Demography and the Composition of Taxes

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Abstract

This paper analyzes the impact of population aging on the composition of taxes in a political economy model where the median voter is pivotal. As in Razin, Sadka and Swagel (2002) increased share of retirees leads to smaller income taxes. On the other hand expenditure taxes decline with increasing share of retirees. Importantly, population aging conceivably increases demand for expenditure taxes rather than income taxes. This idea is tested in a panel of over 100 countries. Consistent with the theory, the data exhibit a robust negative correlation between the extent of taxes on income relative to taxes on expenditure, and the fraction of retired population.

Keywords: population aging, tax structure

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1 Introduction

How does population aging affect the political economy of fiscal policy? A political economy model developed by Razin, Sadka and Swagel (2002) (hereafter RSS), building on Meltzer and Richard (1981) and Saint-Paul (1994), theorizes that increases in the dependency ratio lead to lower labor tax rates and a reduction in the generosity of social transfers in democracies. In RSS the role of government is to redistribute funds emanating solely from income taxes to both workers and retirees, and under democracy the equilibrium tax rate is that preferred by the median voter. In the case of positive population growth the median voter is a worker. A greater dependency ratio implies a fall in the population growth rate, and lowers income taxes and transfers.

Empirical evidence generally has not supported the RSS hypothesis. For example OECD countries have relatively large fractions of retired population but with larger welfare states. Disney (2007), Sanz and Velazquez (2007), and Shelton (2008) all find a positive relationship between population aging and the size of the welfare state. In response to this puzzle, a new theoretical literature (Galasso and Profeta, 2007; Simonovits, 2007; Mateos-Planas, 2008) has appeared through which a larger proportion of retirees can be accompanied with higher taxes and more generous social transfers under democracy.

The theory proposed in this paper is also motivated by recent rises in taxes on goods and services especially in an era of aging, and moreover the taxable labor income share has declined in recent years (see Azmat et al., 2012; Karabarbounis and Neiman, 2014). Revenue sources outside of income taxes (i.e. expenditure taxes) are thus empirically an increasingly important component of total revenue. This is potentially a paradox as it might have been expected that countries with larger fractions of retired populations would have higher income taxes and lower expenditure taxes, reflecting the increased political clout of the retired population who presumably would prefer income taxes.

Given the increased importance of expenditure taxes this paper examines how population aging might affect the composition of taxes. Despite the fact that there is an enormous literature focusing on optimal taxation, starting with Diamond and Mirrlees (1971), relatively little of this literature provides a positive analysis of political economy determination of the tax composition. One related work by Pickering and Rajput (2015) links inequality to the composition of taxes. Even if related work analyzes the adoption of tax instruments in a historical study and development process (see Aidt and Jensen, 2009; Keen and Lockwood, 2010), it still neglects the effect of demography on the adoption process in general.

In an overlapping generations model, taxes are levied on both income and expenditure, which finance redistribution, with a balanced budget period by period. As in Meltzer and Richard (1981) the choice of the median voter is the unique Condorcet winner. Though here the policy problem is multidimensional, the ideal policy mix across individuals is still one dimensional in income according to the condition of intermediate preferences identified by Grandmont (1978). In the case of positive rate of population growth the median voter who is pivotal in determining political equilibrium tax rates is a young individual.

The argument is related to that of RSS in that an increased fraction of retirees in the population paradoxically leads to smaller income taxes. On the other hand expenditure taxes decline with increasing share of retirees. Importantly, the result relating to the composition of taxes is novel. This paper defines the composition of taxes as the extent of taxes on income relative to taxes on expenditure. Increases in the proportion of retirees lead to increases in expenditure taxes relative to income taxes, since the working-age population (including the median voter) wants to get the retired population to pay the expenditure taxes.

The relationship between population aging and the extent of taxes on income relative to taxes on expenditure is investigated empirically using a panel of over 100 countries. Following Pickering and Rajput (2015) the dependent variable is constructed by the ratio of taxes on income, profits and capital gains (as a share of revenue) and taxes on goods and services (as a share of revenue), and the measure of population aging is the percentage of the population over the age of 65. These data are all taken from the World Development Indicators database. Our empirical analysis reports results from annual data and cross-country regressions using within-country averages. This econometric analysis of cross-country estimation at least has the advantage of addressing potential cyclicality in the data. Moreover we also separately examine how different categories of tax measures respectively co-move with the proportion of retirees. Consistent with our theory, in the empirical analysis the extent of taxes on income relative to taxes on expenditure is found to be negatively associated with the fraction of retired population. This relationship is robust across different econometric specifications employed. In the panel estimation with fixed effects, a one standard deviation increase in the fraction of retired population, is statistically associated with a fall of 0.63 in the ratio of income to expenditure taxes, holding all else equal. The magnitude of this estimated correlation is sizable - implying more than a half of the raw standard deviation in the policy variables. This negative relationship holds up significantly in countries with higher degrees of democracy, in support of the mechanism proposed in our paper.

The next section theoretically analyzes how the composition of taxes changes with population aging. Section 3 contains the empirical work, and section 4 concludes.

2 The Model

In this section, this paper formally analyzes the impact of population aging on the composition of taxes. The model extends RSS to include expenditure taxes as well as income taxes. This paper considers an overlapping generations model with population growth rate at n, where individuals live for only two periods: a working (young) period and a retirement (old) period. The utility u of an individual born in period t depends on his consumption in two periods ($c_{1,t}$ and $c_{2,t+1}$):

$$u_t = u(c_{1,t}) + \beta u(c_{2,t+1}) \tag{1}$$

where parameter β lies within (0, 1), and utility function $u(c)$ is strictly concave. Due to the presence of an expenditure (or consumption) tax $\tau_{c,t}$, in period t consumption $c_{1,t}$ is less than expenditure $x_{1,t}$,

$$c_{1,t} = (1 - \tau_{c,t})x_{1,t}. \tag{2}$$

First-period expenditure $x_{1,t}$ is

$$x_{1,t} = (1 - \tau_{y,t})y_{1,t} + r_{1,t} - S_t \tag{3}$$

where income $y_{1,t}$ is taxed at linear income tax rate $\tau_{y,t}$, $r_{1,t}$ is lump-sum redistribution, and S_t denotes this individual savings in period t. Second-period expenditure $x_{2,t+1}$ is

$$x_{2,t+1} = (1 + R)S_t + r_{2,t+1} \tag{4}$$

where R denotes interest rate, and $r_{2,t+1}$ is lump-sum redistribution in period $t + 1$.

By (1), (2), (3), and (4) the utility of an individual born in period t thus yields,

$$u_t = u\{(1-\tau_{c,t})[(1-\tau_{y,t})y_{1,t} + r_{1,t} - S_t]\} + \beta u\{(1-\tau_{c,t+1})[(1+R)S_t + r_{2,t+1}]\} \qquad (5)$$

which indicates that the policy problem is thus multidimensional (τ_c and τ_y). This model assumes $y_{1,t} = \bar{y}_t$ here, while in practice and in order to conceivably obtain positive tax rates we should incorporate hetergeneity in income. Given that $y_{1,t} = \bar{y}_t$, the preferred policy of the median voter is still Condorcet winner even though the policy problem is two-dimensional.

Each individual therefore chooses saving so as to maximize (5). The first-order condition for saving is:

$$-(1-\tau_{c,t})\frac{\partial u}{\partial c_{1,t}} + \beta(1-\tau_{c,t+1})(1+R)\frac{\partial u}{\partial c_{2,t+1}} = 0. \qquad (6)$$

The budget of the government is balanced period by period. Redistribution is financed by consumption and income tax revenue, and is paid to both working and retired people as in RSS,

$$r_t N_0[(1+n)^{t-1} + (1+n)^t] = \tau_{c,t}\bar{x}_t N_0[(1+n)^{t-1} + (1+n)^t] + \tau_{y,t}\bar{y}_t N_0(1+n)^t \qquad (7)$$

where N_0 is the initial size of young individuals, and $\bar{x}_t$ and $\bar{y}_t$ are the average levels of expenditure and income in period t. Further expenditure equals income at the aggregate level in period t,

$$\bar{x}_t N_0[(1+n)^{t-1} + (1+n)^t] = \bar{y}_t N_0(1+n)^t. \qquad (8)$$

Combining (7) and (8), the lump-sum redistribution equals

$$r_t = (\tau_{c,t} + \tau_{y,t})\frac{1+n}{2+n}\bar{y}_t. \tag{9}$$

In order to capture the spirit of Meltzer and Richard (1981), mean income is modeled to be declining in taxes as in Pickering and Rockey (2011) and Pickering and Rajput (2015),

$$\bar{y}_t = y_t^*(1 - \frac{\delta_y \tau_{y,t}\bar{y}_t}{y_t^*} - \frac{\delta_c \tau_{c,t}\bar{y}_t}{y_t^*}) \tag{10}$$

where y_t^* is potential income, and $0 < \delta_y < 1$ and $0 < \delta_c < 1$ capture the sensitivity of actual income respectively to income and expenditure taxes. The parameters δ_y and δ_c also represent deadweight losses, either as the result of the costs of tax collection and/or their influences on economic activity. High values of δ_y and δ_c indicate high costs for taxes collection or low levels of tax base.

