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Implications of public debt on economic growth and development. A European perspective

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Abstract

This paper takes an ambitious look at long-run economic growth and investigates the relationship between debt, investments and economic development in a European context. The novelty of the approach is that it includes public debt as an independent variable in the augmented Solow model. The analysis is based on fixed effects models on a panel consisting of 12 European countries, observed across more than 30 years (1980-2012). Various estimation and validity issues are raised, including endogeneity and reverse causality. The general findings of this research are that economic growth has a significant negative effect on public debt accumulation. As economic growth slows down it leads to an increase in the budget deficit through reduced public revenue, leading to new debt issuance. The specific analyses for Italy and Portugal show that they have been on an unsustainable path in the last decades, accompanied by huge fiscal deficits, negative net exports, and rising interest rates on their debt.

Keywords:

Public debt, fiscal deficit, fiscal policy, Portugal, Italy, economic growth.

JEL classification:

E60; E62; E63; F32; F34; F43; O15; O16.

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Implicaciones de la deuda pública en el crecimiento y el desarrollo económico. **Una perspectiva europea**

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Resumen

En este artículo se lleva a cabo un ambicioso análisis del crecimiento económico a largo plazo y se investiga la relación entre la deuda, la inversión y el desarrollo económico en un contexto europeo. La novedad del planteamiento es que incluye la deuda pública como una variable independiente en el modelo aumentado de Solow. El análisis ha llevado a cabo mediante modelos de efectos fijos aplicados a un panel compuesto por 12 países europeos de los cuales se han tomado las correspondientes observaciones durante una referencia temporal de más de 30 años (1980-2012). Se plantean varias cuestiones de estimación y validez, incluyendo las relativas a la endogeneidad y causalidad inversa. Las conclusiones generales de esta investigación hacen referencia al efecto significativamente negativo que tiene el crecimiento económico en la acumulación de deuda pública. La ralentización del crecimiento económico conduce a un aumento en el déficit presupuestario debido a la disminución de los ingresos públicos, lo que se traduce en nuevas emisiones de deuda. Los análisis específicos para Italia y Portugal muestran que ambos países han recorrido en las últimas décadas un camino insostenible, con, además, enormes déficits fiscales, exportaciones netas negativas y un aumento de los tipos de interés sobre su deuda.

Palabras clave:

Deuda pública, déficit fiscal, política fiscal, Portugal, Italia, crecimiento económico.

1. Introduction

The topic of economic growth and public debt is of primary importance as it directly concerns current taxpayers, future generations, and our expectations about the future. Significant events such as the global economic recession and the debt crisis in Europe challenge future growth prospects. As the economic performance of European countries has worsened, their deficits have been on the rise and member states are unable to pay their outstanding debt obligations. The stylized facts show that the average gross public debt in EU is around 62%[1]. A big part of the economic growth literature has taken the growth-debt nexus as a one-sided phenomenon. Researchers have tried to infer the impact of debt on economic growth, assuming that the causality goes from high public debt to low economic growth. This paper investigates this particular linkage and evaluates the effect of debt and its relationships with economic growth and investments.

In approaching the problem, the analysis is founded on the well-known economic growth framework by Solow (1956), which includes human capital. In particular, I expect that the causality goes from low economic growth to higher debt levels. My hypothesis relies on the fact that as growth declines, government revenues decline as well, thus opening a fiscal gap that would have to be filled in by debt issuance; my next hypothesis is related to the effect of debt on the growth of GDP per worker. Here the prior expectation is that it does not affect growth in light of the causality direction postulated above. Finally, it is expected that increasing levels of debt "crowd out" investments as a higher debt stock absorbs more resources from the government budget, thus leaving less for investments to be made. The paper is structured as follows: Initially, a brief review of the literature is provided; next, the augmented Solow model, which forms the framework of the analysis, is presented. Following, the data are described and the empirical analysis is performed. Then detailed analysis of fiscal policy and growth performance is undertaken for two debtor countries of Italy and Portugal, and inferences for these two cases are drawn based on the model estimates. Finally, some conclusions are offered.

2. Literature review

The pioneering work on growth theory is the Solow model (1956), based on the popular Cobb-Douglas production function. This growth model is still used as one

[1] *The figure is an average of the Debt/GDP ratio of EU12 countries included in the dataset.*

of the primary frameworks for analyzing differences in cross-country economic growth patterns and convergence.

Notable contributions to mainstream growth theory have been made by Lucas (1988), who augmented the neoclassical Solow model by adding a previously ignored factor, human capital. This addition is very important as it captures the effect of education and acquired skills of workers on output, thus differentiating among agents. The inclusion of human capital as it factors into the growth model has been empirically tested by Romer *et al.* (1992) and found to fit the data better.

Influenced by the neoclassical arguments of economic growth, Stiglitz and Hoff (2000) augment the potential list of factors having an effect on growth and convergence among countries, focusing on constructs such as historical background, institutions, culture, government and rule of law. They argue that law enforcement, information access, and non-market institutions can have nearly the same influence on economic outcomes as limited technological advancement possibilities.

On the debt-growth nexus there have been several very influential papers, starting with Reinhart and Rogoff (2010), who analyze financial and economic data for 44 countries spanning across 200 years. Their main findings are that different debt levels have varying effects on economic growth; for instance, there is only a weak relationship between debt accumulation and GDP growth for Debt/GDP ratios below 90%. Their analysis also produces evidence that a Debt/GDP ratio of 60% leads to a decline in growth of around 2% p.a.

