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Income distribution and tax structure: Empirical test of the Meltzer–Richard hypothesis

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Abstract

The Meltzer–Richard hypothesis that more unequal income distribution will create a majority for more redistribution has generated much research, but little empirical support. The empirical literature has concentrated on cross-country studies and the size of the public sector, and the results broadly do not indicate more redistribution with more inequality. This analysis suggests that the hypothesis should be investigated in a more homogenous setting with comparable institutions and with an explicit decision about redistribution (here tax structure). New data on poll tax and property tax in decentralized government in Norway are exploited. We show how the multi-dimensional decision can be analyzed as majority rule assuming intermediate preferences. In the econometric analysis, instruments are used to account for endogeneity of income level and income distribution. The estimated model supports the understanding that more unequal income distribution implies a shift in the tax burden from poll tax to property taxes and thereby gives more redistribution.

JEL classification: H23; H71

Keywords: Income distribution; Tax structure

1. Introduction

When the median voter has less income than the mean, the typical income distribution observed, the decisive median voter will apply income taxation for redistribution. This is the key insight of Meltzer and Richard (1981). More uneven income distribution is associated with more redistribution, only held back by negative incentives to work and save. The setup assumes proportional income taxation financing lump sum

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government transfers. The theory is based on an earlier work on optimal redistributive taxation by Romer (1975) and Roberts (1977), where the decisive voter chooses parameters of an income tax function. Cukierman and Meltzer (1991) continue this tradition and show conditions when marginal progressivity of the income tax is determined by the median voter.

Meltzer and Richard (1983) started up the empirical tests of the hypothesis in an analysis of US time series data of government spending. They conclude that the spending level is negatively related to the ratio of median to mean income. Later the Meltzer–Richard model is basically interpreted as a theory of government size and tested on cross-country data, but with little support. Government spending is assumed to concentrate on redistribution, and the income distribution is understood as the major determinant of government size. It is hard to get away from the observation that many countries with equal income distribution have large government spending, notably the Scandinavians, while many countries with unequal income distribution have smaller public sectors, as in many developing countries. Perotti (1996) analyzes a broad dataset including the marginal tax rate and different expenditure components, and he concludes that there is little evidence of a negative association between equality and fiscal variables. Bassett et al. (1999) reach the same conclusion with other definitions of transfers and spending. Milanovic (2000) has a more direct measure of redistribution, the income gain of different income groups from factor income to disposable income. His estimates support the hypothesis that countries with greater inequality redistribute more, but are less supportive of the median voter hypothesis. The spread of the income distribution, among the poor and among the middle class, is the background concern.

Alesina and Rodrik (1994) and Persson and Tabellini (1994) develop the redistribution model in a dynamic context and extend the empirical cross-country analyzes to economic growth. This approach implies two links, from income distribution to distortions with redistribution, and from distortions to economic growth. Again the evidence is mixed, and the link via distortions like taxation is not documented. Saint Paul and Verdier (1996) review some critical arguments.

The lack of strong evidence in favor of the Meltzer–Richard hypothesis has motivated the development of theoretical models with the opposite prediction, i.e. that more inequality leads to less redistribution. Persson (1995) and Benabou (2000) emphasize that redistribution may improve welfare and economic performance, in which case less inequality may increase the popular support for redistribution. Sinn (1996) questions whether the causality runs from inequality to redistribution or the other way around. The argument is that redistributive programs involve social insurance that stimulates risk taking and moral hazard effects, which increases the pre-tax inequalities.

The Meltzer–Richard hypothesis may stand a better chance in more homogenous political systems, and with a sharper focus on redistributive instruments. Decentralized government is a potentially interesting source of information about politics and distribution. Alesina et al. (2000) exploit this type of data in a recent study of US cities, and find a positive relationship between inequality and public employment. On the other hand, Rodriguez (1999) find no association between distributional skewness and welfare spending in the US States. It seems to us productive to get back to the relationship between income distribution and taxation as a basis of evaluating redistributive

politics and to bring in evidence about the tax structure to investigate the hypothesis. Chernick and Reschovsky (1996) measure the degree of progressivity of the state tax burdens. Income inequality comes out as an important explanation of progressivity, and the result is seen as consistent with an interest group model of tax choice. The problem with the political economy models is that the decision making is a black box. Slemrod and Bakija (2000) argue that optimal taxation theory predicts that growing inequality should increase progressivity, but notice the failure to identify such effects in the recent US experience of increased inequality.

Our empirical analysis addresses the role of the income distribution for the choice of tax structure in local governments in Norway. The 434 local governments are comparable political institutions based on elections to the local council, and their main revenue decision is the choice between user charges and property taxes. New data on residential property taxes and housing-related utility charges per standardized households in each municipality allow for this test of Meltzer–Richard. Utility charges per standardized household are hereafter denoted as poll tax. Our understanding is that the broad income distribution in the communities is not much affected by the local revenue decision, but our econometric analysis addresses this potential endogeneity.

The multi-dimensionality issue has been a challenge to the modeling of the political decisions in this area. Goodspeed (1998) develops a majority rule voting model for the relationship between state income taxes and local property taxes in the US. Income distribution is important for the tax structure since the distribution of the income tax base is different from the distribution of the property tax base. His model allows a unidimensional decision since the two taxes are decided at different political levels. Inman (1979) solves his multi-dimensionality problem in a study of 41 US cities by assuming a two-step process. First the aggregate tax level is determined in an expenditure demand model, then the tax structure decision (property tax share of total taxes) is an allocation of the total taxes. We take benefit of restrictions on the preferences that imply that the two revenue instruments and government spending can be understood as unidimensional. This condition of intermediate preferences is due to Grandmont (1978) and is discussed by Persson and Tabellini (2000). The intuition here is that the conflict of interest is along the same dimension and follows the income distribution.

Section 2 outlines a theoretical framework of the relationship between income distribution and tax structure investigated. The conditions for unidimensionality and majority voting outcome are shown. Section 3 presents the empirical and institutional background of the empirical analysis, and the data and the econometric approach are discussed in Section 4. Estimation results for the effect of income distribution on tax structure are presented in Section 5, with alternative formulations to check for robustness and including instrument variables to handle endogeneity. Section 6 addresses the broader determinants of tax structure. Concluding remarks are offered in Section 7.

