The world is flat: Existing tax benefit systems approximate a linear one*

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Abstract

Tax benefit systems around the world have evolved to quite complex entities resulting in recurring calls for simplification – including Flat Tax proposals. In this paper, I reveal a statistical regularity that has not been documented before: when taking into account all different taxes and benefits, the relationship between net tax payments and gross income is approximately linear in many countries. My empirical analysis is based on micro data for 26 European countries and the US. I show that a linear tax system explains roughly on average 94% of the variation in taxes. Besides income, non-income characteristics are much more important than non-linearities in income. This has important implications for optimal taxation both in terms of the use of tagging as well as the accordance with the equal-sacrifice principle.

JEL Codes: H2, D63, D31

Keywords: flat tax, tax complexity, simplification, optimal taxation, tagging, equal sacrifice

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"*The flat tax [...] is probably my favorite one of all. [...] If we did pass it, all of a sudden, [...] you have the whole tax system run by a little old lady on a home computer, doing the work of all these thousands of bureaucrats and accountants. Passing that would be amazing, wouldn't it?*"
(Clint Eastwood, New York Daily News, 19 November 1997)

1 Introduction

Tax benefit systems around the world have evolved to quite complex entities resulting in recurring calls for simplification in order to lower administrative and compliance costs as well as to increase the transparency of the tax code (e.g., Gale; 2001). The simplest form of a relationship between income and tax payment is a linear one, as in flat tax systems.[1] In this paper, I reveal a statistical regularity that has not been documented before: when taking into account all different taxes and benefits, the relationship between net tax payments and gross income is approximately linear in many countries. This finding has important implications for tax policy design and raises the question of the fundamental underlying mechanisms.

My paper is a natural follow-up of Young (1990) who estimates whether observed tax schedules follow an equal sacrifice principle. He confirms this result for the US as well as Germany, Italy, Japan and the UK and finds remarkably similarities between countries. However, the work of Young as well as the follow-ups of Berliant & Gouveia (1993) and Gouveia & Strauss (1994) look only at the personal income tax schedule applied to taxable income. In this paper, I look at the relationship between taxes and full (economic) income, i.e. taking into account deductions and allowances as well as other taxes besides the personal income tax.

The concept of equal sacrifice in taxation goes back to John Stuart Mill:

[1]Note that the incidence of flat taxes in practice is not proportional but (indirect) progressive due to the basic allowance (Keen et al.; 2008). In terms of progressivity, a flat tax system can be more or less progressive than a graduated rate structure – depending on the marginal rate and basic allowance (Davies and Hoy; 2002).

> "*As a government ought to make no distinction of persons or classes in the strength of their claims on it, whatever sacrifices it requires from them should be made to bear as nearly as possible with the same pressure upon all [...] Equality of taxation, therefore, as a maxim of politics, means equality of sacrifice.*"
> (Mill (1848, p. 804).)

A large literature on sacrifice theory and the ability-to-pay-principle followed (e.g., Cohen Stuart, 1889, Edgeworth, 1897, 1919, Pigou, 1928, Samuelson, 1947, Musgrave, 1959).[2] However, the equal sacrifice theory, in general, does not allow to conclude whether the tax schedule should be progressive, proportional or even regressive – it only allows concluding that the rich should pay more in tax. In real life, the favored solution to many related problems (e.g. of dividing a cake or sharing a burden) is to allocate the gains or losses proportionally. In fact, proportionality is a time-honored principle: already Aristole considered it as synonymous with distributive justice:

> "*What is just [...] is what is proportional, and what is unjust is what violates the proportion.*"
> (Aristole, Ethics, Book V.)

Transferred to income taxation, proportionally implies that every taxpayer should pay the same proportion of income. The introduction of such a linear flat tax has been extensively discussed in the academic and public debate at least since the famous contribution by Hall and Rabushka (1985). Flat tax reforms are supposed to increase employment as well as GDP growth and to reduce tax distortions, administration and compliance costs as well as incentives for tax avoidance or evasion. However, apart from a few Eastern European countries, flat tax concepts have not been very popular – despite an ongoing debate both in academics and politics. Yet, while flat income taxes have not become the norm among OECD countries, many countries have moved into that direction (Sabirianova Peter et al.; 2010). However, usually in most analyses of the progressivity of tax systems is not taken into

[2]More recent contribution include Richter (1983), Musgrave (1985), Young (1987, 1988), Weinzierl (2012).

account that besides the (progressive) income tax other elements of the tax benefit systems (with different degrees of progressivity or regressivity) also shape the relationship between net taxes and gross income.

In this paper, I analyze to what extent existing tax benefit systems effectively differ from a flat tax system. I use the deviation of existing tax and benefit systems (including income and payroll taxes as well as cash benefits) from linearity as a summary measure of complexity that allows comparing the design of tax systems across countries. This is an important contribution in itself as the literature on complexity and simplification is still searching for a sophisticated measure of complexity (see Slemrod). In addition, as real world systems account for many other (individual or household) characteristics when determining the actual tax liability – for instance marital status or number of children, I pay special attention to this degree of non-income information used in the tax code (Ooghe and Peichl; 2011; Robinson and Slemrod; 2012).

