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Tax policy and economic growth: does it really matter?

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Abstract We study the relationship between per capita GDP, overall tax revenue and tax composition. We find that there is some evidence of a negative and statistically significant relationship between tax revenue and economic growth, while there are no robust relationships between revenue-neutral tax shifts and economic growth. The results hold in different samples of OECD countries for different time periods. We also identify different relationships between the short run and long run. Overall, our results cast doubts on the potential growth enhancing effects of a shift from direct to indirect taxation, with paramount consequences on tax policy.

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1 Introduction

In a time of tight public finance conditions, often because of the high level of sovereign debts, there is a large and expanding debate on the effects of taxation on the level and growth of GDP. Scholars and policy makers alike—for a given level of fiscal pressure—are interested in whether the tax mix, i.e., the distribution of overall tax revenue across different tax sources, has a separate influence on the growth performance of a country. The 'common wisdom' on the relationship between tax mix and growth is that a shift from direct to indirect taxation is associated with higher GDP growth. The main international organizations that deal with economic matters, i.e., the IMF and the OECD, claim that high taxes on labor are detrimental to economic growth, and a shift from direct to indirect taxes has a growth enhancing effect. The European Commission adopted this view back to 1993. Since then, the tax shift has remained at the center of the European Commission's agenda and it has pervaded its policy recommendations to member states: '*tax should be designed to be more growth-friendly, for instance by shifting the tax burden away from labor on to tax bases linked to consumption, property and combating pollution*' (European Commission 2013).

This paper provides new empirical evidence on the relationship between taxation and tax shift and growth, which challenges this 'common wisdom.' While we are able to identify in some cases a negative and significant relationship between the overall tax revenue and growth, we do not find any significant and robust relationships between various types of revenue-neutral tax shift and growth.

On the theoretical side, scholars suggest to cut tax rates and broaden tax bases in order to reduce economic distortions while keeping a constant level of fiscal pressure. Consumption taxes allow to precisely follow these prescriptions: consumption is a broader tax base than labor income because households' consumption choices can be financed by using other sources of income than wages. Moreover, reducing labor taxes should enhance economic growth by increasing labor supply and demand, and by stimulating investment. Thus, the recommendations on the tax shift from direct to indirect taxation are essentially based on the higher economic efficiency of consumption taxes with respect to income taxes.[1] Similarly, a shift from income to wealth taxation could lead to positive efficiency gains, given that income is more elastic to taxes than wealth. Also, the traditional public finance argument posits that taxing income-producing assets is equivalent to taxing the 'normal' income arising from those assets, so that extra income due to extra effort is effectively taxed at a zero rate, thus enhancing that effort (Einaudi 1924).

[1] Obviously shifting taxes away from labor could negatively affect redistribution. In this paper, we do not take into account redistributive issues. Thus, we leave aside the large literature on optimal taxation which studies the trade-off between efficiency and equity in relation to taxation and the tax mix.

Even if this is not explicitly discussed within the traditional Public Finance theory, growth is the dynamic counterpart of efficiency at a macroeconomic level and has been for decades the main focus and goal of government action.[2]

What do the data say about the relationships between the tax mix and economic efficiency (growth)? The most influential empirical contribution on this issue is a paper by Arnold et al. (2011). For a sample of 21 OECD countries over the 1971–2004 period, they show that tax revenue is negatively and significantly associated with per capita GDP, while a shift from direct to indirect taxation is positively and significantly correlated with per capita GDP. More precisely, they identify a 'tax and growth ranking' according to which the most harmful taxes for economic growth are: corporate taxes, personal income taxes, consumption taxes and finally property taxes. This ranking has been adopted by international organizations, such as IMF, OECD and the European Commission, to offer policy recommendations to countries. This analysis has been recently confirmed by Acosta-Ormaechea and Yoo (2012) using an enlarged sample of countries (69, including non-OECD countries) and an extended time period (up to 2009).[3] Focusing on a smaller set of countries, Xing (2012) challenges the robustness of these results, suggesting that they are less general than what is claimed by previous studies, as they depend on the set of countries and the time period under investigation.[4] Indeed, some European countries have partly aligned with the Commission's prescriptions (Estonia, Italy, Spain), while others have recently introduced the tax shift objective in their reforms programs (Belgium, Finland, France, Germany, Lithuania, the Netherlands). However, the evidence on the implementation of this tax shift is still limited (see Mathé et al. 2015).

Figure 1 shows the relationship between the tax shift, computed as the rate of growth of the ratio between income taxes and the sum of consumption and income taxes (horizontal axis) and GDP growth (vertical axis) in 34 OECD countries in the time period 1995–2014. Figure 1 suggests that—in line with the conclusions by Mathé et al. (2015)—there is no unconditional evidence in favor of the idea that a shift from direct to indirect taxation has had a growth enhancing effect in the last 50 years. In fact, to date those policy recommendations on efficient tax shifts have been only very partially implemented by developed countries.[5]

The limited correlation between the tax shift from direct to indirect taxes and economic growth may be to some extent explained by a low elasticity of labor supply: if lower taxes on labor income do not have a strong positive impact on labor supply, we

[2] As well argued by Mathé et al. (2015) endogenous growth models are the best theoretical baseline to study the connections between tax policy and economic growth. The predictions of endogenous growth models are empirically investigated—among others—by Kneller et al. (1999) and Gemmell et al. (2014). More recently, Jaimovich and Rebelo (2017) show that the link between taxation and economic growth can be nonlinear, mainly because of different incentives to invest that entrepreneurs face in low and high tax contexts.

[3] Similar results are obtained by Arachi et al. (2015) in a sample of 15 OECD countries over the period 1965–2011.

[4] See also the results in Sanzo et al. (2017) on a sample of 20 OECD countries and the review by Shinohara (2014).

[5] On EU countries see, e.g., European Commission Services (European Commission Services 2006) and Bernardi (2013).

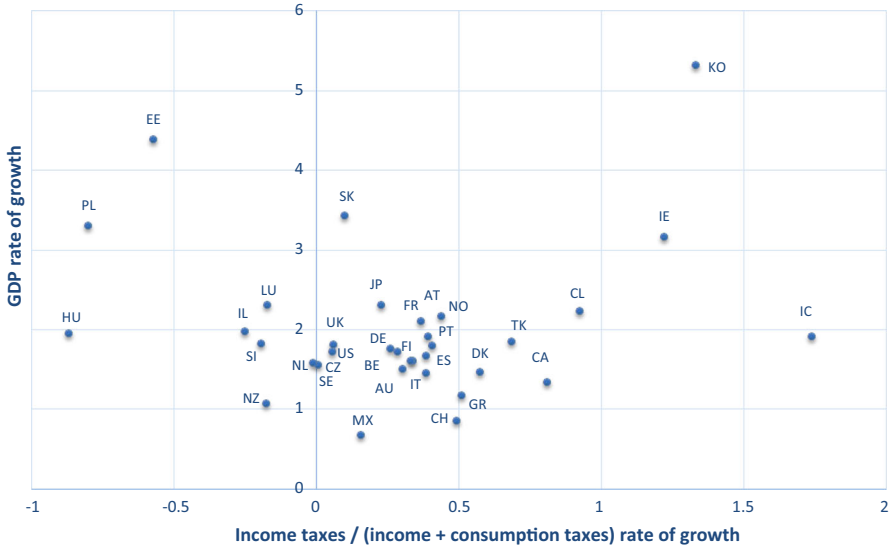

Fig. 1 Trend in tax composition and GDP—34 OECD countries in the time period 1995–2014. *Notes* The figure shows the relationship between the rate of growth of the ratio between income taxes and the sum of consumption and income taxes (horizontal axis) and GDP growth (vertical axis). Our elaboration on OECD data

expect to observe a rather small—if not null—effect on economic growth. Indeed, a large recent literature has shown that the income tax elasticities of labor supply are quite small (see Saez et al. 2012 for a review). More specifically, Jäntti et al. (2015) have discussed the discrepancy between more traditional macroeconometric studies, which provide evidence of high labor supply elasticities, and the more recent microeconometric studies, which instead find low labor supply elasticities. In their exercise, where macrovariables are aggregated on the basis of microdata for several countries, there is no strong support for macrolevel elasticities to be higher than microlevel (low) elasticities.

