Tax structure and economic growth : how can we reconcile the literature and what are the takeaway results ?

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Abstract

The effect of tax structure and tax shifts on economic growth has been studied for the past ten years in the economic literature. This literature, although working most of the time on the same database, has levered contradictory results : some studies showing a strong bond between tax structure and economic growth and others concluding on the absence of clear links between these two. This paper tries to reconcile this literature and to understand the origin of the differences in results. We reassess the link between tax structure and economic growth on new extended datasets. We point out and particularly test for the use of literature specific control variable and we show that differences in controls variables could have impacted previous results. Finally, we assess results that are robust to different control specifications and reassess the link between tax structure and growth in the light of these new concerns.

Introduction

Economic downturn and uncertainty are hitting Europe and many others developed countries. Covid-crisis, high inflation and recently the energy crisis are putting developed countries' economies under hard pressure. Achieving to finance public debts in time of economic downturn and preventing future government-debt crisis, as Greece suffered from 2009 to 2017, without hampering economic recovery is a challenge most governments have to face. Therefore, levying tax in the best possible ways seems an even stronger necessity than before. Especially in tormented times, it is a strong necessity for governments to promote tax reforms and state efficiency that support and enhance economic development and offer future perspectives.

Tax reforms are one of the main instrument in the hand of the government that have an impact on systemic development and that can foster long-term economic growth. Different tax reforms have been studied in the literature, some affecting the total tax wedges levied by the States other dedicated to a tax shift between different forms of taxation.

Literature on tax wedges reforms has levered no wide consensus in the literature, and no clear link could be established between economic growth and the total level of taxation (or similarly, between economic growth and the total level of public expenditure) (Arnold 2008 ; Jaimovich & Rebelo 2017)[1]. This seems coherent as

[1] A review of the evidence on the correlation between taxation and growth can be found in Jaimovich & Rebelo (2017) p268-271.

that the total size of public expenditure bears two opposite effect : one the one hand it allows public investment, requested to foster economic growth and particularly needed in time of economic crisis, on the other hand, it generates heavy distortions (Arnold 2008).

Tax shift literature however has levered groundbreaking results, stating that tax shifts, if implemented well, had a strong impact on long-term economic growth (Arnold, Brys, et al. 2011 ; Xing 2012 ; Arachi et al. 2015). These results were at the basis of political recommendations from different international organisations, such as IMF, OECD and European Commission, many of which have been implemented in developed countries (Mathé et al. 2015 ; Baiardi et al. 2018)[2,3].

Furthermore, revenue-neutral tax shift reforms[4] are easier to implement than reforms modifying the overall level of taxation and this might also partly explain their political success. Tax shift reforms promote or deter certain behaviours, hence realising political promises, without increasing deficits or having to cut aids. Considering the point of view of political parties, it is less risky electoral to find a consensus, and hence a majority, on how to levy taxation than on increasing global tax wedges or diminishing public expenditures.

Finally, following Arnold 2008 and Arnold, Brys, et al. 2011, we argue that the size of the public sector (and thus, the overall level of taxation) depends on the country's preference and remain a political choice more than an economical one.

Some countries have built a preference towards public education, public transports and public healthcare, while others prefer to see these sectors being privately regulated. On the contrary, the way to levy tax and tax structure, may be seen as purely technical : no matter the political choices undertaken, some tax structure could ensure better policy efficiency than others. Accordingly, tax structure could be considered as a variable needed to be adjusted to reduce market distortions and promote economic development.

However, this work only if efficient redistribution can be achieved. Tax shift reforms change money redistribution between populations categories and redistribution concerns cannot be avoided as taxation itself is a primary tool to allocate money.

Empirical literature results

In 2011, Arnold, Brys, et al., were able to establish a clear link between tax structure and long-term economic growth. Using a panel of 21 OECD countries over the 1971-2004 period, they found that some tax structures were correlated with structural higher economic growth and that a shift from direct to indirect taxation was

[2] A comprehensive summary of these recommandations and their implementations can be found in Mathé et al. (2015) p10-14.
[3] Reffering to the belgian example, one of the European Council recommandation's was to « *adopt and implement a comprehensive tax reform broadening the tax base, shifting the tax burden away from labour and removing inefficient tax expenditures* » (European Commission 2015). This policy has been later implemented between 2016 and 2020 by the belgian government lead by Prime Minister C. Michel, now sitting as President of the European Council (a comprehensive summary of the tax shift implemented in Belgium can be found in Simar 2016).
[4] I.e. reforms that keep the total tax revenue constant but change they way to levy taxes.

positively and significantly correlated with GDP per capita. More in detail, they were able to establish a growth-friendly ranking between different types of taxes. This ranking states that the most harmful, or the less beneficial, types of taxes are corporate taxes, directly followed by personal income taxes, followed by consumption taxes and finally completed by property taxes ; property taxes being thus the less harmful, or the most growth-enhancing, type of taxes relatively to growth[5,6].

Xing (2012) challenged these results using a smaller set of 17 OECD countries over the period 1970-2004. Contrary to Arnold, Brys, et al. (2011), she did not find any robust ranking between the different types of taxes relatively to their growth effects except for property taxes. Specifically, she could not rank between each other consumption taxes, personal income taxes and corporate income taxes. However, she found robust evidence that tax shifts towards property taxes are associated with a higher level of income per capita in the long run.

In 2015, Arachi et al. estimated the effect of tax structure on long-run income on a smaller set of 15 countries but on a longer time period ranging from 1965 till 2011, challenging previous results. Arachi et al. used two kinds of tax structure indicator : « tax ratios » as defined and used by Arnold, Brys, et al. (2011) and Xing (2012), and « implicit tax rates », more based on an accounting perspective. They define three tax categories instead of the four previously used : taxation on capital, taxation on consumption and taxation on labour. Using the « tax ratios » (i.e. the same tax indicators as previous studies used), they find evidence that a tax shift towards consumption is correlated with a higher level of income per capita in the long run. Labour taxation seems to be the most harmful to growth, whereas the impact of capital taxation appears less clear. Using implicit tax rates, Arachi et al. find that a shift from labour and capital taxation towards consumption seems to have a positive effect in the long run. However, these results do not seem robust when accounting for unobservable shocks and releasing the homogeneity assumption in the slope of the long-run coefficient.

In 2018, Baiardi et al. reassessed the relationship between long-run income and tax structure using various dataset of OECD countries (ranging from 15 to 34 countries) over various periods (ranging from 19 years to 43 years). Baiardi et al. were able to show that a revenue-neutral tax shift from direct to indirect taxes is positively and significantly correlated to economic growth only when using Arnold, Brys, et al. (2011) sample of countries and time period. Overall, considering larger datasets, they were not able to establish a clear ranking between different forms of taxation when extending the time period or the set of countries.

Table A summarises the countries' dataset and time range taken into consideration in previous literature studies. It also presents the dataset and time range we will use in this paper for the computation of new estimates.

[5] This paper has been prepared by a a series of working papers (Arnold 2008 ; Arnold, Bassanini, Scarpetta 2011). These two papers developped, discussed and tested empirical model specifications and presented data later being used to compute the impact of a tax shift on long-term economic growth. They also computed early results and checked for robustness.
[6] Similar results were found in IMF working papers by Acosta-Ormaechea et al (2012) using a broader panel of 69 OCDE and non-OCDE countries (21 highincome, 23 middle-income and 25 low-income countries) over the period 1970-2009.