Alesina and Tabellini (1989) also find that politically unstable countries create an incentive for governments with short-sight horizons to borrow heavily. Consequently, this leaves future governments with big debt burdens to be repaid.

Another channel through which debt can have an influence on economic growth is total factor productivity (TFP) (see Pattillo *et al.,* 2004). Thus, as a country funds its deficits by foreign external debt, it dedicates a larger fraction of the future output to foreign entities. This in turn can reduce the incentives for higher productivity as people will not be motivated to innovate or become more efficient because foreign investors would benefit most.

An attempt has been made to incorporate debt in the Solow model for an open economy by Villanueva and Mariano (2006). Their findings are that in the long-run the Debt/GDP ratio can vary substantially based on differing levels of savings, investments, and depreciation and exogenous factors such as perceived risk and required risk premiums from lenders.

3. Theoretical framework

3.1. Human capital augmented Solow model

I use the human capital augmented Solow model as a core framework to analyze the growth implications of debt. The big simplification in the original Solow model was that the productivity of workers, their skills, and education level were correlated. Romer *et al.* (1992) proposed the addition of human capital to obtain the new human capital augmented Solow model:

$$Y = h^{1-\alpha} A K^{\alpha} L^{1-\alpha}$$

where Y is output, h denotes the amount of labor that is supplied by each worker in the economy, A is technological development (shifter), K is capital and L is the number of workers. Thus, now the total labor input is equal to hL. Factors such as quality of education, access to higher education, culture and incentives all have an effect on human capital accumulation. As one might expect, in some countries the level of education is higher than in others and those quality differences have an impact on labor productivity and the skills of workers.

3.2. Investments and savings

Recalling back the identity for an open economy where NX simply means net exports equal to trade balance:

$$Y - C - G = I + NX$$
$$S - I = NX$$

where C is consumption, G is government spending, I is investments, NX are net exports (the difference between exports and imports) and S is equal to private and public saving together. If $(S-I)$ is positive then there will be a trade surplus: the country has exported more than it has imported, i.e. the country will be a net lender to other countries. If investments are higher than savings in the economy, i.e. $(S-I)<0$, net exports (trade balance) are negative, and the country is experiencing trade deficits and a net borrowing position.

It is clear that when a country invests more than it saves, the gap is filled by debt issuance. If government spending is higher than government revenue, then the difference has to be financed by debt or a tax increase. In fact, if $I>S$ this implies that borrowers are confident that at some future point in time the country will be able to repay its debt. Risk premiums sharply increase due to excessive borrowing and

sustained fiscal deficits. Such an increase in interest rates on government bonds further deepens the problem with increasing Debt/GDP levels as the cost of servicing increases substantially, even for small increases (Alesina, 1988). So far the easiest way for highly indebted countries has been to pay those interest proceedings by raising new debt from investors, i.e. roll-over of debt (Abel, 1992).

Researchers have analyzed the determinants of savings across the UK, US, and Italy and their impact (Kirsanova and Sefton, 2007). Such factors are the retirement age, the welfare system, and credit access. Furthermore, faced with a higher degree of uncertainty, people will save more in order to protect themselves against unexpected economic shocks (Deaton, 1992).

Nevertheless, the current policy of the ECB of keeping interest rates low due to inflationary pressure won't possibly lead to an increase in savings. The reason is that with the low interest rates the potential winners are mortgage payers, banks, exporters and asset holders. On the other hand, savers, pension funds and consumers are among the losers of the low interest rate environment due to the low return on their savings as suggested by Belke (2013).

4. Data and methods

4.1. Data

The dataset comprises twelve countries in Europe, observed over 30 years (1980-2012). Because data entries are not available for several countries for the full period, the working dataset is limited to the period 1985-2010. The descriptive statistics can be seen in the Appendix. All of the countries included are part of the European Union, which implies that the inferences drawn from this investigation may not be totally attributable to countries outside Europe. The following countries are included: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain.

The majority of the variables are presented in ratio form, as percentages. Others such as population and real GDP are in level and logarithmic form because often positive variables in level form have skewed distributions. Another benefit is that the log form of a variable is usually much less dispersed, causing fewer biases due to outliers (Wooldridge, 2009). Another advantage is that a log-transformed variable has a distribution close to the theoretical normal one. This becomes important later on when analyzing the residuals and their distribution as one of the important assumptions, namely is that the error term (ε_{it}) follows a normal distribu-

tion[2]. The average years of schooling (*School*) has been used as a proxy for human capital[3]. This measure has proved to be instrumental; by educating people, ideas are generated, and ideas are the underlying factor behind technological progress, fostering economic growth (Romer, 1990).

4.2. Methods

I use panel data, which allows for several countries to be tracked on various variables across prolonged periods of time. The econometric models are estimated using fixed effects[4] (LSDV[5]). This type of model assumes the same slope for the regressors for each country, but a varying intercept for each cross-section in order to capture the unobservable effects that do not change over time, namely: geographical location, country size, culture, etc. This allows us to control for endogeneity and exclude the time-invariant components of the data in the estimation.

