Property taxation as incentive for cost control: Empirical evidence for utility services in Norway*)

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Abstract

Recent theoretical research suggests that property taxation has incentive effects and can contribute to lower costs in the public sector. We are able to investigate the empirical relevance of this proposition, since some, but not all, local governments in Norway have residential property tax. The raw data show that local governments with property tax have about 20% lower unit costs in utilities. The econometric analysis addresses issues of non-random selection and endogeneity. The alternative controls and matching comparisons are not able to wash out the difference in unit costs and indicate that property taxation has significant negative effect on costs.

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1. Introduction

Political institutions responsible for public service production face issues of cost control. The public services are often provided by lower-level agencies under monopoly, while the financing is arranged at the political level. Since the services are not delivered at an open market, the competitive mechanisms to secure cost-efficiency are not in place. The costs are difficult to evaluate, because the political institutions have limited ability to monitor the production of the bureau.

The broad background of this analysis is the suggestion by Brennan and Buchanan (1977) that revenue-maximizing governments can be constrained by the design of tax constitution. Glaeser (1996) links this to property taxes, and shows that property taxation works as an incentive mechanism for local service provision, since the services raise housing values and thereby the property tax base. Gordon and Wilson (2000) analyze similar relationships between voters and officials emphasizing government waste (or slack) and in the context of tax competition. Property taxation may reduce waste since the officials will take into account the feedback via property values. Hoxby (1999) provides a theoretical framework to analyze costs and efforts in schools and introduces property taxation as a disciplining device. Property taxation links school quality to school financing and helps control costs and efforts in schools.

The Norwegian public sector allows this first empirical investigation of the incentive effect of property taxation. Since we can separate between local governments with and without property tax financing, the Norwegian situation works like a natural experiment. The paper addresses unit costs of utility services. Utilities are assumed to be of direct importance for property values and therefore of particular relevance for the incentive effects of property taxation. Local governments are politically responsible for the utility service supply and control the budget of the bureau producing utility services. When the bureau has preferences for output and slack, a conflict of interest exists between politicians and bureaucrats in standard fashion. The limited information of the politicians about bureaucratic costs sets the stage for a regulation problem where the budget constraint of the bureau is important. The existence of a property tax influences the budget constraint, and we investigate the hypothesis that property taxation induces the bureau to set lower costs.

Our dataset covers unit costs of utilities and economic and demographic characteristics for Norwegian local governments during the period 1993-1998. Around 30% of the local governments have residential property tax. In a raw comparison of cost levels, local governments with property tax have more than 20% lower unit costs than those without. Two econometric challenges stand out. First, other characteristics may explain the different cost levels of utilities between local governments, notably the settlement pattern. Small local governments in the periphery do not have property tax and their cost level may be higher because of local cost conditions. We use standard regression analysis and matching to control for other observable characteristics. Second, background factors may influence both the cost level and the historical decision to have property tax. We attempt at controlling for this by using instrument variables. If local governments choose to have property tax because they have a problem of cost control, the possible estimation bias will tend to underestimate the cost reduction effect of having property tax.

Section 2 outlines a simple framework to understand the decision-making situation. The property taxes and the budget constraint of the bureau are analyzed in a model of local service production with mobile households. The model shows how the bureau sets unit costs dependent of the feedbacks via the housing market. The empirical formulation of the analysis is documented in Section 3. Estimation results for the benchmark econometric model including cost and political controls are reported in Section 4, while the estimates using matching are discussed in Section 5. Concluding remarks are written in Section 6.

2. Stylized model of property tax incentives

We study a setup where local governments provide services and their cost challenge is the control of lower-level bureaus organizing the service production. Local governments are basically financed by grants, but they can have property taxation and thereby influence marginal funds. Property tax incentives are about the financial constraints of the bureau. The bureau is assumed to have an information advantage and to enjoy budgetary slack. We will show how property tax financing affects the economic incentives of the bureau and thereby the costs of services.

Our starting point is a model of local public goods with mobile households. This workhorse model of local public finance combines household demand and location with political decisions about taxation and service supply. Glaeser (1996) applies a similar design in his discussion about incentive effects of property taxation. Wilson and Gordon (2000) develop a broader understanding of the housing market and a richer formulation of the problem of political control. Both Glaeser and Wilson and Gordon address the voter control of the local government, and do not introduce a bureau producing a service. Our formulation of the interaction with the bureau simplifies Hoxby (1999). Boadway et al. (1999) recently have designed a model of government funded decentralized agencies emphasizing how the structuring of the financing creates incentives to reveal costs and induce effort. Their model includes several agencies and handles various incentive problems, but does not include a housing market.