2. Theoretical framework: Income distribution and tax structure

As the basis of our empirical analysis, the model below gives a stylized description of local governments choosing between poll tax and property tax to finance local public

services at the margin. The choice of revenue instruments is understood as the outcome of majority voting in a setting where income distribution is important. The model clarifies under what conditions the decision about tax structure can be analyzed as unidimensional and generates hypotheses for empirical testing. The design conforms to the literature (as in Alesina and Rodrik, 1994) in having a distortionary tax (property taxation) and assuming per capita spending. The model considers non-redistributive spending programs that have the same impact on all voters.[1] To simplify the model we assume away mobility, although mobility issues are discussed in the empirical part, and the property tax is linked to a simple housing market.

The community comprises N voters with identical Cobb–Douglas utility functions:

$$U_i = c_i^{\alpha} h_i^{1-\alpha} g^{\beta}, \quad 0 < \alpha < 1, \ \beta > 0, \quad i = 1, \ldots, N. \tag{1}$$

The utility function includes private consumption (c), housing (h) and per capita provision of local public services (g). The individual voter chooses a mix of private consumption and housing by solving the following maximization problem:

$$\max_{c_i, h_i} c_i^{\alpha} h_i^{1-\alpha} \quad \text{s.t.} \quad c_i + (1+t)h_i = y_i - f. \tag{2}$$

The voters have different exogenous income (y_i) that finances private consumption, housing and the poll tax (f). The market prices of private consumption and housing are normalized to unity, and the gross price of housing is $1+t$ where t is the property tax rate. Housing supply is perfectly elastic. The individual optimization problem leads to familiar demand functions for private consumption and housing:

$$\begin{aligned} c_i &= \alpha(y_i - f), \\ h_i &= \frac{1-\alpha}{1+t}(y_i - f). \end{aligned} \tag{3}$$

By plugging the demand functions into the utility function, we arrive at the following indirect utility function:

$$W_i = A(1+t)^{\alpha-1}(y_i - f)g^{\beta}, \quad A = \alpha^{\alpha}(1-\alpha)^{1-\alpha}. \tag{4}$$

The property tax rate, the poll tax, and the provision of local public services are determined by political decision-making. The political choice set is restricted by the local government budget constraint as

$$g = th + f + l. \tag{5}$$

The unit cost of local public services is normalized to unity, and h is average housing demand and l per capita grants from the central government. By inserting the budget constraint, we can write the indirect utility function with only t and f as policy instruments, and the local policy choice comes out as two dimensional:

$$W_i = A(1+t)^{\alpha-1}(y_i - f)(th + f + l)^{\beta}. \tag{6}$$

[1] The implications of redistributive spending programs are discussed below.

It is well known from the public choice literature that a majority rule equilibrium may not exist when the policy space has more than one dimension. The decision-making process may suffer from a cycling problem where any allocation can be beaten by another proposal. However, a majority rule equilibrium can be obtained by imposing restrictions on preferences or institutions.

One class of restrictions on preferences is the so-called intermediate preferences, which can be considered as a generalization of single crossing to multidimensional policies. The idea is that voter heterogeneity is limited and can be projected on a single dimension where voters can be ordered by their type. In our case the redistributive conflict is related to income variation. Following Persson and Tabellini (2000, p. 25), the condition for intermediate preferences is that the indirect utility function can be written as

$$W_i = J(f,t) + K(y_i)H(f,t), \tag{7}$$

where $K(y_i)$ is monotonic in y_i, and $J(f,t)$ and $H(f,t)$ are common to all voters. It is easy to verify that the indirect utility function given by Eq. (6) can be written on this form with $J(f,t) = -A(1+t)^{\alpha-1}(th+f+l)^{\beta}f$, $H(f,t) = A(1+t)^{\alpha-1}(th+f+l)^{\beta}$ and $K(y_i) = y_i$. The political equilibrium is the policy preferred by the voter with median income, and is characterized by

$$\frac{\partial W_m}{\partial f} = \frac{\partial W_m}{\partial t} = 0, \tag{8}$$

where subscript m denotes the voter with median income. The equilibrium property tax rate and poll tax are determined by median income, mean income and central government grants. In the benchmark case where median income equals mean income it is easy to verify that the solution implies a zero property tax rate and public goods financed by poll tax only. With a typical right-skewed income distribution the property tax rate will be positive.

The effect of more equal distribution can be found by investigating the impact of higher median income (keeping mean income constant). As shown in Appendix A, higher median income has the following impact on the policy choice:

$$\frac{\partial f}{\partial y_m} > 0, \quad \frac{\partial t}{\partial y_m} < 0, \quad \frac{\partial g}{\partial y_m} > 0. \tag{9}$$

It appears that higher median income (keeping mean income constant) will change both the tax structure and the level of local government spending. The change in tax structure reflects that a relatively richer median voter prefers less redistribution, and less redistribution is achieved by shifting the financing from the redistributive property tax to the poll tax. The increase in the poll tax exceeds the reduction in property tax revenue, which implies that provision of local public services increases. This effect is driven by the positive income elasticity for local public services.

Mean income has the opposite effect of median income on the two revenue instruments. An increase in mean income (keeping median income constant) leads to a more unequal income distribution and shifts the tax structure from the poll tax to the

redistributive property tax. As median income, mean income has a positive effect on the provision of local public services. When grants are raised, the model predicts a revenue substitution effect in the sense that less revenue is collected locally. The effect on tax structure is ambiguous since we cannot tell which of the two local revenue instruments that will be reduced most. Moreover, grants have a positive effect on service provision. That is, the reduction in locally collected revenues following an increase in grants is less than the grant increase.

It should be noticed that the impact of income distribution on tax structure is more robust to the assumption of non-redistributive spending programs than the impact on provision of local public services. If spending programs are redistributive, a richer median voter (relative to the mean) might prefer a lower level of spending. However, he will still prefer a change in the tax structure towards the poll tax. The econometric analysis concentrates on the impact of income distribution and tax structure, but we will also report results for the impact on the sum of property tax and poll tax.

3. Data on tax structure

Decentralized government allows empirical analysis of comparable political institutions influencing the tax structure. In the Norwegian case, local governments can choose between poll tax and property taxation of about 10% of their revenue. The analysis of poll tax and residential property taxes covers most of the marginal revenue of the local governments in this otherwise centralized system of financing (grants and regulated taxes).