Another argument that could help reconcile theory and evidence is the cost of transition, which is often neglected in the literature on the efficiency effects of tax shifts. In fact, tax reforms are always costly, both in terms of political constraints and in terms of their administrative burden. The so-called status quo bias (see Castanheira et al. 2012) is a crucial well-studied political obstacle to tax reforms, even when they are theoretically efficient, independently from equity concerns. Moreover, on the administrative side, complex tax systems are not easily modified, and, when they are, the costs of transition may be substantial (see Winer et al. 2015) and thus negatively affect economic growth. Taking this into account, even tax reforms which are expected to be theoretically efficient may turn out not to be implemented and, if they are, they could show no significant relationships with economic growth.

This paper estimates these relationships between tax burden, tax mix and per capita GDP, controlling for the standard growth determinants (fixed capital formation, human capital, population growth). Following the previous literature, we adopt the panel

version of an error correction model (ECM) specification, i.e., the pooled mean group estimator (Pesaran et al. 1999). We face a trade-off in the choice of our sample: data for the largest set of 34 OECD countries are only available for the 1995–2014 period, while data for a narrower sample of 23 OECD countries are available for a longer time period, i.e., from 1971 to 2014. We therefore show results for both choices.

First, focusing on a sample of 23 OECD countries in the time period from 1971 to 2014, we find a significant long-run negative correlation between the revenue-neutral shift from indirect to direct taxes and GDP growth. However, in the short run, this correlation becomes positive even when we separately look at consumption and property taxes. On the other hand, the long-run correlation between tax revenue and GDP growth is only significant in one specification over five. Different from all previous studies, we integrate the standard ECM models with more conservative estimates of the standard errors, i.e., we cluster them at the country level (Bertrand et al. 2004; Cameron et al. 2008). When doing so, none of these long-run correlations is significant.

Second, we consider an extended set of countries in the available years: the full—and balanced—sample of 34 OECD countries during the 1995–2014 period. In this case, neither the correlation of per capita GDP with tax revenue nor the ones with the revenue-neutral tax shifts are found to be statistically significant. This holds mainly for the long run, with and without clustered standard errors. The only noticeable exceptions to this lack of significant results are that—when not clustering the standard errors—a shift from consumption to corporate taxation of income is positively and significantly correlated with GDP per capita in the long run and that a shift from income to property taxes is negatively associated with per capita GDP in the short run.

To understand why our results differ from those of previous contributions, we also replicate the analysis by Arnold et al. (2011) for the same 21 countries and the same time period 1971–2004, with and without clustering the standard errors. While we can confirm some of their results with 'unclustered' standard errors, those same results are no longer significant when clustering the standard errors. This lack of robustness should suggest more caution in deducing policy recommendations from the relationships emphasized by Arnold et al. (2011), on which in fact the OECD view is mainly based.

Finally, we restrict ourselves to the sample of OECD countries belonging to the Eurozone, during the 1995–2014 period. Results are similar to what obtained for the sample of 34 OECD countries in the same investigated time period.[6]

Overall, this paper challenges the validity of the relationship between tax mix and growth when a significant number of years after the 2008 economic and financial crisis and different sets of countries are considered. The lack of robust findings seems to be particularly relevant from a policy perspective, since robust findings should be the basis for sound advice on growth enhancing fiscal policies, as the one provided by international organizations such as the IMF and the OECD. It is also the case that the

[6] When clustering the standard errors the only mildly significant finding is the negative correlation between a revenue-neutral shift from indirect to personal income taxes and per capita GDP.

shift from direct to indirect taxes, which has been so far implemented only by few European countries, is now attracting the attention of non-European countries as well. A prominent example is the USA, where President Trump has recently proposed a large reduction in personal and corporate income taxes, with the Republican majority in Congress initially pushing for a 'Border Adjustment Tax' to (partially) achieve revenue neutrality.

The paper is organized as follows: Sect. 2 presents the data and the empirical strategy, while Sect. 3 displays our results. Section 4 concludes.

2 Data and empirical strategy

We collect economic and fiscal data on OECD countries for the period from 1971 to 2014.[7]

Economic variables include GDP at constant 2010 prices per head of population aged 15–64 years, the investment rate (proxied by the ratio of gross fixed capital formation to real GDP), the stock of human capital (proxied by the average number of years of schooling of the population aged between 15 and 64 years) and the growth rate of the working age population. All variables come from OECD but the human capital variable, which is taken from the Barro and Lee (2013) dataset, recently updated up to 2016.

Fiscal data refer to total government (central and local) and are taken from OECD revenue statistics. We organize these data as follows: income taxes include categories 1000 (taxes on income, profits and capital gains), 2000 (social security contributions) and 3000 (taxes on payroll and workforce); personal income taxes include categories 1100 (taxes on income, profits and capital gains of individuals), 2000 and 3000.[8] Consumption and property taxes include categories 4000 (taxes on property), 5000 (taxes on good and services) and 6000 (other taxes); consumption taxes in turn include categories 5000 and 6000. Recurrent taxes on immovable property include categories 4100 (recurrent taxes on immovable property) and 4600 (other recurrent taxes on property), while other property taxes include categories from 4200 to 4500 (recurrent taxes on net wealth; estate inheritance and gift taxes; taxes on financial and capital transactions; non-recurrent taxes on property). The overall tax burden is computed as the ratio of total tax revenue to GDP, while all the other fiscal variables are expressed as shares over total tax revenue. This allows to estimate the relationship between revenue-neutral tax shifts and GDP per capita. All data are available at yearly frequency.

[7] Data are available for all years and countries from 1995 to 2014 for the following 34 OECD countries: Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, Turkey, UK and USA. For the period 1971–2014, data are available only for 23 countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany (Western Germany, up to 1989 only), Greece, Ireland, Italy, Japan, South Korea, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, UK and USA.

[8] Corporate income taxes refer to category 1200 (taxes on income, profits and capital gains of corporates).

Table 1 Descriptive statistics for the sample of 23 OECD countries in the period 1971–2014

Variable	Obs	Mean	SD	Min	Max
GDP per capita	984	47.35	17.57	5.76	133.34
GDP per capita rate of growth	984	3.79	0.39	1.75	4.89
Physical capital	984	22.44	4.12	9.83	38.03
Human capital	984	9.45	1.88	2.93	13.18
Population growth	984	0.64	0.55	− 0.59	3.87
Overall tax burden	984	33.64	7.68	11.98	50.88
Income taxes	984	62.95	8.34	25.14	77.04
Personal income taxes	967	53.82	9.61	9.39	72.58
Corporate income taxes	967	8.78	4.71	0.60	29.34
Consumption and property taxes	984	39.94	8.34	22.96	74.86
Consumption taxes	984	30.74	8.32	12.78	65.16
Property taxes	984	6.20	3.39	0.83	21.42
Property taxes: immovable property	984	3.14	3.19	0.00	13.46
Property taxes: others	984	3.07	2.29	0.11	20.86

Our elaborations on OECD data

Table 2 Descriptive statistics for the sample of 34 OECD countries in the period 1995–2014

Variable	Obs	Mean	SD	Min	Max
GDP per capita	670	49.50	19.86	16.51	133.34
GDP per capita rate of growth	670	3.82	0.41	2.80	4.89
Physical capital	670	21.48	3.95	9.83	36.58
Human capital	670	10.45	1.54	5.44	13.18
Population growth	670	0.65	0.66	− 1.46	2.93
Overall tax burden	670	33.74	7.29	14.84	50.88
Income taxes	670	60.56	8.35	25.58	73.64
Personal income taxes	631	52.19	7.72	30.49	67.03
Corporate income taxes	631	8.92	4.30	1.66	29.34
Consumption and property taxes	670	39.24	8.40	26.36	72.43
Consumption taxes	670	33.72	8.93	16.07	64.63
Property taxes	670	5.52	3.42	0.70	21.42
Property taxes: immovable property	670	2.98	2.77	0.00	13.36
Property taxes: others	670	2.54	2.33	0.00	20.86

Our elaborations on OECD data

Tables 1, 2, 3 and 4 show the summary statistics for the four different samples of countries and years that we consider in our analysis.