This model now turns to the policy-setting decision. As long as the rate of population growth, $n > 0$, the condition that there are more young individuals than old individuals (or more working individuals than retired individuals) always holds up. This implies that the pivotal voter in determining political equilibrium tax rates is still among the working-age population. Maximization of (5) with respect to τ_y yields:

$$-y + \frac{\partial r}{\partial \tau_y} = 0 \tag{11}$$

and maximization of (5) with respect to τ_c yields:

$$(1-\tau_c)\frac{\partial r}{\partial \tau_c} - [(1-\tau_y)y + r - S] = 0. \tag{12}$$

The mathematical derivations are contained in the appendix. Note that the choices of income tax and expenditure tax are not affected by saving due to the envelope condition (eq. [6]). Combining equations (11) and (12), given (9) and (10), yields income tax rate

$$\tau_y = \frac{(\frac{1+n}{2+n}-1)[(\frac{1+n}{2+n}+1)\delta_y - (\frac{1+n}{2+n}-1)\delta_c] - \delta_y(\frac{1+n}{2+n}-1)[\frac{1+n}{2+n}(\delta_y-\delta_c) - (\frac{1+n}{2+n}-1)] - \frac{\delta_y^2 S}{y}\frac{1+n}{2+n}}{\delta_y \frac{1+n}{2+n}[(\frac{1+n}{2+n}+1)\delta_y - (\frac{1+n}{2+n}-1)\delta_c]} \tag{13}$$

and expenditure tax rate

$$\tau_c = \frac{(\frac{1+n}{2+n}-1)[\frac{1+n}{2+n}(\delta_y-\delta_c) - (\frac{1+n}{2+n}-1)] + \frac{\delta_y S}{y}\frac{1+n}{2+n}}{\frac{1+n}{2+n}[(\frac{1+n}{2+n}+1)\delta_y - (\frac{1+n}{2+n}-1)\delta_c]}. \tag{14}$$

Again the appendix contains more mathematical detail on how (13) and (14) are derived. Note that $\tau_y < 0$, and no restrictions are required in order to ensure $\tau_c < 1$. Income taxes can be positive if heterogeneous income is contained. It is trivially clear from (2) that the median voter will not want to set expenditure taxes in excess of 100% as this will mean negative consumption. $\tau_c > 0$ requires $\frac{S}{y} > \frac{(1+n)(\tau_y-\tau_c)+1}{(1+n)(2+n)\tau_y}$. For the median voter to desire positive expenditure taxes at all, there has to be a threshold minimum of $\frac{S}{y}$. The proof of these is in the appendix.

The ratio of income to expenditure taxes thus is:

$$\frac{\tau_y}{\tau_c} \equiv T = \frac{(\frac{1+n}{2+n} - 1)[(\frac{1+n}{2+n} + 1)\delta_y - (\frac{1+n}{2+n} - 1)\delta_c]}{\delta_y(\frac{1+n}{2+n} - 1)[\frac{1+n}{2+n}(\delta_y - \delta_c) - (\frac{1+n}{2+n} - 1)] + \frac{\delta_y^2 S}{y}\frac{1+n}{2+n}} - 1. \tag{15}$$

The derivative of equation (15) with respect to population growth rate yields the proposition 1, for which details are available in the appendix. Since the saving ratio $\frac{S}{y}$ is the decision of each individual, which we take as given, it follows that $\frac{S}{y}$ is independent of n.

Proposition 1. *The ratio of income to expenditure taxes rises as the rate of population growth rises, and the ratio falls as n falls, i.e.,*

$$\frac{dT}{dn} > 0. \tag{16}$$

Proposition 1 is straightforward but novel. The derivative of the ratio of income to consumption taxes with respect to n is positive. In other words, increases in the fraction of retired population (falls in population growth rate) lead to increases in consumption taxes relative to income taxes. The reason is that as the fraction of retired population increases, the working-age population (including the median voter) wants to get the retired population to pay the consumption taxes.

It is also of interest to see how income taxes and consumption taxes separately respond to an increase in the population growth rate. The derivative of equation (13) with respect to n yields the proposition 2, and the derivative of equation (14) with respect to n yields the proposition 3. In order to obtain positive income taxes using (12) given (9), (10) and τ_y as a parameter yields expenditure tax rate, then its derivative with respect to n yields the proposition 4. Again details are available in the appendix.

Proposition 2. *The income tax rate rises as the rate of population growth rises.*

Proposition 3. *The expenditure tax rate rises as the rate of population growth rises.*

Proposition 4. *The expenditure tax rate rises as the rate of population growth rises in the case of fixed income taxes.*

The income taxes case is more straightforward. In this instance, an increase in the rate of population growth increases the political economy equilibrium income tax rate ($\frac{d\tau_y}{dn} > 0$), with consistent underpinning as the hypothesis in RSS where redistribution is solely financed by income taxes. On the other hand the impact of increasing n on expenditure taxes is not distorted by negative income taxes. An increase in the rate of population growth also increases the equilibrium expenditure tax rate ($\frac{d\tau_c}{dn} > 0$). Figure 1 depicts how income and expenditure taxes change with population growth under the (arbitrary) parameterization $\delta_y = 0.9$, $\delta_c = 0.3$ and $S = 0.1y_d$. The position of taxes curves might change with different values of parameters, but the key properties still hold under the condition projected. Both income taxes and expenditure taxes increase monotonically with n, though negative. Figure 2 indicates that expenditure taxes could be positive as long as the saving ratio is high enough (i.e. $S = 0.8y_d$ here).

Importantly $\frac{dT}{dn} > 0$ always holds at different values of n as the curve of income tax has higher level of gradient compared to the expenditure tax curve. This conversely provides an explanation of the paradox that expenditure taxes have been conceivably rising relative to income taxes even though the proportion of old (retired) people has been increasing as well.

3 Evidence

The main agenda in this section is to test the theory of our model - whether and how the ratio of income to expenditure taxes across countries and time systematically changes with population growth, or in other words the fraction of retired population. This empirical analysis focuses on a panel of over 100 countries with various degree of democracy throughout the sample. Cross-country annual data on income and expenditure taxes revenue are available over the period 1990-2012 from the World Development Indicators (hereafter WDI). This paper also reports results from cross-country regressions with data measured by within-country averages. This econometric analysis at least has the advantage of addressing potential cyclicality in the data. Moreover we separately examine how different categories of tax measures respectively co-move with the fraction of retired population.

Following Pickering and Rajput (2015), the main dependent variable is the ratio of income taxes to expenditure taxes, $T = \frac{\tau_y}{\tau_c}$, constructed by the ratio of taxes on income, profits and capital gains (as a percentage share of tax revenue) and taxes on goods and services (as a percentage share of tax revenue). Both are extracted from the WDI database. In practice within countries rates of tax vary with different types of income and goods, but the measure of ratio proposed is a way to capture the extent to which taxes are levied on income relative to expenditure. Due to the relatively small value in the data of taxes on goods and services we use the natural logarithm of T, $\ln(T)$, in the below regression analysis. Our argument predicts that the extent of taxes on income relative to taxes on expenditure declines with increased proportion of retired population.