The property tax, which generates about 2% of local government revenue, is limited to urban areas and certain facilities (notably power stations), and is not available to all local governments. Residential property tax can only be levied in urban areas and local governments that levy property tax on power stations do not need to tax residential property. In practice, around 200 of the 434 local governments have property tax, and of these only one third have residential property tax. The local governments can choose property tax rate within a narrow band (0.2–0.7%), but most of the local governments with property tax apply the maximum rate. Because of the large variation in assessment practice and the amount that can be deducted from the assessed value, there is more variation in the effective tax rates than in the formal rates. In this study we concentrate on the residential part of the property tax. Property tax revenue related to power stations and other related facilities are not included.

The poll tax, as defined in this study, consists of housing related utility charges, or more precisely charges for water supply, discharge of sewage, garbage collection and chimney sweep. The poll tax amounts to nearly 50% of total user charges or 8% of local government revenue. The market for utilities can be characterized as a local government monopoly where the use of the service is compulsory. The poll tax is limited by central government regulations, and cannot exceed total production costs.

In the empirical analysis we take advantage of a new dataset on property tax and poll tax for all 434 local governments in the years 1996–1998.[2] Among the 70 municipalities with residential property taxation, the average tax in 1996 is NOK 1300 (USD 150) per standardized house, varying from NOK 450 to nearly 3000. Roughly half of them have property tax revenue between NOK 1000 and 1600. Among all 434 local governments, the average poll tax is NOK 5800 (USD 670), varying from NOK 2400 to nearly 13 000. About 50% of the local governments have poll tax between NOK 5000 and 7000.

Since we concentrate on the mix between poll tax and property tax, the tax structure is described by the property tax share of the sum of poll tax and property tax. Local governments with residential property tax have an average property tax share of 18%. The tax structure is of interest since this share varies from 5% to 37%, and half of them have a property tax share between 14% and 22%. In the raw data there is no evidence of tax substitution where local governments with property tax have lower poll tax than local governments without property tax. Rather the difference goes in the opposite direction. During the period 1996–1998, the poll tax of an average local government with property tax were 1–5% higher than the sample average for local governments without property tax. This finding may reflect that other factors, like central government grants, affect the poll tax and the property tax in the same direction.

A key aspect of the theoretical model laid out in Section 2 is that the property tax is redistributive. The distributional consequences of the property tax have been investigated by a government commission that in 1996 proposed a new Property Tax Act (NOU 1996: 20). They concluded that the property tax is roughly proportional to household income. Their finding fits our assumption of a redistributive property tax. The literature on property taxation is concerned with the owner/renter divide and tax exporting. Ownership is the dominating form of housing in Norway, and the renting market is not expected to be important for this analysis. Tax exporting may affect property taxation related to summerhouses and business property. The tax is measured per standardized house and should capture most of the residential population. Property taxation of summerhouses is negligible because most of them are outside the urban areas where property tax can be applied. It would have been of interest to correct for share of business property involved, but such data are not available.

4. Econometric specification

The econometric design primarily relates income distribution to tax structure. When the income distribution is log-normal, the standard assumption, increased gap between

[2] The dataset is collected by *Norsk Familieøkonomi* (Norwegian Household Finances). Since 1996 the association has collected yearly data on property taxes and user charges in all local governments. The data are standardized and therefore comparable across the country. The local governments are asked to state the property tax for a standard house of 200 m^2 and a market value of NOK 750 000 (about USD 85 000). Property tax revenue is only registered when property tax is levied on more than half of the residential property. The poll tax is calculated as user charges for a household with water consumption of 200 m^3 per year, the weekly collection of a 'regular' garbage can, and yearly cleaning of one chimney.

median to mean income reflects increased mean-preserving spread. This ratio of median to mean income (y_m/y) is applied as measure of the skewness of the distribution. The average median to mean ratio is 0.83.[3]

It is well known that increased variance with constant mean will not necessarily reduce the ratio of the median to the mean when the distribution is not log-normal. This is an argument for looking at alternative measures of the income distribution, and the gap between the 75% and 25% fractiles also is investigated. The high voter participation in Norway (in the area of 60–70% in local elections) reduces the problem of representativeness of the voters, but voting also is an argument for investigating the robustness of the measure used for income distribution.

The empirical analysis is based on the following benchmark econometric model using an unbalanced panel of 1176 observations:

$$DEP_{it} = \gamma_t + \gamma_1 \left(\frac{y_m}{y}\right)_{it} + \gamma_2 l_{it} + \gamma_3 \bar{y}_{it} + \gamma_4 CONTROLS_{it} + u_{it},$$

where the dependent variable (DEP) represents the three measures of taxation included: Poll tax per standard house, property tax per standard house, and property tax share. The subscript it denotes community i in year t.

The key prediction from the theoretical model is that median to mean income will have a positive sign in the poll tax equation and a negative sign in the property tax and the property tax share equations. The coefficient of mean income ($\bar{y}$) reflects the impact of a proportional increase in median and mean income. Since median and mean incomes are predicted to have opposite effects on the two revenue instruments, the expected sign is ambiguous.[4] Exogenous revenue (l) typically has a revenue substitution effect, and thereby a negative sign in the poll tax equation and the property tax equation. Exogenous revenue includes lump-sum grants and regulated income and wealth taxes.

Our broad understanding is that the level of private income and the income distribution in each community is determined by background factors such as industrial structure and urbanization, and that the limited tax discretion does not have much impact. Mobility in Norway is low. The potential endogeneity problem is addressed by using instrument variables. As instruments we have used the industrial structure back

[3] When all local governments are included, the ratio of median to mean income varies from 0.43 to 1.06. The analysis applies the 90% of the observations in the interval [0.75, 0.90], assuming that most of the observations outside the interval reflect measurement error. Many of these have large fluctuations in median to mean income from one year to another. According to the database, 125 local governments levied property tax on more than half of residential property in 1996. The corresponding figures for the two later years are 66 (1997) and 59 (1998). The discrepancy probably reflects that many local governments in the first year of data collection reported the existence of property taxation. We have chosen to modify the property tax data for 1996 in the following way: If the local government reported a positive property tax in 1996 and zero property tax in 1997 and 1998, the property tax is set to zero also for 1996. This leaves us with 71 observations with a positive property tax in 1996.

[4] It should be noticed that y_m/y and $\bar{y}$ are based on slightly different measures of income due to data limitations. Whereas $\bar{y}$ is based on disposable income net of income and wealth taxes to local, county and central government (our preferred income measure), y_m/y is based on before tax income (net of deductions). However, both measures are appropriate in the sense that they are pre-poll tax and pre-property tax.

in 1990 and median-to-mean income in 1988–1990. Differences in industrial structure represent differences in wage structure and profits, the main sources of variation in income distribution.

