence presented makes practical sense in the real world.

4.3. **Setting up the empirical model**

The goal of this chapter is to present the econometric model for examining the question of this study: How do tax rates and investments in productivity-enhancing programs – like education – affect public debt?

The final version of the empirical model is:

$$\Delta debt_i = \Delta inv_i + \Delta tax_i \qquad \forall i = 1, 2$$

where *i* is the country index: 1 for EST, or Estonia, and 2 for EL, or Greece.

The output of both regressions is summarized in Table A.5. It can be seen that none of the two variables are enough to explain variation in debt-to-GDP at a sufficient level in the case of Estonia. A relatively simple model performs better in the case of Greece with the investment to education variable being significant at 5 percent. Though not significant, the direction of coefficients in regression on Estonia is as expected, especially if we compare it with regression on Greece. Specifically, the return on education does not completely offset the costs of borrowing but this ratio is much smaller than in the case of Greece. Also, taxes negatively affect the ratio of debt to output, as the theoretical framework suggests.

One explanation of why tax rates are not enough to explain variation in debt-to-GDP despite theoretical concept is that they remain fairly constant, especially in the case of Greece, but with some minor variation in the case of Estonia. Consequently, one would expect a greater response of debt-to-GDP in the latter case than in the former. Nevertheless, the role of investments in education in the Greek case justified the initial preposition, though in the opposite direction than expected. Namely, the higher were investments in education, the higher was debt-to-GDP. Such a high coefficient, most probably, can be explained lack of fiscal discipline Greece experienced in the last several decades. The country expanded government consumption, borrowed from financial markets, and invested in various projects, including education, but returns from these investments were not enough to cover the costs of borrowing. At least, at this point.

Another reason for the weak performance of models is the relatively short period of observations included in the model. The famous Ricardian equivalence can be applied to longer periods of time and then the consequences of massive borrowing, spending, and following fiscal tightening can be analyzed with greater confidence.

5. Conclusion

The aim of this paper is to find out whether there is a relationship between debt-to-GDP ratio, investments in productivity-enhancing programs like education and tax rate. This was tested on the example of Estonia and Greece - two countries with diametrically opposite in terms of debt-to-GDP. The strength of the relationship found in this empirical work is somewhat weak. There could be a few reasons for that. First, the period of data recorded for this study is relatively short, while the effect of tax system and investments in productivity could be better analyzed in the long term. Second, tax rates were not very varying in this period, implying that it is hard to track a change of it on debt level.

Relatively stronger relationship between investments and education, tax rates, and debt-to-GDP was found in case of Greece. We found a significantly positive and very high in magnitude tendency of increase in debt-to-GDP due to increase in investments in education. Most probably, the most recent sovereign debt crisis is candidate for outlier which made this relationship strong.

Some of the possible ways of improving this empirical set-up is to extend the covered period, include more control variables, and include more countries in the data set.

6. References

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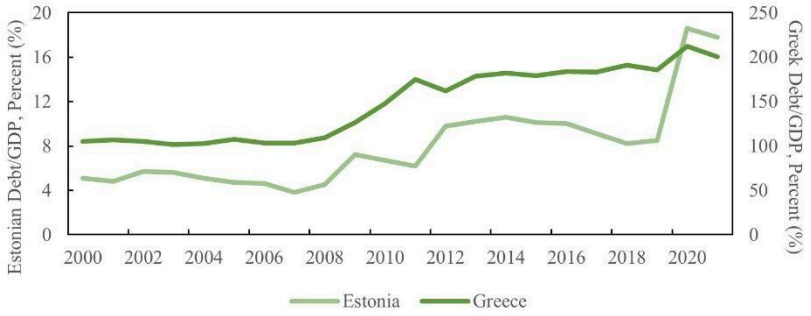
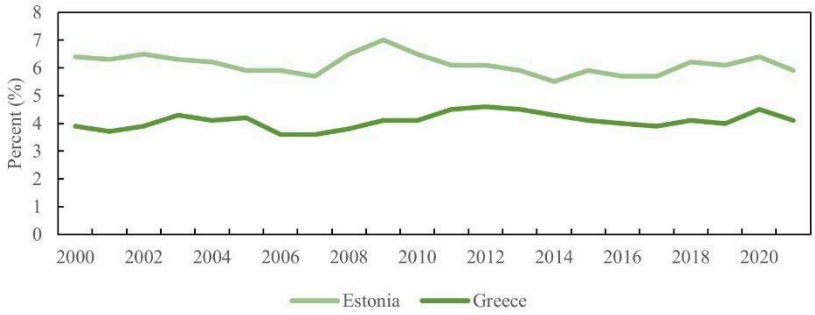
7. Appendix