The methodology used to estimate the relationship between the distribution of overall tax revenue across different tax sources, and the economic performance of

Table 3 Descriptive statistics for the sample of 21 OECD countries in the period 1971–2004

Variable	Obs	Mean	SD	Min	Max
GDP per capita	693	42.63	11.68	19.63	88.99
GDP per capita rate of growth	693	3.72	0.27	2.98	4.49
Physical capital	693	22.76	3.79	15.12	36.37
Human capital	693	9.03	1.84	2.93	12.64
Population growth	693	0.59	0.52	− 0.57	3.87
Overall tax burden	693	33.83	7.46	16.63	49.54
Income taxes	693	63.64	7.05	37.13	77.04
Personal income taxes	676	55.60	7.65	31.54	72.58
Corporate income taxes	676	7.86	4.24	0.60	28.13
Consumption and property taxes	693	36.30	7.04	22.96	62.87
Consumption taxes	693	30.45	7.60	12.78	51.21
Property taxes	693	5.85	3.37	0.83	21.42
Property taxes: immovable property	693	3.14	3.31	0.00	13.46
Property taxes: others	693	2.71	1.90	0.11	20.86

Our elaborations on OECD data

Table 4 Descriptive statistics for the sample of Eurozone countries in the period 1995–2014

Variable	Obs	Mean	SD	Min	Max
GDP per capita	295	52.25	20.84	17.02	133.34
GDP per capita rate of growth	295	3.89	0.36	2.83	4.89
Physical capital	295	21.53	4.02	9.83	35.98
Human capital	295	10.07	1.36	6.69	12.82
Population growth	295	0.45	0.63	− 1.46	2.93
Overall tax burden	295	36.54	4.99	27.38	45.82
Income taxes	295	62.79	4.89	44.62	70.83
Personal income taxes	295	54.77	6.38	36.72	66.89
Corporate income taxes	295	7.71	3.29	1.66	20.46
Consumption and property taxes	295	36.87	4.90	28.77	55.38
Consumption taxes	295	32.53	5.20	23.38	44.39
Property taxes	295	4.34	2.64	0.70	21.42
Property taxes: immovable property	295	1.71	1.17	0.18	5.71
Property taxes: others	295	2.63	2.37	0.00	20.86

Our elaborations on OECD data

a country is based on macrogrowth regressions,[9] where, under the hypothesis of a constant return to scale technology, aggregate production at time t is assumed to be a Cobb-Douglas type, which is a function of physical capital (K), human capital (H)

[9] On this point, see, for instance, Arnold et al. (2011).

and labor (L) as follows:

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} [A(t)L(t)]^{(1-\alpha-\beta)} \tag{1}$$

The parameters α and β are the partial elasticity of output with respect to physical and human capital, while the variable $A(t)$ incorporates technological progress, the growth-related effects of institutions and public policies (see Cellini 1997) and is assumed to be labor augmenting. Equation (1) can thus be easily rewritten as an expression for the steady-state output in intensive form as follows:

$$\begin{aligned} \Delta \log Y_{i,t} = {} & a_{o,i} + \phi_i log Y_{i,t-1} + a_{1,i} log K_{i,t} + a_{2,i} log H_{i,t} + a_{3,i} n_{i,t} \\ & + \sum a_{j,i} FISCAL_{i,t} + F_i(t) \\ & + b_{1,i} \Delta log K_{i,t} + b_{2,i} \Delta log H_{i,t} + b_{3,i} \Delta n_{i,t} \\ & + \sum b_{j,i} \Delta FISCAL_{i,t} + \epsilon_{i,t} \end{aligned} \tag{2}$$

where, for each country i and in each year t, Y is real GDP per head of population, K is the investment rate, H is the stock of human capital, and n is the growth rate of the working age population. *FISCAL* is a vector of tax variables: the overall tax burden over GDP, and the shares over total tax revenue of (i) income taxes, (ii) personal income taxes, (iii) corporate income taxes, (iv) consumption and property taxes (taken together), (v) consumption taxes, (vii) property taxes, (viii) recurrent taxes on immovable property and (ix) other property taxes. The parameters a_0 are a set of country fixed effects, and $F_i(t)$ is a set of 5-year dummies, whose coefficients are country specific.

The terms with coefficients starting with 'a' and 'b' capture long-term and short-term dynamics, respectively, while $\epsilon_{i,t}$ is the error term.[10]

Equation (2) is estimated by means of a panel error correction model (ECM), where estimation results are computed with the pooled mean group (PMG) estimator proposed by Pesaran et al. (1999), which allows short-run coefficients, the speed of adjustment and error variances to differ across countries, but imposes coefficients on long-run slopes that are common across countries. Cross-sectional dependence is also taken into account, given that the countries analyzed are characterized by a high degree of economic integration. [11]

Notice that—for each sample of countries and years under consideration—Eq. (2) is estimated twice: first with conventional standard errors and then with standard errors that are clustered at the country level. The use of clustered standard errors allows us not to inflate the precision of our estimates because of potential within-group correlation of the error terms (Bertrand et al. 2004). Notice that the choice of clustering the standard errors at the country level is not the most conservative one, as one could argue that

[10] Estimates of steady-state coefficients as well as of the parameters of the production function are computed as the ratio between a and ϕ.

[11] Results are obtained by means of the very recent Stata routine `xtdcee2`, proposed by Ditzen (2016), which estimates a heterogeneous coefficient model in a dynamic panel with dependence between cross-sectional units. This routine is the evolution of the `xtpmg` Stata command (Blackburne and Frank 2007).

within-cluster correlation of the error terms might also arise at a wider geographical level, e.g., at the continental level.[12]

We perform several sets of estimates. First, we estimate Eq. (2) for 23 OECD countries in the time period 1971–2014. Second, we enlarge the set of countries up to all the 34 OECD countries. In this case, since for some countries OECD fiscal data are only available from 1995 we obtain a balanced panel by focusing on the 1995–2014 period. Third, we estimate Eq. (2) for 21 OECD countries in the 1971–2004 period to replicate Arnold et al. (2011). Finally, we perform our analysis on a reduced set of more homogeneous countries, i.e., OECD countries that are current members of the Eurozone.[13]

3 Empirical results

Results are presented in Tables 5, 6, 7, 8, 9 and 10. Odd-numbered tables show results with conventional standard errors, while in even-numbered tables we cluster the standard errors at the country level.[14] Since the PMG estimator allows for country-specific short-run dynamics, there is a difference in the estimated conventional and clustered standard errors only for the *long-run* coefficients. Hence, in odd-numbered tables we display both long-run and short-run results, while in even-numbered tables we only show the long-run ones.