The measure of the proportion of retired population used in this paper is the percentage of the population over the age of 65 (denoted $PROP65$), which is also taken from the WDI database. This measure of the retired fraction is preferable to the dependency ratio used by RSS. The measure of dependency ratio includes children as well as retirees which would have different impacts on taxes as shown by Shelton (2008).

One important determinant of the composition of taxes is the level of development (Ram, 1987), so we include the natural logarithm of GDP per capita in constant chained PPP US$ ($\ln(y)$), taken from the Penn World Tables, as a first control in the regression analysis. As another measure of the development level and institutional capacity OECD membership (denoted $OECD$) is also employed as a further control variable. To fully capture demographic effects, the econometric analysis also includes the percentage of the population between 15 and 64 years of age (denoted $PROP1564$, also from the WDI database) as an additional control.[1] Another potential determinant of the composition of taxes is inequality (Pickering and Rajput, 2015), taken from the University of Texas Inequality Project′s Estimated Household Income Inequality data of Galbraith and Kum (2005), so the inequality measure (denoted $UTIP$) is also included as a control.

Governments collect tax revenue through means beyond taxation on income and consumption. One crucial source is the revenue from import duties and tariffs due to openness (Rodrik, 1998). Thus the trade share (the sum of exports and imports as a percentage of GDP - denoted $TRADE$) is also employed in the regression analysis. Apart from these control variables the natural logarithm of the total population size (denoted $\ln(POP)$) is included as well, to some extent capturing any scale (dis-)economies related to particular forms of tax collection. These data (i.e. trade and population) are also taken from the WDI

[1]Robustness checks by excluding $PROP1564$ still confirm our prediction (see tables 6-9).

database.

There may also be cyclical movements in policy variables. To remove the potential problem the regression analysis employs the Persson and Tabellini (2003) cyclical control variables. For this reason the output gap (the difference between the aggregate output and its trend value in percentage - denoted $YGAP$) is included as a further control. The policy variables may be affected by the degree of democracy through various channels, so the democracy score (with -10 denoting the highest level of autocracy, and 10 denoting the highest level of democracy) provided by the Polity IV project is included as a final control, to account for the quality of democracy (denoted $POLITY2$).

Table 1 contains descriptive statistics of the variables used in the regression analysis below. Note that there is considerable dispersion in the means of how countries raise their tax revenue. Over the sample period taxes on income occupy a smaller fraction of total revenue than taxes on goods and services. This indicates that the capacity to raise revenue through income taxes is normally limited in those countries with low income. For instance in the OECD members, taxes on income are approximately 32% of total revenue, whilst the rest countries have much smaller income taxes, accounting for just 20% of total revenue on average.

The $PROP65$ data cover 155 countries, and numerically range from 1.37 (Qatar) to 18.39 (Italy) on average, with higher numbers meaning greater proportion of retired population. Notably, these data are positively correlated with GDP per capital across the sample, with a correlation coefficient of around 0.72. Richer countries have greater retired fraction of the population than poorer countries. This thus has an incentive to include controls for the level of economic development, or the measure of retired fraction may become a proxy for other drivers of policy variables.

Columns 1 and 2 of table 2 contain estimation results examining the impact of population aging on the ratio of income to expenditure taxes using OLS. Column 1 is a simple specification with the fraction of retired population ($PROP65$) and a number of control variables using annual data. Column 2 extends the regression of column 1 to include time effects. The use of time effects will substantially control for the potential problem of secular trend. In these specifications the sign of the fraction of retired population is negative in all cases, and all are statistically significant at the 1% level. This is consistent with our theory - an increase in the retired fraction increases in expenditure taxes relative to income taxes. Columns 3 and 4 repeat the analysis of columns 1 and 2 using country fixed effects panel estimation instead. The results using panel estimation support those found using OLS estimation. The estimated statistical significance of the fraction of retired population is unaffected and even remains at the 5% level in column 3. Using the estimate from column 3 of table 2, a one standard deviation increase in the fraction of retired population, is statistically associated with a fall of 0.63 in the ratio of income to expenditure taxes, holding all else equal. The magnitude of this estimated correlation is sizable - implying more than a half of the raw standard deviation in the policy variables.

It is natural to investigate whether or not the results reported change with the degree of democracy, under the premise that our theory is based on the median voter framework. Table 3 thus extends the regression results to include different levels of democracy in columns 1 and 2 using panel estimation with annual data. Column 1 contains results for countries with stronger democratic credentials (i.e. with the democracy score $POLITY2$ of 8 or above over the sample period). Column 2 contains results for countries with weaker democratic credentials (i.e. with $POLITY2$ of less than 8). When the sample is separated it becomes clear that the negative relationship between the fraction of retired population and the ratio of income to expenditure taxes holds only in the subsample of democratic regimes. This is in line with our theory, which relies on a complete franchise. In column 1 the p-value for the estimated coefficient for the fraction of retired population is 1.1%, and the estimated effect is sizable: A one standard deviation increase in the fraction of retired population is statistically associated with the policy variable $\ln(T)$ which is smaller by 0.78. It is also of interest to ask whether there are other stories (i.e. Laffer curve) explaining an era of increasing expenditure taxes. Columns 3 and 4 split the sample with stronger democratic credentials by income taxes (determined by the median value of income taxes). Statistical significance here implies that the estimates are stable across these subsamples, which in turn supports our theory proposed.

It is also natural to ask whether the results are specific to a group of countries or change with level of development. Table 4 thus extends the regression results to include whether or not countries are with OECD membership in columns 1 and 2 using panel estimation with annual data. As can be seen in all cases, the ratio of income to expenditure taxes is negatively correlated with the fraction of retired population. Indeed, this negative relationship holds significantly only in the group of non-OECD countries. It is also of interest to see whether the results reported vary with level of development. Columns 3 and 4 split the sample with higher income levels by GDP per capita (determined by the median value of GDP per capita). Statistical significance in the group of countries with higher income level implies that rich countries are approximately approaching the top of Laffer curve, and thus they presumably prefer to switch revenue from income taxes to expenditure taxes. In column 3 the p-value for the estimated coefficient for the fraction of retired population is 4.2%, and the estimated effect is sizable: a one standard deviation increase in the fraction of retired population, is statistically associated with a reduction of 0.61 in the policy variable $\ln(T)$.

In columns 1 and 2 of table 5 results are presented respectively for the extent to which taxes are levied on income, τ_y, and the extent to which taxes are raised through expenditure, τ_c. An increase in the proportion of retired population is found to be negatively related with taxes on income though at a very weak significant level, whilst positively related with taxes on expenditure and even statistically significant at the 1% level. In the case of income taxes the weak estimated relationship shows a very slight variation in income taxes within countries over the sample period. This in turn has an incentive to examine the relationship between population aging and the extent to which taxes are levied on income relative to expenditure, instead of income taxes only. Column 3 contains cross-country estimation result for regression examining the effect of population aging on the ratio of income to expenditure taxes. The estimated effect using cross-country regression still remains negative and is statistically significant at the 1% level. Using this estimate, a one standard deviation increase in the the proportion of retired population, is statistically associated with a reduction of 0.46 in the policy variable $\ln(T)$. In columns 4 and 5 results are again presented respectively for τ_y and τ_c whilst using cross-country estimation. As in RSS increased proportion of retired population leads to smaller income taxes. While increased proportion of retired population is found to be positively related with expenditure taxes but at a very weak significant level unfortunately.

In columns 4 and 5 of table 5 the results relating to the control variables in the case of income taxes are of interest. One regularity is that consistent with Rodrik (1998) there is a clear positive relationship between income taxes and trade (though not statistically strong), which probably indicate greater potential to tax in countries with higher level of openness. In addition as shown by Besley and Persson (2014) there is a positive relationship with income per capita, which likely indicates greater potential to tax in richer countries. There are some differences between the results relating to the controls for income taxes and expenditure taxes. For instance trade is negatively related to τ_c, which implies that globalization might constrain the capacity to raise revenue through taxes on goods and services in line with Baunsgaard and Keen (2010). Further in contrast to τ_y there is a negative relationship between τ_c and income per capita, which reflects the ability to collect revenue through taxes on income in particular. Interestingly the extent of democracy is positively associated with both τ_y and τ_c. This probably means that revenue relied on τ_y and τ_c is increasingly related with the stronger level of democracy.