5. Empirical analysis

5.1. Regression on public debt

Here the hypothesis regarding the growth-debt nexus is tested. An interesting feature of this study is that it challenges the assumed causality from high debt to lower growth. In this section I provide evidence why the relationship between those variables is reversed and in fact lower growth leads to higher debt. The model that has been estimated has the form:

$$\log(Debt/GDP)_{it} = \alpha + \beta_0 grGDP_{it} + \boldsymbol{\theta}\mathbf{x} + n_i + \varepsilon_{it} \quad (1)$$

where $grGDP$ is the growth rate of real GDP in level form, **x** is a vector encompassing several other explanatory variables, n_i is the fixed country effect, which is invariant across time, and ε_{it} is the idiosyncratic error. Before estimating the model, it is useful to consider which variables from **x** shall enter the relationship. These variables are the budget balance-to-gdp ratio (*BB/GDP*) and current account balance-to-gdp (*CAB/GDP*). They affect debt accumulation or reduction, because as governments run

[2] *A residual analysis test has been performed and the residuals follow a normal distribution.*

[3] *Another approach taken in empirical literature is to use school enrollment rates. These tend to be problematic because current enrollment rates depend on lagged values for investments in human capital and usually exaggerate the real effect of human capital.*

[4] *By way of a Hausman test I have been able to identify that fixed effects would be the more appropriate and robust estimation method to apply. The Hausman Chi square statistic ranged from 7.74 to 86.62, meaning that we reject H_0: random effects would be consistent and efficient, in favor of the alternative hypothesis that random effects would be inconsistent, thus we prefer fixed effects. For only 2 estimations we cannot reject H_0, obtaining a Chi square statistic of 4.37 and 3.02.*

[5] *Least Squares Dummy Variable model.*

a budget deficit (*BB/GDP*>0), they need to borrow money or raise taxes (which is not popular among decision makers) in order to fill in the gap. The budget and the current account balances are important determinants of the *Debt/GDP* ratio dynamics. The relevance of the current account balance surpluses for debt has been emphasized by Roubini (2001). He argued that the discounted value of debt should be exactly equal to the future current account surpluses that a country will have to generate.

5.2. Causality

Next the Granger causality test[6] (1980) is used, including up to 10 lags to determine the direction of the causality. The obtained results are significant along the entire lag length. The conclusion is that one cannot reject H_0 that *Debt/GDP* does not Granger-cause *grGDP*. Strong evidence is obtained at the 1% level in support of the alternative hypothesis that *grGDP* does Granger-cause *Debt/GDP* (*F*-statistics range from 3.74 to 8.55). This method relies on overfitting the data to ensure that serial dependence is removed. This is not harmful in relation to unbiasedness, but may result in an inefficient OLS estimator. As a result, this technique is appropriate for determining the significance of causality but should not be used for structural coefficient estimation. Thus, one can reject the hypothesis that higher debt leads to lower growth in favor of the alternative, i.e. lower growth rates lead to piling up of debt.

5.3. Regression of public debt on GDP growth

Next, the results from the regression analysis of public debt on GDP growth are presented. The main interest is to see the effect of lower economic growth on debt. Slower than anticipated economic growth leads to less public revenue. Because revenues are not enough to run a balanced budget, governments have to borrow in order to fill this fiscal gap (Irons and Bivens, 2010). As a result, public debt increases. Higher debt levels increase the borrowing rate because of higher perceived risk of default. Such a development can "crowd out" private investments and in turn reduce growth even further. Hence, a feedback loop is generated where some of the independent variables (investments) are endogenously determined by past performance of the dependent variable (public debt).

According to the existing literature, the factors that could influence the debt of a country are growth of GDP, savings, the budget and current account balances. The estimation results are presented in Table 1:

[6] *Granger causality: One could think that a variable X causes another variable Y if and only if the expected value of Y given the historical value of X is different from the unconditional expectation of the variable Y.*

● Table 1. **Panel OLS-LSDV estimation results for log(*Debt/GDP*) and *grDebt***

Dependent variable	log(*Debt/GDP*)					*grDebt*
Estimation	**OLS (1)**	**OLS (2)**	**OLS (3)**	**OLS (4)**	**OLS (5)**	**OLS (6)**
Constant	4.051***	4.043***	3.948***	5.567***	5.258***	3.546
	(0.028)	(0.284)	(0.040)	(0.119)	(0.125)	(6.571)
grGDP	-0.030***	-0.025***	-0.015***	0.022***	0.006**	-1.592***
	(0.008)	(0.008)	(0.009)	(0.007)	(0.002)	(0.273)
BB/GDP			0.021***			0.904*
			(0.006)			(0.202)
CAB/GDP		-0.016**			0.031***	-0.560**
		(0.006)			(0.004)	(0.274)
Savings/GDP				-0.075***	-0.047***	0.039
				(0.005)	(0.004)	(0.298)
AR(1)					0.915***	
					(0.018)	
R^2	0.725	0.730	0.744	0.826	0.979	0.381
Observations	301	300	278	301	298	277
DW coeff.	0.140	0.144	0.110	0.219	1.697	1.69
Cross-sections	12	12	12	12	12	12
FE - Italy	0.636	0.626	0.743	0.553	0.510	-1.474
FE - Portugal	-0.327	-0.417	-0.297	-0.486	0.236	1.062

*Note: * ,** and *** indicate significance at 10%, 5% and 1% respectively.*

The main objective was to assess the influence of economic growth (*grGDP*) on debt. The findings are comparable to other studies, e.g. (Kumar and Woo, 2010) who find that in contrast to conventional wisdom, high debt accumulation leads to lower growth. That is, there is evidence of reverse causality.

