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Taxation and economic growth in the European Union: a quantile approach

Impuestos e ingresos en la Unión Europea: un enfoque de cuantiles

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Abstract

The available literature on the relationship between taxation and economic growth is mixed, although some consensus exists on the negative effects of some taxes on growth. In this paper we study the relationship between taxation and growth for the European Union in 2004 – 2016 through a quantile regression approach to detect different patterns along the distribution. The results show a negative effect of the tax burden, with higher impact at the last quantiles, evidencing a non-linear relationship between tax burden and economic growth in the European Union. In contrast, the top corporate tax rate appears as non-significant in this study. In addition, population growth, with negative impact, and investment and human capital, with positive effect, also explain the economic growth in the period.

Keywords: Taxation; Economic Growth; European Union; Quantile Regression.

Resumen

La literatura existente sobre la relación entre impuestos y crecimiento económico no es concluyente, aunque existe cierto consenso sobre los efectos negativos de determinados impuestos sobre el crecimiento económico. En este trabajo se estudia la relación entre fiscalidad y crecimiento económico en los países de la Unión Europea mediante regresión cuantílica en el periodo 2004-2016 para detectar distintos comportamientos a lo largo de la distribución. Los resultados muestran una relación negativa de la presión fiscal, con mayor impacto en los últimos cuantiles, evidenciando una relación no lineal entre impuestos y crecimiento en la Unión Europea. Sin embargo, el tipo máximo del impuesto de sociedades no resulta significativo en este estudio. Finalmente, el crecimiento de la población, con impacto negativo, y la inversión y el capital humano, con efecto positivo, también explican el crecimiento económico en el periodo analizado.

Palabras clave: impuestos, crecimiento económico, Unión Europea, regresión cuantílica.

Clasificación JEL: C31, H20, O40.

1. Introduction

The relationships between public sector and economic growth have been analysed in recent decades from several perspectives, such as expenditure, revenue, tax burden, quality of public finance and fiscal decentralisation. Conte and Darrat (1988), Koester and Kormendi (1989), Engen and Skinner (1992), Levine and Zervos (1993), Easterly and Rebelo (1993), Cashin (1995), De la Fuente (1997), Mendoza, Milesi-Ferretti and Asea (1997), Miller and Russek (1997), Agell, Lindh and Ohlsson (1997) and Kneller, Bleaney and Gemmell (1999) are excellent examples of the early studies on these issues.

With regard to the nexus between taxation and economic growth, neoclassical growth models and endogenous growth models differ in the predictions, the former maintaining that taxation only has short-term effects and the latter a stronger and medium- and long-term effect. In addition, the empirical evidence is clearly mixed, depending on several characteristics of each study, such as countries, period, methodology or explicative variables.

Beyond a linear or monotonic relationship between taxation and economic growth, and despite a more complete revision of the literature reported in Section 2, it should be noted that the most recent papers have pointed out the heterogeneous relationship among taxation and economic growth (Durusu-Ciftci, Gokmenoglu and Yetkiner, 2018) or non-linear (Arin *et al*., 2013; Jaimovich and Rebelo, 2017). In addition, Milasi and Waldmann (2018) recently reported a quadratic relationship between top marginal personal income tax rates and economic growth.

With this premise, in this paper we study the effect of taxation on economic growth in the European Union through a quantile regression approach. Indeed, this approach is our major contribution, since, to the best of our knowledge, this is the first study with this perspective. This methodology enhances the possibility to analyse the phenomenon taking into account different patterns along the distribution of the growth, as low-, medium- and high-growth countries can exhibit different results. In fact, the European Union really comprises nations with a great range in economic growth and income levels, hence justifying an approach that analyses the data beyond the average behaviour of the linear models. Specifically, in 2016, the per capita GDP varies from 6,000 euros in Bulgaria to 80,900 euros in Luxembourg, with an unweighted average of 27,196 euros and a median of 22,900 euros.

The remainder of the paper is organised as follows. Section 2 reviews the literature on the topic. Section 3 contains the methodology and Section 4 the data and main results. Finally, Section 5 concludes.

2. BACKGROUND: THEORETICAL MODELS AND EMPIRICAL STUDIES

From a theoretical framework, the economic growth models differ on the relationship between taxation and economic growth. The neoclassical models (Solow, 1956, 1962; Swan, 1956; Sato, 1963) establish that economic growth only depends on the accumulation of capital, an increase in the labour force and exogenous technological change, while other variables, such as taxes, only have short-term effects. Thus, a shift in taxation may have a level effect along the growth path, but not on its slope, as it does not alter the long-term growth rate.

Nevertheless, since then, several endogenous growth models (Barro, 1990; King and Rebelo, 1990; Lucas, 1990; Jones, Manuelli and Rossi, 1993; Stokey and Rebelo 1995) have attempted to address how taxes can affect medium and long-run economic growth.