4 Conclusion

This paper analyzes how population aging affects the composition of taxes. In an overlapping generations model taxes levied on both income and expenditure, solely finance redistribution, and this budget is balanced period by period. As in Meltzer and Richard (1981) the median voter is the unique Condorcet winner even though the policy problem is multidimensional.

Consequently, increased share of retirees leads to smaller income taxes and expenditure. Importantly the result relating to the composition of taxes, defined as the extent of taxes on income relative to taxes on expenditure, is novel. Increases in the fraction of retired population conceivably lead to increases in expenditure taxes relative to income taxes, because the working-age population (including the median voter) wants to get the retirees to pay the expenditure taxes.

The relationship between population aging and the composition of taxes is tested in a panel of over 100 countries, including the fraction of retired population as a potential explanatory variable. Data for tax composition and the fraction of retired population are all from the WDI database. Consistent with our theory, the extent of taxes on income relative to taxes on expenditure is found to be negatively associated with the fraction of retired population. This new finding holds across various econometric specifications employed. In particular when the sample is splitted by the degree of democracy, the results found hold up significantly in countries with strong democratic credentials.

Appendix

Derivation of equations (11) and (12)

The problem of the pivotal voter is to choose income tax rate so as to maximize:

$$u_t = u\{(1-\tau_{c,t})[(1-\tau_{y,t})y_{1,t} + r_{1,t} - S_t]\} + \beta u\{(1-\tau_{c,t+1})[(1+R)S_t + r_{2,t+1}]\}$$

and the first-order condition for the pivotal voter with respect to income tax rate is:

$$\frac{\partial S_t}{\partial \tau_{y,t}}[-(1-\tau_{c,t})\frac{\partial u}{\partial c_{1,t}} + \beta(1-\tau_{c,t+1})(1+R)\frac{\partial u}{\partial c_{2,t+1}}] + (1-\tau_{c,t})(-y_{1,t} + \frac{\partial r_{1,t}}{\partial \tau_{y,t}})\frac{\partial u}{\partial c_{1,t}} = 0.$$

Using the envelope condition (eq. [6]) and then simplifying yields equation (11) in the text.

The problem of the pivotal voter is to choose expenditure tax rate so as to maximize:

$$u_t = u\{(1-\tau_{c,t})[(1-\tau_{y,t})y_{1,t} + r_{1,t} - S_t]\} + \beta u\{(1-\tau_{c,t+1})[(1+R)S_t + r_{2,t+1}]\}$$

and the first-order condition for the pivotal voter with respect to expenditure tax rate is:

$$(1-\tau_{c,t})\frac{\partial r_{1,t}}{\partial \tau_{c,t}}\frac{\partial u}{\partial c_{1,t}} - [(1-\tau_{y,t})y_{1,t} + r_{1,t} - S_t]\frac{\partial u}{\partial c_{1,t}} + \frac{\partial S_t}{\partial \tau_{c,t}}[-(1-\tau_{c,t})\frac{\partial u}{\partial c_{1,t}} + \beta(1-\tau_{c,t+1})(1+R)\frac{\partial u}{\partial c_{2,t+1}}] = 0.$$

Using the envelope condition (eq. [6]) and then simplifying yields equation (12) in the text.

Derivation of equations (13) and (14)

From (11), given (9) and (10), we have

$$-y + \frac{1+n}{2+n}\bar{y} - (\tau_c + \tau_y)\frac{1+n}{2+n}\delta_y\bar{y} = 0.$$

Given that $y = \bar{y}$ and rearranging yields

$$\tau_c + \tau_y = \frac{\frac{1+n}{2+n} - 1}{\frac{1+n}{2+n}\delta_y}.$$

From (12), given (9) and (10), we have

$$(1-\tau_c)[\frac{1+n}{2+n}\bar{y} - (\tau_c + \tau_y)\frac{1+n}{2+n}\delta_c\bar{y}] = (1-\tau_y)y + (\tau_c + \tau_y)\frac{1+n}{2+n}\bar{y} - S.$$

Given that $y = \bar{y}$, and dividing through by y this yields

$$(1-\tau_c)[\frac{1+n}{2+n} - (\tau_c + \tau_y)\frac{1+n}{2+n}\delta_c] = (1-\tau_y) + (\tau_c + \tau_y)\frac{1+n}{2+n} - \frac{S}{y}.$$

Substituting for $(\tau_c + \tau_y)$ and τ_y using $\tau_c + \tau_y = \frac{\frac{1+n}{2+n} - 1}{\frac{1+n}{2+n}\delta_y}$ implies

$$(1-\tau_c)[\frac{1+n}{2+n} - \frac{\frac{1+n}{2+n} - 1}{\delta_y}\delta_c] = 1 + \tau_c - \frac{\frac{1+n}{2+n} - 1}{\frac{1+n}{2+n}\delta_y} + \frac{\frac{1+n}{2+n} - 1}{\delta_y} - \frac{S}{y}.$$

Solving for τ_c yields equation (14) in the text. Substituting (14) into $\tau_y = \frac{\frac{1+n}{2+n} - 1}{\frac{1+n}{2+n}\delta_y} - \tau_c$ yields equation (13) in the text.

Proof that $\tau_y < 0$

Simplifying (13) we have

$$\tau_y = \frac{-[(3+2n)\delta_y + \delta_c] + \delta_y[(1+n)(\delta_y - \delta_c) + 1] - \frac{\delta_y^2 S}{y}(1+n)(2+n)}{\delta_y(1+n)[(3+2n)\delta_y + \delta_c]}.$$

Given minimum value $S = 0$ whether τ_y is positive or negative will depend on:

$$\delta_y[(1+n)(\delta_y - \delta_c) + 1] - [(3+2n)\delta_y + \delta_c] \gtreqless 0.$$

Thus LHS leads to

$$(1+n)(\delta_y - \delta_c)\delta_y + \delta_y - (3+2n)\delta_y - \delta_c.$$

This equals

$$[(1+n)\delta_y + 1](\delta_y - \delta_c) - (3+2n)\delta_y.$$

Therefore

$$[(1+n)\delta_y + 1]\delta_y - (3+2n)\delta_y - [(1+n)\delta_y + 1]\delta_c.$$

Thus we get

$$[(1+n)\delta_y - 2(1+n)]\delta_y - [(1+n)\delta_y + 1]\delta_c.$$

Thus we have

$$(1+n)(\delta_y - 2)\delta_y - [(1+n)\delta_y + 1]\delta_c < 0.$$

This holds unambiguous, and shows that $\tau_y < 0$.

Derivation of condition that $\tau_c > 0$

From (14), for $\tau_c > 0$ we have

$$(\frac{1+n}{2+n} - 1)[\frac{1+n}{2+n}(\delta_y - \delta_c) - (\frac{1+n}{2+n} - 1)] + \frac{\delta_y S}{y}\frac{1+n}{2+n} > 0.$$

Thus this leads to

$$-[(1+n)(\delta_y - \delta_c) + 1] + \frac{\delta_y S}{y}(1+n)(2+n) > 0.$$

Therefore

$$\frac{S}{y} > \frac{(1+n)(\delta_y - \delta_c) + 1}{(1+n)(2+n)\delta_y}.$$

Proof that $\tau_c < 1$

Simplifying (14) we have

$$\tau_c = \frac{-[(1+n)(\delta_y - \delta_c) + 1] + \frac{\delta_y S}{y}(1+n)(2+n)}{(1+n)[(3+2n)\delta_y + \delta_c]}.$$

For $\tau_c < 1$ we have

$$-[(1+n)(\delta_y - \delta_c) + 1] + \frac{\delta_y S}{y}(1+n)(2+n) < (1+n)[(3+2n)\delta_y + \delta_c].$$

Therefore this requires

$$(1+n)(3+2n)\delta_y + (1+n)\delta_c - \frac{\delta_y S}{y}(1+n)(2+n) + (1+n)(\delta_y - \delta_c) + 1 > 0.$$

Thus this requires

$$(1+n)\delta_y[(3+2n) - (2+n)\frac{S}{y}] + (1+n)\delta_y + 1 > 0.$$

This holds unambiguous.