In Table 1, one can see the expected negative signs on *grGDP*, significant at 1% (in equations 1, 2, 3 and 4). However, as additional explanatory variables are added, such as *BB/GDP* and *CAB/GDP*, the effect of *grGDP* on public debt declines. The point estimates range between –0.015 and –0.030. The interpretation is as follows: an increase in growth of GDP by 1 percentage point leads to a decrease in *Debt/GDP* by 3% (in equation 1), 2.5% (in equation 2) and 1.5% (in equation 3), everything else being equal. The negative relationship is as predicted by the economic literature (Irons and Bivens, 2010; Kumar and Woo, 2010). However, attention should be paid when assessing the robustness of the results. There are clear signs of autocorrelation, based on the very low DW statistic, ranging from 0.11 to 0.14 for equations 1 to 3.

An additional regression (equation 6) was performed on growth of debt (*grDebt*), using *CAB/GDP, BB/GDP, grGDP* and *Savings/GDP* (savings as percent of GDP). It shows that the effect of *CAB/GDP, BB/GDP* and *grGDP* are different from 0 at the 1% significance level. The signs are once again as expected and the coefficient for *grGDP* can be

interpreted such that a 1 percentage point increase in economic growth would lead to 1.59 percentage point decrease in debt growth per year, everything else equal. The effect of *BB/GDP* shows that a 1 percentage point increase in the variable would lead to 0.90 percentage point increase in growth of debt. The budget balance is represented as $(G-T)/Y$. As government expenditure increases, this increases the deficit (assuming that taxes stay fixed), which in turn will make the government either raise taxes or increase its debt load. In my view, the most conclusive estimations are 3 and 6. Even though the specifications differ, they best represent the relationship between growth of GDP and public debt, based on the expectations and the results from similar empirical studies.

In conclusion to this section, specific correction for the persistent problem of autocorrelation in the residuals is proposed. Equation 5 includes an autoregressive error of the first order, which is the autocorrelation that is suspected to exist in the residuals. The transformation is done à la the Cochrane-Orcutt method. The reason for approaching this problem with caution is because the OLS estimator is inefficient otherwise. *Savings/GDP* exhibits the same strong negative effect on *Debt/GDP* ratio development as before. The effect of *grGDP* on *Debt/GDP* falls considerably from 0.022 to 0.006.

In conclusion, the results give persuasive support for the initial expectation that economic growth has for the most part a negative effect and in only two cases a negligible effect on public debt, ranging anywhere from –3% to 0.6%. Additionally, *BB/GDP* has a positive effect on public debt.

5.4. Investments and growth

It was shown that $S \equiv I+NX$. As governments run sustained public deficits, public savings decrease. In connection to the identity above, this means that the decrease in S shall be exactly offset by a decrease in investments, net exports, or a combination of both. Considering the first channel, investments may decrease because public dissaving reduces loan availability to businesses and the public. Investments have a positive effect on economic growth as they play a role in capital formation. Secondly, budget deficits tend to result in trade deficits, which affect the current account of a country. Those trade deficits are in fact financed by the sale of domestic assets abroad. However, this deterioration of the capital account[7] makes foreign investors less willing to possess domestic bonds.

An interesting, often-ignored factor to consider is the aging populations of countries (captured here by workforce growth). When a country's population becomes older, more people fall under the social security system (medical care, pensions, etc.).

[7] *The capital account can be defined as the change in of domestically owned foreign assets less domestic assets owned by foreigners. Furthermore, there are 3 categories in the capital account: Foreign direct investment, portfolio investments and other investments.*

This research attempts to evaluate and expand current knowledge by using the Solow model empirically and adding debt as a potential regressor. It is hypothesized that debt may have an impact on growth, and the results in this paper suggest that the causality is reversed. Studies point, however, to the fact that the Granger-causality is always bidirectional. I tend to agree partially with this suggestion because a growing debt would absorb a greater part of the fiscal budget, thus leading to decreased investments and new debt issuance, as well. This would have a negative impact on economic output. The Solow model is not easy to replicate and translate into an exact empirical specification, as practice shows (Gundlach, 2007). However, I try to include debt.

The augmented Solow model estimated in this paper tries to predict cross-country differences on the basis of capital accumulation, keeping technological level constant. The reason for this is that in a European context, the sample more or less consists of technologically homogeneous countries in comparison to many less developed countries around the world where the differences are more profound. Additionally, the transfer of technology and methods of production are widespread across countries in Europe. TFP is kept as a constant. Further support of this specification is that technological differences are unobservable in the real world. This makes it difficult to break down income differences between countries into what is due to technological differences and what is due to differing levels of capital accumulation. This can be partly overcome by adding instrumental variables such as institutional quality, property rights enforcement, health technology, etc. (Acemoglu *et al.*, 2001).

5.5. Regression of investments

In this subsection, I test my preliminary expectation that increases in gross public debt would crowd-out investments and the coefficient will have a negative sign. As the debt increases, more and more resources from the government budget are spent on servicing the debt. Furthermore, countries with high debt levels are also perceived as riskier for investments. The estimated model for investments is the following:

$$\log(INV/GDP)_{it} = \alpha + \beta_0 \log(Debt/GDP)_{i,t-1} + \beta_1(\mathrm{BB}/GDP)_{it} + \boldsymbol{\xi}\mathbf{x_{it}} + \eta_i + \varepsilon_{it} \qquad (2)$$

where the dependent variable is the log of investments as percent of GDP, the explanatory variables are log of lagged debt as percent to GDP, the budget balance as percent of GDP and a vector of other explanatory variables. Such variables are: openness (*Open/GDP*), savings (*Savings/GDP*), schooling (*School*), etc. Based on the results listed in Table 2, it can be seen that in accordance with our hypothesis, the *Debt/GDP* ratio from a previous period negatively affects investments.