Some of these models try to assess the effect that changes in taxation may produce in the accumulation of human or physical capital and, in consequence, in economic growth. However, their conclusions differ widely.

Lucas (1990) proposed a model of endogenous growth suitable to assess the effects on growth of Ramsey optimal taxation. He studied how changes in tax structure, consisting of a flat-rate on capital and labour income, affect decision-making about three key issues: investment, work and accumulation of human capital. He concluded that eliminating capital tax and raising labour tax in a revenue-neutral way has a negligible effect of the US growth rate, and that the negative impact of physical capital income taxation could be offset by an increase in human capital accumulation.

On the contrary, King and Rebelo (1990) examined how differences in national public policies affected the long-term growth rates. They used both a neoclassical model and an endogenous growth model, which considers human capital formation as a comprehensive measure of technical progress. They concluded that there are larger welfare costs of taxation in endogenous growth models than in comparable neoclassical models with exogenous technological change, as altering incentives for accumulation of physical and human capital through taxation policy influence the long-term growth rates. The effect of this policy would be higher for small open economies with substantial capital mobility.

In the same way, Jones, Manuelli and Rossi (1993) employed several models of endogenous growth to analyse the effects on welfare and growth rates of a radical tax reform in the Ramsey way. In all the cases they studied, with inelastic or elastic labour supply and with exogenous or endogenous government spending, they found large growth and welfare gains if distortionary taxes were eliminated.

Stokey and Rebelo (1995) reviewed previous models quoted above trying to explain the divergence among their results. They found that elasticities of substitution in production are not critical for growth effects. But differences in estimates of some elements, such as the factor share in the production of human capital, the elasticity of intertemporal substitution in utility and the long-run elasticity of labour supply have relevant effects on growth rate calculations. They also concluded that the empirical evidence about the value of these parameters reinforces Lucas's result showing small growth effect of changes in tax rates.

Barro (1990)[1] adopted perhaps a more comprehensive approach than those studies as he not only analysed the negative effects of distortionary taxes, but also the positive effects of productive government expenditures. Barro incorporated public sector into an endogenous growth model with constant returns of physical and human capital. So, he considered that taxation appropriates resources otherwise available for capital accumulation, but also that tax revenues finance productive government expenditures, which enhances private production as an externality. Thus, taxation has both a negative and a positive impact in the long-term growth rates.

Other studies, such as Baier and Glomm (2001), followed Barro (1990) in including, among productive inputs, publicly provided input. This provides a positive role for taxation as revenue can be used to finance productive public expenditure.

Summarizing, we can say that taxation may affect economic growth in several ways.

It is also relevant to distinguish between distortionary versus non-distortionary taxes. Taxation on capital or labour income can affect the incentives to invest or to work and the accumulation of physical and human capital. Thus, reducing taxes or shifting from direct income taxation to property or consumption taxation could raise the rate of growth. In addition, the existence of productive public sector expenditures can result in taxation having a beneficial impact on growth. The public sector can contribute toward increasing the productivity of factors, building infrastructures, investing in education or financing R&D[2] programmes, for example.

However, the models do not give a clear answer to these questions, as some results are contradictory to others. Now we review the empirical evidence of how taxation may affect economic growth.

With regard to the wide existing empirical literature on this topic, interesting revisions can be found in Poot (2000), Zagler and Durnecker (2003), Nijkamp and Poot (2004), Delgado and Salinas-Jiménez (2009) or, more recently, in Durusu-Ciftci, Gokmenoglu and Yetkiner (2018). We summarize below some

[1] In a related paper, Bajo-Rubio (2000) extended the Solow (1956) model and the results from Barro (1990), concluding a non-monotonic relationship between the rate of growth of per capita output and government size.

[2] See Stokey (1995) for an interesting theoretical study on R&D and growth.

selected recent (and other previous studies, highly cited) empirical papers on the relationship between taxation and economic growth for groups of countries, since we do not consider papers based on single countries. We present this selection of empirical studies in several groupings:

TAX STRUCTURE[3]

- Widmalm (2001) analysed 23 OECD countries for the period 1965 – 1990, concluding a negative effect on economic growth of both the percentage of personal income taxes and tax progressivity.
- Lee and Gordon (2005) used a sample of 70 countries during 1970 – 1997 to conclude that statutory corporate tax rates were negatively correlated with economic growth rates.
- Johansson *et al*. (2008), for the OECD, concluded that corporate taxes are the most harmful for growth, followed by personal income taxes and consumption taxes.
- Arnold *et al*. (2011) stated empirically that economic growth can be enhanced by moving the tax base towards consumption and immovable (residential) property.
- Martínez-Vázquez and Vulovic (2014) studied the impact of the tax structure on the economic growth in Latin America, finding that higher reliance on direct taxes slowed the economic growth.
- Arachi, Bucci and Casarico (2015) focused on the relationship between tax structure and long-term income, concluding weak evidence of a negative impact of labour taxes on long-term income, and a positive impact on income of a shift from labour and capital taxes to consumption taxes in the short-run. This study was performed for 15 OECD countries in the period 1965 – 2011.
- Di Sanzo, Bella and Graziano (2017) focused on the relationship between the tax structure and economic growth. They concluded that recurrent taxation on property is the least harmful for growth, without evidence of the potential advantages of consumption taxation over income taxation.
- Yanikkaya and Turan (2018) studied the relationship between the tax structure and economic growth for 100 high-, middle- and low-income countries. They concluded that the overall tax rate or changes in tax structure do not have a significant effect on growth, and that a shift from consumption and property taxation to income taxes has a positive effect on growth for low-income countries.