OECD Countries	Arnold, Brys, et al. (2011)	Xing (2012)	Arachi et al. (2015)	Baiardi et al. (2018)				Dataset used in this paper		
	1971-2004	1970-2004	1965-2011	1971-2014	1995-2014	1971-2004	1995-2014	1971-2004	1972-2019	1995-2019
1 Australia	x	x	x	x	x	x		x	x	x
2 Austria	x	x	x	x	x	x	x	x	x	x
3 Belgium	x	x	x	x	x	x	x	x	x	x
4 Canada	x	x	x	x	x	x		x	x	x
5 Chile					x					x
6 Czech Republic					x					x
7 Denmark	x	x		x	x	x		x	x	x
8 Estonia					x		x			x
9 Finland	x	x	x	x	x	x	x	x	x	x
10 France	x	x	x	x	x	x	x	x	x	x
11 Germany	x			x	x	x	x	x	x	x
12 Greece	x	x	x	x	x	x	x	x	x	x
13 Hungary					x					x
14 Iceland					x					x
15 Ireland	x	x		x	x	x	x	x	x	x
16 Israel					x					x
17 Italy	x		x	x	x	x	x	x	x	x
18 Japan	x	x	x	x	x	x		x	x	x
19 Korea				x	x				x	x
20 Latvia										x
21 Lithuania										x
22 Luxembourg				x	x		x		x	x
23 Mexico					x					x
24 Netherlands	x	x	x	x	x	x		x	x	x
25 New Zealand	x	x		x	x	x	x	x	x	x

26	Norway	x	x	x	x	x	x		x	x	x
27	Poland					x					x
28	Portugal	x			x	x	x	x	x		x
29	Slovak Republick					x		x			x
30	Slovenia					x		x			x
31	Spain	x		x	x	x	x	x	x	x	x
32	Sweden	x	x	x	x	x	x		x	x	x
33	Switzerland	x	x		x	x	x		x	x	x
34	Turkey					x				x	x
35	United Kingdom	x	x	x	x	x	x		x	x	x
36	United States	x	x	x	x	x	x		x	x	x
	Number of countries included	21	17	15	23	34	21	15	21	23	36
	Time period in years	33	34	46	43	19	33	19	33	47	24
	Additional notes						Similar dataset as Arnold, Brys, et al. (2011)	Eurozone countries only	Similar dataset as Arnold, Brys, et al. (2011)	Longest period of time	Largest set of countries

Table A : Summary of the countries and time range taken into consideration in previous literature studies from Arnold, Brys, et al. (2011), Xing (2012), Arachi et al. (2015), Baiardi et al. (2018). Columns 8 to 10 presents the dataset and time range used to compute new estimates in this paper : column 8 is a reproduction of the dataset used by Arnold, Brys, et al. in 2011 for comparison purpose ; column 9 account for the longest possible time period considering data availability ; column 10 accounts for the largest possible set of countries considering data availability.

We were facing a tradeoff when defining our datasets, having to choose between the number of countries and the length of our time period. Similarly to Baiardi et al. (2018), we decided not to choose and to run our analysis both on the longest time period and the largest set of countries.

This paper estimates the link between tax structures and growth in three datasets of countries : one similar to the dataset of Arnold, Brys, et al. 2011 for comparison purpose (21 countries, 1971-2004), one using the longest possible period considering data availability (23 countries, 1972-2019) and one using the largest possible set of countries considering data availability (36 countries, 1995-2019).

We point out and test different specifications regarding country specific control variable and discuss their relative impact on results. We observe robust results through all specifications and we reassess the link between tax structure and long-term economic growth on the same panel of countries and time period as previous literature as well as on a new extended panel of countries and broader time periods.

This paper is divided as follows : section 2 presents the empirical model specification, section 3 presents the dataset, section 4 discusses the impact of country-specific time controls, section 5 presents the results and section 6 concludes.

Empirical specification

We estimate the relation between tax structure and economic growth through a human capital augmented Solow model with a standard Cobb-Douglas production function following Arnold, Brys, et al. (2011). We consider a constant return to scale technology, where aggregate production at time *t* is modelled as a function of physical capital, human capital, labour, level of technology and the efficiency of the interactions between these variables as follows :

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} \big(A(t)L(t)\big)^{1-\alpha-\beta} \quad (1)$$

Y represents the total output of production, K is the amount of physical capital, H is the amount of human capital, L the quantity of labour worked, and A is the level of technological progress and economic efficiency (which incorporate the effect of public institutions and policies on economic development, including the effect of tax structure)[7] and is assumed to be labour augmenting. α, β represents respectively the partial elasticity of output with respect to the physical capital and human capital. Respectively, $1 - \alpha - \beta$ is the partial elasticity of output with respect to the product of labour and efficiency.

[7] Specifically, A(t) can be decomposed into two elements : one accounting for the improvement in technology (pure exogenous technological progress depending from time only) and one accounting for economic efficiency, which represents the efficiency of public policies and the interactions of public institutions (see Cellini 1997)

We can easily rewrite Equation (1) into an expression for the steady-state output in intensive form (see Arnold, Bassanini, Scarpetta 2011 ; Arnold, Brys, et al. 2011 and Xing 2012) where the real GDP per capita is represented as a function of the stock in physical and human capital, the growth rate of the population and the efficiency of public policies and public services. Using an error correction model (ECM) framework, this growth equation in intensive form is expressed as follows :

$$\Delta lnY_{i,t} = a_{0,i} + \phi_i lnY_{i,t-1} + a_{1,i} lnK_{i,t} + a_{2,i} lnH_{i,t} + a_{3,i} n_{i,t} + \sum a_{j,i} TAXES_{i,t} + F_i(t) + b_{1,i} \Delta lnK_{i,t} + b_{2,i} \Delta lnH_{i,t} + b_{3,i} \Delta n_{i,t} + \sum b_{j,i} \Delta TAXES_{i,t} + \epsilon_{i,t} \quad (2)$$

where for each country *i* and year *t*, *Y* is the real GDP per capita of the working age population, *K* is the investment rate, *H* is the stock of human capital and *n* is the growth rate of the working age population. The symbol TAXES in our regression equation stands for a vector containing all fiscal variables. This vector includes the overall tax burden expressed as a percentage of GDP and the share over total tax revenue of (1) income tax, (2) personal income taxes, (3) corporate income taxes, (4) consumption and property taxes, (5) consumption taxes, (6) property taxes, (7) recurrent taxes on immovable property and (8) other property taxes[8,9,10]. Note that indicators (1) to (8) are never meant to be included all together into the regression equation to avoid overspecification. a_0 is a country fixed effect and $F_i(t)$ represent country specific time control variables incorporated to account for crisis, booms and structural instiblitaty in the economic cycle.

Equation (2) is written in the form of an error correction model (ECM) allowing both short- and long-run dynamics to appear. ϵ is the error term and ϕ represents the speed of convergence at which the model will come back to its initial path. « a » coefficients capture the long-run dynamics of the model while « b » coefficients capture the short-run effects.

Equation (2) is the functional form used for the regression in this paper. Following the literature, it has been estimated with the help of the pooled mean group (PMG) estimator developed by Pesaran et al. (1999). This estimator allows the speed of convergence, the short-run coefficients ("b") and the error variances to differ between countries while imposing homogenous long-run coefficients ("a") across countries.

[8] Where indicators (1) equal the sum of indicators (2) and (3) ; indicators (4) equal the sum of indicators (5) and (6) ; indicators (6) equal the sum of indicators (7) and (8). More details about the taxes revenue taken into consideration in each of these indicators can be found in the Data section of this paper.

[9] Indicators (1) to (8) are the so called tax ratios discussed in the litterature (as defined in Arnold, Bassanini, Scarpetta 2011 ; Arnold, Brys, et al. 2011 and Arachi et al. 2015). These ratios represents the tax structure of a country. They are computed by taking the share of a particular tax category over total tax revenues (for example : tax ratio for property taxes = tax revenue from property taxes/total tax revenue).

[10] We acknowledge the critic made by Arachi et al. (2015) stating that a change in the value of these tax ratios might as well represent a change in tax pressure as a change in the importance of an economic sector over another. Tax ratios, however, still capture a fair representation of tax structre as they represent the share over tax revenue of each tax category and remain, in our advice, preferable to their account-based counterpart for not mixing accounting and real data value.

Data

We collect data on 36 OECD countries on a time period ranging from as late as 1965 till 2019. All our data are coming from OECD databases but the human capital data which are coming from the Barro and Lee (2013) dataset.[11]

Economic data

Our economic data include production, physical and human capital and the growth of the population. Production is proxied by the **Gross domestic product**, defined as the real GDP per head of working-age population, physical capital is proxied by **Investment rate**, defined as the percentage of GDP used for gross fixed capital formation, human capital is proxied by the **level of education,** defined as the average number of years of schooling of the adult population. The **population growth** is equal to the growth rate of the working-age population.