3.1 23 OECD countries, from 1971 to 2014

Tables 5 and 6 show the estimation results of Eq. (2) for 23 OECD countries in the time period 1971–2014. In Table 5 only in one specification out of five the negative long-run correlation between the tax burden and per capita GDP is found to be (mildly) significant. We can confirm the positive long-run correlation of per capita GDP with a shift from income taxation to consumption and property taxation. However, when disentangling personal and corporate income taxes, only a revenue-neutral shift to the former is negatively associated with GDP. Moving to the short run, the tax burden is negatively and significantly associated with GDP in all specifications, while correlations with the revenue-neutral tax shifts run contrary to what is found in the long run: a shift from consumption and property taxation to income taxation is *positively* and significantly correlated with GDP, while a shift from direct to indirect taxes (both consumption and property) is *negatively* and significantly correlated with GDP. In

[12] We thank an anonymous reviewer for pointing this out.

[13] These countries are: Austria, Belgium, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Slovakia, Slovenia and Spain.

[14] A potential concern with clustered standard errors is the relatively low number of clusters (countries) in our sample. However, as discussed by Cameron et al. (2008), this would imply that the cluster option does compute standard errors that are *smaller* than the correct ones, thus inducing over-rejection of the null hypothesis. But this bias goes in our direction, since our results with clustered standard errors by and large do not reject the null hypothesis of zero correlation between economic growth and tax variables.

Table 6 we find that, when clustering standard errors at the country level, none of the long-run correlations is significant.[15]

3.2 34 OECD countries, from 1995 to 2014

Tables 7 and 8 show results for an expanded dataset composed of all the 34 OECD countries, for the period 1995–2014. We find that the tax burden is not significantly associated with economic growth in the long run, and that it is negatively associated with economic growth in the short run only in two out of five specifications. A shift from income to consumption and property taxes is not significantly related to per capita GDP in the long run, while the association between these two variables in the short run turns out to be negative and statistically significant, as already found in Table 5. Interestingly, a revenue-neutral shift from consumption and property taxes to corporate taxation of income is positively and significantly correlated with GDP per capita in the long run. Table 8 shows our results when we cluster the standard errors at the country level. In this case, we do not find any significant relationship.[16] As a robustness check, to exclude that the lack of significant relationships is driven by an outlier country, we rerun our baseline regression on the set of 34 OECD countries by dropping one country at a time. Results, reported in Tables A1–A5 in the Supplementary material, are reassuring against this potential concern: the relationship between tax revenue and economic growth and the relationship between a revenue-neutral tax shift and economic growth are never statistically significant.

3.3 A critical assessment of Arnold et al. (2011)

Table 9 replicates the estimates contained in Arnold et al. (2011) for the same sample of 21 countries and the same time period 1971–2004.

In line with what they found, in the long run we identify a negative and significant long-run correlation between the tax burden and per capita GDP, and a positive and significant long-run correlation between a revenue-neutral shift from income to consumption and property taxes and growth.[17] Different from Arnold et al. (2011)—who find a negative and significant correlation—in our replication exercise a shift to corporate income taxation is not significantly correlated with per capita GDP. Interestingly, in the short run the tax burden is negatively and significantly correlated with per capita GDP only in three specifications out of five, while the only significant tax shift is the one toward taxes on immovable property, which in fact is *negatively* correlated

[15] To understand whether the financial crisis played any role in guiding these results, we rerun the same regressions for the pre-crisis time period, i.e., from 1971 to 2007. Results are similar and show no significant relationship between tax shift and economic growth.

[16] Again, we rerun the same regressions for the pre-crisis time period, i.e., from 1995 to 2007. Results are similar to those obtained on the whole time period, as they show no significant relationship between tax shift and economic growth.

[17] When separating out consumption and property taxes, only a shift from income to property taxation is positively and significantly correlated with GDP.

Table 5 Taxation and GDP per capita: 23 OECD countries, 1971–2014

	(1)	(2)	(3)	(4)	(5)
Long-run parameters					
Convergence parameter (ϕ)	−0.110***	−0.115***	−0.109***	−0.116***	−0.0999***
	(0.020)	(0.019)	(0.020)	(0.020)	(0.020)
Physical capital (a_{1i})	0.135	0.0885	0.134	0.169	0.0848
	(0.111)	(0.110)	(0.112)	(0.105)	(0.132)
Human capital (a_{2i})	−0.940	−0.474	−0.953	−0.723	−0.631
	(0.654)	(0.564)	(0.659)	(0.609)	(0.700)
Population growth (a_{3i})	−16.27***	−11.20***	−16.38***	−13.94***	−14.81***
	(4.262)	(3.507)	(4.302)	(3.817)	(4.503)
Overall tax burden (a_{4i})	−0.004	−0.012*	−0.005	−0.005	−0.008
	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)
Income taxes (a_{5i})	−0.023***	–	–	–	–
	(0.007)				
Personal income taxes (a_{6i})	–	−0.027***	–	–	–
		(0.00712)			
Corporate income taxes (a_{7i})	–	0.005	–	–	–
		(0.00713)			
Consumption and property taxes (a_{8i})	–	–	0.021***	–	–
			(0.00724)		
Consumption taxes (a_{9i})	–	–	–	0.013**	0.014*
				(0.007)	(0.007)
Property taxes (a_{10i})	–	–	–	0.037***	–
				(0.012)	

Table 5 continued

	(1)	(2)	(3)	(4)	(5)
Property taxes: immovable property (a_{11i})	–	–	–	–	−0.014
					(0.023)
Property taxes: others (a_{12i})	–	–	–	–	0.058***
					(0.017)
Short-run parameters					
Overall tax burden (b_{4i})	−0.004***	−0.003***	−0.004***	−0.004***	−0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Income taxes (b_{5i})	0.003***				
	(0.000752)	–	–	–	–
Personal income taxes (b_{6i})	–	0.001	–	–	–
		(0.000824)	–	–	–
Corporate income taxes (b_{7i})	–	0.003***	–	–	–
		(0.000890)			
Consumption and property taxes (b_{8i})	–	–	−0.003***	–	–
			(0.001)		
Consumption taxes (b_{9i})	–	–	–	−0.002**	−0.002**
				(0.001)	(0.001)
Property taxes (b_{10i})	–	–	–	−0.004**	–
				(0.00185)	
Property taxes: immovable property (b_{11i})	–	–	–	–	−0.027**
					(0.013)
Property taxes: others (b_{12i})	–	–	–	–	0.001
					(0.00275)

Table 5 continued

	(1)	(2)	(3)	(4)	(5)
5-Year dummy variables	Yes	Yes	Yes	Yes	Yes
Constant	0.738***	0.706***	0.500***	0.479***	0.439***
	(0.016)	(0.017)	(0.016)	(0.015)	(0.013)
Observations	985	966	985	985	984
R-squared	0.842	0.865	0.841	0.850	0.865
Number of groups	23	23	23	23	23
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Income taxes	Income taxes	Income taxes

Estimates are obtained by means of the pooled mean group estimator proposed by Pesaran et al. (1999) within a panel error correction framework. All columns include measures of the accumulation of physical and human capital and population growth as basic growth determinants as well as the overall tax burden as a control variable. They also report the effects of various revenue-neutral tax shifts. All economic variables are in logs. All the variables in the short run are in first difference. The short-run coefficients related to economic variables (b_{1i}, b_{2i} and b_{3i}) are not reported. Standard errors are shown in parentheses: *significant at 10%; **significant at 5%; ***significant at 1%

Table 6 Taxation and GDP per capita: 23 OECD countries, 1971–2014, clustered standard errors