[3] Hettich and Winer (1984, 1988) review the tax structure from a theoretical perspective. In addition, Pecorino (1993) theoretically analyses the tax structure and economic growth in a model with human capital.

- McNabb (2018), in a study for 100 countries, analysed the relationship between tax structure and economic growth. The results indicate differences according to the income level, such as the assumption adopted in the present study.

Taxation, tax rates

- Karras (1999) studied 11 OECD countries in 1960 – 1992 and the conclusions were consistent with the neoclassical models instead of the endogenous growth models.
- Arin *et al*. (2013) analysed 6 OECD countries and concluded non-linear effects of taxation, specifically considering the average marginal tax.
- Gemmell, Kneller and Sanz (2014), for 15 OECD countries, found small long-run effects of average tax rates on capital income and consumption.
- Milasi and Waldmann (2018) analysed 18 OECD countries for 1965 – 2009 and conclude a quadratic top tax–growth relationship.

Capital taxation,[4] consumption taxation

- Mao (2017) studied the connection between capital income taxation and growth for 30 OECD countries in the period 1990 – 2013. The conclusions reveal a negative impact on economic growth, but also on income inequality, hence contributing to income redistribution.
- Bösenberg, Egger and Zoller-Rydzek (2018) modelled the effects of capital taxation on growth in small open economies. They empirically studied 79 countries in 1996 – 2011 and concluded that reductions in capital taxes lead to positive effects on output in a time interval of 5 years but not after that time.
- Durusu-Ciftci, Gokmenoglu and Yetkiner (2018), in their study of 30 OECD countries in 1995 – 2016 established that only consumption tax has a significant but small negative effect on long-term income.

In summary, the predictions from the theoretical models of economic growth are mixed, and the available empirical evidence is not unique. Hence, further empirical studies are required in this field.

3. Methodology

We employ a quantile regression approach to capture different patterns through the distribution. In contrast to linear regression, which summarizes the average relationship between regressors and dependent variable, this semiparametric approximation, proposed initially by Koenker and Basset (1978) and

[4] Chen *et al*. (2017) examined theoretically the effects of capital taxation on economic growth, concluding clear differences between the short-run and the long-run.

reviewed in Buchinsky (1998) and Koenker and Hallock (2001), minimizes the deviations in absolute value with asymmetric weighting instead of minimizing the squares of the errors as in OLS.

Hence, in the quantile regression approach, with the 0.10, 0.20, ... and 0.90 quantiles considered, the estimated marginal effects from the estimates of β would indicate how the 10 (20, 30, ... and 90) per cent conditional quantile would be affected at all x values.

Methodologically, the quantile regression estimator can be more efficient than OLS if errors deviate from normality and the quantile estimators are less sensitive to outliers. Besides, quantile regression provides a richer characterization of the data and is invariant to monotonic transformations. Additionally, we can perform a symmetry test for the quantiles: the null hypothesis is that the effect of the variable is the same at the symmetric percentiles (0.10 and 0.90; 0.20 and 0.80; 0.30 and 0.70; and 0.40 and 0.80).

Table 1 contains the variables employed in the empirical analysis. As dependent variable, we choose the growth of GDP per capita. As explicative variables, and following the theoretical and empirical studies revised previously, we consider the level of GDP per capita at the initial moment, the population growth, the total fixed assets and the human capital. As tax indicators, we have included the total tax burden and the top statutory corporate tax rates. In addition, we include a dummy variable to incorporate the Great Recession. Specifically, this variable takes value 1 in years 2008 and 2009, and otherwise 0.