Fiscal data

Using the OECD tax classification, we collect fiscal data on the overall level of taxation, on income taxes (divided between private and corporate income taxes), on consumption taxes and on property taxes (divided between recurrent taxes on immovable property and other property taxes) as follows :

- Income taxes regroup the tax categories 1000, 2000 and 3000
- Personnal income taxes regroup the tax categories 1100, 2000 and 3000
- Corporate income taxes regroup the tax category 1200
- Consumption and property taxes regroup the tax categories 4000, 5000 and 6000
- Consumption taxes excluding property taxes regroup the tax categories 5000 and 6000
- Property taxes regroup the tax category 4000
- Property taxes : Recurrent taxes on Immovable Property regroup the tax categories 4100 and 4600
- Property taxes : Other property taxes regroup the tax categories 4200 to 4500

The overall tax burden is expressed as a percentage of GDP. All other tax indicators are expressed as a share of the total tax revenue. Fiscal data sum up the taxation of local, regional, federal and supranational levels and add the taxation dedicated to social security.

[11] More details about these data and their source can be found in Appendix 1.

Discussion on country-specific time controls

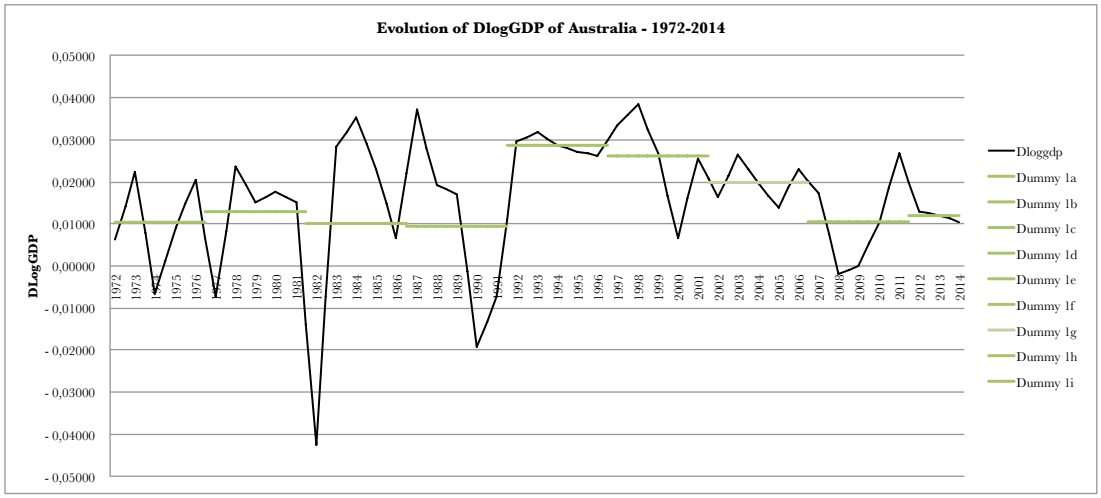
Previous literature studies use country specific time controls into their growth model specifications to estimate the effect of tax structure on economic development (Arnold 2008 ; Arnold, Brys, et al. 2011 ; Xing 2012 ; Arachi et al. 2015 ; Baiardi et al. 2018). These country-specific time controls were first introduced by J. Arnold in his working paper « *Do Tax Structures Affect Aggregate Economic Growth? Empirical evidence from a panel of OECD countries* » (2008) and are aimed at purging the model from unobserved and non-constant country idiosyncrasies, economic cycle effects, and country specific and non-country specific economic crisis. While implementing time controls, Arnold (2008) tested both a linear time trend and a non-linear specification using 5-year periods. He retained the non-linear specification as it seemed to be the most stable one. These country specific time controls take the form of 5-year dummies, each being worth 1 during a 5-year period and 0 otherwise. The coefficients of these dummies remain free to adjust at the country level. Subsequent literature studies use the same procedure and introduce 5-year dummies aimed at off balancing the seasonality of data and heterogeneous shocks between countries.

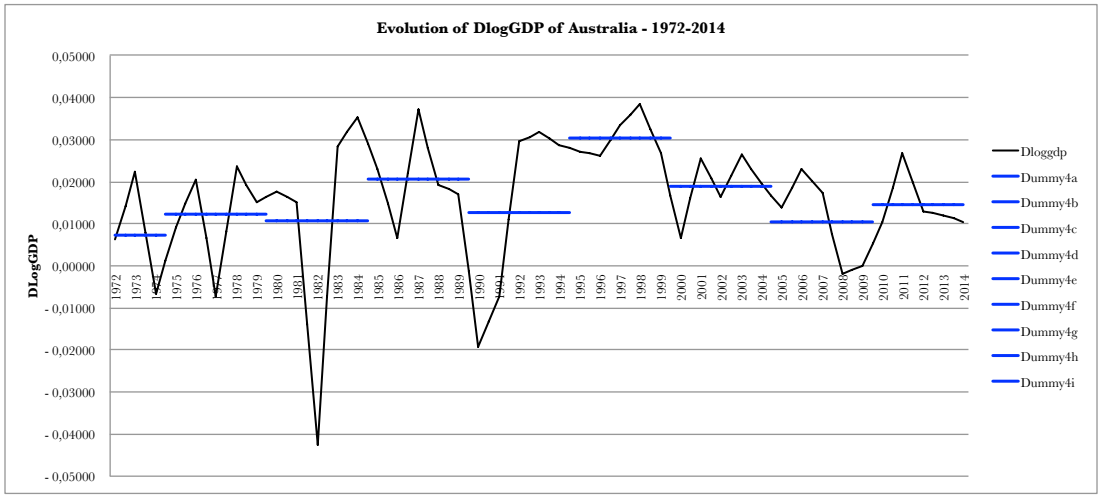
Construction of 5-year dummy sets

Previous literature gives little information concerning the construction of their 5-year dummy set representing country specific time controls (Arnold 2008 ; Arnold, Brys, et al. 2011 ; Xing 2012 ; Arachi et al. 2015 ; Baiardi et al. 2018). However, different constructions are possible and some arbitrage need to be done. Consider an example where a 5-year dummy set for a time period of 33 years has to be created (as in Arnold, Brys, et al. 2011). A first solution consists in creating six 5-year dummies for the first 30 years and 1 dummy representing the last 3 years ; a second option consists in creating a dummy representing the first 3 years, and 6 subsequent 5-year dummies representing the last 30 years ; a last option consists in creating two dummies of 4 years and 5 dummies of 5 years, raising new questions on which periods should be represented by these 4 year dummies.

Here below, graph 1 and graph 2 illustrate this idea and show the information left to estimate by our model after the introduction of two different sets of 5-year average. We use 5-year average as first approach as the regression coefficient of a dummy describes, in general, the average increase of the dependent variable when the value of the dummy is equal to 1. The variation of our dependent variables left to estimate through other explanatory variables is shown by the deviation from the 5-year average and appears to strongly depend on the chosen set.

Allowing 5-year dummy to vary at the country level also introduces a number of control variables in our model which is equal to one plus our period of time divided by 5, times the number of countries (as there is always a country-specific fixed effect). In some case, this may lead to the indrocution of more than 250 control variables, which is very specific for our model.





Graphs 1 and 2 : Evolution of the growth rate of Australia from 1972 to 2014. The deviation from 5-year average shows the information left to estimate by other explanatory variables after the introduction of different sets of 5-year average.

Considering the specificity of the country specific time controls, we believe there are enough reasons to assess their impact on our specification. Furthermore, the construction method used to build the set of 5-year country-specific time control appears to also possibly have some influence and could be a source of differences between previous studies. Therefore, we estimate our results without and with dummies using different specifications of 5-year dummies. Concluding, we assess tax shift estimates that are significant and robust to change in control specifications.

Results

As stated before, we estimated three different data panels ranging from 21 to 36 countries on a period from 24 to 47 years using different time control specifications :

- our first panel aims at reproducing Arnold, Brys, et al. (2011) results, it compiles data from 21 countries from 1971 to 2004 ;
- our second panel consider the longest data sample provided data availability, it compiles data from 23 countries on 47 years ;
- our third panel consider the largest set of countries provided data availability, it compiles data from 36 countries on 24 years.

Each data panel is estimated without country specific time control and with country-specific time control using different set of 5-year dummies. All results tables are displayed in appendices.