My analysis is related to work comparing the progressivity between the US and European countries based on micro data. For instance, Piketty and Saez (2007) show that the French income tax is more progressive than the US one. Other studies take as given that European tax systems reveal a higher degree of progressivity (e.g., Alesina and Glaeser; 2004) and discuss to what extent differences in economic outcomes such as hours worked can be explained by different tax structures. By providing a new summary measure for progressivity and complexity, this paper sheds further light on existing differences between the US and European tax and transfer systems. I show that my measure of complexity is correlated with more traditional measures of complexity and tax evasion like the time it takes to comply with taxation or the cash flow in an economy (Djankov et al.; 2010) as well as with measures of inequality and redistribution.

My analysis is based on the 2007 EU-SILC data for 26 European countries and the CPS data for the US and yields the following results. A linear tax system explains roughly between 80 and 90% of the variation in tax payments. Besides income, non-income characteristics are much more important than non-linearities in income. The full regression model explains up to 96% of the variation. This indicates that there is a substantial room for simplifying the tax code as the same degree of redistribution can be achieved with a rather simple function of income and observed characteristics instead of the complex tax code in place. A back-of-the-envelope calculations shows that this could yield a reduction in tax compliance costs of about 0.3% of GDP. Further, my analysis shows that the gradients (i.e. marginal tax rates) are remarkably similar. This might indicate that the fundamental preferences for a fair tax benefit system are rather similar across countries.

These results provide new directions for research on optimal income taxation in the tradition of Mirrlees (1971), whose simulations showed that the optimal tax schedule could be close to linearity. While different assumptions can lead to very different conclusions (e.g., Tuomala; 1990; Saez; 2002), Mankiw et al. (2009) conclude – again based on simulations – that "*proposals for a flat tax are not inherently unreasonable.*" This has been criticized by Diamond and Saez (2011) who argue show that marginal tax rates will increase at the top when including the participation margin in the simulations. I contribute to this debate by showing that existing systems are not linear but close and that non-income characteristics play an important role. Therefore, instead of discussing the shape of the tax schedule with respect to income, more emphasis could be put on the use of tagging in optimal taxation (e.g., Salanié; 2003; Mankiw et al.; 2009, for overviews). [3]

The setup of the paper is organized as follows: Section 2 describes the empirical approach. Results are presented in section 3 and discussed in section 4. Section 5 concludes.

[3]Besides **?**, the theoretical use of tagging in optimal taxation schemes has been analyzed by, among others, Immonen et al. (1998) and Salanié (2002, 2003). While the previous authors do not have a specific tag in mind, for instance, Blomquist and Micheletto (2008) and Weinzierl (2010) consider age tags, Mankiw and Weinzierl (2008) study height, and Alesina et al. (2008) and Cremer et al. (2010) focus on gender. While tagging has a very intriguing theoretical appeal, very little of it is observed in reality. Weinzierl (2012) discusses this in relation to the equal sacrifice principle.

2 Empirical Approach

2.1 Estimation strategy

To assess the deviation of the existing tax system from linearity, I estimate a linear system and evaluate the fraction of the total variance in the data which is explained by this estimated system. In a first step, net taxes (income and payroll taxes minus benefits) are regressed on gross income X:

$$T = \alpha_0 + \alpha_1 X + \epsilon \tag{1}$$

where ϵ is the OLS residual. The coefficient of gross income α_1 is taken as the flat marginal tax rate and should be positive, while α_0 corresponds to a refundable tax credit and should be negative. [4]

In the second step, I control for the shape of the tax schedule by adding higher order polynominals of income to the equation:

$$T = \alpha_0 + \alpha_1 X + \sum_{i=2}^{8} \alpha_i X^i + \epsilon. \tag{2}$$

In the third step, I only allow a vector of non-income factors $\mathbf{z}$ (e.g. marital status, number of children, age and interaction terms) to influence the tax liability by estimating

$$T = \alpha_0 + \beta \mathbf{z} + \epsilon. \tag{3}$$

In the fourth step, I combine equations (1) and (3) to estimate a linear tax system based on income and various non-income characteristics:

$$T = \alpha_0 + \alpha_1 X + \beta \mathbf{z} + \epsilon. \tag{4}$$

In the final step, I combine equations (2) and (3) to jointly estimate the

[4]Depending on the generosity of the tax credit, such a system is either labelled as negative income tax or basic income flat tax (Atkinson (1995)).

effect of the shape of the tax schedule and the non-income factors:

$$T = \alpha_0 + \alpha_1 X + \sum_{i=2}^{8} \alpha_i X^i + \beta \mathbf{z} + \epsilon. \tag{5}$$

For all estimations, I report the explained variance (R^2) as a summary measure for the compliance with the estimated tax system, i.e. $1 - R^2$ as a measure for the complexity of the existing system. Note that only for equation (1), $1 - R^2$ can be interpreted as a measure for the deviance of a flat tax system.