Measures of mobility are included as controls. Mobility is measured by in- (CO_IN) and out- (CO_OUT) commuting, the fraction of employees working in the community that lives in another community and the fraction of employees living in the community that works in another community, respectively. There is a large body of literature, both theoretical and empirical, on the relationships between redistribution and mobility. The theoretical literature (e.g. Brown and Oates, 1987) has emphasized whether decentralized responsibility for welfare and redistribution will lead to a 'race to the bottom'. The empirical literature has investigated whether generous welfare programs attract low-income households and whether governments respond to such migration by reducing the amount of redistribution, see Wheaton (2000) for a recent contribution. Our variables capture possible effects of tax competition and tax exporting.

Previous studies of the Scandinavian countries show that ideological orientation of the voters affects fiscal variables including taxation. Ideology can be seen as a background preference variable varying between communities and that may influence the tax structure independent of the income distribution. The share of elected socialist representatives in the local council (SOC) represents ideology. Since the income distribution and ideological orientation can be correlated, we report results with and without the socialist variable.

Two additional types of control variables are included. The first set of controls is the population size (POP) and the share of the population living in rural areas ($RURAL$). They capture background factors that may influence the cost of utilities and the determination of the property tax (restricted to urban areas). The second set takes into account that local services are oriented towards specific age groups of the population, notably schooling and care for the elderly, and that demographic factors tend to be important for service demand. The demographic controls are the fraction of the population below 7 years of age (CH), the fraction of the population between 7 and 15 years of age (YO), and the fraction of the population 80 years and above (EL). Sample averages and standard deviations of the variables are reported in Table 4.

Although we have a panel, the analysis basically investigates variables with substantial cross-section variation, but very limited time-series variation. The political variables and the share of the population living in rural areas have no time series variation at all, as they are based on election data for 1995 and national census data from 1990, respectively. In order to utilize the cross-section variation in the data, we start out by estimating the models without any community specific effects. Time dummies (γ_t) are included to capture the impact of shocks that are common to all local government. To check for robustness, we also estimate the model year by year. The poll tax equation is estimated by OLS, whereas the TOBIT method is used to estimate the property tax and property tax share equations where around 85% of the observations equal zero. We also check whether the results are robust to the inclusion of random community specific effects.

5. Estimated effect of income distribution on tax structure

The Meltzer–Richard hypothesis implies that income distribution influences taxation and redistribution. We assume that the tax structure is the key instrument of redistributive politics, and the income distribution is expected to influence the tax structure via the median voter. More equal income distribution motivates less redistribution by shifting the financing from property taxes to poll tax. The estimates of the basic model A, shown in Table 1, are consistent with this hypothesis. The ratio of median-to-mean income is positive and significant in the poll tax equation, and negative and significant in the property tax and the property tax share equations. An increase in the ratio of median to mean income by 10%-points (say an increase in the ratio of median to mean from 0.80 to 0.90) increases the poll tax by more than NOK 500 (USD55) per standardized house or 9%, and reduces the property tax revenue by more than NOK 800 (USD 90) or 64%. The calculations are based on an average community with residential property tax. The tax structure is shifted so that the property tax share is reduced by nearly 12%-points.

While the results support the Meltzer–Richard hypothesis regarding the tax structure, they do not imply that government size will increase with increased median income relative to the mean. The estimates of the basic model indicate that an increase in the ratio of median to mean income by 10%-points will reduce the sum of poll tax and property tax by NOK 320.[5] This result is in conflict with the underlying theoretical model assuming non-redistributive public spending, but, as discussed in Section 2, it may reflect that spending programs are redistributive. We have run an OLS regression with the sum of poll tax and property tax as dependent variable (not reported), and with this specification we reach the opposite conclusion, i.e. the ratio of median to mean income comes out with a significantly positive coefficient. However, this estimate may be misleading since it is likely to underestimate the impact on the property tax. Our data do not offer concluding evidence regarding the relationship between income distribution and government size.

The main variation in our sample is of cross-sectional character, and it can be argued that the pooled regressions in Table 1 hide weak relationships. This is investigated by separate year-by-year regressions of the basic model reported in Table 5. Basically, both the size of the coefficients and the statistical significances survive when we look at each year separate.

The ideology variable, measured by the share of socialists in the local council, contributes to a higher tax level and also a relative shift towards property taxation. The estimates indicate that an increase in the share of socialists by 10%-points will increase the poll tax by NOK 80 or about 1–2%, the property tax by NOK 340 or 20%, and the sum of the two by NOK 420 or 6–7%. As the property tax is relatively more responsive than the poll tax, the property tax share increases by close to 5%-points. Our interpretation is that socialists see property taxation as an attractive instrument of redistribution. Pettersson (2001) has shown using Swedish data that ideology influences fiscal policy independent of income variables. As shown in

[5] We are unable to calculate the significance of this effect since it combines OLS and TOBIT estimates.