TABLE 1. VARIABLES

Variable	Definition	Source	Expected
Growth	Growth of GDP per capita	Eurostat	
LGDPpcinit	GDP per capita initial (in logarithms)	Eurostat	Undefined
PopGrowth	Population growth	Eurostat	Undefined
Invest	Total fixed assets (%GDP)	Eurostat	Positive
HumCap	Human capital, measured as upper-secondary and post-secondary non-tertiary education (levels 3 and 4) and tertiary education (levels 5 – 8), with respect to population from 15 to 64 years	Eurostat	Positive
TaxBurden	Tax burden (%GDP)	Eurostat	Undefined
TopCTR	Top statutory corporate income tax rates (including surcharges)	Eurostat	Negative
DummyGR	Dummy Great Recession, 1 in years 2008 and 2009 and 0 otherwise	Own elab.	Negative

4. Data and Results

4.1. Data

We employ data from 26[5] EU countries for the period 2004 – 2016. Hence, we analyse both economic growth and crisis periods, since the Great Recession affected most countries in this period. The summary statistics are reported in Table 2, while Table 3 contains the correlation matrix. A first look at these correlations evidences a priori positive correlation between economic growth and investment and human capital, and negative correlation between growth and population growth, tax burden and top corporate tax rate. In addition, the correlation between economic growth and the GDP per capita initial is also negative, denoting a potential beta convergence process in the data.

Table 2. Summary statistics

Variable	Mean	Std. Dev.	Min	Max
Growth	1.6891	3.958	-14.290	23.970
LGDPpcinit	9.9671	0.631	8.268	11.343
PopGrowth	0.3090	0.863	-2.845	3.136
Invest	21.9077	4.150	11.500	36.700
HumCap	70.5213	13.115	25.700	87.700
TaxBurden	36.6536	5.768	23.800	49.900
TopCTR	24.2254	7.574	10.000	38.700

Source: own elaboration.

Table 3. Correlation matrix

	Growth	LGDPpcinit	PopGrowth	Invest	HumCap	TaxBurden	TopCTR
Growth	1						
LGDPpcinit	-0.3006	1					
PopGrowth	-0.2506	0.6540	1				
Invest	0.3553	-0.2281	0.0172	1			
HumCap	0.1570	-0.1531	-0.2657	0.1375	1		
TaxBurden	-0.2649	0.6250	0.2867	-0.1848	-0.0686	1	
TopCTR	-0.1802	0.4761	0.2494	-0.1628	-0.4937	0.5978	1

Source: own elaboration.

With the aim of reaching a more detailed description of the dynamics in the period, we have computed the sigma convergence measures – coefficients of variation, initial and final, and annual rate of change – of each variable. Table 4 contains the evolution of the dispersion throughout the period. We observe a sigma convergence process in the economic growth and GDP per capita, with an annual rate of 0.90% and 1.40% respectively, and also in the human capi-

[5] EU-28 except Croatia and Romania for data unavailability. Data for 2004 and 2016 are reported in the Annex to enhance the interpretation of the results.

tal, with a rate of 3.14%. On the contrary, investment, with a rate of 2.81%, experienced a high process of sigma divergence in the period, as did the tax burden and population growth, although in a slow manner. Finally, the top corporate tax rate presents the same dispersion at the initial and final year of the period. Hence, the determinant factors of growth have experienced different trajectories along the period considered in this study, resulting in an overall sigma convergence process of the growth of GDP per capita.

TABLE 4. SIGMA CONVERGENCE: COEFFICIENTS OF VARIATION

Variable	2004	2016	Annual rate (%)	
Growth	0.6807	0.6074	-0.90	σ-convergence
LGDPpcinit	0.0704	0.0585	-1.40	σ-convergence
PopGrowth	2.3775	2.4323	0.19	σ-divergence
Invest	0.1526	0.2040	2.81	σ-divergence
HumCap	0.2245	0.1399	-3.14	σ-convergence
TaxBurden	0.1545	0.1587	0.23	σ-divergence
TopCTR	0.3047	0.3052	0.01	--

Source: own elaboration.

4.2. RESULTS

The main results are summarised in Table 5 and represented in Figure 1. The symmetric quantile tests are included in Table 6. We will comment separately on each determinant, focusing on the two tax indicators, the core of this research:

GDP PER CAPITA INITIAL

The level of GDP per capita is not significant in our study to explain the economic growth. Hence, our results do not support the beta convergence hypothesis for EU in 2004-2016.

POPULATION GROWTH

Our estimations indicate a negative and statistically significant effect of population growth on economic growth. However, there are no significant differences among quantiles.

With regard to previous literature, Becker, Glaeser and Murphy (1999) reported both positive and negative effects of population on productivity and growth, concluding an undetermined net effect. In similar terms, Barlow (1994) indicated these complex relationships between population, fertility and economic growth.

Investment

In the case of the investment, the effects are positive and decreasing in the first half of distribution, to increase again in the second half reaching at 0.90 practically the same value that for 0.10. Hence we found a U-shape relationship between investment and economic growth. In addition, we do not find significant differences among quantiles.

Human capital

We found a positive effect for human capital, but not always statistically significant. This result manifests the relevance of the level of education on the development, as pointed out in previous studies, such as Benhabib and Spiegel (1994), but the effect is not constant in the distribution of growth.[6]

Tax burden

Our results for the tax burden show a negative effect at all the deciles, and statistically significant in all deciles except 0.10, 0.20 and 0.30. This negative impact on economic growth is in line with most empirical literature, as was reviewed in Section 2.