2.2 Data

I use the 2007 EU-SILC (European Union - Statistics on Income and Living Conditions) data, which is the first wave to include gross income information for all countries. The sample size varies from 3,505 households in Cyprus to 20,982 households in Italy.[5] In addition, I use data from IPUMS-CPS (King et al., 2010) which is an integrated dataset of the March Current Population Survey (CPS). The CPS is a monthly household survey conducted jointly by the US Census Bureau and the Bureau of Labor Statistics. My analysis is based on the 2007 survey and the variable values and definitions are adapted to follow the EU-SILC standard.

I select single and couple individuals with or without children in households attached to the labor market, i.e. ate least one member between 18–64 in order to avoid problems due to missing data on second and third pillar pensions across countries. I trim the top and bottom 1% of the income distribution in order to avoid estimation problems due to extreme outliers. To make incomes comparable across countries, I adjust national income amounts by the multilateral current purchasing power parities provided by Eurostat.

EU-SILC and IPUMS-CPS only include direct taxes and benefits that can be reasonably attributed to households. Therefore, corporate taxes as well as indirect taxes and in-kind benefits are not included. In order to get a grasp

[5] The survey is representative for the whole population in each country due to the construction of population weights.

of the importance of these elements of the redistributive system, I proceed in two steps in the following analysis: I either take only the information available in the data or I use imputed values for the missing elements. The imputation methods follow Dolls et al. (2012) and Piketty and Saez (2007).

Consider first the case of employer social insurance contributions (or payroll taxes). Including them requires me to make an assumption on their incidence. So far, I have assumed that all taxes and transfers are borne by employees and, following Piketty and Saez (2007), I make the same assumption for employer social insurance contributions (which are available in the data and its relative importance varies a lot between countries).

As the data includes no information on consumption expenditures of households, the consumption taxes actually paid cannot be calculated directly. Instead, I use implicit tax rates (ITR) on consumption taken from European Commission (2009) for European countries and McIntyre et al. (2003) for the US. The ITR is a measure for the effective tax burden which includes several consumption taxes such as VAT or sales taxes, energy and other excise taxes. This implicit tax rate relates consumption taxes paid to overall consumption and varies across income quintiles.

The same approach is undertaken for the the corporate income tax (CIT). Following Piketty and Saez (2007), I assume that the CIT falls entirely on capital income and that all financial assets bear the tax equally. The incidence of the CIT is not clearly identified in the literature (see the summary of Auerbach, 2006) and hence the procedure adopted here can "can be seen as a middle-ground assumption" Piketty and Saez (2007), (p. X).

The levels of non-cash transfers differ across countries (see, e.g., Garfinkel et al. (2006)). Usually, they are more evenly distributed than cash benefits. In order to impute in-kind benefits, I follow the approach of Paulus et al. (2010). Marical et al. (2006) report in their Table A.8 the ratio between in-kind benefits from public services (health, education, public housing) and disposable income of households for each quintile of the income distribution. I use this ratio to assign to each household (depending on its position in the income distribution) the average value of in-kind benefits.

The following information is included in the vector of non-income characteristics: age, gender, marital status, number of household members, number and age of children, employment status, disability status, country of birth, place of residence, homeownership and mortgage payments. I use levels as well as dummy variables and interactions resulting in almost 75 parameters to be estimated for the (very flexible) full model.

3 Empirical results

Tax benefit systems in Europe and the US evolved to quite complex entities embedding various linear and non-linear elements. For instance, income tax systems are generally non-linear with various exemptions, allowances and different tax rates for different levels of income. But, in some countries, some income components (like capital income in dual income tax systems) are taxed at a proportional rate. Payroll taxes, though, are often proportional to income and capped at a certain ceiling resulting in a regressive system. Furthermore, many benefits have a proportional withdrawal rate above a certain threshold. The combination of all these measures could result in a system being close to linearity.

I analyze three different net tax measures (i.e. taxes paid minus benefits received). I start with looking only at personal income taxes (PIT). Next, I add payroll taxes or social insurance contributions (SIC) and cash benefits. Finally, I also account for indirect and corporate income (CIT) taxes as well as in-kind benefits.

Figures 1 (PIT), 2 (PIT+SIC-BEN) and 6 (all taxes) plot net taxes against gross income for all countries. At first glance, the tax benefit system is surprisingly close to linearity in all countries as soon as the analysis accounts for more than PIT only. This might indicate that the underlying deep preferences for redistribution and fairness of the tax benefit system are rather similar across countries. At least according to the information embedded in the tax benefit systems which have evolved over time with lots of fights, struggles and changes depending on the political party in power. Note that while the gradients, i.e. the marginal tax rates, are rather similar, the levels of taxation (i.e. the constants in the regression) are not. This might still reflect different preferences for the size of redistribution or different (beliefs about) efficiency constraints. But still, given the size of the redistribution, the way of redistributing income is very similar across countries with an almost linear relationship between net taxes and gross income which is in line with the principle of an equal proportional sacrifice.