Proof that $\frac{dT}{dn} > 0$

Simplifying (15) we have

$$T \equiv \frac{\tau_y}{\tau_c} = \frac{-[(3+2n)\delta_y + \delta_c]}{-\delta_y[(1+n)(\delta_y - \delta_c) + 1] + \frac{\delta_y^2 S}{y}(1+n)(2+n)} - 1$$

$$= \frac{(3+2n)\delta_y + \delta_c}{[\delta_y(\delta_y - \delta_c) - \frac{\delta_y^2 S}{y}(2+n)](1+n) + \delta_y} - 1.$$

The first-order condition with respect to n yields:

$$\frac{dT}{dn} = \frac{2\delta_y\{[\delta_y(\delta_y - \delta_c) - \frac{\delta_y^2 S}{y}(2+n)](1+n) + \delta_y\}}{\{[\delta_y(\delta_y - \delta_c) - \frac{\delta_y^2 S}{y}(2+n)](1+n) + \delta_y\}^2}$$

$$\frac{-[(3+2n)\delta_y + \delta_c][\delta_y(\delta_y - \delta_c) - \frac{\delta_y^2 S}{y}(2+n) - \frac{\delta_y^2 S}{y}(1+n)]}{\{[\delta_y(\delta_y - \delta_c) - \frac{\delta_y^2 S}{y}(2+n)](1+n) + \delta_y\}^2}.$$

After some algebra we have

$$\frac{dT}{dn} = \frac{2\delta_y^2 - (\delta_y + \delta_c)[\delta_y(\delta_y - \delta_c) - \frac{\delta_y^2 S}{y}(2+n)] + [(3+2n)\delta_y + \delta_c]\frac{\delta_y^2 S}{y}(1+n)}{\{[\delta_y(\delta_y - \delta_c) - \frac{\delta_y^2 S}{y}(2+n)](1+n) + \delta_y\}^2}.$$

Therefore we have

$$\frac{dT}{dn} = \frac{2\delta_y^2 - \delta_y(\delta_y^2 - \delta_c^2) + (\delta_y + \delta_c)\frac{\delta_y^2 S}{y}(2+n) + [(3+2n)\delta_y + \delta_c]\frac{\delta_y^2 S}{y}(1+n)}{\{[\delta_y(\delta_y - \delta_c) - \frac{\delta_y^2 S}{y}(2+n)](1+n) + \delta_y\}^2}$$

$$= \frac{\delta_y^2(2 - \delta_y) + \delta_y\delta_c^2 + (\delta_y + \delta_c)\frac{\delta_y^2 S}{y}(2+n) + [(3+2n)\delta_y + \delta_c]\frac{\delta_y^2 S}{y}(1+n)}{\{[\delta_y(\delta_y - \delta_c) - \frac{\delta_y^2 S}{y}(2+n)](1+n) + \delta_y\}^2} > 0.$$

Proof that $\frac{d\tau_y}{dn} > 0$

Simplifying (13) we have

$$\tau_y = \frac{-[(3+2n)\delta_y + \delta_c] + \delta_y[(1+n)(\delta_y - \delta_c) + 1] - \frac{\delta_y^2 S}{y}(1+n)(2+n)}{\delta_y(1+n)[(3+2n)\delta_y + \delta_c]}.$$

The first-order condition with respect to n yields

$$\frac{\partial \tau_y}{\partial n} = \frac{[(3+2n)\delta_y + \delta_c]^2 - (\delta_y - \delta_c)2\delta_y^2(1+n)^2 - (5+4n)\delta_y^2 - \delta_y\delta_c + (\delta_y - \delta_c)\delta_y^2\frac{S}{y}(1+n)^2}{\delta_y(1+n)^2[(3+2n)\delta_y + \delta_c]^2}.$$

This leads to

$$\frac{\partial \tau_y}{\partial n} = \frac{(3+2n)^2\delta_y^2 + 2(3+2n)\delta_y\delta_c + \delta_c^2 - (5+4n)\delta_y^2 - \delta_y\delta_c + (\delta_y - \delta_c)\delta_y^2(1+n)^2(\frac{S}{y} - 2)}{\delta_y(1+n)^2[(3+2n)\delta_y + \delta_c]^2}.$$

Thus we have

$$\frac{\partial \tau_y}{\partial n} = \frac{\delta_y^2(4n^2 + 8n + 4) + \delta_y\delta_c(4n+5) + \delta_c^2 + (\delta_y - \delta_c)\delta_y^2(1+n)^2(\frac{S}{y} - 2)}{\delta_y(1+n)^2[(3+2n)\delta_y + \delta_c]^2}.$$

Therefore

$$\frac{\partial \tau_y}{\partial n} = \frac{\delta_y^2(1+n)^2[4 + (\delta_y - \delta_c)(\frac{S}{y} - 2)] + \delta_y\delta_c(4n+5) + \delta_c^2}{\delta_y(1+n)^2[(3+2n)\delta_y + \delta_c]^2} > 0.$$

Proof that $\frac{d\tau_c}{dn} > 0$ in the case of homogeneous income

Simplifying (14) we have

$$\tau_c = \frac{-[(1+n)(\delta_y - \delta_c) + 1] + \frac{\delta_y S}{y}(1+n)(2+n)}{(1+n)[(3+2n)\delta_y + \delta_c]}.$$

The first-order condition with respect to n yields

$$\frac{\partial \tau_c}{\partial n} = \frac{-(\delta_y - \delta_c)(1+n)[(3+2n)\delta_y + \delta_c] + [(1+n)(\delta_y - \delta_c) + 1][(3+2n)\delta_y + \delta_c + (1+n)2\delta_y]}{(1+n)^2[(3+2n)\delta_y + \delta_c]^2}.$$

$$\frac{+(\delta_c - \delta_y)\delta_y \frac{S}{y}(1+n)^2}{(1+n)^2[(3+2n)\delta_y + \delta_c]^2}.$$

This leads to

$$\frac{\partial \tau_c}{\partial n} = \frac{[(3+2n)\delta_y + \delta_c] + (1+n)2\delta_y[(1+n)(\delta_y - \delta_c) + 1] + (\delta_c - \delta_y)\delta_y \frac{S}{y}(1+n)^2}{(1+n)^2[(3+2n)\delta_y + \delta_c]^2}.$$

Thus we have

$$\frac{\partial \tau_c}{\partial n} = \frac{\delta_y + \delta_c + (1+n)2\delta_y[(1+n)(\delta_y - \delta_c) + 2] + (\delta_c - \delta_y)\delta_y \frac{S}{y}(1+n)^2}{(1+n)^2[(3+2n)\delta_y + \delta_c]^2}.$$

Then we get

$$\frac{\partial \tau_c}{\partial n} = \frac{\delta_y + \delta_c + (1+n)\delta_y[2(1+n)(\delta_y - \delta_c) + 4 + (1+n)(\delta_c - \delta_y)\frac{S}{y}]}{(1+n)^2[(3+2n)\delta_y + \delta_c]^2}$$

$$= \frac{\delta_y + \delta_c + (1+n)\delta_y[(1+n)(\delta_y - \delta_c)(2 - \frac{S}{y}) + 4]}{(1+n)^2[(3+2n)\delta_y + \delta_c]^2} > 0.$$

Proof that $\frac{d\tau_c}{dn} > 0$ *in the case of fixed income taxes*

Using (12) given (9), (10) and τ_y as a parameter yields

$$\tau_c = \frac{1}{2(1+n)y\delta_c}\{(1+n)y(2+\delta_c-\delta_c\tau_y)$$

$$-\sqrt{(1+n)y((1+n)y(-2+\delta_c(\tau_y-1))^2+4\delta_c(-(2+n)S+y(1+(-1+\delta_c+n\delta_c)\tau_y)))}\}.$$

Maximization of above equation with respect to n yields

$$\frac{\partial\tau_c}{\partial n} = \frac{-S+y(1-\tau_y)}{(1+n)\sqrt{(1+n)y((1+n)y(-2+\delta_c(\tau_y-1))^2+4\delta_c(-(2+n)S+y(1+(-1+\delta_c+n\delta_c)\tau_y)))}}.$$

Due to $-S+y(1-\tau_y) > 0$, $\frac{d\tau_c}{dn} > 0$ in the case of fixed income taxes.