Specifically, we found the highest impact for the last quantiles, although without significant differences among quantiles, except 0.10 and 0.90. As stated above, in a recent study McNabb (2018) concludes differences in the results according to the income level for a sample of 100 countries. Our results indicate that the policymakers must take into account the level of income of the country to establish the tax burden, and other determinants, to promote the economic growth.

Top marginal corporate tax rate

We did not find a significant effect of the top marginal corporate tax rate, except in 0.10, with significant differences among the quantiles 0.10 and 0.90. As stated in the revision of Section 2, Lee and Gordon (2005) identified a negative association between corporate tax rates and economic growth for 70 countries during 1970 – 1997, but we do not conclude a significant effect in our sample.

The importance of the corporate tax rates consists of the potential effects on the decisions of the firms on investments in capital and, hence, productivity improvements. In addition, high corporate tax rates can reduce the foreign direct investment (FDI), with consequences for economic growth. However, our results do not evidence a significant impact of corporate tax rates for the EU.

[6] More on human capital and economic growth can be found in Barro (1991).

Table 5. Results from the quantile regression

Variable	Quantiles								
	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
LGDPpcinit	-0.5701	-0.0676	0.4093	-0.0815	-0.3313	0.0793	0.1223	-0.3970	-0.0542
	(0.7576)	(0.7475)	(0.6866)	(0.4535)	(0.2379)	(0.2773)	(0.4157)	(0.5126)	(0.6000)
PopGrowth	-0.2899	-0.8508**	-1.0657***	-0.7178**	-0.7839***	-1.1871***	-1.1263***	-0.7937**	-0.6629**
	(0.5607)	(0.4575)	(0.3422)	(0.2120)	(0.2079)	(0.1878)	(0.2852)	(0.3003)	(0.3086)
Invest	0.3557***	0.2930***	0.3197***	0.2720***	0.2842***	0.3208***	0.3488***	0.3244***	0.3368***
	(0.0791)	(0.0656)	(0.0740)	(0.0496)	(0.0446)	(0.0336)	(0.0309)	(0.0297)	(0.0592)
HumCap	0.0448*	0.0097	0.0183	0.0307**	0.0156	0.0134	0.0151*	0.0270***	0.0374
	(0.0242)	(0.0162)	(0.0156)	(0.0125)	(0.0107)	(0.0118)	(0.0132)	(0.0155)	(0.0307)
TaxBurden	-0.0534	-0.0664	-0.0855	-0.1036**	-0.0830**	-0.1200***	-0.1325***	-0.1569***	-0.2290***
	(0.0577)	(0.0547)	(0.0538)	(0.0496)	(0.0410)	(0.0446)	(0.0337)	(0.0328)	(0.0612)
TopCTR	0.0936**	0.0355	0.0338	0.0228	0.0090	0.0124	0.0067	0.0041	-0.0061
	(0.0497)	(0.0365)	(0.0342)	(0.0372)	(0.0332)	(0.0300)	(0.0297)	(0.0310)	(0.0376)
DummyGR	-8.6256***	-6.0771***	-6.1644***	-5.7337***	-4.9010***	-3.9095***	-3.5100***	-3.4391***	-3.2199***
	(2.3969)	(1.1329)	(0.9275)	(1.0871)	(1.0836)	(0.8259)	(0.4736)	(0.5012)	(0.6657)
PseudoR^2	0.3773	0.3183	0.2843	0.2631	0.2620	0.2816	0.3075	0.3409	0.3869