Table 2. **Panel OLS-LSDV estimation results for log(*INV/GDP*)**

Dependent variable	**log(*INV / GDP*)**				
Estimation	**OLS (1)**	**OLS (2)**	**OLS (3)**	**OLS (4)**	**OLS (5)**
Constant	3.177***	3.532***	1.173**	-0.553	-2.067***
$log(Debt/GDP)_{t-1}$	(0.340)	(0.145)	(0.548)	(0.686)	(0.693)
	-0.161*	-0.149*	-0.124***	-0.079***	-0.0882***
	(0.015)	(0.017)	(0.016)	(0.020)	(0.018)
log(*School*)					0.672***
					(0.113)
log(*CAB/GDP*)	0.056*		0.343***	0.485***	0.609***
	(0.033)		(0.070)	(0.077)	(0.075)
BB/GDP	-0.016***	-0.017***	-0.017***	-0.014***	-0.016***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
log(*Open/GDP*)				-0.0338***	-0.647
				(0.057)	(0.075)
log(*Savings/GDP*)		0.056*	-0.251***	0.145***	0.184***
		(0.031)	(0.055)	(0.036)	(0.035)
R^2	0.67	0.70	0.69	0.71	0.75
Observations	265	277	265	265	265
DW coeff.	0.56	0.54	0.59	0.54	0.69
Cross-sections	12	12	12	12	12
FE - Italy	0.025	0.020	-0.095	-0.142	-0.208
FE - Portugal	0.157	0.142	0.244	0.318	0.466

*Note: * ,** and *** indicate significance at 10%, 5% and 1% respectively.*

The estimates range from –0.16 to –0.08 and are all highly significant at 1% level. One reasonable interpretation could be that a 10% increase in the debt level of a country from a preceding year will result in a 0.79% decrease in investments (equation 4). For equation 1 the effect is a decrease of 1.6% in the level of investments, thus both negative and within the stated range.

Specification 5 is the most suitable one because all variables are significant at 1% level and a higher explanatory power is obtained compared to the other estimations. Unfortunately, a negative coefficient for log(*Open/GDP*) was found, which is surprising as a more open economy should benefit investments. In equations 4 and 5 a negative effect is obtained of the *BB/GDP* on the investment level, as expected. The point estimate ranges from –0.014 to –0.017, which is fairly consistent with the literature. The interpretation is that a 1 percentage point increase in the fiscal budget would lead to a decrease in investments of about 1.4%-1.7%. The log of schooling is also added in the investments regression. As expected, increases in schooling positively affect investments at the 1% level. This means that 1% increase in the years of schooling would lead to 0.672% increase in *INV/GDP*. It should be recalled that in the established model there is strong evidence that debt has a negative effect on investments, consequently affecting growth.

5.6. Regression of per worker GDP growth

The model has as a dependent variable - growth of output per worker, which is derived as the difference in the logarithm of *Y/L*. The model is specified as follows:

$$(grGDP/Wor)_{it} = \alpha + \beta_0 (grGDP/wor)_{i,t-1} + \beta_1 \log(Debt/GDP)_{it} + \boldsymbol{\gamma}\mathbf{x_{it}} + \eta_i + \varepsilon_{it} \qquad (3)$$

where *grGDP / Wor* is the growth of GDP per worker, $(grGDP/wor)_{i,t-1}$ is the per worker output growth at the initial level, $\log(Debt/GDP)_{it}$ is log of *Debt/GDP* ratio, $\mathbf{x_{it}}$ is a vector of explanatory variables such as average schooling years (*School*), investments (as percent of GDP, *INV/GDP*), labor force growth (n), depreciation (δ), assumed constant, technological level, and η_i - the unobserved country specific effect. The log of *Debt/GDP* ratio has been added in order to test the hypothesis of whether public debt has any effect on growth per worker GDP. In the estimations, $n+g+\delta$ is the sum of labor growth, technological growth (g) and depreciation, respectively. In the empirical literature it has been found that δ and g all together sum up to 5% (0.05) (Islam, 1995). The data for *School* has been taken from the dataset[8], constructed by Barro and Lee (1996).

● Table 3. **Panel OLS-LSDV estimation results for *grGDP*/wor and log(*GDP/wor*)**

Dependent variable	***grGDP/wor***				**log(GDP/wor)**
Estimation	**OLS (1)**	**OLS (2)**	**OLS (3)**	**OLS (4)**	**OLS (5)**
Constant	-1.206	-10.765***	-12.347	-6.909	8.144***
	(4.734)	(3.511)	(5.548)	(5.684)	(0.251)
$(grGDP/wor)_{t-1}$	0.030***	0.321***	0.342***	0.315***	
	(0.059)	(0.060)	(0.062)	(0.061)	
log(*INV/GDP*)	5.829***	6.355***	6.513***	7.067***	0.249***
	(1.182)	(1.184)	(1.453)	(1.436)	(0.061)
log(*School*)	-3.728***			-4.553***	0.945***
	(1.258)			(1.361)	(0.060)
log(*n+d+g*)	-4.262***	-4.423***	-4.400***	-4.273***	-0.004
	(0.579)	(0.584)	(0.577)	(0.568)	(0.005)
log(*Debt/GDP*)			0.240	0.920*	-0.005
			(0.456)	(0.492)	(0.021)
R^2	0.33	0.30	0.32	0.35	0.87
Observations	299	299	288	288	288
DW coeff.	1.37	1.34	1.26	1.28	0.06
Cross-sections	12	12	12	12	12
FE - Italy	-0.779	-0.504	-0.585	-1.344	0.180
FE - Portugal	-1.926	-1.151	-1.029	-1.951	-0.356