	(1)	(2)	(3)	(4)	(5)
Convergence parameter (ϕ)	−0.110***	−0.115***	−0.109***	−0.116***	−0.0999***
	(0.031)	(0.028)	(0.032)	(0.029)	(0.027)
Physical capital (a_{1i})	0.135	0.0885	0.134	0.169	0.0848
	(0.223)	(0.209)	(0.224)	(0.217)	(0.299)
Human capital (a_{2i})	−0.940	−0.474	−0.953	−0.723	−0.631
	(0.958)	(0.765)	(0.976)	(0.821)	(0.874)
Population growth (a_{3i})	−16.27**	−11.20***	−16.38**	−13.94***	−14.81***
	(6.532)	(3.457)	(6.561)	(5.242)	(5.428)
Overall tax burden (a_{4i})	−0.004	−0.012	−0.005	−0.005	−0.008
	(0.008)	(0.009)	(0.008)	(0.007)	(0.008)
Income taxes (a_{5i})	−0.023	–	–	–	–
	(0.0155)				
Personal income taxes (a_{6i})	–	−0.027	–	–	–
		(0.0172)			
Corporate income taxes (a_{7i})	–	0.005	–	–	–
		(0.0144)			
Consumption and property taxes (a_{8i})	–	–	0.021	–	–
			(0.0155)		
Consumption taxes (a_{9i})	–	–	–	0.013	0.014
				(0.011)	(0.013)
Property taxes (a_{10i})	–	–	–	0.037	–
				(0.036)	

Table 6 continued

	(1)	(2)	(3)	(4)	(5)
Property taxes: immovable property (a_{11i})	–	–	–	–	−0.014
					(0.029)
Property taxes: others (a_{12i})	–	–	–	–	0.058
					(0.062)
5-Year dummy variables	Yes	Yes	Yes	Yes	Yes
Constant	0.738***	0.706***	0.500***	0.479***	0.439***
	(0.016)	(0.017)	(0.016)	(0.015)	(0.013)
Observations	985	966	985	985	984
R-squared	0.842	0.865	0.841	0.850	0.865
Number of groups	23	23	23	23	23
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Income taxes	Income taxes	Income taxes

Estimates are obtained by means of the pooled mean group estimator proposed by Pesaran et al. (1999) within a panel error correction framework. All columns include measures of the accumulation of physical and human capital and population growth as basic growth determinants as well as the overall tax burden as a control variable. They also report the effects of various revenue-neutral tax shifts. All economic variables are in logs. Clustered standard errors are shown in parentheses: *significant at 10%; **significant at 5%; ***significant at 1%

Table 7 Taxation and GDP per capita: all 34 OECD countries, 1995–2014

	(1)	(2)	(3)	(4)	(5)
Long-run parameters					
Convergence parameter (ϕ)	−0.181***	−0.159***	−0.144***	−0.117**	−0.104**
	(0.045)	(0.047)	(0.040)	(0.048)	(0.049)
Physical capital (a_{1i})	0.645***	0.711***	0.735***	0.752***	0.593**
	(0.163)	(0.202)	(0.202)	(0.278)	(0.288)
Human capital (a_{2i})	0.643***	0.988***	0.589*	0.923**	1.020**
	(0.224)	(0.269)	(0.343)	(0.396)	(0.480)
Population growth (a_{3i})	−6.521*	−8.254*	−8.334*	−10.283	−9.820
	(3.668)	(4.294)	(4.603)	(6.597)	(7.474)
Overall tax burden (a_{4i})	−0.000	−0.003	0.002	−0.004	−0.005
	(0.007)	(0.008)	(0.009)	(0.012)	(0.014)
Income taxes (a_{5i})	0.002	–	–	–	–
	(0.005)				
Personal income taxes (a_{6i})	–	−0.014	–	–	–
		(0.009)			
Corporate income taxes (a_{7i})	–	0.022**	–	–	–
		(0.010)			
Consumption and property taxes (a_{8i})	–	–	−0.000	–	–
			(0.006)		
Consumption taxes (a_{9i})	–	–	–	−0.010	−0.003
				(0.009)	(0.011)
Property taxes (a_{10i})	–	–	–	0.019	–
				(0.017)	

Table 7 continued

	(1)	(2)	(3)	(4)	(5)
Property taxes: immovable property (a_{11i})	–	–	–	–	−0.049
					(0.046)
Property taxes: others (a_{12i})	–	–	–	–	0.018
					(0.019)
Short-run parameters					
Overall tax burden (b_{4i})	−0.003	−0.005***	−0.003	−0.002	−0.004**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Income taxes (b_{5i})	0.003	–	–	–	–
	(0.002)				
Personal income taxes (b_{6i})	–	−0.000	–	–	–
		(0.002)			
Corporate income taxes (b_{7i})	–	0.003	–	–	–
		(0.002)			
Consumption and property taxes (b_{8i})	–	–	−0.003*	–	–
			(0.002)		
Consumption taxes (b_{9i})	–	–	–	−0.002*	−0.002
				(0.001)	(0.001)
Property taxes (b_{10i})	–	–	–	−0.016**	–
				(0.008)	
Property taxes: immovable property (b_{11i})	–	–	–	–	−0.100***
					(0.037)
Property taxes: others (b_{12i})	–	–	–	–	0.007
					(0.008)

Table 7 continued

	(1)	(2)	(3)	(4)	(5)
5-Year dummy variables	Yes	Yes	Yes	Yes	Yes
Constant	0.085***	0.050***	0.051***	− 0.004	0.019
	(0.016)	(0.016)	(0.017)	(0.013)	(0.012)
Observations	671	631	671	671	670
R-squared	0.883	0.915	0.880	0.903	0.924
Number of groups	34	32	34	34	34
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Income taxes	Income taxes	Income taxes

Estimates are obtained by means of the pooled mean group estimator proposed by Pesaran et al. (1999) within a panel error correction framework. All columns include measures of the accumulation of physical and human capital and population growth as basic growth determinants as well as the overall tax burden as a control variable. They also report the effects of various revenue-neutral tax shifts. All economic variables are in logs. All the variables in the short run are in first difference. The short-run coefficients related to economic variables (b_{1i}, b_{2i} and b_{3i}) are not reported. Standard errors are shown in parentheses: *significant at 10%; **significant at 5%; ***significant at 1%

Table 8 Taxation and GDP per capita: 34 OECD countries, 1995–2014, clustered standard errors

	(1)	(2)	(3)	(4)	(5)
Convergence parameter (ϕ)	−0.181**	−0.159**	−0.144**	−0.117	−0.104
	(0.092)	(0.074)	(0.074)	(0.085)	(0.094)
Physical capital (a_{1i})	0.645*	0.711*	0.735*	0.752	0.593
	(0.380)	(0.384)	(0.414)	(0.613)	(0.712)
Human capital (a_{2i})	0.643*	0.988**	0.589	0.923	1.020
	(0.368)	(0.419)	(0.602)	(0.775)	(1.100)
Population growth (a_{3i})	−6.521	−8.254	−8.334	−10.283	−9.820
	(5.333)	(6.135)	(5.898)	(9.642)	(13.726)
Overall tax burden (a_{4i})	−0.000	−0.003	0.002	−0.004	−0.005
	(0.011)	(0.017)	(0.014)	(0.019)	(0.026)
Income taxes (a_{5i})	0.002	–	–	–	–
	(0.010)				
Personal income taxes (a_{6i})	–	−0.014	–	–	–
		(0.015)			
Corporate income taxes (a_{7i})	–	0.022	–	–	–
		(0.022)			
Consumption and property taxes (a_{8i})	–	–	−0.000	–	–
			(0.011)		
Consumption taxes (a_{9i})	–	–	–	−0.010	−0.003
				(0.019)	(0.024)
Property taxes (a_{10i})	–	–	–	0.019	–
				(0.031)	

Table 8 continued

	(1)	(2)	(3)	(4)	(5)
Property taxes: immovable property (a_{11i})	–	–	–	–	−0.049
					(0.074)
Property taxes: others (a_{12i})	–	–	–	–	0.018
					(0.044)
5-Year dummy variables	Yes	Yes	Yes	Yes	Yes
Constant	0.085***	0.050***	0.083***	−0.004	0.019
	(0.016)	(0.016)	(0.016)	(0.013)	(0.012)
Observations	671	631	671	671	670
R-squared	0.880	0.920	0.880	0.900	0.920
Number of groups	34	32	34	34	34
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Income taxes	Income taxes	Income taxes