Table 1
Estimation results

	Model A			Model B			Model C			Model D		
	Poll tax	Pr. tax	Pr. tax sh.	Poll tax	Pr. tax	Pr. tax sh.	Poll tax	Pr. tax	Pr. tax sh.	Poll tax	Pr. tax	Pr. tax sh.
y_m/y	5355	−8556	−1.189	6117	−5889	−0.834	5199	−7103	−0.967			
	(3.91)	(−3.31)	(−3.39)	(4.54)	(−2.32)	(−2.43)	(3.73)	(−2.68)	(−2.67)			
$(y_{0.75} - y_{0.25})/y$										−3812	2436 (1.27)	0.362 (1.39)
										(−3.59)	(1.27)	(1.39)
l	−0.045	−0.157	−0.000022	−0.039	−0.154	−0.000022	−0.063	−0.128	−0.000018	−0.041	−0.162	−0.000023
	(−4.46)	(−5.67)	(−5.88)	(−3.94)	(−5.54)	(−5.75)	(−6.34)	(−4.77)	(−4.87)	(−4.12)	(−5.78)	(−5.99)
$\bar{y}$	0.011	−0.047	−0.0000052	0.029	−0.064	−0.0000075	0.025	−0.079	−0.0000010	−0.009	−0.032	−0.0000030
	(1.00)	(−2.40)	(−1.94)	(4.03)	(−3.9)	(−2.83)	(2.53)	(−4.22)	(−3.94)	(−0.80)	(−1.40)	(−0.96)
RURAL	−248	−3570	−0.479	−247	−3879	−0.521	342	−4829	−0.661	−290	−0.363	−0.487
	(−0.99)	(−6.35)	(−6.28)	(−1.02)	(−6.88)	(−6.81)	(1.41)	(−8.27)	(−8.24)	(−1.16)	(−6.32)	(−6.24)
POP	0.0055	0.0049	0.00000034	0.0048	0.0036	0.00000017	0.0016	0.0100	0.00000109	0.0041	0.0069	0.00000061
	(1.74)	(1.34)	(0.68)	(1.52)	(0.96)	(0.33)	(0.50)	(2.65)	(2.10)	(1.32)	(1.88)	(1.23)
CH	−20588	−13508	−1.247	−24149	−20473	−2.196	−24460	−1613	0.402	−20389	−17055	−1.736
	(−4.06)	(−1.25)	(−0.85)	(−4.85)	(−1.90)	(−1.50)	(−4.74)	(−0.15)	(0.27)	(−4.79)	(−1.57)	(−1.18)
YO	−23441	−2831	−0.407	−24243	−21750	−2.911	−15839	−21525	−2.954	−22138	−179	−0.069
	(−5.15)	(−0.26)	(−0.28)	(−5.91)	(−2.18)	(−2.16)	(−3.49)	(−2.04)	(−2.04)	(4.79)	(−0.02)	(−0.05)
EL	−7999	−21786	−2.580	−9076	−3709	−4.506	−18215	700	0.668	−10059	−16395	−1.856
	(−1.65)	(−1.96)	(−1.71)	(−1.93)	(−5.68)	(−3.02)	(−3.87)	(0.07)	(0.46)	(−2.07)	(−1.50)	(−1.25)
CO_OUT	2579	−3971	−0.556	2636	−3709	−0.520				2403	−3796	−0.530
	(7.33)	(−6.07)	(−6.24)	(7.50)	(−5.68)	(−5.86)				(6.76)	(−5.85)	(−6.00)
CO_IN	−1375	1405	0.152	−1882	781	0.070				−1525	1680	0.190
	(−2.42)	(1.41)	(1.12)	(−3.40)	(0.79)	(0.52)				(−2.69)	(1.69)	(1.41)
SOC	848	3413	0.454				1151	3164	0.426	936	2941	0.390
	(2.19)	(4.41)	(4.32)				(2.92)	(3.94)	(3.87)	(2.43)	(3.89)	(3.80)
# obs.	1176	1176	1176	1176	1176	1176	1176	1176	1176	1176	1176	1176
Estimation	OLS	TOBIT	TOBIT	OLS	TOBIT	TOBIT	OLS	TOBIT	TOBIT	OLS	TOBIT	TOBIT
R^2_{adj}	0.219			0.211			0.184			0.217		
Log likelihood		−1690	−160		−1701	−170		−1713	−185		−1695	−165

OLS and TOBIT estimates with t-values in parentheses.

model B in Table 1, the effect of income distribution on tax structure is not much affected by excluding the socialist variable. Given our result, it is hard to argue that the ideology factor creates a bias in the effect of income distribution, since the effect on the property tax is even larger when the socialist variable is included (model A).

Another source of possible bias is the role of mobility, and the variables measuring in- and out-commuting are excluded in model C in Table 1. Again the effect of income distribution on tax structure is not much affected by the exclusion. The main effect of out-commuting is to shift the tax structure away from the redistributive property tax. This is in accordance with the fiscal competition literature, including the analysis of Carlsen et al. (2001) using Norwegian data. The effect on total taxes is rather small.

We argued above that the ratio of the median to the mean is not necessarily a good measure of the skewness of the income distribution when the distribution is not log-normal or when voter participation is associated with income levels. In model D in Table 1 we investigate an alternative measure of income distribution, the interquartile range (the distance between the 75% and 25% fractiles) relative to the mean. The estimates confirm the results obtained with median to mean as a measure of income distribution. More unequal income distribution (a larger interquartile range) reduces the poll tax and increases the property tax, although only the coefficient of the poll tax is statistically significant.

The main econometric challenge of the analysis is to handle the potential endogeneity of the income distribution. The limited mobility in Norway and the marginal importance of the tax decision investigated reduce the problem, but migration response to fiscal variables may imply that the level of private income and the income distribution adjusts to the tax structure. In Table 2, the level of private income and the income distribution is instrumented by the industrial structure in 1990 and the median to mean income in 1988–1990, about 6–8 years before the data of the analysis.[6] The choice of instrument is based on the assumption that the industrial structure is important for the income distribution, but not for the choice of taxes and the tax structure. It appears that the instrumented effects of income distribution on tax structure have the expected signs and are statistically significant. The quantitative effects of income distribution on poll tax and property taxation are larger than in the basic model.

Residential property taxation is not available to all local governments since the property tax is restricted to urban areas. When no residential property tax is observed, the local government has been restricted from having property tax because it has no defined urban area or has chosen not to introduce it. In the estimations reported above all local governments without residential property tax are treated equally. In an attempt to check the distinction between the two choices and the restriction, we have applied population size as a proxy to exclude small local governments without urban areas. This approximation is necessary since there is no clear-cut rule that determines whether

[6] The reported t-values for the estimates in the property tax and the property tax share equations are based on standard errors from TOBIT regressions were the predicted values of y_m/y and $\bar{y}$ are used as regressors. It is well known that these t-values may be biased. We have investigated this bias in the user charge equation, and it is of little importance (in the order of 0.01–0.03).