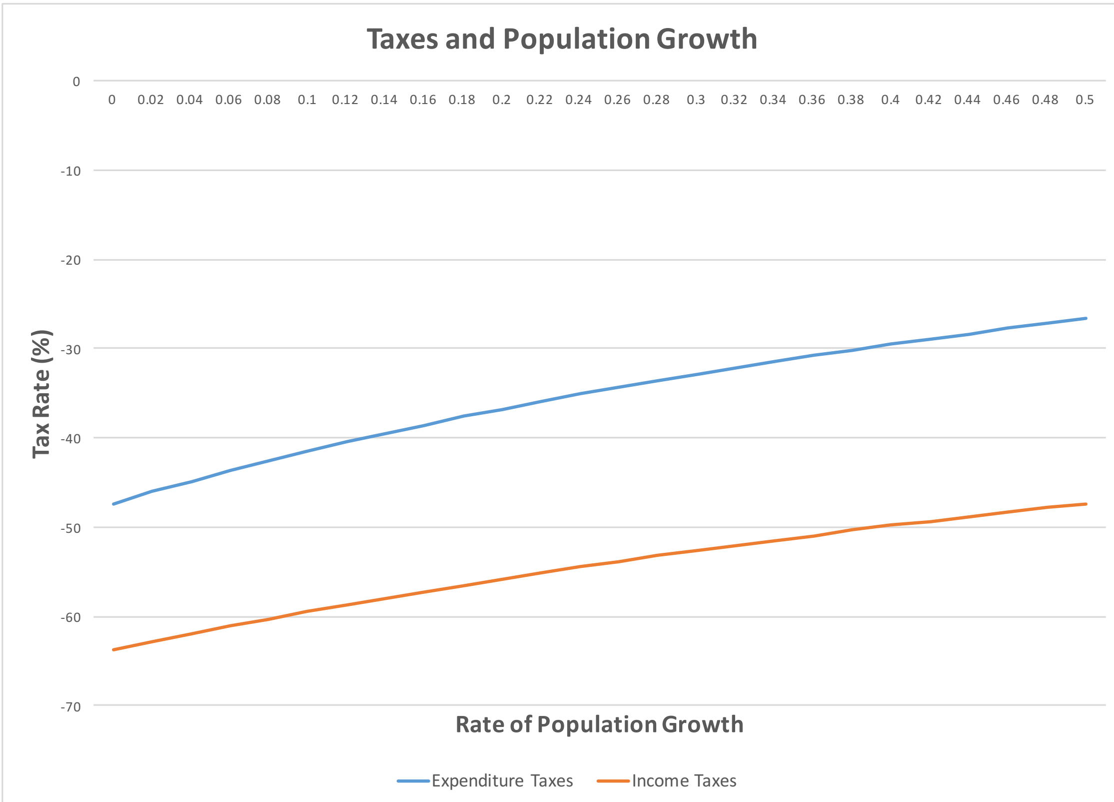

Figure 1: How Income and Expenditure Taxes change with Population Growth, parameterization $\delta_y = 0.9$, $\delta_c = 0.3$ and $S = 0.1y_d$

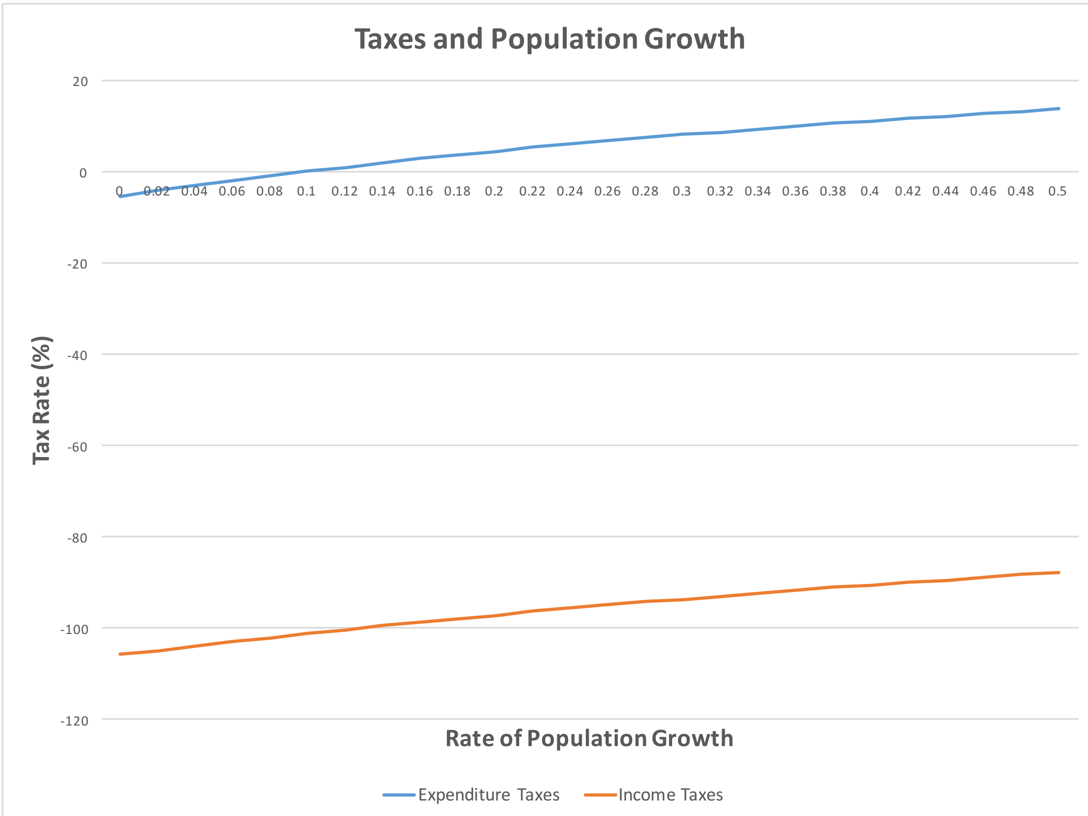

Figure 2: How Income and Expenditure Taxes change with Population Growth, parameterization $\delta_y = 0.9$, $\delta_c = 0.3$ and $S = 0.8y_d$

Table 1. Descriptive Statistics

	obs	mean	std. dev.	min	max
$\ln(T)$	2091	-0.261	1.00	-4.00	5.09
τ_y	2142	22.45	12.75	0.349	75.24
τ_c	2141	29.06	13.76	0.024	89.22
$PROP65$	4633	7.01	4.72	0.335	25.08
$PROP1564$	4633	61.20	7.01	45.29	85.81
$UTIP$	1556	42.79	6.71	22.75	59.96
$\ln(y)$	3652	8.58	1.29	5.03	11.73
$OECD$	5325	0.138	0.345	0	1
$TRADE$	4263	86.94	51.96	0.309	531.7
$\ln(POP)$	5302	15.07	2.35	9.11	21.04
$POLITY2$	3790	3.04	6.69	-10	10
$YGAP$	4668	0	0.034	-0.609	0.505

The data are sample annuals between 1990-2014. τ_y denotes taxes on income, profits and capital gains as a percentage of revenue - taken from the World Development Indicators (WDI). τ_c denotes taxes on goods and services as a percentage of revenue - also taken from the WDI. $T = \frac{\tau_y}{\tau_c}$. $PROP1564$ and $PROP65$ are respectively the proportion of the population aged between 15 and 64, and 65 and above. $UTIP$ is the University of Texas Inequality Projects Estimated Household Income Inequality. y is real GDP at chained PPPs in millions of 2005 US dollars per capita - taken from the Penn World Tables. $OECD$ is a dummy variable denoting OECD membership. $TRADE$ is the sum of exports and imports as a percentage of GDP. POP is the size of country population. $POLITY2$ is a measure of democracy provided by the Polity IV project, with -10 denoting the highest level of autocracy, and 10 denoting the highest level of democracy. $YGAP$ is the difference between the actual output and its trend value in percentage.