This finding is investigated further in Tables 1 (PIT), 2 (PIT+SIC-BEN) and 3 (all taxes) which present the R^2 measure of explained variance for the different tax regressions (regression results available upon request). While the fit for the PIT only varies a lot between countries (Table 1), the linear flat tax (column 2) explains 75–91% of the total variation as soon as SIC and benefits are added (Table 2). Interestingly, the fit of the linear model for the flat tax countries (Estonia, Latvia, Lithuania, Iceland, Slovak Republic, Czech Republic) is high but not perfect which can be explained by non-linearities created through benefits and payroll taxes, whereas it is surprisingly high for the Nordic countries which are considered among the countries with a highly redistributive and complex tax system. The fit of the linear model increases to 88–98% when looking at all taxes (Table 3).

The full model (equation 5, column (1) in each Table) explains 43–93% (85–96%) [92–99%] of the variation in taxes in case 1 (2) [3]. This indicates that such a regression-based approach (as, e.g., used in the literature on decomposing changes in inequality, see Frenette et al.; 2007) is a fairly good approximation of a tax-benefit calculator. Non-income characteristics alone explain roughly half of the variation. Putting these characteristics together with a linear term on income has almost the same explanatory power as the full model, i.e. the gain from adding higher order income terms is negligible. This is also confirmed by a regression of the income terms without the non-income variables.

4 Discussion

In the last part of my analysis, I interpret $1 - R^2$ as a measure for the complexity of the existing system. This might be helpful for future research conducting cross-country comparisons or analyses within one country over time, as so far no agreed-upon measure of complexity exists (Slemrod XXX).

In Figure 3, I plot $1 - R^2$ from case 2 against two measures for the complexity of the tax system taken from Djankov et al. (2010). The first measures the time it takes to comply with (i.e. prepare, file and pay) labor taxes. The second measure ("seignorage") is the currency outside banks as percentage of GDP which can be seen as a proxy for the shadow economy. I observe a positive (but not perfect) correlation between my measure of complexity and both the time to comply with taxes (corr=.38) and the size of the shadow economy (corr=.5). This indicates that $1 - R^2$ is indeed a good approximation of the complexity.

Figure 4 shows the correlation between my complexity measure and inequality as measured by the Gini coefficient as well as the Reynolds-Smolensky index of redistribution. The results show that more complexity is associated with higher inequality (corr=.72) and less redistribution (corr=-0.4).

These simple correlations show that $1 - R^2$ is associated with both complexity and progressivity of the tax system. Interestingly, when comparing e.g. the United States with Germany or France which are said to have very complex tax systems, I observe higher levels of complexity in the US but much lower levels of taxation. Hence, the fact that the US exhibits less redistribution is not due to the fact that it is lacking a complex and progressive tax system but rather due to the relatively low level of taxation in general.

What would be the welfare gains associated with a switch from the existing complex system to the simple regression based formula? My regression formula uses about 25 (individual and household level) variables. Most of them (age, gender, number of children) are easy to observe and, hence, the average time to comply with (labor) taxes can be reduced significantly. Therefore, in a back-of-the-envelope calculation, I assume that it should not take longer than 60 minutes in total to fill out the tax form. In order to roughly estimate the welfare gains, I multiply the difference between the time to comply with labor taxes and one hour with the average hourly wage in each country. I express this per capita reduction in compliance costs in relation to GDP per capita. Results are presented in Figure 5. Assuming no behavioral responses, the welfare gains vary between 0.05 and 0.8% of

GDP with a mean of 0.3% which is sizeable. In addition, this simplification would reduce administration costs as well.[6] An interesting avenue for future research would be to estimate the welfare gains with more sophisticated methods.

5 Conclusion

In this paper, I have estimated tax equations for many European countries and the US. My results show that linear tax systems explain roughly between 80 and 90% of the variation in existing systems.[7] While such a flat tax system might be a fairly good approximation, the case for considering non-linear models in optimal income taxation could be made. However, the fit of the estimation is improved considerably when considering non-income characteristics (and less so for non-linear income terms). Therefore, as these non-income variables are a greater source of non-linearity, a stronger focus should be put on the optimal design of a tax system based on various characteristics.

My analysis shows that there is room for considerable simplification of existing tax systems which tend to include an almost unmanageable amount of detailed and highly specific regulations to account for a vast number of imaginable individual circumstances. Instead of relying on very complicated tax law, the same degree of redistribution can, however, be generated with a rather simple function of income and some observed socio-demographic characteristics. This would lower administrative and compliance costs and increase the enforceability and transparency of the tax code considerably.