Table 2
IV estimates

	Poll tax	Pr. tax	Pr. tax sh.
y_m/y	9347	−11978	−1.701
	(3.68)	(−2.35)	(−2.44)
l	−0.046	−0.180	−0.000025
	(−4.51)	(−6.15)	(−6.32)
$\bar{y}$	0.051	−0.081	−0.0000095
	(2.45)	(−2.06)	(−1.79)
RURAL	114	−4198	−0.570
	(0.37)	(−6.17)	(−6.14)
POP	0.0054	0.0040	0.00000020
	(1.62)	(0.98)	(0.36)
CH	−23110	−18872	−2.004
	(−4.42)	(−1.68)	(−1.31)
YO	−16589	−7366	−1.059
	(−3.17)	(−0.61)	(−0.64)
EL	−4453	−26243	−3.170
	(−0.88)	(−2.19)	(−1.95)
CO_OUT	2379	−4099	−0.578
	(6.50)	(−5.99)	(−6.17)
CO_IN	−1889	1787	0.209
	(−2.89)	(1.52)	(1.31)
SOC	903	2932	0.393
	(2.10)	(3.47)	(3.42)
Estimation, method	IV	TOBIT IV	TOBIT IV
# obs.	1149	1149	1149
R^2_{adj}	0.204		
Log likelihood		−1581	−158

T-values in parentheses.

a local government can levy residential property tax or not. In the end the issue is settled by the courts. Residential property tax is observed in less than 1% of local governments with population size below 2000 and for only 5% of those with 2000–4000 inhabitants. The proportion with residential property tax jumps to 15% for local governments with 4000–5000 inhabitants.

Table 3 shows the results when the basic equation is estimated for local governments with population size above 2000 and 4000, respectively. It appears that the impacts of income distribution are very robust to the exclusion of local governments that cannot use residential property tax. Median to mean income is still positive and significant in the poll tax equation and negative and significant in the property tax equations. The quantitative effects are similar to those obtained on the full sample in Table 1. Most other results are also robust to the exclusion of small local governments. The only exception is that exogenous revenue has no significant impact on the property tax when the sample is restricted to local governments with more than 4000 inhabitants.

Another concern is the background role of the housing market. If the housing values are very different among the local governments, the conditions for property taxation

Table 3
Estimation results excluding small and large local governments

	Population size > 2000			Population size > 4000			Excluding 10 largest cities		
	Poll tax	Pr. tax	Pr. tax sh.	Poll tax	Pr. tax	Pr. tax sh.	Poll tax	Pr. tax	Pr. tax sh.
y_m/y	5709	−8398	−1.174	6470	−9458	−1.351	5238	−9829	−1.371
	(3.57)	(−3.18)	(−3.28)	(3.22)	(−3.39)	(−3.57)	(3.77)	(−3.51)	(−3.56)
l	−0.024	−0.181	−0.000026	−0.044	−0.047	−0.000008	−0.047	−0.194	−0.000027
	(1.19)	(−2.78)	(−2.31)	(1.93)	(−2.70)	(−2.31)	(0.99)	(−1.80)	(−1.40)
$\bar{y}$	(−1.32)	(−3.99)	(−4.18)	(−1.17)	(−0.84)	(−1.07)	(−4.35)	(−5.78)	(−5.88)
	0.014	−0.056	−0.0000063	0.030	−0.059	−0.0000063	0.011	−0.038	−0.0000040
RURAL	−597	−3579	−0.479	−548	−3830	−0.479	−277	−3988	−0.542
	(−1.94)	(−5.89)	(−5.81)	(−1.29)	(−5.80)	(−5.81)	(−1.07)	(−6.28)	(−6.20)
POP	0.0056	0.0048	0.00000032	0.0046	0.0048	0.00000032	0.0013	−0.048	−0.0000048
	(1.71)	(1.32)	(0.64)	(1.30)	(1.29)	(0.64)	(0.14)	(−2.39)	(−2.38)
CH	−27825	−11384	−0.896	−29560	−6688	−0.896	−20590	−13845	−1.300
	(−4.32)	(−1.01)	(−0.58)	(−3.43)	(−0.54)	(−0.58)	(−4.01)	(−1.21)	(−0.82)
YO	−22699	−1206	−0.217	−17896	−10350	−0.217	−23495	−2401	−0.345
	(−3.87)	(−0.11)	(−0.15)	(−2.16)	(−0.83)	(−0.15)	(−5.11)	(−0.21)	(−0.22)
EL	−5428	−13884	−1.478	748	−15717	−1.478	−8440	−23253	−2.748
	(−0.86)	(−1.19)	(−0.93)	(0.08)	(−1.23)	(−0.93)	(−1.71)	(−1.91)	(−1.65)
CO_OUT	2963	−4004	−0.560	2893	−3954	−0.560	2563	−4561	−0.636
	(7.58)	(−6.05)	(−6.23)	(6.19)	(−5.85)	(−6.23)	(7.12)	(−6.27)	(−6.34)
CO_IN	−1763	1709	0.191	−1757	1429	0.191	−1341	2486	0.293
	(−2.67)	(1.69)	(1.39)	(−2.19)	(1.31)	(1.39)	(−2.27)	(2.30)	(1.97)
SOC	548	3079	0.409	1529	2669	0.409	840	3790	0.510
	(1.17)	(3.89)	(3.81)	(2.44)	(3.09)	(3.81)	(2.14)	(4.59)	(4.49)
# obs.	937	937	937	633	633	633	1148	1148	1148
Estimation method	OLS	TOBIT	TOBIT	OLS	TOBIT	TOBIT	OLS	TOBIT	TOBIT
R^2_{adj}	0.201			0.220			0.216		
Log likelihood		−1652	−148		−1506	−148		−1503	−162

OLS and TOBIT estimates with t-values in parentheses.

differ. Our understanding is that the larger cities may have housing markets and prices different from the rest and this may disturb our results. This is investigated in the final columns of Table 3 by excluding the 10 largest cities. Again the effect of income distribution on tax structure survives, and the quantitative effects are quite similar to the basic model.

Finally, we reestimate the equations of the basic model in Table 1 by including community specific effects. Because of the short-time period covered, we cannot rely on fixed effects that only make use of the time series variation in the data. We apply the random effects method that includes some of the cross-section variation and assumes that the community specific effects are uncorrelated with the explanatory variables. The results are reported in Table 6, and it appears that the impact of income distribution is robust to this modification of the empirical model. Median-to-mean income is still significant with the expected signs, but the quantitative effects are somewhat reduced in the poll tax equation and the property tax equation. The quantitative effect on the property tax share is roughly the same as in Table 1.

6. Interpretation of the broader determinants of tax structure

The estimated model offers insights into the economics and politics of local taxation. The interpretations below concentrate on the basic model A of Table 1. Increased private income level raises the poll tax and reduces the property tax, and leads to a significant shift in the tax structure away from property taxes. The impact of a 10% increase in private income is to increase the poll tax by 1% and to reduce the property tax by about 25%.[7] Total taxes will be reduced by 3% and the property tax share is reduced by nearly 4% points. The result is in conflict with other empirical evidence that private income contributes to higher tax levels, as in Goodspeed (1998). On the other hand, Inman (1989) finds that higher income level may reduce the demand for city services as well as discourage redistributive services.