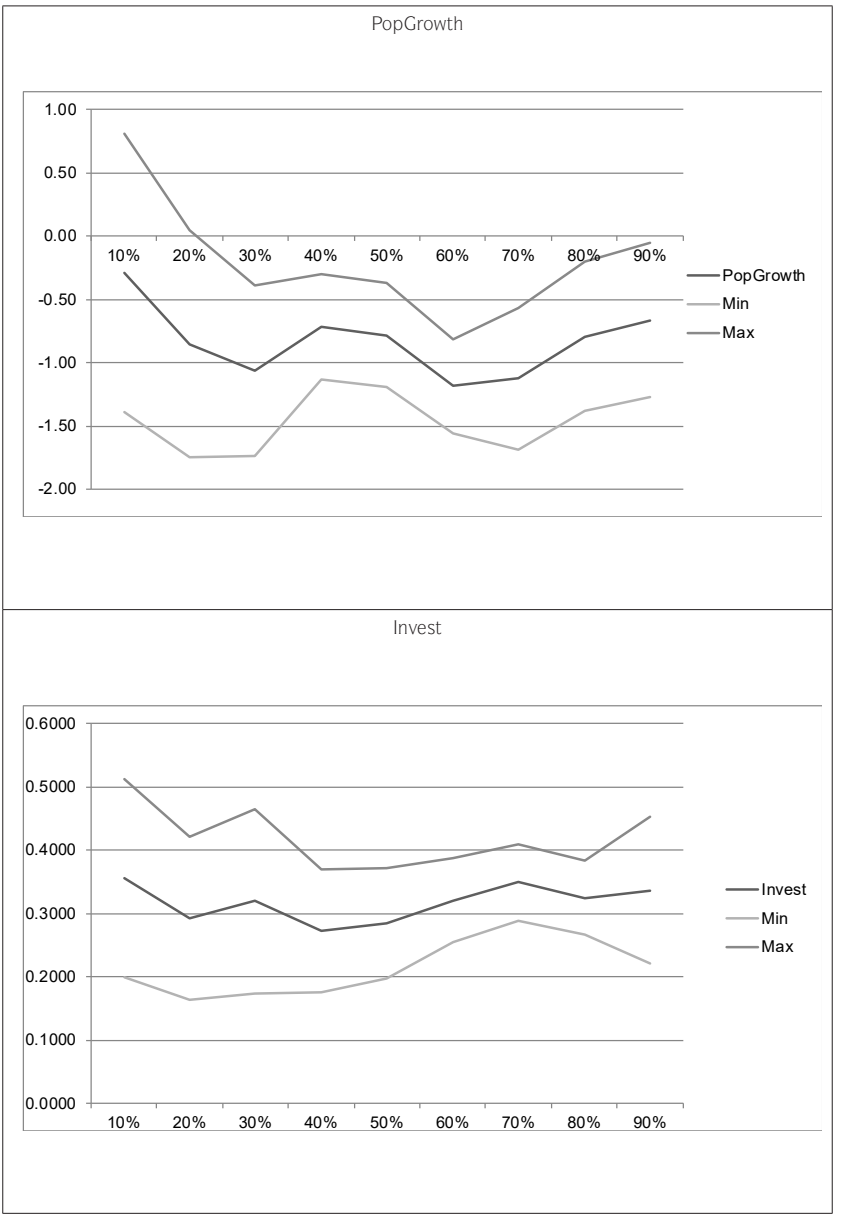
Source: own elaboration.
***, **, * denotes statistical significance at the 1 per cent, 5 per cent and 10 per cent levels, respectively.
Standard errors in parentheses.

Table 6. Symmetric quantile test

Variable	Quantiles	F	p-value	
LGDPpcinit	q60–q40	0.12	0.7275	
	q70–q30	0.17	0.6828	
	q80–q20	0.17	0.6809	
	q90–q10	0.22	0.6427	
PopGrowth	q60–q40	1.87	0.1719	
	q70–q30	0.03	0.8628	
	q80–q20	0.02	0.8844	
	q90–q10	0.74	0.3909	
Invest	q60–q40	1.14	0.2856	
	q70–q30	0.18	0.6739	
	q80–q20	0.18	0.6693	
	q90–q10	0.04	0.8405	
HumCap	q60–q40	4.58	0.0330	**
	q70–q30	0.08	0.7732	
	q80–q20	0.75	0.3859	
	q90–q10	0.04	0.8498	
TaxBurden	q60–q40	0.35	0.5532	
	q70–q30	0.54	0.4630	
	q80–q20	2.27	0.1327	
	q90–q10	6.59	0.0107	**
TopCTR	q60–q40	0.12	0.7261	
	q70–q30	0.87	0.3513	
	q80–q20	1.82	0.1787	
	q90–q10	2.80	0.095	*