Set 1 : 21 countries – 1971-2004 (reproduction Arnold, Brys, et al. 2011)

Table 1.1 to Table 1.6 display estimates of our first panel of data. Table 1.1 displays estimates without country specific time control. Tables 1.2 to 1.6 display estimates introducing respectively dummy sets 1 to 5. We find that a tax shift towards income taxes is negatively correlated with long-run development except for one dummy set where it appears to be non-significant. Personnal income taxes in particular seem to drive this relationship and is significantly and negatively correlated with our dependent variable. The estimates on corporate income taxes are on the contrary not robust to change in dummy sets and appear to depend strongly on the dummy set used : while we estimate a significative positive relationship between corporate income taxes and growth without dummies and using dummy sets 1, 4, 5 ; we observe a significative negative relationship using dummy sets 2 and 3. Differences in dummy set construction lead thus to differences in results.

Consumption and property taxes taken together are always positively correlated when significant. The significancy level of this relationship depends on the dummy set used. The estimated effect of consumption taxes on growth in particular seems to be mainly driven by the dummy set used : in function of the dummy set specified, we observe both a highly significative positive and negative relationship, once again, underlining the impact of the dummy set on estimated results. Property taxes seems robust to variation in the dummy set and is always positively correlated although its significance level depends on the dummy set used. Note that three specifications could not be estimated using the Newton-Raphson method.

Regarding control variable, consistently with the literature, we observe that physical capital and human capital are positively correlated with our dependent variable whereas population growth is negatively correlated. As expected, overall tax burden is found non-significant in many estimates and negatively correlated to growth if significant.

Set 2 : 23 countries – 1972-2019

Tables 2.1 to 2.6 display the results of our estimates on our second set of data. Similarly as in our first set, we find a significant negative relationship between income taxes and growth in all specifications. More specifically, personal income taxes appear to drive this negative relationship. The effect of corporate income taxes is unclear, as in function of the dummy set used, it varies between positive, negative and non-significant, emphasising the importance of the dummies used on results.

A tax shift towards consumption and property taxes seems in general to have a positive impact on our dependent variable. However, estimated separately, consumption taxes appears to be not significant in some specification. Furthermore, the impact of immovable property taxes seems to be unclear and to depend on the dummy set used as the estimated relationship is found sometime positive, negative or non-significant.

In terms of control variable, consistently with previous estimates and previous literature, physical capital and human capital are found to be positively correlated whereas population growth is negatively correlated with our dependent variable. The estimates regarding the overall tax burden are not robust to change in dummy sets and are found both positive and negative.

Set 3 : 36 countries – 1995-2019

Tables 3.1 to 3.3 present the results of our third data panel considering the largest set of countries provided data availability. As in our previous dataset, we observe a negative relationship between income taxes and growth and more specifically between personal income taxes and growth. The relationship between corporate income taxes and growth depends on the dummy set used : although always significative, the relationship varies between positively and negatively correlated with growth.

Consumption and property taxes together are found to be significative and positively correlated with growth in one estimate. More in detail and estimated separately, the effect of consumption taxes and immovable property taxes in unclear and depend on the dummy set used. Note that dummy sets 3, 4 and 5 were found difficult to impossible to estimate in most specifications and are omitted, once again emphasising the importance of the dummies on the convergence of our model.

Regarding control variables, physical capital is found to have a positive relationship with our dependent variable whereas, as in previous datasets, population growth has a negative one. The effect of human capital and overall tax burden seems to depend on the dummy set used.

Conclusion

Using extended datasets, we find that, no matter the specifications, a tax shift favouring income taxes, and more specifically personal income taxes, seems to be correlated with a negative impact on economic development. This correlation is robust to change in control specifications and is valid for all dataset exploited.

On the contrary, the effect of corporate income taxes is unclear and appears to depend on the control specifications and on the method used to build country specific time controls dummies. We find that a tax shift towards consumption and property taxes seems to favour growth. Although, in particular, it is difficult to distinguish between these two kinds of taxes as we observe disparities in estimates in function of the control specifications.

This paper provides evidence that some highly significant relations between tax structure and growth are not robust to change in dummy sets. These findings support our discussion regarding country specific time control and their influence on the stability of our model. These results underline the impact of these controls variable and suggest a parsimonious use of such controls. As no details were levered regarding the construction of previous dummy sets used in the literature, previous research could, while working on the same dataset, have been using different control specifications. This could be a source of differences in results and could possibly explain previous observed heterogeneity in results.

This type of exercise proposes a beginning of analysis regarding the effect of budgetary neutral changes in fiscal policy on growth. Although, as shown, results must be considered with cautions. Further research accounting for fiscal concurrence between neighbouring countries and analysing the effect of fiscal devaluation offer bright future scientific development regarding this field of study. Furthermore, in times where inequalities are on the rise and political stability is at stake, tax shifts reform cannot elude redistribution matters. As taxation itself is a primary tool to allocate money, further research is needed to explore the empirical effects of tax shifts on redistribution between population category.

Appendix 1 : Data

All our data are coming directly from the OECD databases, except for data on human capital which are coming from the Baro and Lee (2012) database. Specifically gross domestic product and gross fixed capital formation are coming from the National Account database, population numbers are retrieved from the Demography and Population database and fiscal data are coming from the Public sector, Taxation and Market regulation database. Human capital data are coming from the Baro and Lee (2012) dataset on Educational Attainment and are available on a 5-year basis, we proxy the missing value using a standard linear approach.

For replication purpose, here below is the complete definition of all data used :

Economic data

GDP per capita : The gross domestic product, computed at constant price and constant purchasing power parity following the expenditure approach and expressed in US dollars, divided by the working age population (population aged from 15 to 64 years old)

Investment rate : The investment rate is defined as the ratio between the gross fixed capital formation, taken at constant price, constant purchasing power parity and expressed in US dollars, and the real GDP, taken at constant price, constant purchasing power parity, expressed in US dollars and computed through the expenditure approach

Education rate : The education rate is defined as the average number of years of schooling of the population aged of 25 years or more (male and female)

Population growth : Population growth is defined as the growth rate of the working-age population aged from 15 to 64 years old

Fiscal data

Fiscal data describing tax revenue are collected at the total government level (i.e. we collect data referring to all types of government within the country - specifically the tax levied by total government is equal to the tax levied by local government, plus the tax levied by regional government, plus the tax levied by federal or central government, plus the tax levied by supranational institutions, plus the tax levied for social security). Following the OECD classification, we collect data on the following tax category :

- **1000 Taxes on income, profits and capital gains**
    - 1100 Taxes on income, profits and capital gains of individuals
    - 1200 Taxes on income, profits and capital gains of corporates

- **2000 Social security contributions**
- **3000 Taxes on payroll and workforce**
- **4000 Taxes on property**
    - 4100 Recurrent taxes on immovable property
    - 4200 Recurrent taxes on net wealth
    - 4300 Estate, inheritance and gift taxes
    - 4400 Taxes on financial and capital transactions
    - 4500 Non-recurrent taxes on property
    - 4600 Other recurrent taxes on property except 4100 and 4200
- **5000 Taxes on good and services**
- **6000 Taxes other than 1000, 2000, 3000, 4000 and 5000**

We also collect data relative to the **overall tax burden** of each country as control variable.

Tax ratios

In order to compute our set of tax ratio, used to represent the tax structure, we organise our fiscal data as follows and define different tax categories :

- **(1) Income taxes** = 1000 Taxes on income, profits and capital gains + 2000 Social security contributions + 3000 Taxes on payroll and workforce
    - **(2) Personnal income taxes** = 1100 Taxes on income, profits and capital gains of individuals+ 2000 Social security contributions + 3000 Taxes on payroll and workforce
    - **(3) Corporate income taxes** = 1200 Taxes on income, profits and capital gains of corporates
- **(4) Consumption and property taxes** = 4000 Taxes on property + 5000 Taxes on good and services + 6000 Taxes other than 1000, 2000, 3000, 4000 and 5000
    - **(5) Consumption taxes excluding property taxes** = 5000 Taxes on good and services + 6000 Taxes other than 1000, 2000, 3000, 4000 and 5000
    - **(6) Property taxes** = 4000 Taxes on property
        - **(7) Property taxes : recurrent taxes on Immovable Property** = 4100 Recurrent taxes on immovable property + 4600 Other recurrent taxes on property except 4100 and 4200
        - **(8) Property taxes : other property taxes** = 4200 Recurrent taxes on net wealth + 4300 Estate, inheritance and gift taxes + 4400 Taxes on financial and capital transactions + 4500 Non-recurrent taxes on property

The tax ratios are computed by taking the share over the total tax revenue of tax category (1) to (8). They are expressed as a percentage of the total tax revenue. The overall tax burden, serving as control variable, is contrary to tax ratios, expressed as a percentage of GDP.