Estimates are obtained by means of the pooled mean group estimator proposed by Pesaran et al. (1999) within a panel error correction framework. All columns include measures of the accumulation of physical and human capital and population growth as basic growth determinants as well as the overall tax burden as a control variable. They also report the effects of various revenue-neutral tax shifts. All economic variables are in logs. Clustered standard errors are shown in parentheses: *significant at 10%; **significant at 5%; ***significant at 1%

Table 9 Taxation and GDP per capita: 21 OECD countries, 1971–2004 (Arnold et al. 2011 sample)

	(1)	(2)	(3)	(4)	(5)
Long-run parameters					
Convergence parameter (ϕ)	−0.173***	−0.216***	−0.170***	−0.179***	−0.148***
	(0.037)	(0.039)	(0.037)	(0.038)	(0.038)
Physical capital (a_{1i})	0.220***	0.174***	0.217***	0.244***	0.282***
	(0.074)	(0.064)	(0.075)	(0.072)	(0.091)
Human capital (a_{2i})	1.483***	1.499***	1.024***	0.991***	0.911***
	(0.204)	(0.164)	(0.177)	(0.170)	(0.218)
Population growth (a_{3i})	−13.253***	−8.335***	−13.450***	−12.184***	−14.070***
	(3.789)	(2.496)	(3.889)	(3.583)	(4.776)
Overall tax burden (a_{4i})	−0.018***	−0.016***	−0.018***	−0.015***	−0.016**
	(0.005)	(0.004)	(0.005)	(0.005)	(0.006)
Income taxes (a_{5i})	−0.011**	–	–	–	–
	(0.004)				
Personal income taxes (a_{6i})	–	−0.011***	–	–	–
		(0.003)			
Corporate income taxes (a_{7i})	–	0.005	–	–	–
		(0.004)			
Consumption and property taxes (a_{8i})	–	–	0.010**	–	–
			(0.004)		
Consumption taxes (a_{9i})	–	–	–	0.006	0.007
				(0.004)	(0.007)
Property taxes (a_{10i})	–	–	–	0.020***	–
				(0.01)	

Table 9 continued

	(1)	(2)	(3)	(4)	(5)
Property taxes: immovable property (a_{11i})	–	–	–	–	0.034*
					(0.019)
Property taxes: others (a_{12i})	–	–	–	–	0.020**
					(0.009)
Short-run parameters					
Overall tax burden (b_{4i})	−0.002*	−0.001	−0.001*	−0.002	−0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Income taxes (b_{5i})	0.001	–	–	–	–
	(0.000)				
Personal income taxes (b_{6i})	–	0.000	–	–	–
		(0.000)			
Corporate income taxes (b_{7i})	–	0.001	–	–	–
		(0.000)			
Consumption and property taxes (b_{8i})	–	–	−0.000	–	–
			(0.000)		
Consumption taxes (b_{9i})	–	–	–	0.000	0.000
				(0.000)	(0.001)
Property taxes (b_{10i})	–	–	–	−0.002	–
				(0.002)	
Property taxes: immovable property (b_{11i})	–	–	–	–	−0.025*
					(0.014)
Property taxes: others (b_{12i})	–	–	–	–	0.003
					(0.002)

Table 9 continued

	(1)	(2)	(3)	(4)	(5)
5-Year dummy variables	Yes	Yes	Yes	Yes	Yes
Constant	0.110***	0.131***	0.109***	0.109***	0.094***
	(0.005)	(0.008)	(0.004)	(0.004)	(0.004)
Observations	693	675	693	693	693
R-squared	0.81	0.82	0.81	0.82	0.84
Number of groups	21	21	21	21	21
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Income taxes	Income taxes	Income taxes

Estimates are obtained by means of the pooled mean group estimator proposed by Pesaran et al. (1999) within a panel error correction framework. All columns include measures of the accumulation of physical and human capital and population growth as basic growth determinants as well as the overall tax burden as a control variable. They also report the effects of various revenue-neutral tax shifts. All economic variables are in logs. All the variables in the short run are in first difference. The short-run coefficients related to economic variables (b_{1i}, b_{2i} and b_{3i}) are not reported. Standard errors are shown in parentheses: *significant at 10%; **significant at 5%; ***significant at 1%

Table 10 Taxation and GDP per capita: 21 OECD countries, 1971–2004, clustered standard errors (Arnold et al. 2011 sample)

	(1)	(2)	(3)	(4)	(5)
Convergence parameter (ϕ)	−0.173**	−0.216**	−0.170**	−0.179**	−0.148*
	(0.078)	(0.099)	(0.079)	(0.082)	(0.078)
Physical capital (a_{1i})	0.220	0.174	0.217	0.244	0.282
	(0.169)	(0.143)	(0.172)	(0.167)	(0.217)
Human capital (a_{2i})	1.483***	1.499***	1.024***	0.991***	0.911***
	(0.391)	(0.352)	(0.282)	(0.276)	(0.348)
Population growth (a_{3i})	−13.253*	−8.335*	−13.450*	−12.184*	−14.070*
	(6.781)	(4.953)	(7.010)	(6.704)	(8.531)
Overall tax burden (a_{4i})	−0.018**	−0.016**	−0.018**	−0.015**	−0.016
	(0.008)	(0.007)	(0.009)	(0.008)	(0.010)
Income taxes (a_{5i})	−0.011	–	–	–	–
	(0.009)				
Personal income taxes (a_{6i})	–	−0.011	–	–	–
		(0.009)			
Corporate income taxes (a_{7i})	–	0.005	–	–	–
		(0.006)			
Consumption and property taxes (a_{8i})	–	–	0.010	–	–
			(0.009)		
Consumption taxes (a_{9i})	–	–	–	0.006	0.007
				(0.009)	(0.009)
Property taxes (a_{10i})	–	–	–	0.020	–
				(0.021)	

Table 10 continued

	(1)	(2)	(3)	(4)	(5)
Property taxes: immovable property (a_{11i})	–	–	–	–	0.034
					(0.030)
Property taxes: others (a_{12i})	–	–	–	–	0.020
					(0.027)
Observations	693	675	693	693	693
R-squared	0.806	0.821	0.806	0.820	0.839
Number of groups	21	21	21	21	21
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Income taxes	Income taxes	Income taxes

Estimates are obtained by means of the pooled mean group estimator proposed by Pesaran et al. (1999) within a panel error correction framework. All columns include measures of the accumulation of physical and human capital and population growth as basic growth determinants as well as the overall tax burden as a control variable. They also report the effects of various revenue-neutral tax shifts. All economic variables are in logs. Clustered standard errors are shown in parentheses: *significant at 10%; **significant at 5%; ***significant at 1%

with per capita GDP. In Table 10, the only result robust to clustering is the negative relationship between overall tax revenue and per capita GDP in the long run.[18]

3.4 Eurozone countries, from 1995 to 2014

Finally, since the tax shift has been mainly implemented in European countries, Tables 11 and 12 are focused on the OECD countries that are current members of the Eurozone, again for the period 1995–2014. In Table 11, we find a negative and significant correlation between the overall tax burden and per capita GDP only in one specification out of five in the long run and in two specifications out of five in the short run. Regarding the tax mix, the shift from consumption and property taxation to income is not statistically significant in the long run: in fact, it is a combination between a negative and significant correlation of per capita GDP with personal income taxation and a positive and significant correlation with corporate taxation. In the short run, the only significant correlation we detect is the negative one between a shift from income to property taxes and GDP, that is driven by immovable property taxes, similar to what is found in Tables 5 and 7.[19] In Table 12, when we cluster the standard errors at the country level, the only significant result is that a revenue-neutral shift away from personal income taxes is related to higher economic growth.[20]

3.5 Addressing the role of business cycle effects

Finally, we try to address potential endogeneity concerns regarding tax variables by purging them from business cycle effects (Arnold 2008, paragraphs 40 and 41). More precisely, we regress the tax variables against the first two lags of the output gap, including those lags both in their linear and in their quadratic forms. The obtained residuals are then used in the second-stage regressions instead of the tax variables themselves. To note, when doing so our sample sizes get reduced with respect to those of our main regressions (Tables 5–12), since the output gap data is only available starting from 1987. Thus, we rerun our main regressions on these restricted samples, in order to have the appropriate benchmark for comparisons with these second-stage regressions. Overall, we find that long-run results of our main regressions are comparable to those obtained in these second-stage regressions only when clustering the standard errors. On the other hand, short-run results are broadly comparable. Thus,

[18] One must notice that—when clustering the standard errors—the coefficient on the accumulation of physical capital in the long run is no longer statistically significant.