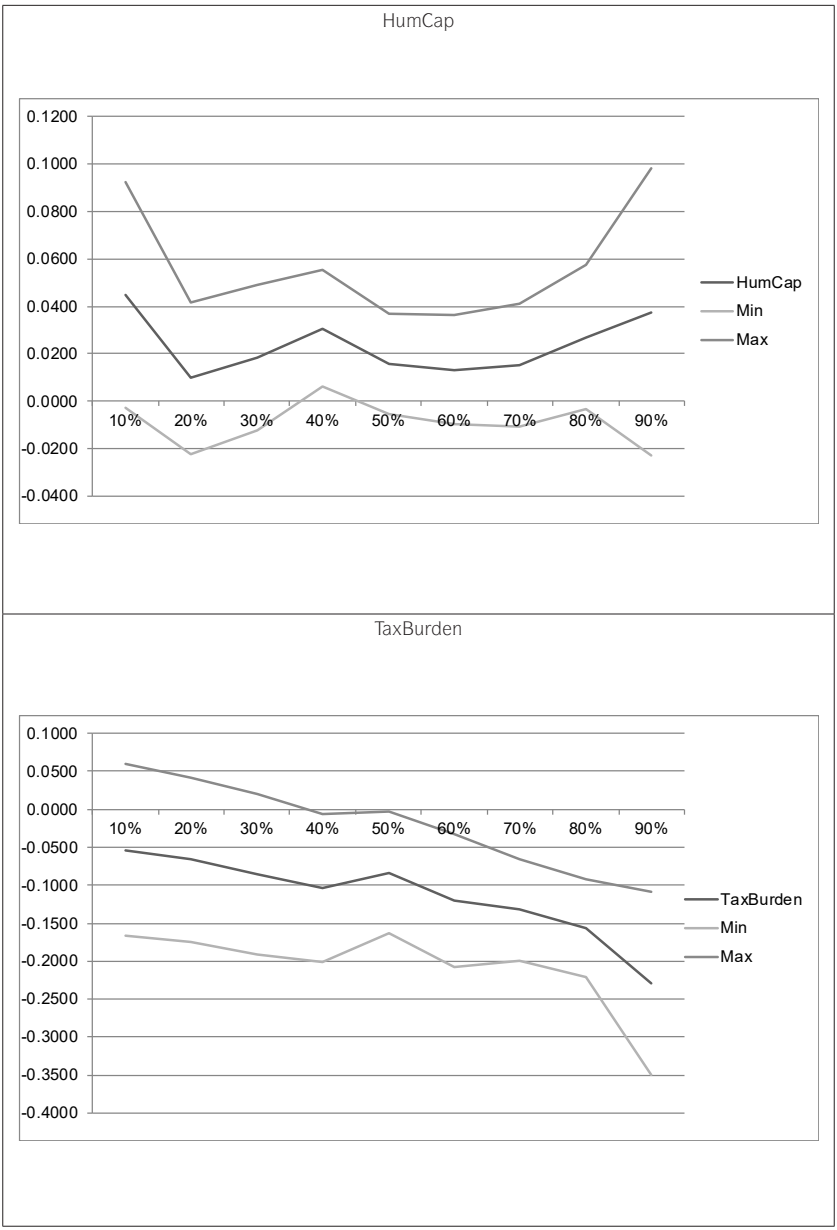
Source: own elaboration.
***, **, * denotes statistical significance at the 1 percent, 5 percent and 10 percent levels, respectively.

FIGURE 1. QUANTILE RESULTS.



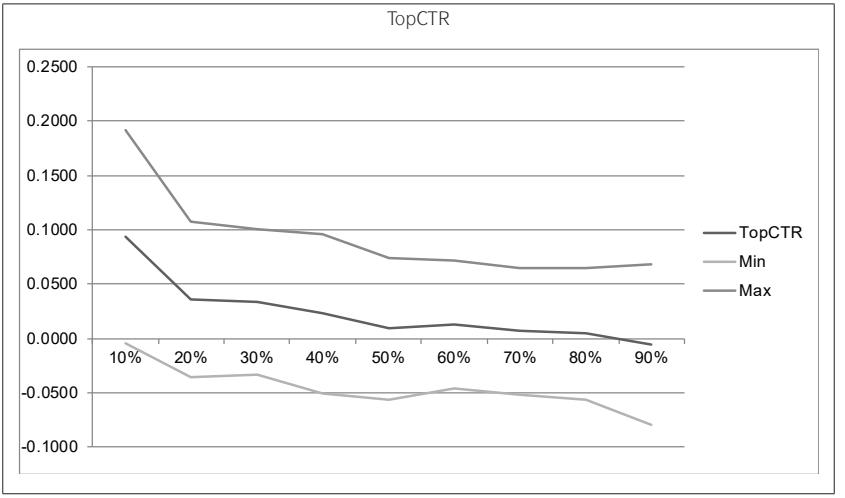
Source: own elaboration.

Figure 1. Quantile results (cont.)



Source: own elaboration.

FIGURE 1. QUANTILE RESULTS (CONT.)



Source: own elaboration.

5. CONCLUDING REMARKS

Taxation is one of the potential determinants of the economic growth identified in the literature, both in the theoretical models and in the empirical studies. Regarding the methodological context, the neoclassical and endogenous growth models differ in the expected effect of the taxation, this being only short-term in the former, but also long-term in the latter. In addition, the empirical literature, certainly vast, is not conclusive and the results are mixed.

We analyse the impact of taxation on economic growth in the European Union in the period 2004 – 2016 through a quantile approach. This approach enables us to explore the growth – taxation link, taking into account the differences during the distribution of growth, as the sample contains countries within a wide interval of income and growth. Specifically, we study the growth of per capita income (GDP) as a function of the determinants identified in the literature – such as population growth, investment and human capital – jointly with two tax variables, namely, the overall tax burden and the top corporate tax rate.

According to our estimations, the population growth has a significant and negative effect on the economic growth, while we found a positive and U-shape impact by investment, and a positive impact by human capital, although non-significant in some quantiles.

With regard to the tax indicators, our results show a negative effect of the tax burden, with higher impact at the last quantiles, but non-significant for the

corporate tax rate. These achievements evidence a non-linear relationship between tax burden and economic growth in the European Union. In addition, we did not find these nonlinearities in the rest of the determinants, except human capital in the extremes of the distribution.