There is strong evidence of revenue substitution in the sense that local governments respond to higher exogenous revenue (lump-sum grants and regulated taxes) by reducing both the poll tax and the property tax. The relative reduction is largest for the property tax, and consequently the tax structure is shifted from property tax to poll tax. An increase in l by NOK 2000 per capita (roughly 10% of the average) reduces the poll tax by NOK 90 per standardized house and the property tax by NOK 300. The sum of the poll tax and the property tax is reduced by about 3%, and the property tax share is reduced by 4% points.

The evidence of revenue substitution is consistent with the recent Norwegian study of Borge (2000) who uses a different data set for the poll tax. On the other hand, a selected review of the voluminous US literature indicates that the results are rather mixed. Inman (1979) estimates a positive (but insignificant) relationship between total tax revenue and grants in an analysis of the 41 largest cities. In an extended and updated analysis (Inman, 1989) he concludes that exogenous revenue (lump-sum grants and

[7] We still consider an average community with property tax.

regulated income and sales taxes less of exogenous interest payments) has a negative impact on user charges and property tax, but only for the property tax is the effect statistically significant. Holtz-Eakin and Rosen (1990) find that grants have a positive (but insignificant effect) on the property tax rate in a sample of municipal governments. Stine (1994) and Goodspeed (1998) report that increases in grants are associated with lower property tax revenue. The estimates of Skidmore (1999) show that grants have a significant positive effect on local own-source revenues and an insignificant effect on property taxes. Apparently, there is some need for more concluding evidence on the revenue substitution in the US.

Taken together the impacts of exogenous revenue and private income point towards a substantial flypaper effect. Whereas most of a grant increase is reflected in higher spending, we are not able to document that increased private income has a positive effect on spending. If we assume 2.5 persons per household, the point estimates of the basic model predict that an increase in grants by NOK 1000 per capita will increase per capita spending by NOK 920. An equal increase in private disposable income is predicted to reduce per capita spending by NOK 36. The result adds to the international evidence of flypaper effect as summarized by Oates (1999).

Controls are introduced to take into account cost factors in utilities production and the limitations imposed on property taxation. Communities where a large share of the population resides in rural areas rely less on property tax compared to other communities. These findings probably reflect that the revenue potential of the property tax is small in rural areas. Since the coefficient in the poll tax equation is economically and statistically insignificant, the sum of property tax and poll tax tend to be low in communities where a large share of the population resides in rural areas. If the share of the population living in rural areas increases by 10% points, the property tax is reduced by more than 25%, the sum of property taxes and poll tax will be reduced by about 10%, and the property tax share will be reduced by 5% points. Population size does not come out as an important cost factor.

Borge and Rattsø (1995) show how age groups compete for services. The results here imply that large age groups in the relevant ages (children, young and old) do not drive up the tax level. On the contrary, large shares of the population in the age groups in question seem to contribute to lower tax level, and in particular to lower poll tax. A possible explanation is that increased demand for welfare services directed towards the young and the elderly imposes financial pressure on utility services. This may reduce the production and costs of utility services and thereby the poll tax. Borge and Rattsø (2000) document that the share of elderly has a negative effect on the unit cost in the utility sector.

7. Concluding remarks

The tax structure is important for the income distribution and therefore a key playground for redistributive politics. The starting point of the paper is the Meltzer–Richard hypothesis that more unequal income distribution will create a majority for more redistribution. While the empirical literature investigating the hypothesis has concentrated

on the size of the public sector, this analysis exploits data about the tax structure in decentralized government in Norway. The choice of revenue instruments studied involves poll and property tax. The approach is in the tradition of majority rule, and we show how the local government decisions regarding tax structure and spending level can be understood as one dimensional. This motivates the empirical analysis where the actual income distribution is measured by the ratio of median to mean income. The estimated model supports the understanding that more equal income distribution implies a shift in the tax burden from property taxes to poll tax and thereby gives less redistribution. We conclude that the tax structure is responsive to income distribution. More unequal distribution allows the majority to avoid the poll tax and shift the tax burden towards a property tax that is proportional to income.

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Appendix A. The solution of the model and comparative statics

In this appendix we derive the solution of the model and the comparative statics. The solution of the model is defined by the following two equations:

$$\frac{\partial w_m}{\partial t} = -\frac{1-\alpha}{1+t} + \frac{\beta}{g}\frac{1-\alpha}{(1+t)^2}(y-f) = 0, \tag{A.1}$$

$$\frac{\partial w_m}{\partial f} = -\frac{1}{y_m - f} + \frac{\beta}{g}\frac{1+\alpha t}{1+t} = 0, \tag{A.2}$$

where w_m is the log of the indirect utility function of the voter with median income. Together with the local government budget constraint, Eqs. (A.1) and (A.2) determine the property tax rate (t), the poll tax (f), and the provision of local public services (g) as functions of median income (y_m), mean income (y), and central government grants (l). By differentiating the system, we can show that the effect of increased median income (keeping mean income constant) is as follows:

$$\frac{\partial t}{\partial y_m} = -\frac{1}{\Delta}\frac{\beta^2}{g^3}\frac{1-\alpha}{(1+t)^4}(1+\alpha t)^2(1+\alpha t+\beta) < 0, \tag{A.3}$$

Table 4
Data description and descriptive statistics

Variable	Description	Mean (St. dev.)
Poll tax	The sum of charges for water supply, discharge of sewage, garbage collection and chimney sweep for a standard house, NOK	5843 (1677)
Property tax	Annual property tax payment for a standard house, set to zero if property tax is levied on less than half of residential property, NOK	196 (519)
Property tax share	Property tax as share of the sum of user charges and property tax	0.027 (0.069)
Income distribution (y_m/y)	The ratio of median to mean income, based on before tax income net of deductions for all taxpayer	0.827 (0.034)
The interquartile range $(y_{0.75} - y_{0.50})/y$	The interquartile range of the income distribution, based on before tax income net of deductions for all taxpayers	
Exogenous local government revenue (l)	The sum of lump-sum grants from the central government and regulated income and wealth taxes, NOK per capita	21048 (5542)
Private disposable income ($\bar{y}$)	Taxable income minus income and wealth taxes to local, county and central government, NOK per capita	69642 (7762)
Settlement pattern ($RURAL$)	The share of the population living in rural areas (1990)	0.562 (0.283)
Population size (POP)	Total population, January 1	8794 (16370)
The share of children (CH)	The share of the population 0–6 years, January 1	0.093 (0.012)
The share of youths (YO)	The share of the population 7–15 years, January 1	0.118 (0.014)
The share of elderly (EL)	The share of the population 80 years and above, January 1	0.049 (0.015)
The share of socialists (SOC)	The share of socialist representatives in the local council	0.371 (0.143)
Out-commuting (CO_OUT)	The fraction of employees living in the community that works in another community	0.266 (0.179)
In-commuting (CO_IN)	The fraction of employees working in the community that lives in another community	0.158 (0.111)