[19] The human capital variable enters with a positive sign in the regressions but is not statistically significant at ordinary confidence levels. This result is similar to Mankiw et al. (1992) and Islam (1995).

[20] One must notice that—when clustering the standard errors—the coefficient on the accumulation of physical capital is statistically significant only in two specifications out of five, while the coefficient on the population growth rate is no longer statistically significant.

Table 11 Taxation and GDP per capita: Eurozone countries, 1995–2014

	(1)	(2)	(3)	(4)	(5)
Long-run parameters					
Convergence parameter (ϕ)	−0.182***	−0.185***	−0.180***	−0.164***	−0.091*
	(0.044)	(0.045)	(0.045)	(0.048)	(0.051)
Physical capital (a_{1i})	0.827***	0.479**	0.827***	0.807***	1.137*
	(0.220)	(0.204)	(0.227)	(0.256)	(0.645)
Human capital (a_{2i})	1.214	0.475	1.225	1.161	0.542
	(0.913)	(0.853)	(0.926)	(1.048)	(2.022)
Population growth (a_{3i})	−11.419**	−9.264*	−11.713**	−13.111*	−20.723
	(5.602)	(4.997)	(5.725)	(6.925)	(16.179)
Overall tax burden (a_{4i})	−0.013	−0.023*	−0.014	−0.017	−0.004
	(0.014)	(0.013)	(0.014)	(0.016)	(0.032)
Income taxes (a_{5i})	−0.012	–	–	–	–
	(0.009)				
Personal income taxes (a_{6i})	–	−0.033***	–	–	–
		(0.012)			
Corporate income taxes (a_{7i})	–	0.029**	–	–	–
		(0.012)			
Consumption and property taxes (a_{8i})	–	–	0.010	–	–
			(0.010)		
Consumption taxes (a_{9i})	–	–	–	0.001	0.022
				(0.014)	(0.033)
Property taxes (a_{10i})	–	–	–	0.022	–
				(0.016)	

Table 11 continued

	(1)	(2)	(3)	(4)	(5)
Property taxes: immovable property (a_{11i})	–	–	–	–	0.053
					(0.111)
Property taxes: others (a_{12i})	–	–	–	–	0.025
					(0.029)
Short-run parameters					
Overall tax burden (b_{4i})	−0.004*	−0.003	−0.003	−0.004	−0.006**
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Income taxes (b_{5i})	0.002	–	–	–	–
	(0.002)				
Personal income taxes (b_{6i})	–	0.002	–	–	–
		(0.002)			
Corporate income taxes (b_{7i})	–	−0.000	–	–	–
		(0.003)			
Consumption and property taxes (b_{8i})	–	–	−0.002	–	–
			(0.002)		
Consumption taxes (b_{9i})	–	–	–	−0.002	−0.000
				(0.003)	(0.002)
Property taxes (b_{10i})	–	–	–	−0.025*	–
				(0.013)	
Property taxes: immovable property (b_{11i})	–	–	–	–	−0.178**
					(0.068)
Property taxes: others (b_{12i})	–	–	–	–	0.006
					(0.009)

Table 11 continued

	(1)	(2)	(3)	(4)	(5)
5-Year dummy variables	Yes	Yes	Yes	Yes	Yes
Constant	−0.016	0.726***	−0.215***	−0.100***	−0.119***
	(0.025)	(0.024)	(0.025)	(0.021)	(0.013)
Observations	296	295	296	296	295
R-squared	0.893	0.930	0.892	0.910	0.929
Number of groups	15	15	15	15	15
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Income taxes	Income taxes	Income taxes

Estimates are obtained by means of the pooled mean group estimator proposed by Pesaran et al. (1999) within a panel error correction framework. All columns include measures of the accumulation of physical and human capital and population growth as basic growth determinants as well as the overall tax burden as a control variable. They also report the effects of various revenue-neutral tax shifts. All economic variables are in logs. All the variables in the short run are in first difference. The short-run coefficients related to economic variables (b_{1i}, b_{2i} and b_{3i}) are not reported. Standard errors are shown in parentheses: *significant at 10%; **significant at 5%; ***significant at 1%

Table 12 Taxation and GDP per capita: Eurozone countries, 1995–2014, clustered standard errors

	(1)	(2)	(3)	(4)	(5)
Convergence parameter (ϕ)	−0.182***	−0.185***	−0.180***	−0.164**	−0.091
	(0.064)	(0.063)	(0.065)	(0.074)	(0.089)
Physical capital (a_{1i})	0.827*	0.479	0.827*	0.807	1.137
	(0.453)	(0.493)	(0.480)	(0.551)	(1.314)
Human capital (a_{2i})	1.214	0.475	1.225	1.161	0.542
	(0.783)	(0.792)	(0.767)	(0.983)	(2.229)
Population growth (a_{3i})	−11.419	−9.264	−11.713	−13.111	−20.723
	(7.953)	(7.479)	(8.140)	(9.907)	(23.647)
Overall tax burden (a_{4i})	−0.013	−0.023	−0.014	−0.017	−0.004
	(0.015)	(0.020)	(0.014)	(0.019)	(0.059)
Income taxes (a_{5i})	−0.012	–	–	–	–
	(0.015)				
Personal income taxes (a_{6i}	–	−0.033*	–	–	–
		(0.019)			
Corporate income taxes (a_{7i})	–	0.029	–	–	–
		(0.030)			
Consumption and property taxes (a_{8i})	–	–	0.010	–	–
			(0.015)		
Consumption taxes (a_{9i})	–	–	–	0.001	0.022
				(0.026)	(0.073)
Property taxes (a_{10i})	–	–	–	0.022	–
				(0.029)	

Table 12 continued

	(1)	(2)	(3)	(4)	(5)
Property taxes: immovable property (a_{11i})	–	–	–	–	0.053
					(0.137)
Property taxes: others (a_{12i})	–	–	–	–	0.025
					(0.049)
Observations	296	295	296	296	295
R-squared	0.890	0.930	0.890	0.910	0.930
Number of groups	15	15	15	15	15
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Income taxes	Income taxes	Income taxes

Estimates are obtained by means of the pooled mean group estimator proposed by Pesaran et al. (1999) within a panel error correction framework. All columns include measures of the accumulation of physical and human capital and population growth as basic growth determinants as well as the overall tax burden as a control variable. They also report the effects of various revenue-neutral tax shifts. All economic variables are in logs. Clustered standard errors are shown in parentheses: *significant at 10%; **significant at 5%; ***significant at 1%

this exercise casts some further doubts on the relevance of the tax shift from direct to indirect taxes as a policy to enhance economic growth in the long run.[21]

4 Conclusions

This paper develops a data-driven analysis of the relationship between tax burden, revenue-neutral tax shifts and economic growth. In the long run, the overall tax pressure is negatively and statistically significantly related to per capita GDP, and the revenue-neutral tax shift from direct to indirect taxes is positively and statistically significantly related to economic growth only when we consider the sample of 21 OECD countries for the period 1971–2004 as in Arnold et al. (2011). However, when we adopt more cautious estimates of the standard errors, i.e., when we cluster them at the country level, only the result on the negative relationship between the overall tax burden and per capita GDP still holds. When we extend the time period under investigation, consider the full sample of OECD countries or focus only on current members of the Eurozone neither the long-run relationship between tax burden and economic growth nor the relationships between revenue-neutral tax shifts and economic growth are statistically significant. Overall, our analysis provides a comprehensive assessment of these relationships which is robust to the choice of the investigated sample of countries and years. Our study also suggests that the inconsistent findings that appear in previous empirical contributions in the macroliterature may be due to the different—mainly arbitrary—choices about the sets of countries and years that different authors decide to include in their analyses. International organizations such as the IMF and the OECD, if they want to make sound policy recommendations—e.g., to move from direct to indirect taxation—need more robust analyses than the ones provided by Arnold et al. (2011).