The model assumes a large number of fixed and identical jurisdictions with identical and mobile households. The individual household preferences include private consumption q, housing h, and public services subject to bureau production x (all volume variables are measured per capita):

$$u = u(q, h, x) \qquad (1)$$

Marginal utilities are positive and declining in the three arguments and x is interpreted as utility services in the empirical analysis. The link between supply of utility services and housing demand is of importance for the incentive effects here, and we allow for complimentarity between housing and utility services. The individual voter allocates private income to private consumption and housing. It is assumed that her exogenous private income y finances private consumption and payment of the costs of housing (annualized gross housing price p). Housing wealth is not taken into account in the short-run budget constraint. The individual optimization problem takes the housing price as given:

$$\underset{q,h}{Max} \quad u(q, h, x) \quad s.t. \quad q + ph = y \qquad (2)$$

The demand function for housing depends on the gross price of housing, private income, and the supply of utility services:

$$h = h(p, y; x) \quad \frac{\partial h}{\partial x} > 0 \tag{3}$$

The demand for housing and thereby the tax base of the property tax responds to the supply of local utility services given the assumption of complimentarity. More utility services shift the demand from private consumption to housing. The allocation of the individual household can be represented with an indirect utility function v in gross housing price, private income, and utility service supply:

$$v = v(p, y; x) \tag{4}$$

In migration equilibrium the households are indifferent across communities, and the individual household obtains a global utility level U_o:

$$v(p, y; x) = U_0 \tag{5}$$

The migration equilibrium includes two types of capitalization effects of utility services. First, more utility services raise the individual household demand for housing when they are complimentary. Second, more utility services make the community more attractive for inmigration. Both factors drive up the gross housing price, which can be represented by the following capitalization function:

$$p = p(x, y) \tag{6}$$

The gross price of housing is a positive function of utility service supply and private income level. The individual housing demand and the reduced form migration equilibrium, equations (3) and (6), describe the determination of the property tax base. The property tax base feed into the budget constraint of the local government.

The housing market must be in equilibrium. Aggregate community housing demand is Nh with N households, and total housing supply H is assumed exogenous in the short run. The housing market equilibrium is:

$$Nh(p(x,y),y;x)) = H \tag{7}$$

The equilibrium number of residents N responds to the utility service supply:

$$\frac{\partial N}{\partial x} = -\frac{N}{h}\left(\frac{\partial h}{\partial p}\frac{\partial p}{\partial x} + \frac{\partial h}{\partial x}\right) \tag{8}$$

The adjustment of the population size when service supply goes up can be positive or negative. The capitalization of utility services into housing prices motivates inmigration, while the complimentarity effect contributes to higher housing demand and outmigration. Weak complimentarity effect and elastic housing demand contributes to higher population size when service supply goes up. It should be noticed that utility services affect the housing price also in a closed economy. In this situation, equation (7) determines the housing price given the population size (and no migration equilibrium (5) is imposed).

The individual housing demand and the migration equilibrium are the key elements of the endogenous budget constraint of the bureau. We do not study a full political equilibrium, but concentrate on the incentive mechanism created by property taxation. The budget balance of the local government assumes that grants g finance mandated welfare services w (both measured in per capita terms) and utility services and with a possible role for property taxation. The unit costs of utilities c are endogenous, while welfare services have fixed unit costs equal to 1. Property tax revenue is determined by the tax rate, the net price of housing, and the available housing. The net price of housing is p/(1+t). Welfare service supply and the property tax rate are held constant, to highlight the relationship between unit costs of utilities and the funding available for utilities production. The assumption is not unrealistic in the case of Norway, since welfare service spending is mandated and all taxes are regulated.[1] Making use of the capitalization function (6), the budget constraint of utility services can be written:

$$cx = g - w + \frac{t}{1+t} p(x,y) \frac{H}{N} \tag{9}$$

Utilities are produced by a bureau and the local government has limited information about the cost conditions. The bureau sets unit costs based on its own preference for service output and slack and given the above budget constraint. The bureau utility function b = b(x, s) reflects positive marginal utility of service volume x and slack per unit s, db/dx > 0 and db/ds > 0. The slack is measured by the reported unit costs in excess of the true unit costs c_0, $s = c - c_0$. The utility function assumes that both x and s are normal goods. This basic formulation of bureaucratic behavior was suggested by Migue and Belanger (1974), and the first order condition of the bureau utility maximization describes a Nash-equilibrium:

$$\frac{\partial b}{\partial s} + \frac{\partial b}{\partial x}\frac{\partial x}{\partial c} = 0 \tag{10}$$