Table 2. Basic Estimation Results - the composition of taxes

	(1)	(2)	(3)	(4)
$PROP65$	-0.095	-0.104	-0.133	-0.125
	(0.010)***	(0.010)***	(0.052)**	(0.064)*
$PROP1564$	-0.072	-0.076	-0.052	-0.045
	(0.008)***	(0.009)***	(0.025)**	(0.022)**
$UTIP$	-0.0003	-0.008	-0.013	-0.010
	(0.007)	(0.007)	(0.018)	(0.018)
$\ln(y)$	0.715	0.713	1.072	1.024
	(0.048)***	(0.049)***	(0.231)***	(0.226)***
$OECD$	0.311	0.338	-0.040	0.070
	(0.094)***	(0.097)***	(0.083)	(0.117)
$TRADE$	0.001	0.001	0.001	0.0003
	(0.0006)*	(0.001)	(0.002)	(0.002)
$\ln(POP)$	0.150	0.137	0.002	0.430
	(0.022)***	(0.022)***	(0.610)	(0.948)
$POLITY2$	-0.017	-0.019	-0.013	-0.011
	(0.006)***	(0.006)***	(0.012)	(0.012)
$YGAP$	0.253	-0.132	-0.937	-0.541
	(1.123)	(1.269)	(0.734)	(0.707)
Obs	796	796	796	796
No. Countries			87	87
Data	Annual	Annual	Annual	Annual
Time Effects?	No	Yes	No	Yes
Adj. R-sq	0.41	0.42		
R-sq (within)			0.17	0.20

Notes: Columns (1)-(2) contain results using OLS regressions of the composition of taxes, $\ln(T)$, including $PROP1564$, $UTIP$, $\ln(y)$, $OECD$, $TRADE$, $\ln(POP)$, $POLITY2$, and $YGAP$ as control variables. Columns (3)-(4) contain results using Panel regressions with country fixed effects. Robust standard errors are shown in parentheses. *, **, and *** respectively denote significant levels at 10%, 5% and 1%.

Table 3. Panel Estimation Results with Fixed Effects

	(1)	(2)	(3)	(4)
*PROP*65	-0.165	-0.116	-0.111	-0.124
	(0.063)**	(0.095)	(0.058)*	(0.041)***
*PROP*1564	-0.119	-0.012	-0.106	-0.077
	(0.051)**	(0.017)	(0.050)**	(0.043)*
UTIP	-0.023	0.0003	-0.023	-0.010
	(0.021)	(0.021)	(0.017)	(0.024)
$\ln(y)$	1.628	0.875	0.892	1.595
	(0.465)***	(0.299)***	(0.447)*	(0.296)***
OECD	0.053	-0.050		-0.024
	(0.088)	(0.118)		(0.066)
TRADE	0.001	0.001	0.005	-0.0001
	(0.003)	(0.003)	(0.004)	(0.003)
$\ln(POP)$	1.833	-0.981	0.715	3.173
	(1.081)*	(0.515)*	(1.340)	(1.352)**
*POLITY*2	0.015	-0.011	0.397	-0.154
	(0.156)	(0.021)	(0.365)	(0.072)**
YGAP	-1.749	-0.146	-0.451	-1.664
	(1.405)	(1.015)	(1.129)	(1.408)
Obs	496	300	273	223
No. Countries	56	41	38	32
Data	Annual		Annual	
R-sq (within)	0.28	0.20	0.25	0.35

Notes: Regression specification is the same as column 3 of Table 2. Columns (1) and (2) respectively corresponds to higher and lower democracy levels. Columns (3) and (4) respectively corresponds to higher and lower levels of income taxes.

Table 4. Panel Estimation Results with Fixed Effects

	(1)	(2)	(3)	(4)
$PROP65$	-0.00738	-0.160**	-0.129**	-0.128
	(0.0328)	(0.0787)	(0.0623)	(0.248)
$PROP1564$	0.0655	-0.0538**	-0.0253	-0.100**
	(0.0563)	(0.0268)	(0.0289)	(0.0432)
$UTIP$	-0.00799	-0.0117	-0.0437*	0.0199
	(0.0137)	(0.0191)	(0.0251)	(0.0189)
$\ln(y)$	0.361	1.122***	1.171***	0.967***
	(0.228)	(0.247)	(0.412)	(0.328)
$OECD$			-0.000149	
			(0.0939)	
$TRADE$	-0.00185	0.00119	0.000949	0.00140
	(0.00150)	(0.00280)	(0.00219)	(0.00354)
$\ln(POP)$	0.879	-0.0665	-0.955	0.747
	(1.225)	(0.635)	(1.234)	(0.811)
$POLITY2$	-0.0371	-0.0121	-0.0249*	-0.00594
	(0.0220)	(0.0133)	(0.0142)	(0.0131)
$YGAP$	0.650	-0.996	-2.434*	-0.873
	(1.163)	(0.807)	(1.239)	(0.850)
Obs	254	542	559	237
No. Countries	26	65	67	31
Data	Annual		Annual	
R-sq (within)	0.21	0.18	0.21	0.21

Notes: Regression specification is the same as column 3 of Table 2. Columns (1) and (2) respectively corresponds to OECD countries and non-OECD countries. Columns (3) and (4) respectively corresponds to higher and lower levels of income.

Table 5. Further Estimation Results

Dep var	τ_y	τ_c	$\ln(T)$	τ_y	τ_c
	(1)	(2)	(3)	(4)	(5)
$PROP65$	-0.340	2.166	-0.098	-1.372	0.295
	(0.341)	(0.323)***	(0.031)***	(0.431)***	(0.433)
$PROP1564$	-0.307	0.869	-0.059	-0.407	0.793
	(0.154)**	(0.144)***	(0.024)**	(0.334)	(0.341)**
$UTIP$	-0.147	0.228	0.033	0.194	-0.322
	(0.113)	(0.107)**	(0.021)	(0.301)	(0.298)
$\ln(y)$	7.378	-11.010	0.783	6.620	-6.691
	(1.374)***	(1.333)***	(0.138)***	(1.959)***	(1.939)***
$OECD$	-2.855	-1.702	0.505	7.656	-2.458
	(1.688)*	(1.577)	(0.317)	(4.504)*	(4.465)
$TRADE$	0.041	0.015	0.001	0.015	-0.028
	(0.016)**	(0.016)	(0.002)	(0.028)	(0.029)
$\ln(POP)$	-2.303	-1.007	0.097	1.870	-1.044
	(3.417)	(3.252)	(0.059)	(0.815)**	(0.827)
$POLITY2$	-0.382	-0.080	-0.033	0.485	0.507
	(0.098)***	(0.091)	(0.018)*	(0.242)**	(0.247)**
$YGAP$	-13.166	7.993			
	(7.625)*	(7.267)			
Obs	826	797	111	112	111
No. Countries	89	87			
Data	Annual	Annual	Cross-country	Cross-country	Cross-country
R-sq (within)	0.09	0.14			
R-sq			0.44	0.31	0.22

Notes: Columns (1)-(2) contain results using the same regression specification as column 3 of Table 2. Columns (3)-(5) contain results using cross-country regressions. The cyclical control variable, $YGAP$, is omitted in the cross-country regressions.

Table 6. Further Estimation Results

	(1)	(2)	(3)	(4)
$PROP65$	-0.124	-0.125	-0.124	-0.0722
	(0.00944)***	(0.0102)***	(0.0576)**	(0.0625)
$UTIP$	0.00707	0.00437	-0.0145	-0.00911
	(0.00741)	(0.00772)	(0.0208)	(0.0191)
$\ln(y)$	0.525	0.513	0.842	0.853
	(0.0449)***	(0.0452)***	(0.202)***	(0.196)***
$OECD$	0.599	0.645	-0.0406	0.0825
	(0.0927)***	(0.0948)***	(0.0704)	(0.114)
$TRADE$	-0.000536	-0.000746	0.00121	0.000895
	(0.000595)	(0.000625)	(0.00207)	(0.00235)
$\ln(POP)$	0.0870	0.0794	-0.508	0.535
	(0.0214)***	(0.0220)***	(0.598)	(0.956)
$POLITY2$	-0.0289	-0.0307	-0.0183	-0.0139
	(0.00621)***	(0.00629)***	(0.0112)	(0.0113)
$YGAP$	0.0779	0.169	-0.964	-0.512
	(1.175)	(1.331)	(0.792)	(0.736)
Obs	796	796	796	796
No. Countries			87	87
Data	Annual	Annual	Annual	Annual
Time Effects?	No	Yes	No	Yes
Adj. R-sq	0.37	0.38		
R-sq (within)			0.14	0.18

Notes: As for Table 2.