More fundamentally, one could also argue that cross-country regressions based on macrodata, as in Arnold et al. (2011), even when using fixed effects may not be sufficiently informative to infer policy implications. In fact, the identification strategy behind this approach could be plagued by first-order consistency issues such as omitted variable bias and reverse causality; moreover, the specification itself is based on strong theoretical assumptions (e.g., a Cobb-Douglas production function); thus, there are cautious limits to what we can learn from the results of these types of analyses, over and above the lack of robust results we have shown here. Alternative empirical approaches are instead based on quasi-experimental within-country microeconometric data (Saez et al. 2012) and might represent a more robust guidance to tax policy. As already mentioned, these studies find a small labor supply elasticity to income tax, thus suggesting that shifting taxes from income to other tax bases might not have significant growth enhancing effects, in a direction that is consistent with our robust and cautious macroeconometric approach.

Still, to the extent that one trusts this type of macroeconometric exercise, we find some interesting differences in the relationships between tax variables and growth between the short run and the long run. In the short run, the negative and statistically

[21] Results are available upon request.

significant relationship between tax burden and economic growth seems to be more robust. At the same time, regardless of the sample of countries and the time period under investigation, we find a negative and significant correlation between a shift from income taxes to recurrent taxes on immovable property and economic growth, which runs contrary to the standard 'OECD view' and the recommendations by both IMF and the European Commission. Short-run correlations might be very important when assessing the political feasibility of economic reforms, because voters are more likely to care about short—rather than long—run 'effects' (Castanheira et al. 2012). This is particularly true in times of economic instability, as reflected by the growing consensus obtained by populist parties which base their platforms on short-term protectionist policies and on 'pandering' to what people want (Canes-Wrone et al. 2001). From a theoretical viewpoint, the differences we find in the short-run and long-run correlations between economic growth and taxation might be connected with the differential salience of taxes along different time horizons (Chetty et al. 2009). This is a promising avenue for future research.

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References

Acosta-Ormaechea, S., & Yoo, J. (2012). *Tax composition and growth: A broad cross-country perspective*. IMF Working Paper, WP/12/257.

Arachi, G., Bucci, V., & Casarico, A. (2015). Tax structure and macroeconomic performance. *International Tax and Public Finance*, *22*(4), 635–667.

Arnold, J. M. (2008). *Do tax structures affect aggregate economic growth? Empirical evidence from a panel of OECD countries*. OECD Economics Department Working Paper 643.

Arnold, J. M., Brys, B., Heady, C., Johansson, A., Schwellnus, C., & Vartia, L. (2011). Tax policy for economic recovery and growth. *The Economic Journal*, *121*(February), F59–F80.

Barro, R. J., & Lee, J. W. (2013). A new data set of educational attainment in the world, 1950–2010. *Journal of Development Economics*, *104*, 184–198.

Bernardi, L. (2013). Recent findings regarding the shift from direct to indirect taxation in the EA-17. *Rivista di diritto finanziario e scienza delle finanze*, *4*, 233–256.

Bertrand, M., Duflo, E., & Mullainathan, S. (2004). How much should we trust differences-in-differences estimates? *Quarterly Journal of Economics*, *119*(1), 249–275.

Blackburne, E. F, I. I. I., & Frank, M. W. (2007). Estimation of nonstationary heterogeneous panels. *The Stata Journal*, *7*(2), 197–208.

Cameron, A. C., Gelbach, J. B., & Miller, D. L. (2008). Bootstrap-based improvements for inference with clustered errors. *Review of Economics and Statistics*, *90*(3), 414–427.

Canes-Wrone, B., Herron, M. C., & Shotts, K. W. (2001). Leadership and pandering: A theory of executive policymaking. *American Journal of Political Science*, *45*, 532–550.

Castanheira, M., Nicodéme, G., & Profeta, P. (2012). On the political economics of tax reforms: Survey and empirical assessment. *International Tax and Public Finance*, *19*, 598–624.

Cellini, R. (1997). Implication of Solow's growth model in the presence of a stochastic steady-state. *Journal of Macroeconomics*, *19*, 135–153.

Chetty, R., Looney, A., & Kroft, K. (2009). Salience and taxation: Theory and evidence. *American Economic Review*, *99*(4), 1145–1177.

Di Sanzo, S., Bella, M., & Graziano, G. (2017). Tax structure and economic growth: A panel cointegrated VAR analysis. *Italian Economic Journal*, *3*, 239–253.

Ditzen, J. (2016). *xtdcce: Estimating dynamic common correlated effects in stata*. SEEC Discussion Paper Series No 8, July 2016. http://seec.hw.ac.uk/

Einaudi, L. (1924). La terra e l'imposta. *Annali di Economia*, *1*(1), 37–215.

European Commission. (2013). *Annual growth survey 2014*. COM(2013) 800 final.

European Commission Services (DG TAXUD). (2006). Macroeconomic effects of a shift from direct to indirect taxation: A simulation for 15 EU member states. Note presented at the *72nd Meeting of the OECD working party no. 2 on tax policy analysis and tax statistics*, Paris, November 14–16, 2006.

Gemmell, N., Kneller, R., & Sanz, I. (2014). The growth effects of tax rates in the OECD. *Canadian Journal of Economics*, *47*(4), 1217–1255.

Islam, N. (1995). Growth empirics: A panel data approach. *Quarterly Journal of Economics*, *110*(4), 1127–1170.

Jaimovich, N., & Rebelo, S. (2017). Nonlinear effects of taxation on growth. *Journal of Political Economy*, *125*(1), 265–291.

Jäntti, M., Pirttilä, J., & Selin, H. (2015). Estimating labor supply elasticities using cross-country micro data: A bridge between micro and macro estimates? *Journal of Public Economics*, *127*, 87–99.

Kneller, R., Bleaney, M. F., & Gemmell, N. (1999). Fiscal policy and growth: Evidence from OECD countries. *Journal of Public Economics*, *74*(2), 171–190.

Mankiw, N. G., Romer, D., & Weill, D. N. (1992). A contribution to the empirics of economic growth. *Quarterly Journal of Economics*, *107*(2), 407–437.

Mathé, M., Nicodéme, G., & Ruá, S. (2015). *Tax shifts*. Working Paper No 59. Taxation Papers, European Commission.

Pesaran, M., Shin, Y., & Smith, R. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association*, *94*(446), 621–634.

Saez, E., Slemrod, J., & Giertz, S. (2012). The elasticity of taxable income with respect to marginal tax rates: A critical review. *Journal of Economic Literature*, *50*, 3–50.

Shinohara, M. (2014). *Tax structure and economic growth: A survey of empirical analysis*. Institute of Economic Research, Chuo University, Discussion Paper, 217.

Winer, S. L., Profeta, P., & Hettich, W. (2015). *The political economy of taxation*. New York: Oxford Bibliographies.

Xing, J. (2012). Tax structure and growth: How robust is the empirical evidence? *Economics Letters*, *117*(1), 379–382.