[6]Of course, simplifying the tax code would trigger behavioral responses which could be another argument in favor of such a reform as a simpler system with lower compliance costs could increase labor supply and business activities. However, real responses tend to be fairly small (Gorodnichenko et al.; 2009).

[7]This result could help to explain some stylized facts from the macro literature on automatic stabilization (Dolls et al.; 2012). For instance, Girouard and André (2005) estimate a close-to-unity elasticity of revenues with respect to GDP which follows microeconomically from my result that a linear income tax is a fairly good approximation of the existing systems.

Figures and Tables

PIT only

Table 1: : t-pit

	R2total	R2lininc	R2char	R2charlin
AT	0.445	0.215	0.251	0.435
BE	0.596	0.446	0.342	0.566
CZ	0.840	0.734	0.383	0.814
DE	0.530	0.329	0.172	0.442
DK	0.751	0.675	0.407	0.729
EE	0.899	0.881	0.449	0.895
ES	0.518	0.422	0.315	0.495
FI	0.842	0.706	0.395	0.822
FR	0.437	0.239	0.373	0.433
GR	0.461	0.297	0.221	0.434
HU	0.896	0.828	0.456	0.879
IE	0.776	0.694	0.396	0.751
IS	0.933	0.888	0.424	0.928
IT	0.691	0.517	0.329	0.669
LT	0.774	0.733	0.352	0.768
LU	0.643	0.425	0.290	0.594
LV	0.826	0.783	0.346	0.821
NL	0.456	0.060	0.270	0.356
NO	0.757	0.626	0.344	0.736
PL	0.534	0.487	0.338	0.533
PT	0.889	0.786	0.551	0.869
SE	0.784	0.547	0.380	0.745
SI	0.639	0.416	0.287	0.587
SK	0.481	0.305	0.178	0.408
UK	0.790	0.711	0.338	0.770
US	0.825	0.750	0.233	0.806
Mean	0.693	0.558	0.339	0.665