By construction, we have the following relations between tax ratios :

- Income taxes ratio (1) + Consumption and property taxes ratio (4) = 1 ;
- Income taxes ratio (1) = Personnal income taxes ratio (2) + Corporate income taxes ratio (3) ;
- Consumption and property taxes ratio (4) = Consumption taxes excluding property taxes ratio (5) + Property taxes ratio (6) ;
- Property taxes ratio (6) = Property taxes : recurrent taxes on Immovable Property ratio (7) + Property taxes : other property taxes ratio (8).

To avoid overspecification, the sum of all tax ratios inserted in the regression equation must always be inferior to 1.

Appendix 2 : Results

Set 1 : 21 countries - 1971-2004 – dummy sets varying from 0 to 5

Table 1.1 21 countries - 1971-2004	(1)	(2)	(3)	(4)	(5)
Long-run parameters					
Physical capital	**0,886** ***	**0,393** ***	**0,95** ***	**1,013** ***	**1,286** ***
	(0,137)	(0,094)	(0,142)	(0,155)	(0,213)
Population growth	**-23,751** ***	**-17,998** ***	**-24,707** ***	**-26,85** ***	**-31,891** ***
	(3,012)	(2,054)	(3,163)	(3,425)	(4,251)
Human capital	**0,524** ***	**0,698** ***	**0,514** ***	**0,343** **	**0,354** **
	(0,129)	(0,094)	(0,134)	(0,142)	(0,144)
Overall tax burden	**-0,009** **	**-0,012** ***	**-0,01** **	**-0,005**	**-0,011** **
	(0,004)	(0,003)	(0,004)	(0,004)	(0,005)
Income taxes	**-0,015** ***				
	(0,004)				
Personal income taxes		**-0,012** ***			
		(0,003)			
Corporate income taxes		**0,013** ***			
		(0,005)			
Consumption and property taxes			**0,015** ***		
			(0,004)		
Consumption taxes				**0,01** **	**0,003**
				(0,004)	(0,005)
Property taxes				**0,036** ***	
				(0,013)	
Property taxes : immovable property					**0,04** *
					(0,024)
Property taxes : others					**0,006**
					(0,019)
5-Year dummy variables	No dummy	No dummy	No dummy	No dummy	No dummy
Number of observations	692	674	692	692	653
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Incomes taxes	Incomes taxes	Incomes taxes

Note : * Significant at 10% level ; ** significant at 5% level ; *** significant at 1% level. Based on an error correction framework, estimates are computed with the help of the Pooled Mean Group estimator by Pesaran et al. (1999) using the Newton-Raphson technique. Estimates display the long-run effect of different revenue-neutral tax shifts using tax ratios to represent tax structure. Short-run coefficients varying at the country level are not displayed. Physical capital, population growth, human capital and overall tax burden are always presented as standard growth determinants and control variables. Standard errors are in brackets.

Table 1.2 21 countries - 1971-2004	(1)	(2)	(3)	(4)	(5)
Long-run parameters					
Physical capital	**0,444** ***	**0,07**	**0,394** ***	**0,296** ***	
	(0,065)	(0,045)	(0,036)	(0,068)	()
Population growth	**-11,847** ***	**-1,29**	**-2,729** ***	**-13,568** ***	
	(2,108)	(0,99)	(0,882)	(2,144)	()
Human capital	**1,683** ***	**4,496** ***	**3,077** ***	**2,581** ***	
	(0,422)	(0,413)	(0,358)	(0,453)	()
Overall tax burden	**0,003**	**-0,022** ***	**-0,013** ***	**0,004**	
	(0,003)	(0,003)	(0,003)	(0,003)	()
Income taxes	**-0,028** ***				
	(0,004)				
Personal income taxes		**-0,009** ***			
		(0,002)			
Corporate income taxes		**0,01** ***			
		(0,002)			
Consumption and property taxes			**0,007** ***		
			(0,002)		
Consumption taxes				**0,027** ***	
				(0,004)	()
Property taxes				**0,089** ***	
				(0,012)	
Property taxes : immovable property					
					()
Property taxes : others					
					()
5-Year dummy variables	Dummy set 1	Dummy set 1	Dummy set 1	Dummy set 1	Dummy set 1
Number of observations	692	674	692	692	
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Incomes taxes	Incomes taxes	Incomes taxes

Note : * Significant at 10% level ; ** significant at 5% level ; *** significant at 1% level. Based on an error correction framework, estimates are computed with the help of the Pooled Mean Group estimator by Pesaran et al. (1999) using the Newton-Raphson technique. Estimates display the long-run effect of different revenue-neutral tax shifts using tax ratios to represent tax structure. Short-run coefficients varying at the country level are not displayed. Physical capital, population growth, human capital and overall tax burden are always presented as standard growth determinants and control variables. Standard errors are in brackets.

Table 1.3 21 countries - 1971-2004	(1)	(2)	(3)	(4)	(5)
Long-run parameters					
Physical capital	**0,246** ***	**0,152** ***	**0,253** ***	**0,235** ***	
	(0,051)	(0,048)	(0,05)	(0,041)	()
Population growth	**-6,529** ***	**-7,721** ***	**-6,277** ***	**-3,07** ***	
	(1,155)	(1,527)	(1,111)	(0,723)	()
Human capital	**1,059** ***	**1,017** ***	**1,073** ***	**1,262** ***	
	(0,109)	(0,094)	(0,108)	(0,099)	()
Overall tax burden	**-0,013** ***	**-0,005** **	**-0,014** ***	**-0,019** ***	
	(0,003)	(0,002)	(0,003)	(0,003)	()
Income taxes	**-0,008** ***				
	(0,002)				
Personal income taxes		**-0,017** ***			
		(0,003)			
Corporate income taxes		**-0,012** ***			
		(0,003)			
Consumption and property taxes			**0,007** ***		
			(0,002)		
Consumption taxes				**-0,001**	
				(0,002)	()
Property taxes				**0,032** ***	
				(0,006)	
Property taxes : immovable property					
					()
Property taxes : others					
					()
5-Year dummy variables	Dummy set 2	Dummy set 2	Dummy set 2	Dummy set 2	Dummy set 2
Number of observations	692	674	692	692	
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Incomes taxes	Incomes taxes	Incomes taxes

Note : * Significant at 10% level ; ** significant at 5% level ; *** significant at 1% level. Based on an error correction framework, estimates are computed with the help of the Pooled Mean Group estimator by Pesaran et al. (1999) using the Newton-Raphson technique. Estimates display the long-run effect of different revenue-neutral tax shifts using tax ratios to represent tax structure. Short-run coefficients varying at the country level are not displayed. Physical capital, population growth, human capital and overall tax burden are always presented as standard growth determinants and control variables. Standard errors are in brackets.

Table 1.4 21 countries - 1971-2004	(1)	(2)	(3)	(4)	(5)
Long-run parameters					
Physical capital	**0,268** ***	**0,182** ***	**0,287** ***	**0,227** ***	**0,241** ***
	(0,055)	(0,06)	(0,055)	(0,061)	(0,064)
Population growth	**-15,475** ***	**-14,49** ***	**-15,23** ***	**-14,925** ***	**-19,805** ***
	(2,116)	(2,193)	(2,168)	(2,178)	(2,35)
Human capital	**1,306** ***	**1,156** ***	**1,314** ***	**1,549** ***	**2,145** ***
	(0,108)	(0,107)	(0,111)	(0,132)	(0,143)
Overall tax burden	**0,003**	**0,001**	**0,002**	**0,001**	**-0,012** ***
	(0,003)	(0,003)	(0,003)	(0,003)	(0,004)
Income taxes	**-0,027** ***				
	(0,004)				
Personal income taxes		**-0,026** ***			
		(0,004)			
Corporate income taxes		**-0,021** ***			
		(0,004)			
Consumption and property taxes			**0,026** ***		
			(0,004)		
Consumption taxes				**0,027** ***	**0,015** ***
				(0,004)	(0,004)
Property taxes				**0,062** ***	
				(0,01)	
Property taxes : immovable property					**0,042** ***
					(0,011)
Property taxes : others					**0,096** ***
					(0,013)
5-Year dummy variables	Dummy set 3	Dummy set 3	Dummy set 3	Dummy set 3	Dummy set 3
Number of observations	692	674	692	692	653
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Incomes taxes	Incomes taxes	Incomes taxes

Note : * Significant at 10% level ; ** significant at 5% level ; *** significant at 1% level. Based on an error correction framework, estimates are computed with the help of the Pooled Mean Group estimator by Pesaran et al. (1999) using the Newton-Raphson technique. Estimates display the long-run effect of different revenue-neutral tax shifts using tax ratios to represent tax structure. Short-run coefficients varying at the country level are not displayed. Physical capital, population growth, human capital and overall tax burden are always presented as standard growth determinants and control variables. Standard errors are in brackets.