Table 7. Further Estimation Results

	(1)	(2)	(3)	(4)
$PROP65$	-0.117	-0.124	-0.0385	-0.0797
	(0.0631)*	(0.100)	(0.0483)	(0.0401)*
$UTIP$	-0.0308	-0.000954	-0.0345	-0.0124
	(0.0226)	(0.0208)	(0.0183)*	(0.0251)
$\ln(y)$	1.080	0.834	0.503	1.126
	(0.289)***	(0.276)***	(0.375)	(0.170)***
$OECD$	-0.0887	-0.0492		-0.0938
	(0.0700)	(0.114)		(0.0884)
$TRADE$	0.000462	0.00121	0.00569	-0.00109
	(0.00264)	(0.00284)	(0.00473)	(0.00323)
$\ln(POP)$	0.832	-1.083	-0.796	2.837
	(1.335)	(0.561)*	(1.883)	(1.388)**
$POLITY2$	-0.0664	-0.0125	0.243	-0.189
	(0.168)	(0.0199)	(0.326)	(0.0990)*
$YGAP$	-1.603	-0.149	-0.689	-1.225
	(1.382)	(1.028)	(1.041)	(1.219)
Obs	496	300	273	223
No. Countries	56	41	38	32
Data	Annual		Annual	
R-sq (within)	0.20	0.20	0.16	0.31

Notes: As for Table 3.

Table 8. Further Estimation Results

	(1)	(2)	(3)	(4)
$PROP65$	-0.0427*	-0.174*	-0.123*	-0.278
	(0.0237)	(0.0884)	(0.0622)	(0.229)
$UTIP$	-0.00911	-0.0130	-0.0456*	0.0216
	(0.0138)	(0.0210)	(0.0272)	(0.0215)
$\ln(y)$	0.531*	0.895***	1.066***	0.679*
	(0.293)	(0.223)	(0.390)	(0.350)
$OECD$			-0.0112	
			(0.0805)	
$TRADE$	-0.00122	0.00212	0.00123	0.00194
	(0.00197)	(0.00277)	(0.00230)	(0.00443)
$\ln(POP)$	1.120	-0.628	-1.166	-0.121
	(1.055)	(0.615)	(1.288)	(0.692)
$POLITY2$	-0.0328	-0.0154	-0.0250*	-0.0125
	(0.0221)	(0.0126)	(0.0139)	(0.0128)
$YGAP$	0.416	-0.986	-2.397*	-1.512
	(1.456)	(0.861)	(1.239)	(1.093)
Obs	254	542	559	237
No. Countries	26	65	67	31
Data	Annual		Annual	
R-sq (within)	0.17	0.15	0.21	0.15

Notes: As for Table 4.

Table 9. Further Estimation Results

Dep var	τ_y	τ_c	$\ln(T)$	τ_y	τ_c
	(1)	(2)	(3)	(4)	(5)
$PROP65$	-0.289	2.025	-0.120	-1.511	0.598
	(0.664)	(0.835)**	(0.0300)***	(0.417)***	(0.422)
$UTIP$	-0.158	0.258	0.0411	0.246	-0.435
	(0.258)	(0.249)	(0.0214)*	(0.298)	(0.300)
$\ln(y)$	6.036	-7.193	0.562	4.918	-3.713
	(3.865)	(2.720)***	(0.106)***	(1.379)***	(1.487)**
$OECD$	-2.858	-1.692	0.879	10.26	-7.484
	(2.261)	(2.707)	(0.284)***	(3.976)**	(3.992)*
$TRADE$	0.0439	0.00571	0.0000414	0.0127	-0.0198
	(0.0210)**	(0.0274)	(0.00208)	(0.0287)	(0.0292)
$\ln(POP)$	-5.249	7.438	0.0681	1.723	-0.656
	(8.982)	(11.83)	(0.0589)	(0.808)**	(0.827)
$POLITY2$	-0.411	0.000728	-0.0341	0.501	0.519
	(0.239)*	(0.160)	(0.0180)*	(0.242)**	(0.252)**
$YGAP$	-13.30	8.429			
	(13.35)	(7.921)			
Obs	826	797	111	112	111
No. Countries	89	87			
Data	Annual	Annual	Cross-country	Cross-country	Cross-country
R-sq (within)	0.09	0.09			
R-sq			0.40	0.30	0.18

Notes: As for Table 5.

References

Aidt, Toke S., and Peter S. Jensen (2009). The Taxman Tools Up: An Event History Study of the Introduction of the Personal Income Tax. *Journal of Public Economy*, 93(1-2): 160-175.

Azmat, Ghazala, Alan Manning, and John Van Reenen (2012). Privatization and the Decline of Labor's Share: International Evidence from the Network Industries. *Economica* 79: 470-492.

Baunsgaard, Thomas, and Michael Keen (2014). Tax Revenue and (or?) Trade Liberalization. *Journal of Public Economy*, 94(9-10): 563-577.

Besley, Timothy, and Torsten Persson (2014). Why do Developing Countries Tax so Little? *Journal of Economic Perspectives*, 28(4): 99-120.

Diamond, Peter, and James A. Mirrlees (1971). Optimal Taxation and Public Production I: Production Efficiency, and II: Tax Rules. *American Economic Review*, 61(1): 8-27, and 61(3): 261-278.

Disney, Richard (2007). Population Ageing and the Size of the Welfare State: Is there a Puzzle to Explain? *European Journal of Political Economy*, 23: 542-553.

Galasso, Vincenzo, and Paola Profeta (2007). How does Ageing Affect the Welfare State? *European Journal of Political Economy*, 23: 554-563.

Galbraith, James K., and Hyunsub Kum (2005). Estimating the Inequality of Household Incomes: A Statistical Approach to the Creation of a Dense and Consistent Global Data Set. *Review of Income and Wealth*, 51: 115-143.

Grandmont, Jean-Michel (1978). Intermediate Preferences and the Majority Rule. *Econometrica*, 46(2): 317-330.

Karabarbounis, Loukas, and Brent Neiman (2014). The Global Decline of the Labor Share. *Quarterly Journal of Economics* 129(1): 61-103.

Keen, Michael, and Ben Lockwood (2010). The Value Added Tax: Its Causes and Consequences. *Journal of Development Economics*, 92(2): 138-151.

Mateos-Planas, Xavier (2008). A Quantitative Theory of Social Security Without Commitment. *Journal of Public Economics*, 92(3-4): 652-671.

Meltzer, Allan H., and Scott F. Richard (1981). A Rational Theory of the Size of Government. *Journal of Political Economy*, 89(5): 914-927.

Persson, Torsten, and Guido Tabellini (2000). *Political Economics: Explaining Economic Policy*. MIT Press, Cambridge MA.

Persson, Torsten, and Guido Tabellini (2003). *The Economic Effects of Constitutions*. MIT Press, Cambridge MA.

Pickering, Andrew C., and Sheraz Rajput (2015). Inequality and the Composition of Taxes. Discussion Papers 15/04, Department of Economics, University of York.

Pickering, Andrew C., and James Rockey (2011). Ideology and the Growth of Government. *Review of Economics and Statistics*, 93(3): 907-919.

Ram, Rati (1987). Wagners Hypothesis in Time-Series and Cross-Section Perspectives: Evidence from Real Data for 115 Countries, *Review of Economics and Statistics*, 69(2): 194-204.

Razin, Assaf, Efraim Sadka, and Phillip Swagel (2002). The Aging Population and the Size of the Welfare State. *Journal of Political Economy*, 110(4): 900-918.

Rodrik, Dani (1998). Why do More Open Economies Have Bigger Governments? *Journal of Political Economy*, 106(5): 997-1037.

Saint-Paul, Gilles (1994). Unemployment, Wage Rigidity, and the Returns to Education. *European Economic Review*, 38(3-4): 535-543.

Sanz, Ismael, and Francisco J. Velazquez (2007). The Role of Ageing in the Growth of Government and Social Welfare Spending in the OECD. *European Journal of Political Economy*, 23: 917-931.

Shelton, Cameron A. (2008). The Aging Population and the Size of the Welfare State: Is there a Puzzle? *Journal of Public Economics*, 92(3-4): 647-651.

Simonovits, Adras (2007). Can Population Ageing Imply a Smaller Welfare State? *European Journal of Political Economy*, 23: 534-541.