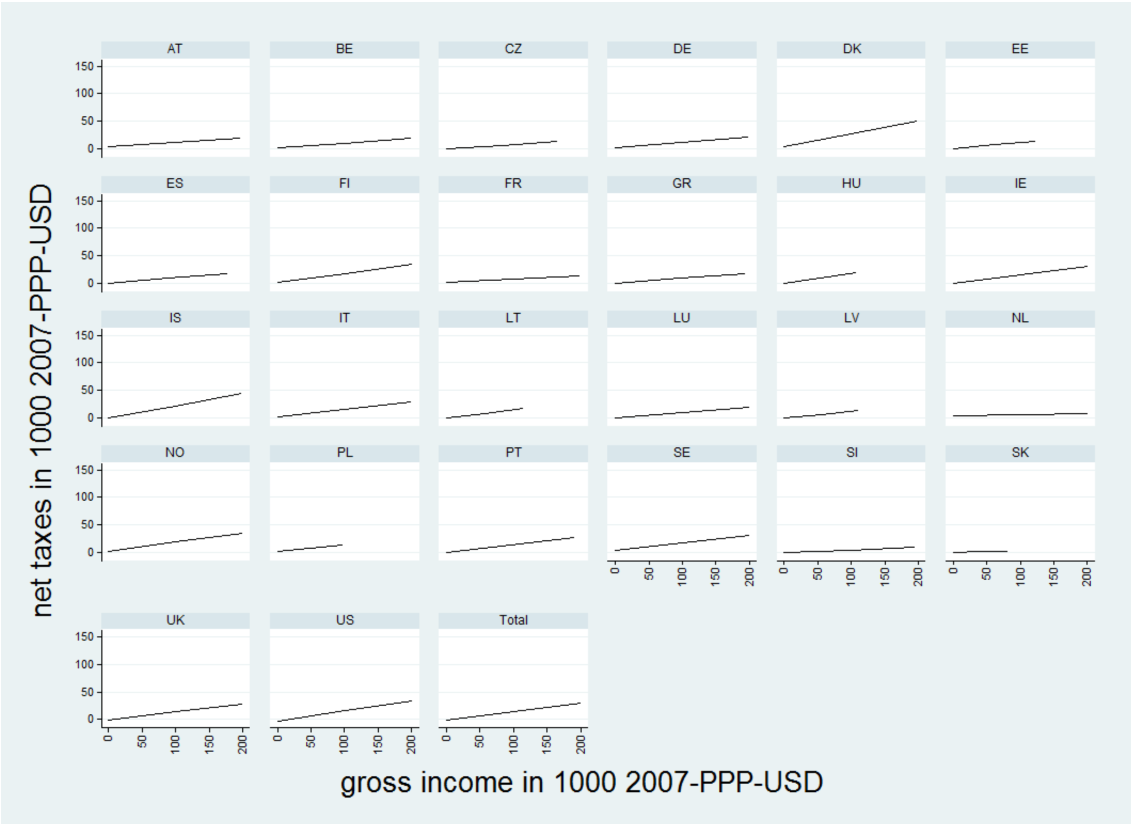

Figure 1: Correlation between gross income and net taxes

PIT + SIC - Benefits

Table 2: R2: tsb-er

	R2total	R2lininc	R2char	R2charlin
AT	0.929	0.861	0.715	0.927
BE	0.969	0.943	0.730	0.968
CZ	0.975	0.946	0.753	0.974
DE	0.926	0.865	0.753	0.922
DK	0.965	0.939	0.636	0.961
EE	0.971	0.937	0.658	0.969
ES	0.900	0.830	0.689	0.898
FI	0.963	0.935	0.675	0.961
FR	0.939	0.884	0.639	0.936
GR	0.942	0.899	0.664	0.940
HU	0.961	0.916	0.702	0.959
IE	0.900	0.834	0.666	0.892
IS	0.937	0.891	0.644	0.934
IT	0.923	0.862	0.685	0.917
LT	0.953	0.922	0.645	0.950
LU	0.918	0.798	0.712	0.917
LV	0.885	0.831	0.586	0.877
NL	0.967	0.938	0.738	0.965
NO	0.959	0.900	0.719	0.958
PL	0.913	0.817	0.734	0.912
PT	0.913	0.850	0.605	0.911
SE	0.977	0.946	0.709	0.976
SI	0.969	0.936	0.712	0.967
SK	0.962	0.921	0.797	0.960
UK	0.929	0.883	0.698	0.925
US	0.852	0.752	0.530	0.845
Mean	0.938	0.886	0.684	0.935