Table 1.5 21 countries - 1971-2004	(1)	(2)	(3)	(4)	(5)
Long-run parameters					
Physical capital	**0,205** ***	**0,191** ***	**0,201** ***	**0,202** ***	
	(0,023)	(0,021)	(0,023)	(0,022)	()
Population growth	**-5,018** ***	**-2,313** **	**-5,066** ***	**-5,657** ***	
	(1,204)	(0,973)	(1,2)	(1,331)	()
Human capital	**0,768** ***	**0,802** ***	**0,762** ***	**0,712** ***	
	(0,048)	(0,042)	(0,048)	(0,05)	()
Overall tax burden	**-0,005** ***	**-0,004** ***	**-0,005** ***	**-0,003** *	
	(0,002)	(0,002)	(0,002)	(0,002)	()
Income taxes	**-0,001**				
	(0,001)				
Personal income taxes		**0,0003**			
		(0,001)			
Corporate income taxes		**0,013** ***			
		(0,002)			
Consumption and property taxes			**0,001**		
			(0,001)		
Consumption taxes				**0,002**	
				(0,001)	()
Property taxes				**-0,0067**	
				(0,004)	
Property taxes : immovable property					
					()
Property taxes : others					
					()
5-Year dummy variables	Dummy set 4	Dummy set 4	Dummy set 4	Dummy set 4	Dummy set 4
Number of observations	692	674	692	692	
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Incomes taxes	Incomes taxes	Incomes taxes

Note : * Significant at 10% level ; ** significant at 5% level ; *** significant at 1% level. Based on an error correction framework, estimates are computed with the help of the Pooled Mean Group estimator by Pesaran et al. (1999) using the Newton-Raphson technique. Estimates display the long-run effect of different revenue-neutral tax shifts using tax ratios to represent tax structure. Short-run coefficients varying at the country level are not displayed. Physical capital, population growth, human capital and overall tax burden are always presented as standard growth determinants and control variables. Standard errors are in brackets.

Table 1.6 21 countries - 1971-2004	(1)	(2)	(3)	(4)	(5)
Long-run parameters					
Physical capital	**0,09**	**0,048**	**0,111**	**0,055**	**0,157** ***
	(0,073)	(0,052)	(0,075)	(0,066)	(0,031)
Population growth	**-12,411** ***	**-9,504** ***	**-12,805** ***	**-8,624** ***	**-5,529** ***
	(2,706)	(1,449)	(2,79)	(2,111)	(0,915)
Human capital	**1,532** ***	**1,549** ***	**1,618** ***	**1,543** ***	**2,078** ***
	(0,193)	(0,147)	(0,205)	(0,174)	(0,097)
Overall tax burden	**0,004**	**-0,003**	**0,003**	**0,0003**	**-0,012** ***
	(0,003)	(0,003)	(0,004)	(0,003)	(0,002)
Income taxes	**-0,012** ***				
	(0,004)				
Personal income taxes		**-0,009** ***			
		(0,002)			
Corporate income taxes		**0,0125** ***			
		(0,003)			
Consumption and property taxes			**0,011** ***		
			(0,004)		
Consumption taxes				**0,002**	**-0,006** ***
				(0,003)	(0,001)
Property taxes				**0,037** ***	
				(0,008)	
Property taxes : immovable property					**-0,003**
					(0,006)
Property taxes : others					**0,022** ***
					(0,004)
5-Year dummy variables	Dummy set 5	Dummy set 5	Dummy set 5	Dummy set 5	Dummy set 5
Number of observations	692	674	692	692	653
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Incomes taxes	Incomes taxes	Incomes taxes

Note : * Significant at 10% level ; ** significant at 5% level ; *** significant at 1% level. Based on an error correction framework, estimates are computed with the help of the Pooled Mean Group estimator by Pesaran et al. (1999) using the Newton-Raphson technique. Estimates display the long-run effect of different revenue-neutral tax shifts using tax ratios to represent tax structure. Short-run coefficients varying at the country level are not displayed. Physical capital, population growth, human capital and overall tax burden are always presented as standard growth determinants and control variables. Standard errors are in brackets.

Set 2 : 23 countries - 1972-2019 – dummy sets varying from 0 to 5

Table 2.1 23 countries - 1972-2019	(1)	(2)	(3)	(4)	(5)
Long-run parameters					
Physical capital	**1,006** ***	**0,181**	**0,942** ***	**1,048** ***	**0,825** ***
	(0,161)	(0,111)	(0,159)	(0,166)	(0,269)
Population growth	**-28,246** ***	**-16,259** ***	**-27,012** ***	**-32,528** ***	**-52,057** ***
	(4,814)	(3,302)	(4,735)	(5,578)	(12,653)
Human capital	**0,16**	**0,426** ***	**0,188**	**-0,076**	**-0,033**
	(0,193)	(0,121)	(0,191)	(0,236)	(0,331)
Overall tax burden	**-0,002**	**-0,012** ***	**-0,002**	**0,004**	**-0,0036**
	(0,006)	(0,004)	(0,005)	(0,006)	(0,01)
Income taxes	**-0,02** ***				
	(0,006)				
Personal income taxes		**-0,041** ***			
		(0,007)			
Corporate income taxes		**-0,007**			
		(0,007)			
Consumption and property taxes			**0,021** ***		
			(0,006)		
Consumption taxes				**0,023** ***	**0,053** ***
				(0,007)	(0,015)
Property taxes				**0,058** ***	
				(0,017)	
Property taxes : immovable property					**-0,028**
					(0,04)
Property taxes : others					**0,217** ***
					(0,047)
5-Year dummy variables	No dummy	No dummy	No dummy	No dummy	No dummy
Number of observations	1079	1079	1081	1081	1080
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Incomes taxes	Incomes taxes	Incomes taxes

Note : * Significant at 10% level ; ** significant at 5% level ; *** significant at 1% level. Based on an error correction framework, estimates are computed with the help of the Pooled Mean Group estimator by Pesaran et al. (1999) using the Newton-Raphson technique. Estimates display the long-run effect of different revenue-neutral tax shifts using tax ratios to represent tax structure. Short-run coefficients varying at the country level are not displayed. Physical capital, population growth, human capital and overall tax burden are always presented as standard growth determinants and control variables. Standard errors are in brackets.

Table 2.2 23 countries - 1972-2019	(1)	(2)	(3)	(4)	(5)
Long-run parameters					
Physical capital	**0,28** ***	**0,332** ***	**0,269** ***	**0,261** ***	**0,217** ***
	(0,042)	(0,045)	(0,043)	(0,046)	(0,056)
Population growth	**-6,577** ***	**-5,033** ***	**-6,592** ***	**-6,683** ***	**-7,503** ***
	(1,17)	(1)	(1,181)	(1,165)	(1,267)
Human capital	**1,035** ***	**0,865** ***	**1,038** ***	**0,944** ***	**0,858** ***
	(0,088)	(0,084)	(0,089)	(0,091)	(0,096)
Overall tax burden	**0,003**	**-0,001**	**0,004** *	**-0,0001**	**-0,004**
	(0,002)	(0,002)	(0,002)	(0,002)	(0,003)
Income taxes	**-0,017** ***				
	(0,002)				
Personal income taxes		**-0,015** ***			
		(0,002)			
Corporate income taxes		**-0,01** ***			
		(0,003)			
Consumption and property taxes			**0,017** ***		
			(0,002)		
Consumption taxes				**0,013** ***	**0,011** ***
				(0,002)	(0,002)
Property taxes				**0,039** ***	
				(0,006)	
Property taxes : immovable property					**0,028** ***
					(0,007)
Property taxes : others					**0,062** ***
					(0,009)
5-Year dummy variables	Dummy set 1	Dummy set 1	Dummy set 1	Dummy set 1	Dummy set 1
Number of observations	1079	1079	1081	1081	1080
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Incomes taxes	Incomes taxes	Incomes taxes

Note : * Significant at 10% level ; ** significant at 5% level ; *** significant at 1% level. Based on an error correction framework, estimates are computed with the help of the Pooled Mean Group estimator by Pesaran et al. (1999) using the Newton-Raphson technique. Estimates display the long-run effect of different revenue-neutral tax shifts using tax ratios to represent tax structure. Short-run coefficients varying at the country level are not displayed. Physical capital, population growth, human capital and overall tax burden are always presented as standard growth determinants and control variables. Standard errors are in brackets.