These results can also be interpreted in terms of policy, as the impact of the variables differs throughout the distribution of the economic growth. Hence, policymakers should adopt different strategies or growth-oriented policies.

Finally, the limitations of the present study are determined, as in other empirical studies, by the elections of the sample, period, variables and econometric approach, in a theoretical context, which predicts mixed results on the links between taxation and economic growth. But we believe that the flexibility of the quantile approach enriches the results achieved in the current analysis, although they must be interpreted with proper caution, and future research on this topic continues to be necessary to better understand the complex process of economic growth and the role of taxes.

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Annex. Data

Country	Growth		LGDPpc		PopGrowth		Invest		HumCap		TaxBurden		TopCTR	
	2004	2016	2004	2016	2004	2016	2004	2016	2004	2016	2004	2016	2004	2016
Belgium	3.23	0.88	10.37	10.45	0.39	0.66	21.4	23.3	61.4	71.8	45.8	46.8	34.0	34.0
Bulgaria	8.33	5.26	8.27	8.70	-0.77	-0.67	21.1	18.6	65.7	78.1	31.7	29.0	19.5	10.0
Czech Rep.	4.92	1.85	9.46	9.71	0.03	0.15	28.1	24.9	82.0	87.7	34.7	34.8	28.0	19.0
Denmark	2.35	1.10	10.68	10.73	0.26	0.84	20.7	20.4	74.4	73.0	47.9	47.3	30.0	22.0
Germany	1.37	1.45	10.30	10.46	-0.01	1.20	19.2	20.1	76.4	80.1	38.5	40.4	38.3	30.2
Estonia	6.38	3.73	9.21	9.54	-0.65	0.08	31.8	23.0	79.6	83.4	31.3	34.7	26.0	20.0
Ireland	4.67	3.71	10.55	10.88	1.63	1.04	27.0	35.7	61.4	76.2	30.9	23.8	12.5	12.5
Greece	5.03	0.00	9.95	9.75	0.23	-0.68	24.4	12.1	58.5	69.9	32.1	42.1	35.0	29.0
Spain	1.76	3.03	10.05	10.08	1.72	-0.02	28.5	19.9	45.4	57.4	34.9	34.1	35.0	25.0
France	2.38	0.95	10.31	10.37	0.69	0.41	21.4	21.9	63.2	74.5	43.9	47.6	35.4	34.4
Italy	0.72	1.56	10.24	10.17	0.64	-0.21	20.8	17.2	47.6	58.4	39.4	42.9	37.3	31.3
Cyprus	3.72	4.76	10.01	10.00	1.29	0.15	20.6	17.7	60.8	75.9	29.5	33.6	10.0	12.5
Latvia	10.61	2.80	8.90	9.31	-0.99	-0.86	28.9	19.6	74.3	85.1	27.8	31.6	15.0	15.0
Lithuania	8.96	3.45	8.90	9.39	-0.95	-1.12	22.9	19.3	78.3	87.6	29.3	30.2	15.0	15.0

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Luxem-bourg	2.31	-0.12	11.23	11.30	1.49	2.36	20.3	18.6	59.7	71.8	38.0	39.6	30.4	29.2
Hungary	5.56	1.80	9.16	9.33	-0.25	-0.25	24.0	19.6	70.3	78.2	37.0	39.4	17.6	20.6
Malta	-0.69	3.14	9.57	9.89	0.65	2.44	20.6	24.4	25.7	52.1	31.5	33.6	35.0	35.0
Nether-lands	1.41	1.53	10.49	10.59	0.40	0.46	20.3	20.0	66.3	72.1	36.0	39.3	34.5	25.0
Austria	2.15	0.83	10.41	10.51	0.52	1.35	23.6	23.2	74.9	80.4	43.3	42.9	34.0	25.0
Poland	5.80	3.67	8.90	9.33	-0.07	-0.10	18.3	18.0	76.5	85.4	32.9	34.4	19.0	19.0
Portugal	1.23	2.41	9.71	9.74	0.27	-0.32	23.4	15.5	26.3	47.1	33.4	36.9	27.5	29.5
Slovenia	3.90	3.35	9.68	9.83	0.07	0.06	26.2	17.5	74.6	82.8	37.7	36.9	25.0	17.0
Slovakia	4.49	2.82	9.14	9.59	-0.06	0.09	25.0	21.3	78.6	85.7	31.7	32.4	19.0	22.0
Finland	3.41	2.05	10.42	10.46	0.26	0.28	22.3	21.7	72.3	81.4	42.0	44.3	29.0	20.0
Sweden	3.94	1.43	10.52	10.66	0.39	1.06	21.7	23.9	78.5	78.9	46.2	44.6	28.0	22.0
United K.	1.74	0.95	10.37	10.37	0.49	0.78	17.0	16.8	69.8	79.6	34.4	35.1	30.0	20.0