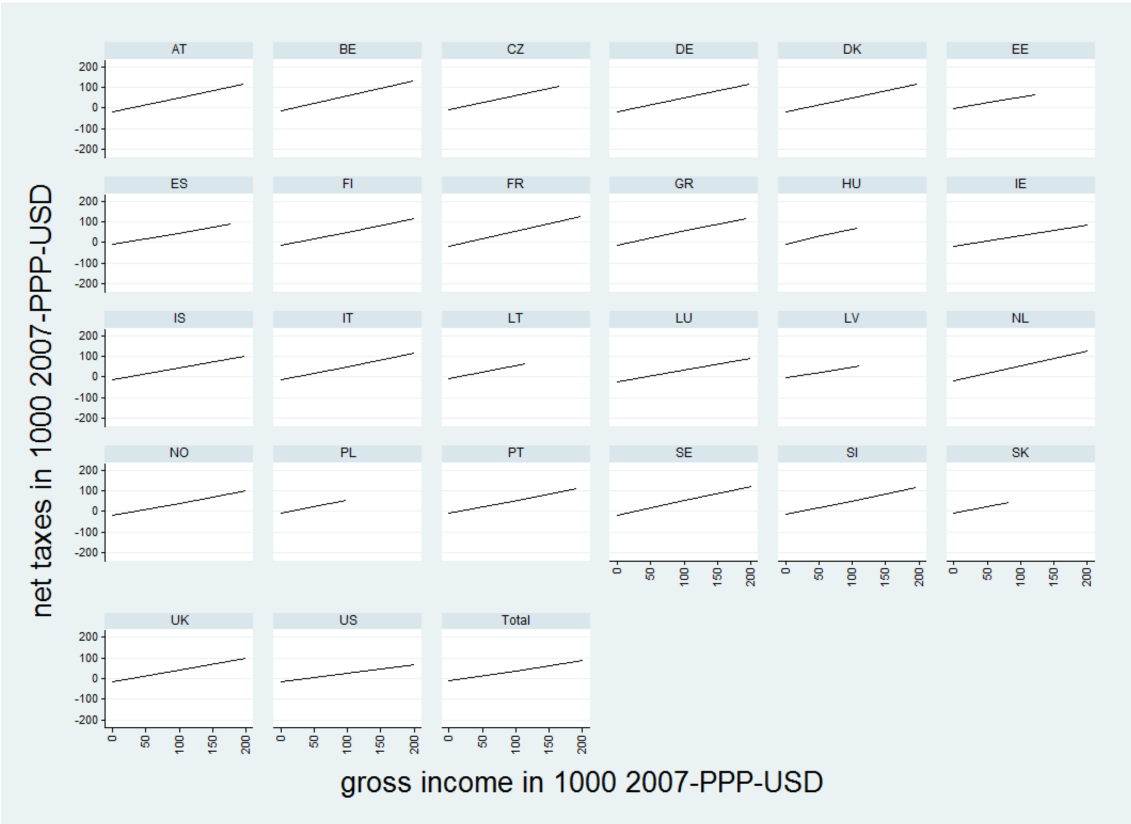

Figure 2: Correlation between gross income and net taxes

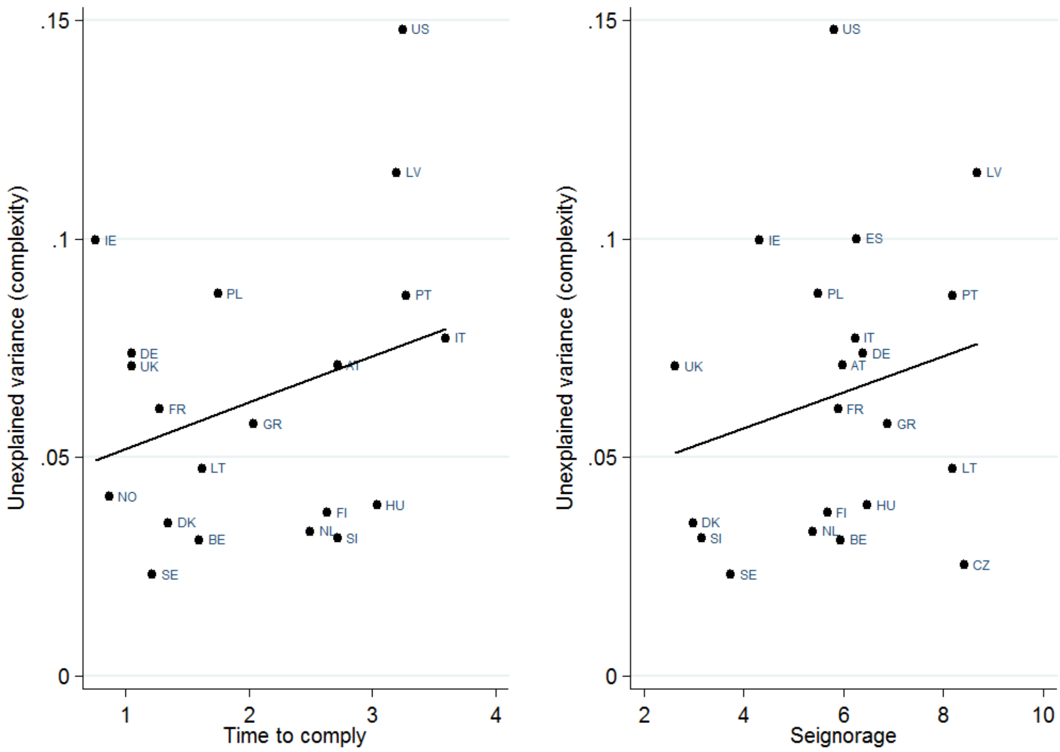

Figure 3: Correlation between complexity and measures of compliance costs

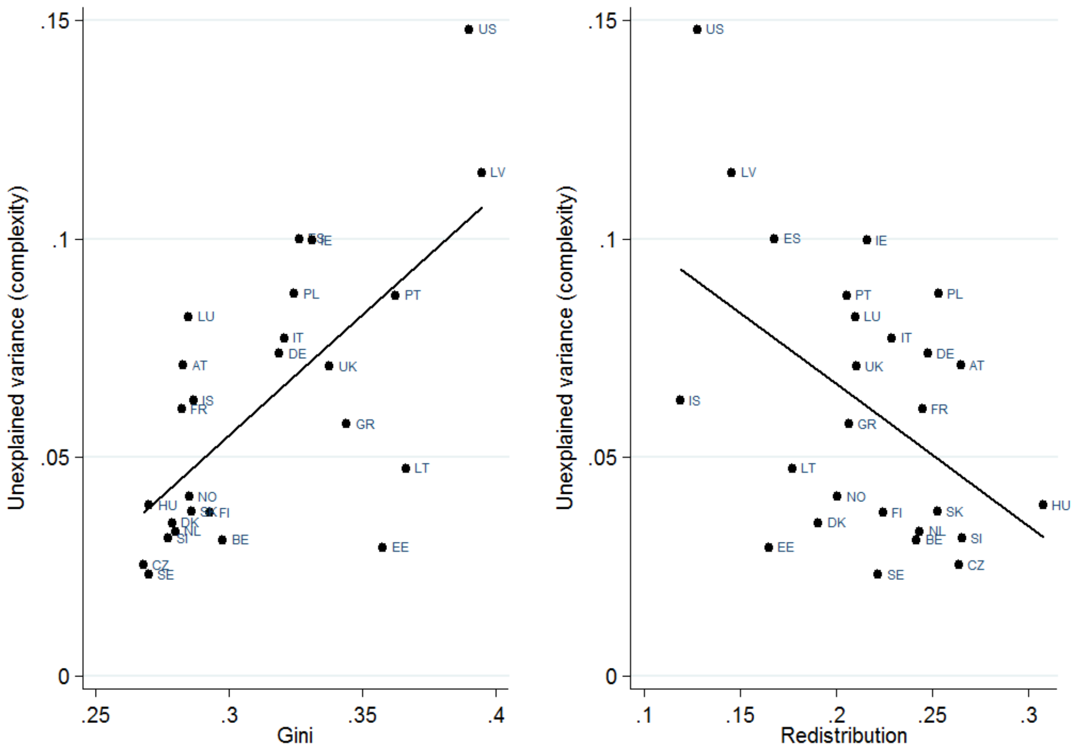

Figure 4: Correlation between complexity and measures of progressivity

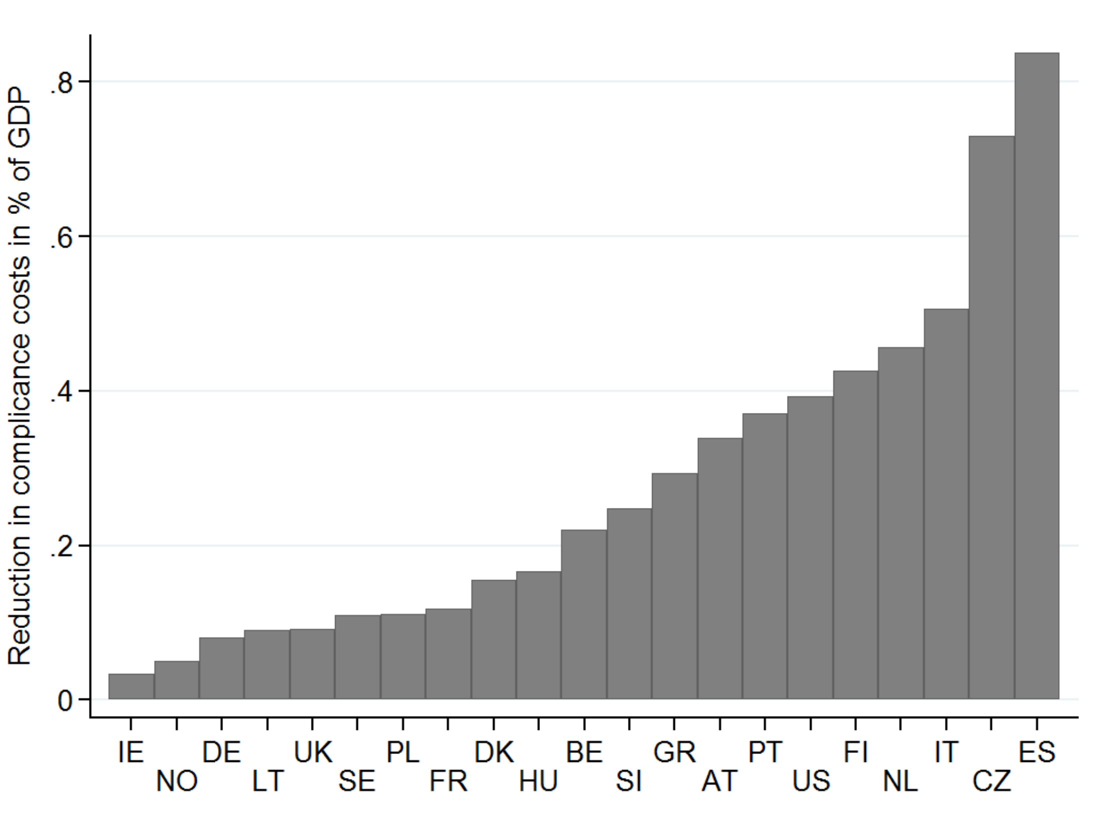

Figure 5: Welfare gains of simplification

T+S-B plus VAT + CIT - in-kind B

Table 3: R2: tsbcikcit-er

	R2total	R2lininc	R2char	R2charlin
AT	0.956	0.915	0.697	0.955
BE	0.982	0.967	0.719	0.981
CZ	0.987	0.973	0.733	0.987
DE	0.953	0.916	0.741	0.950
DK	0.984	0.974	0.629	0.983
EE	0.975	0.949	0.648	0.974
ES	0.978	0.966	0.672	0.978
FI	0.980	0.964	0.663	0.979
FR	0.969	0.943	0.614	0.967
GR	0.968	0.945	0.658	0.966
HU	0.972	0.941	0.690	0.970
IE	0.927	0.881	0.667	0.920
IS	0.974	0.955	0.615	0.973
IT	0.958	0.929	0.673	0.955
LT	0.966	0.945	0.630	0.964
LU	0.953	0.888	0.688	0.953
LV	0.915	0.883	0.578	0.910
NL	0.975	0.953	0.732	0.973
NO	0.977	0.947	0.685	0.977
PL	0.944	0.887	0.714	0.943
PT	0.953	0.919	0.621	0.952
SE	0.985	0.966	0.689	0.984
SI	0.984	0.968	0.702	0.983
SK	0.977	0.954	0.777	0.976
UK	0.972	0.955	0.671	0.970
US	0.935	0.899	0.488	0.931
Mean	0.965	0.938	0.669	0.964

Figure 6: Correlation between gross income and net taxes

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