Table 2.3 23 countries - 1972-2019	(1)	(2)	(3)	(4)	(5)
Long-run parameters					
Physical capital	**0,233** ***	**0,223** ***	**0,233** ***	**0,231** ***	**0,214** ***
	(0,025)	(0,022)	(0,025)	(0,027)	(0,031)
Population growth	**-5,8** ***	**-4,439** ***	**-5,73** ***	**-5,745** ***	**-5,922** ***
	(0,915)	(0,818)	(0,908)	(0,948)	(0,935)
Human capital	**0,752** ***	**0,762** ***	**0,753** ***	**0,794** ***	**0,86** ***
	(0,058)	(0,048)	(0,057)	(0,064)	(0,067)
Overall tax burden	**-0,0025**	**-0,006** ***	**-0,0025**	**-0,0027**	**-0,003** *
	(0,002)	(0,001)	(0,002)	(0,002)	(0,002)
Income taxes	**-0,003** **				
	(0,001)				
Personal income taxes		**-0,004** ***			
		(0,001)			
Corporate income taxes		**0,0061** ***			
		(0,002)			
Consumption and property taxes			**0,003** **		
			(0,001)		
Consumption taxes				**0,001**	**-0,001**
				(0,002)	(0,002)
Property taxes				**0,01** **	
				(0,004)	
Property taxes : immovable property					**-0,011** *
					(0,006)
Property taxes : others					**0,018** ***
					(0,005)
5-Year dummy variables	Dummy set 2	Dummy set 2	Dummy set 2	Dummy set 2	Dummy set 2
Number of observations	1079	1079	1081	1081	1080
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Incomes taxes	Incomes taxes	Incomes taxes

Note : * Significant at 10% level ; ** significant at 5% level ; *** significant at 1% level. Based on an error correction framework, estimates are computed with the help of the Pooled Mean Group estimator by Pesaran et al. (1999) using the Newton-Raphson technique. Estimates display the long-run effect of different revenue-neutral tax shifts using tax ratios to represent tax structure. Short-run coefficients varying at the country level are not displayed. Physical capital, population growth, human capital and overall tax burden are always presented as standard growth determinants and control variables. Standard errors are in brackets.

Table 2.4 23 countries - 1972-2019	(1)	(2)	(3)	(4)	(5)
Long-run parameters					
Physical capital	**0,287** ***	**0,317** ***	**0,29** ***	**0,27** ***	**0,356** ***
	(0,044)	(0,05)	(0,044)	(0,047)	(0,049)
Population growth	**-4,723** ***	**-4,72** ***	**-4,678** ***	**-5,261** ***	**-5,699** ***
	(1,115)	(1,235)	(1,106)	(1,152)	(1,21)
Human capital	**1,036** ***	**0,919** ***	**1,032** ***	**1,041** ***	**0,911** ***
	(0,098)	(0,107)	(0,097)	(0,099)	(0,094)
Overall tax burden	**-0,007** ***	**-0,009** ***	**-0,007** ***	**-0,008** ***	**-0,006** **
	(0,003)	(0,003)	(0,002)	(0,003)	(0,002)
Income taxes	**-0,008** ***				
	(0,002)				
Personal income taxes		**-0,011** ***			
		(0,002)			
Corporate income taxes		**-0,0004**			
		(0,003)			
Consumption and property taxes			**0,008** ***		
			(0,002)		
Consumption taxes				**0,005** **	**0,003**
				(0,002)	(0,002)
Property taxes				**0,026** ***	
				(0,005)	
Property taxes : immovable property					**0,017** **
					(0,007)
Property taxes : others					**0,028** ***
					(0,007)
5-Year dummy variables	Dummy set 3	Dummy set 3	Dummy set 3	Dummy set 3	Dummy set 3
Number of observations	1079	1079	1081	1081	1080
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Incomes taxes	Incomes taxes	Incomes taxes

Note : * Significant at 10% level ; ** significant at 5% level ; *** significant at 1% level. Based on an error correction framework, estimates are computed with the help of the Pooled Mean Group estimator by Pesaran et al. (1999) using the Newton-Raphson technique. Estimates display the long-run effect of different revenue-neutral tax shifts using tax ratios to represent tax structure. Short-run coefficients varying at the country level are not displayed. Physical capital, population growth, human capital and overall tax burden are always presented as standard growth determinants and control variables. Standard errors are in brackets.

Table 2.5 23 countries - 1972-2019	(1)	(2)	(3)	(4)	(5)
Long-run parameters					
Physical capital	**0,247** ***	**0,102** **	**0,243** ***	**0,239** ***	**0,202** ***
	(0,037)	(0,049)	(0,037)	(0,037)	(0,038)
Population growth	**-5,978** ***	**-6,398** ***	**-5,907** ***	**-4,407** ***	**-4,347** ***
	(0,924)	(1,101)	(0,925)	(0,829)	(0,733)
Human capital	**0,572** ***	**0,658** ***	**0,573** ***	**0,604** ***	**0,682** ***
	(0,072)	(0,094)	(0,073)	(0,071)	(0,064)
Overall tax burden	**0,009** ***	**0,008** ***	**0,009** ***	**0,009** ***	**0,007** ***
	(0,002)	(0,003)	(0,002)	(0,002)	(0,002)
Income taxes	**-0,011** ***				
	(0,002)				
Personal income taxes		**-0,018** ***			
		(0,003)			
Corporate income taxes		**0,003**			
		(0,003)			
Consumption and property taxes			**0,011** ***		
			(0,002)		
Consumption taxes				**0,009** ***	**0,008** ***
				(0,002)	(0,002)
Property taxes				**0,026** ***	
				(0,005)	
Property taxes : immovable property					**-0,001**
					(0,007)
Property taxes : others					**0,035** ***
					(0,006)
5-Year dummy variables	Dummy set 4	Dummy set 4	Dummy set 4	Dummy set 4	Dummy set 4
Number of observations	1079	1079	1081	1081	1080
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Incomes taxes	Incomes taxes	Incomes taxes

Note : * Significant at 10% level ; ** significant at 5% level ; *** significant at 1% level. Based on an error correction framework, estimates are computed with the help of the Pooled Mean Group estimator by Pesaran et al. (1999) using the Newton-Raphson technique. Estimates display the long-run effect of different revenue-neutral tax shifts using tax ratios to represent tax structure. Short-run coefficients varying at the country level are not displayed. Physical capital, population growth, human capital and overall tax burden are always presented as standard growth determinants and control variables. Standard errors are in brackets.

Table 2.6 23 countries - 1972-2019	(1)	(2)	(3)	(4)	(5)
Long-run parameters					
Physical capital	**0,389** ***	**0,254** ***	**0,377** ***	**0,383** ***	**0,358** ***
	(0,035)	(0,037)	(0,035)	(0,038)	(0,047)
Population growth	**-4,235** ***	**-3,47** ***	**-4,047** ***	**-4,576** ***	**-5,694** ***
	(0,715)	(0,699)	(0,698)	(0,771)	(0,901)
Human capital	**0,459** **	**0,776** ***	**0,463** **	**0,355** *	**0,383** **
	(0,188)	(0,204)	(0,187)	(0,197)	(0,174)
Overall tax burden	**0,002**	**-0,003**	**0,002**	**0,003**	**0,004** *
	(0,002)	(0,002)	(0,002)	(0,002)	(0,002)
Income taxes	**-0,011** ***				
	(0,002)				
Personal income taxes		**-0,013** ***			
		(0,002)			
Corporate income taxes		**0,001**			
		(0,002)			
Consumption and property taxes			**0,011** ***		
			(0,002)		
Consumption taxes				**0,012** ***	**0,013** ***
				(0,002)	(0,003)
Property taxes				**0,019** ***	
				(0,005)	
Property taxes : immovable property					**0,005**
					(0,008)
Property taxes : others					**0,033** ***
					(0,006)
5-Year dummy variables	Dummy set 5	Dummy set 5	Dummy set 5	Dummy set 5	Dummy set 5
Number of observations	1079	1079	1081	1081	1080
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Incomes taxes	Incomes taxes	Incomes taxes

Note : * Significant at 10% level ; ** significant at 5% level ; *** significant at 1% level. Based on an error correction framework, estimates are computed with the help of the Pooled Mean Group estimator by Pesaran et al. (1999) using the Newton-Raphson technique. Estimates display the long-run effect of different revenue-neutral tax shifts using tax ratios to represent tax structure. Short-run coefficients varying at the country level are not displayed. Physical capital, population growth, human capital and overall tax burden are always presented as standard growth determinants and control variables. Standard errors are in brackets.