*Note: *,** and *** indicate significance at 10%, 5% and 1% respectively.*

[8] *The dataset can be fully accessed at: http://www.barrolee.com/data/full1.htm*

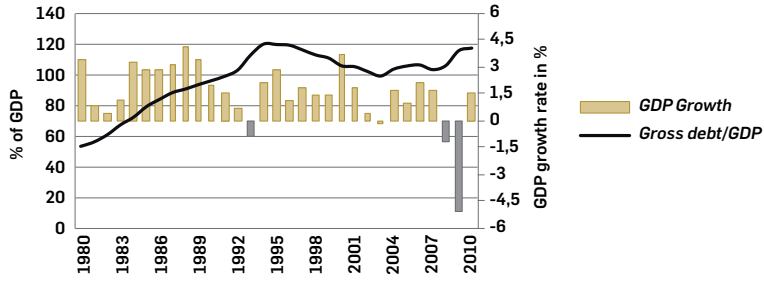
As can be seen in Table 3, in equations 1 to 4 all the independent variables are significant at 1% level except for the *Debt/GDP* ratio. In equation 1, which is the baseline augmented Solow model, one can see that *School* has a negative impact on *grGDP/wor*. This is surprising, as one would expect that as people become more educated, they would contribute more to output. In equation 5, one can see that schooling is highly significant and has a positive effect on GDP per worker. This supports the main reasoning behind the beneficial effect of education. In the same specification, the *Debt/GDP* ratio is insignificant, i.e. the effect is not different from 0. In equation 3 *Debt/GDP* is again insignificant, and in equation 4 it is significant at 10% level but displays a very small effect on *grGDP/wor*. Everything else equal, a 1% increase in *Debt/GDP* ratio level would lead to a 0.0092% point increase in growth—a negligible effect. In equation 4, the *Debt/GDP* ratio as an explanatory variable is significant at a 10% level, but insignificant in equation 3. In equation 5, a 10% increase in *Debt/GDP* would lead to 0.05% decrease in the output per worker, which is basically insignificant. Equations 3 and 5 are considered to be the most appropriate ones. The reason is that they display similar results to the estimates in the literature. On the other hand, estimation 5 shows the highly significant impact of schooling and the insignificance of debt. The coefficient of investments in equation 5 suggests that a 10% increase in *INV/GDP* would lead to a 2.49% increase in *GDP/wor*. In conclusion to this section, it can be claimed that public debt does not have a significant impact on growth of per worker GDP.

6. Country-specific analysis: Italy and Portugal

In this section, particular attention is paid to the debt development and economic performances of Italy and Portugal, respectively. These two countries are interesting for analysis because their paths to the current unsustainable debt levels have been very different. Italy throughout the last decades has been carrying a chronically high debt load and Portugal rapidly accumulated its debt in the last decade. The time series from 1980-2010 shows a negative correlation (–0.40 for Italy and –0.65 for Portugal) between GDP growth and public debt.

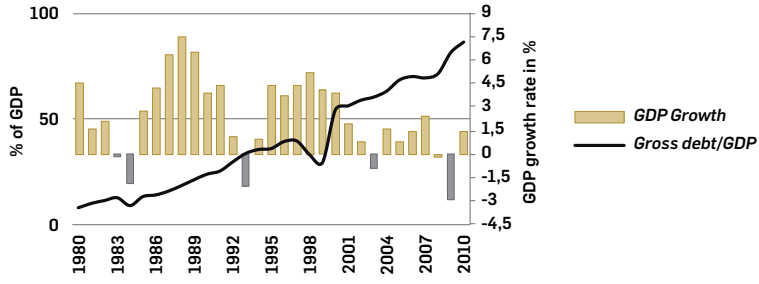
In Figures 1 and 2, it is clear that the *Debt/GDP* ratio has increased from 60% to 120% for Italy and from 10% to 100% for Portugal by 2011. A disturbing fact is that throughout the entire observation period, Italy and Portugal have been incurring sustained severe fiscal and current account deficits (see Figures 3, 4, 5 and 6). Such fiscal account deficits can be financed by either raising taxes or borrowing. The usual approach has been new debt issuance for both countries. Only Italy had a net exporting position in the mid 90's (see Figure 3). This may explain why Italy's debt load decreased during that period. In 2008, debt increased to a new level of 116% of GDP, accompanied with a steep decline in the growth rate.