Figure A.1. Debt to GDP



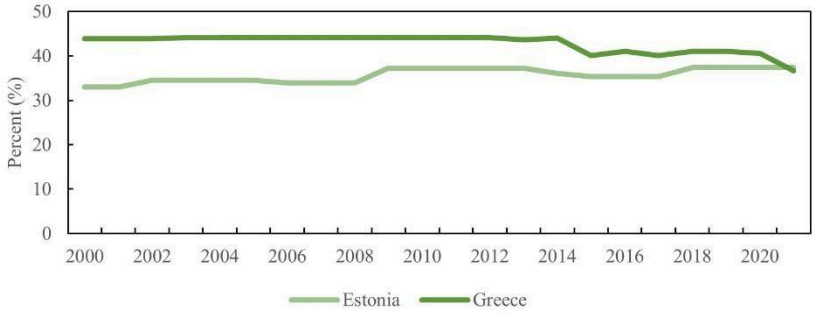
Source: IMF World Economic Outlook.

Figure A.2. Investments in Education as Percent of GDP



Source: Eurostat.

Figure A.3. Social Security Tax Rates



Source: tradingeconomics.com, Estonian Tax and Customs Board, Hellenic Ministry of Labour, Social Insurance and Social Solidarity.

Table A.1. Description of variables

Variable	Description	Units of measurement	Source	Source link
EST_debt EL_debt	General government gross debt	Percent of GDP	IMF World Economic Outlook	https://www.imf.org/external/datamapper/GGXWDG_NGDP@WEO/OEMDC/ADVEC/WEOWORLD?year=2023
EST_inv El_inv	General government expenditures for education	Percent of GDP	Eurostat (online data code: gov_10a_exp)	https://ec.europa.eu/eurostat/databrowser/product/view/gov_10a_exp__custom_8538999?lang=en
EST_tax	Social security tax rate	Percent of individual gross salary	Estonian Tax and Customs Board	https://tradingeconomics.com/estonia/social-security-rate
EL_tax			Hellenic Ministry of Labour, Social Insurance and Social Solidarity	https://tradingeconomics.com/greece/social-security-rate

Note: *EST* indicates Estonia, *EL* indicates Greece, which corresponds to the Eurostat country identification code system.

Table A.2. AR(1) models

	$debt$	$\Delta debt$	inv	Δinv	tax	Δta
$i = 1$	0.935***	-0.1124	0.500***	-0.092	0.775***	-0.013
	(0.165)	(0.235)	(0.197)	(0.246)	(0.129)	(0.235)
Adjusted R^2	0.607	-0.042	0.020	-0.047	0.634	-0.055
$i = 2$	0.974***	-0.226	0.544***	-0.180	1.060***	-0.368
	(0.066)	(0.243)	(0.189)	(0.243)	(0.181)	(0.296)

Adjusted R^2	0.9151	-0.007	0.266	-0.024	0.624	0.027
# observations	21	20	21	20	21	20

Note: the table shows the values of β_1 coefficients in AR(1) model, i.e., of lagged variables. The number in parentheses indicates standard error. *** shows a significance at 5 percent. Regression *i = 1* applies to data on Estonia, *i = 2* applies to data on Greece

Table A.3. Unit root tests

H_0: series has unit root	H_A: series is stationary	
Variable	Test statistic	P-value
EST_debt	-0.774	0.281
EL_debt	-0.634	0.643
EST_inv	-1.123	0.044**
EL_inv	-1.066	0.079*
EST_tax	-0.768	0.392
EL_tax	-0.478	0.862
EST_debt_diff	-1.930	0.000***
EL_debt_diff	-0.889	0.145
EST_inv_diff	-1.850	0.001***
EL_inv_diff	-1.004	0.108
EST_tax_diff	-2.054	0.001***
EL_tax_diff	-0.831	0.197

Note: *** indicates a significance at 1 percent, ** indicates a significance at 5 percent, * indicates a significance at 10 percent.

Table A.4. Granger causality test

H_0: Granger causality not present	H_A: Granger causality present	
Y	X	P-value
EST_debt	EST_tax	0.091*
EST_tax	EST_debt	0.971
EST_debt	EST_inv	0.928
EST_inv	EST_debt	0.047**
EST_tax	EST_inv	0.277
EST_inv	EST_tax	0.079***
EL_debt	EL_tax	0.937
EL_tax	EL_debt	0.024**
EL_debt	EL_inv	0.568
EL_inv	EL_debt	0.490
EL_tax	EL_inv	0.121
EL_inv	EL_tax	0.920

Note: *** indicates a significance at 1 percent, ** indicates a significance at 5 percent, * indicates a significance at 10 percent.

Table A.5. Regression output

i	(1)	(2)
Δinv_i	2.455	20.535*
	(1.756)	(8.721)
Δtax_i	-0.130	0.973
	(0.649)	(1.911)
Sample size	22	22
R^2	0.111	0.295
Adjusted R^2	0.012	0.217

Note: The number in parentheses indicates standard error. * shows a significance at 10 percent. Regression (1) applies to data on Estonia, (2) applies to data on Greece.