Set 3 : 36 countries - 1995-2019 – dummy sets varying from 0 to 2

Table 3.1 36 countries - 1995-2019	(1)	(2)	(3)	(4)	(5)
Long-run parameters					
Physical capital	**0,654** ***	**0,587** ***	**0,761** ***	**0,682** ***	**0,671** ***
	(0,07)	(0,076)	(0,096)	(0,102)	(0,077)
Population growth	**-12,129** ***	**-13,67** ***	**-13,147** ***	**-5,054** **	**-18,841** ***
	(1,935)	(2,168)	(2,191)	(2,144)	(2,413)
Human capital	**0,443** ***	**0,588** ***	**0,1**	**-0,821** *	**0,38** ***
	(0,117)	(0,112)	(0,217)	(0,43)	(0,128)
Overall tax burden	**0,0249** ***	**0,025** ***	**0,0351** ***	**-0,02** *	**0,028** ***
	(0,005)	(0,005)	(0,007)	(0,011)	(0,005)
Income taxes	**-0,006** ***				
	(0,002)				
Personal income taxes		**-0,027** ***			
		(0,005)			
Corporate income taxes		**-0,011** ***			
		(0,003)			
Consumption and property taxes			**0,038** ***		
			(0,007)		
Consumption taxes				**0,101** ***	**0,007** ***
				(0,013)	(0,002)
Property taxes				**0,123** ***	
				(0,03)	
Property taxes : immovable property					**-0,036** **
					(0,015)
Property taxes : others					**0,051** ***
					(0,009)
5-Year dummy variables	No dummy	No dummy	No dummy	No dummy	No dummy
Number of observations	864	857	864	864	863
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Incomes taxes	Incomes taxes	Incomes taxes

Note : * Significant at 10% level ; ** significant at 5% level ; *** significant at 1% level. Based on an error correction framework, estimates are computed with the help of the Pooled Mean Group estimator by Pesaran et al. (1999) using the Newton-Raphson technique. Estimates display the long-run effect of different revenue-neutral tax shifts using tax ratios to represent tax structure. Short-run coefficients varying at the country level are not displayed. Physical capital, population growth, human capital and overall tax burden are always presented as standard growth determinants and control variables. Standard errors are in brackets.

Table 3.2 36 countries - 1995-2019	(1)	(2)	(3)	(4)	(5)
Long-run parameters					
Physical capital	**0,937** ***	**1,156** ***	**0,767** ***	**0,857** ***	**0,271** ***
	(0,102)	(0,257)	(0,052)	(0,208)	(0,039)
Population growth	**-4,867** ***	**-19,771** ***	**-4,419** ***	**-13,359** **	**-6,15** ***
	(1,598)	(5,112)	(0,706)	(5,207)	(0,654)
Human capital	**-1,356** ***	**-3,902** ***	**0,116**	**-3,77** ***	**0,914** ***
	(0,41)	(1,152)	(0,109)	(1,282)	(0,059)
Overall tax burden	**0,023** ***	**-0,063** ***	**0,009** ***	**0,039** ***	**0,003**
	(0,006)	(0,015)	(0,003)	(0,011)	(0,003)
Income taxes	**-0,04** ***				
	(0,007)				
Personal income taxes		**-0,051** ***			
		(0,015)			
Corporate income taxes		**0,138** ***			
		(0,026)			
Consumption and property taxes			**0,0004**		
			(0,001)		
Consumption taxes				**0,101** ***	**-0,004** **
				(0,028)	(0,002)
Property taxes				**0,436** ***	
				(0,119)	
Property taxes : immovable property					**-0,072** ***
					(0,007)
Property taxes : others					**0,051** ***
					(0,007)
5-Year dummy variables	Dummy set 1	Dummy set 1	Dummy set 1	Dummy set 1	Dummy set 1
Number of observations	864	857	864	864	863
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Incomes taxes	Incomes taxes	Incomes taxes

Note : * Significant at 10% level ; ** significant at 5% level ; *** significant at 1% level. Based on an error correction framework, estimates are computed with the help of the Pooled Mean Group estimator by Pesaran et al. (1999) using the Newton-Raphson technique. Estimates display the long-run effect of different revenue-neutral tax shifts using tax ratios to represent tax structure. Short-run coefficients varying at the country level are not displayed. Physical capital, population growth, human capital and overall tax burden are always presented as standard growth determinants and control variables. Standard errors are in brackets.

Table 3.3 36 countries - 1995-2019	(1)	(2)	(3)	(4)	(5)
Long-run parameters					
Physical capital	**0,457** ***	**0,636** ***	**2,502** ***	**0,385** ***	**0,172** ***
	(0,063)	(0,052)	(0,422)	(0,047)	(0,047)
Population growth	**0,4**	**1,072**	**2,711**	**-7,495** ***	**-8,137** ***
	(1,017)	(0,872)	(1,982)	(1,283)	(1,117)
Human capital	**0,309** *	**0,366** ***	**1,548** ***	**0,517** ***	**0,14**
	(0,168)	(0,091)	(0,232)	(0,105)	(0,089)
Overall tax burden	**-0,024** ***	**0,013** ***	**-0,064** ***	**0,007** **	**0,01** ***
	(0,006)	(0,003)	(0,013)	(0,003)	(0,002)
Income taxes	**-0,062** ***				
	(0,007)				
Personal income taxes		**0,0005**			
		(0,002)			
Corporate income taxes		**-0,006** ***			
		(0,002)			
Consumption and property taxes			**-0,008**		
			(0,006)		
Consumption taxes				**0,009** ***	**0,002**
				(0,002)	(0,002)
Property taxes				**0,077** ***	
				(0,009)	
Property taxes : immovable property					**0,04** ***
					(0,012)
Property taxes : others					**0,086** ***
					(0,008)
5-Year dummy variables	Dummy set 2	Dummy set 2	Dummy set 2	Dummy set 2	Dummy set 2
Number of observations	864	857	864	864	863
Revenue neutrality achieved by adjusting	Consumption and property taxes	Consumption and property taxes	Incomes taxes	Incomes taxes	Incomes taxes

Note : * Significant at 10% level ; ** significant at 5% level ; *** significant at 1% level. Based on an error correction framework, estimates are computed with the help of the Pooled Mean Group estimator by Pesaran et al. (1999) using the Newton-Raphson technique. Estimates display the long-run effect of different revenue-neutral tax shifts using tax ratios to represent tax structure. Short-run coefficients varying at the country level are not displayed. Physical capital, population growth, human capital and overall tax burden are always presented as standard growth determinants and control variables. Standard errors are in brackets.

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., Bassanini, A., & Scarpetta, S. (2011). Solow or Lucas? Testing speed of convergence on a panel of OECD countries. *Research in Economics, 65*(2), 110–123.

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.

Baiardi, D., Profeta, P., Puglisi, R., & Scabrosetti, S. (2019). Tax policy and economic growth: does it really matter? *International Tax and Public Finance*, *26*(2), 282–316.

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.

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

European Commission (2015). Council recommendation of 14 July 2015 on the 2015 National Reform Programme of Belgium and delivering a Council opinion on the 2015 Stability Programme of Belgium. *Official Journal of the European Union, C272*, 24–27.

Jaimovich, N., & Rebelo, S. (2017). Nonlinear Effects of Taxation on Growth. *Journal of Political Economy*, 125(1), 265–291.

Mathé, M., Nicodème, 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.

Simar, L. (2016). Le « *tax shift* » ou glissement fiscal. *Courrier hebdomadaire du CRISP*, 2319-2320, 1–64.

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