Figure 1. GDP growth in % and Public debt as % of GDP – Italy (1980-2010)



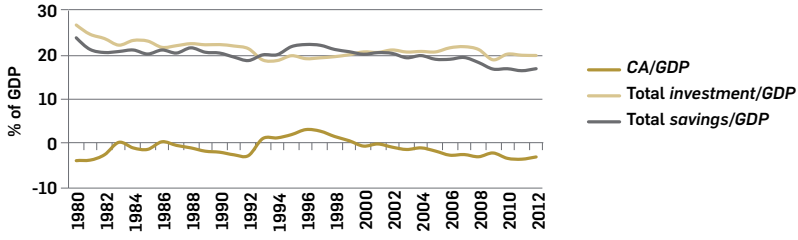
SOURCE: WORLD ECONOMIC OUTLOOK, IMF (SEPT. 2011), REINHART AND ROGOFF, WDI 11 AND AUTHOR'S CALCULATIONS

Figure 2. GDP growth in % and Public debt as % of GDP – Portugal (1980-2010)



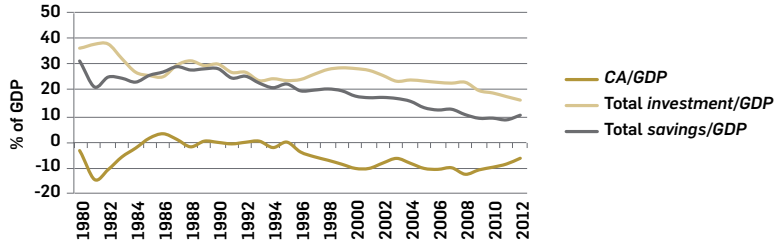
SOURCE: WORLD ECONOMIC OUTLOOK, IMF (SEPT. 2011), REINHART AND ROGOFF, WDI 11 AND AUTHOR'S CALCULATIONS

Figure 3. Investments, Savings and Current account as % of GDP-Italy (1980-2012)



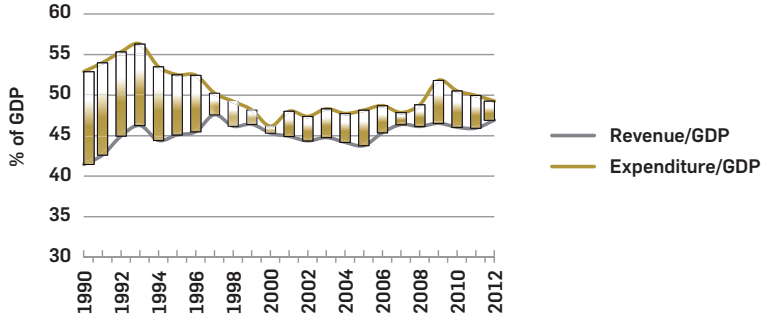
SOURCE: WORLD ECONOMIC OUTLOOK, IMF (SEPT. 2011)

Figure 4. Investments, Savings and Current account as % of GDP-Portugal (1980-2012)



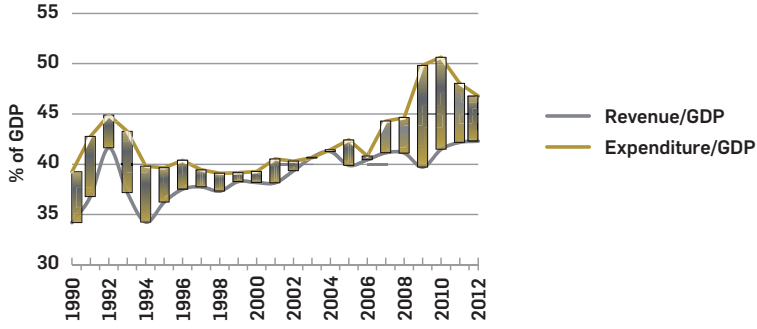
SOURCE: WORLD ECONOMIC OUTLOOK, IMF (SEPT. 2011)

Figure 5. **Italy's Fiscal balance-to-gdp in % (1990-2012)**



SOURCE: WORLD ECONOMIC OUTLOOK, IMF (SEPT. 2011)

Figure 6. **Portugal's Fiscal balance-to-gdp in % (1990-2012)**

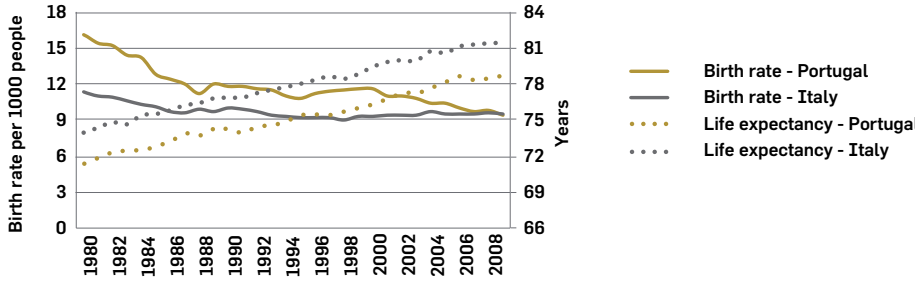


SOURCE: WORLD ECONOMIC OUTLOOK, IMF (SEPT. 2011)

In Portugal, the public finances gap has widened to record high levels in 2009, but under the pressure of the EU, the country was able to systematically decrease its fiscal gap down to 3.5% of GDP. Additionally, a competitiveness problem is visible in the behavior of the current account of both countries, which is partly attributable to the sharply rising wages in Portugal and Italy in comparison to other EU countries.

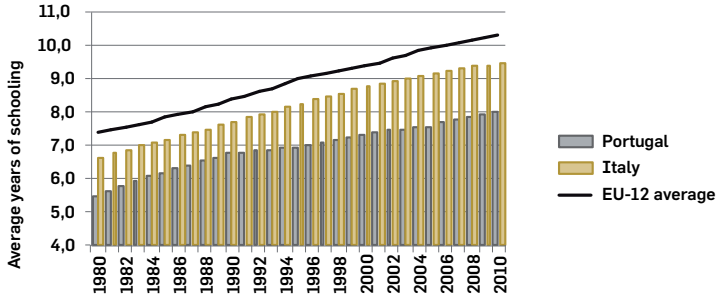
In Figure 8, it is obvious that the schooling in Italy and Portugal is below EU average; however, people in Italy have more years of schooling in comparison to Portugal (see Figure 6). This is disturbing as it directly affects labor force productivity, everything else being equal. In this sense, the prevailing gap of $7,500 between Italy and Portugal's nominal GDP per capita can be partially explained by differing level of schooling. Another cautionary observation is the declining birth rate in both countries and their high life expectancy (see Figure 7).