$$\frac{\partial f}{\partial y_m} = -\frac{1}{\Delta}\frac{\beta}{g^2}\frac{1-\alpha}{(1+t)^4}(1+\alpha t)^2(1-\alpha+\beta) > 0, \tag{A.4}$$

$$\frac{\partial g}{\partial y_m} = \frac{1}{\Delta}\frac{\alpha\beta^2}{g^2}\frac{1-\alpha}{(1+t)^4}(1+\alpha t)^2 > 0, \tag{A.5}$$

where $\Delta = (\partial^2 w_m/\partial t^2)(\partial^2 w_m/\partial f^2) - (\partial^2 w_m/\partial t \partial f)(\partial^2 w_m/\partial f \partial t)$ is positive from the second-order condition.

Table 5
Year-by-year regressions

	1996			1997			1998		
	Poll tax	Pr. tax	Pr. tax sh.	Poll tax	Pr. tax	Pr. tax sh.	Poll tax	Pr. tax	Pr. tax sh.
y_m/y	6093	−7909	−1.178	6863	−8435	−1.176	3882	−10230	−1.1337
	(2.36)	(−1.75)	(−1.88)	(3.06)	(−1.89)	(−1.96)	(1.68)	(−2.29)	(−2.23)
l	−0.043	−0.187	−0.000027	−0.044	−0.161	−0.000023	−0.049	−0.135	−0.000019
	(−2.18)	(−3.57)	(−3.66)	−2.58	−3.36	−3.51	−3.05	−3.05	−3.17
$\bar{y}$	0.018	−0.054	−0.0000060	0.0001	−0.078	−0.0000091	0.012	−0.012	−0.0000007
	(0.85)	(−1.54)	(−1.23)	(0.01)	(−2.18)	(−1.89)	(0.71)	(−0.36)	(−0.16)
RURAL	−177	−3139	−0.431	−364	−3958	−0.524	−285	−3590	−0.477
	(−0.39)	(−3.45)	(−3.42)	(−0.85)	(−3.92)	(−3.86)	(−0.68)	(−3.57)	(−3.53)
POP	0.0106	0.0053	0.00000019	0.0060	0.0048	0.00000036	0.0004	0.0044	0.00000041
	(1.85)	(0.85)	(0.22)	(1.13)	(0.73)	(0.41)	(0.07)	(0.71)	(0.50)
CH	−40533	−7891	−0.503	−13315	−10037	−0.736	−8875	−26906	−3.007
	(−4.41)	(−0.45)	(−0.21)	(−1.56)	(−0.52)	(−0.28)	(−1.02)	(−1.37)	(−1.14)
YO	−13236	−11042	−1.526	−28101	−10960	−1.557	−26887	16346	2.160
	(−1.59)	(−0.63)	(−0.63)	(−3.68)	(−0.57)	(−0.61)	(−3.46)	(0.87)	(0.85)
EL	−7106	−23963	−2.926	−10495	−20551	−2.424	−4634	−23168	−2.698
	(−0.82)	(−1.27)	(−1.12)	(−1.29)	(−1.07)	(−0.94)	(−0.55)	(−1.18)	(−1.02)
CO_OUT	2939	−4060	−0.584	2514	−3405	−0.474	2254	−4673	−0.635
	(4.58)	(−3.78)	(−3.91)	(4.27)	(−2.98)	(−3.09)	(3.77)	(−3.90)	(−3.93)
CO_IN	−1216	1637	0.214	−380	1625	0.147	−2369	819	0.073
	(−1.18)	(1.00)	(0.94)	(−0.40)	(0.92)	(0.62)	(−2.43)	(0.47)	(0.31)
SOC	1710	3320	0.447	539	3024	0.397	314	3894	0.517
	(2.41)	(2.53)	(2.46)	(0.83)	(2.23)	(2.18)	(0.48)	(2.90)	(2.86)
# obs.	392	392	392	392	392	392	392	392	392
Estimation method	OLS	TOBIT	TOBIT	OLS	TOBIT	TOBIT	OLS	TOBIT	TOBIT
R^2_{adj}	0.259			0.234			0.141		
Log likelihood		−606	−55		−582	−57		−499	−45

OLS and TOBIT estimates with t-values in parentheses.

Table 6
Random effects estimates

	Poll tax	Pr. tax	Pr. tax sh.
y_m/y	3715	−4179	−1.071
	(2.13)	(−2.54)	(−5.45)
l	−0.035	−0.160	−0.000014
	(−2.18)	(−7.64)	(−5.94)
$\bar{y}$	0.015	−0.044	−0.0000037
	(1.13)	(−3.68)	(−2.27)
RURAL	−341	−3302	−0.391
	(−0.99)	(−8.51)	(−7.62)
POP	0.0055	0.0033	0.00000117
	(1.25)	(2.01)	(5.62)
CH	−19374	−42703	−1.610
	(−3.08)	(−6.04)	(−1.64)
YO	−20709	−25964	−0.115
	(−3.66)	(−3.42)	(−0.12)
EL	−5578	−54825	−1.366
	(−0.86)	(−7.09)	(−1.61)
CO_OUT	2663	−3365	−0.535
	(5.45)	(−7.48)	(−7.94)
CO_IN	−1508	1262	0.087
	(−1.91)	(1.76)	(1.08)
SOC	1139	1582	0.723
	(2.14)	(3.24)	(8.65)
Estimation method	RE	TOBIT	TOBIT
		RE	RE
# obs.	1176	1176	1176
R^2_{adj}	0.217		
Log likelihood		−1532	13

t-values in parentheses.

Appendix B. Documentation of the variables

Data description and descriptive statistics are shown in Table 4.

Appendix C. Year-by-year regressions and random effects estimates

Year-by-year regressions are shown in Table 5, and random effects estimates are shown in Table 6.

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