Figure 7. **Birth rate and life expectancy – Italy and Portugal (1980-2009)**



SOURCE: WORLD ECONOMIC OUTLOOK, IMF (SEPT. 2011)

Figure 8. **Average years of schooling in Italy, Portugal and EU-12 average (1980-2010)**



SOURCE: BARRO AND LEE (1996) - "INTERNATIONAL MEASURES OF SCHOOLING YEARS AND SCHOOLING QUALITY"

In the near future, this constitutes a problem because there will be greater pressure on public finances as the population ages, and thus more people will rely on social assistance. These trends represent future borrowing, as public revenue may not be enough to run a balanced budget.

In relation to the established models, a transformation procedure of the log model has been applied to find the level form of investments, according to estimation 5 in Table 3. The forecasts obtained show that in 2013, Italy's investments share of GDP was expected to be 19.73%, and for Portugal the number is significantly lower, equal to 11.79%. In the *Debt/GDP* ratio estimation, the dependent variable is in log form (equation 3 in Table 1). The actual predicted value for the *Debt/GDP* ratio was derived by using a procedure for the case when the residuals were normally distributed[9]. According to the estimates obtained, the forecasted *Debt/GDP* ratio level for Italy for 2013 is 124.35% of GDP. For Portugal, the value is 93.4%. These forecasts are very plausible and from the model estimates, are most strongly affected by sustained budget deficits and recent crisis-induced negative growth.

[9] *When we have normally distributed residuals, one can use this transformation:* $\hat{y} = \exp(\varepsilon)\exp(\log y)$

7. Conclusion

This paper tested the relationships among public debt, economic growth, and investments, and determined their direction of causality. Contrary to the large body of empirical literature, it has been found that the causality goes from lower economic growth to higher debt levels. The results suggest that on average, a 1% point increase in growth of GDP would lead to a reduction of *Debt/GDP* ratio by 3% to 1.5%, depending on specifications. The point estimates show that on average a 10% increase in the *Debt/GDP* ratio level from the previous period would lead to a 0.7% to 1.6% decrease in the level of investments.

Furthermore, public debt has been incorporated in the human capital augmented Solow model, which shows that public debt does not have a significant effect on growth of per worker GDP. A major conclusion is that investments are negatively affected when debt increases. In relation to Italy and Portugal, a trend of decreasing investments is visible, meaning that their growth may be seriously hindered in the future. In relation to that, I investigated the average years of schooling. The result is that people in both Italy and Portugal attend school less than people in other European countries on average. This may have serious effects on these countries' productivity and long-term growth.

As the majority of countries analyzed are part of the Economic and Monetary Union (EMU), it means that they cannot rely on their monetary policy to devalue their currency in order to regain competitiveness. It is likely that fiscal policy in the current situation is be locked as well because of the huge fiscal deficits, low labor mobility across the Euro area, and the inability to credibly commit to increasing tax rates.

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Appendix

Variables and descriptive statistics

Variable	Definition	Obs.	Mean	Std. Dev.	Source (database)
BB/GDP	Budget balance-to-GDP ratio	279	2.754	4.306	World Economic Outlook, IMF (Sept. 2011)
CAB/GDP	Current account balance-to-GDP ratio	301	0.299	4.832	World Economic Outlook, IMF (Sept. 2011)
Debt/GDP	Gross Debt/GDP ratio	301	62.467	30.592	World Economic Outlook, IMF (Sept. 2011), Reinhart and Rogoff[10]
GDP/cap	PPP Converted GDP per capita (Laspeyres) in $	300	28850.09	11340.86	PWT 7.0 (Penn World Table)[11]
GDP/wor	PPP Converted GDP per worker (Laspeyres) in $	300	60611.84	15943.61	PWT 7.0 (Penn World Table)
grDebt	Growth of gross public debt	300	3.042	11.191	Author's calculations, World Economic Outlook, IMF (Sept. 2011), Reinhart and Rogoff
grGDP	Growth rate of real GDP	312	2.614	2.690	Author's calculations: $\log(GDP_t)$-$\log(GDP_{t-1})$, WDI 11
grGDP/wor	Growth of GDP per worker	300	1.491	2.537	Author's calculations
INV/GDP	Total investments-to-GDP ratio	312	21.799	3.154	World Economic Outlook, IMF (Sept. 2011)
Log(*n+d+g*)	Logarithm of the sum of depreciation, labor force growth and technological growth	299	1.782	0.248	Author's calculations
Open/GDP	Trade openness as % of GDP (Openness at 2005 constant prices)	312	85.821	60.778	PWT 7.0 (Penn World Table)
Savings/GDP	Savings-to-GDP ratio	312	22.271	5.016	World Economic Outlook, IMF (Sept. 2011)
School	Average years of schooling	312	9.149	1.312	Barro and Lee (1996)

[10] *"This time is different" by Reinhart and Rogoff: http://www.reinhartandrogoff.com/data/browse-by-topic/topics/9/*

[11] *Alan Heston, Robert Summers and Bettina Aten. Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, May 2011.*