The bureau sets unit costs depending on the budget tradeoff between service output and slack. Higher unit cost raises slack per unit by the same amount, but also reduces service supply given the budget constraint. In the case of no property taxation (t=0), the elasticity of service output with respect to unit costs is –1. In this case the bureau is financed by a fixed budget determined by grants in excess of welfare service spending (assuming g > w). Property taxation changes the budget responsiveness to unit costs, and the elasticity of service output with respect to unit costs is:

$$\frac{\partial x}{\partial c}\frac{c}{x} = -\frac{1}{1 - \frac{1}{c}\frac{t}{1+t}\frac{H}{N}(\frac{\partial p}{\partial x} - \frac{p}{N}\frac{\partial N}{\partial x})} \tag{11}$$

[1] It can be argued that welfare services should enter the utility function and thereby affect the migration equilibrium and housing prices. Such a reformulation of the model would affect the incentive effects of property taxation in the Nash-game between the local government and the bureau.

The second term of the denominator captures the change in tradeoff compared to a situation without property taxation. It follows that service supply is more responsive with property tax if the term within the parentheses is positive, i.e. if the per capita property tax base is an increasing function of the supply of utilities. An increase in x has two effects on the per capita property tax base. The first effect goes through housing prices and is clearly positive. The second effect goes through the population size and is positive (negative) if population size is a decreasing (increasing) function of x. When the population size is a decreasing function of x, the effect on the per capita property tax base is unambiguously positive, and the existence of a property tax clearly leads to lower cost. On the other hand, the effect of property taxation on costs becomes ambiguous when population size increases with x.

By utilizing the expression for the population response given by equation (8), the effect of property taxation can be related to the elasticity of housing demand:

$$\frac{\partial p}{\partial x} - \frac{p}{N}\frac{\partial N}{\partial x} = \frac{\partial p}{\partial x}(1-\varepsilon_h) + \frac{\partial h}{\partial x} \qquad \varepsilon_h = -\frac{\partial h}{\partial p}\frac{p}{h} \tag{12}$$

It follows that price inelastic housing demand ($\varepsilon_h < 1$) is a sufficient condition for making service supply more responsive with property taxation. Consequently, the existence of property tax has a negative effect on costs as long as housing demand is not ‘too’ elastic. In his model of voter control, Glaeser (1996) reaches a similar condition and argues that available empirics supports inelastic housing demand.

The role of property taxation is discussed above assuming that the tax rate is regulated. Local discretion to set the property tax rate may reduce the demand responsiveness and thereby the incentive of cost control. A higher cost asked by the bureau for the utility service will partly be passed on to the taxpayers. The empirical analysis addresses the case of regulated property taxes.

3. Data and empirical specification

The cost level of utilities is a concern in the public debate in Norway. The large variation among municipalities has raised discussion about the working of the political system and control of bureaucratic waste. The unit cost measure applied relates to standardized households, and the unit cost varies from NOK 500 to 10000 (USD 60 to 1250) in 1995 (the year with the largest number of observations). About half of the local governments have costs per standardized household between NOK 2000 and 4000 (USD 250 to 500). The cost data are based on local government accounts and include calculated capital costs.[2]

The focus of the analysis is on variation in unit costs dependent on property taxation. We do not have independent observation of service quality. It can be argued that local governments with property taxation have more funds available on the margin and that this may raise the quality and thereby the costs. Since our hypothesis is that property taxation will reduce costs, the possible quality bias will tend to underestimate the cost reduction. We do control for local cost conditions, notably possible economies of scale and the settlement pattern of the population.

The fact that some local governments have and some have not residential property tax enables us to analyze the cost effects of the tax. In our dataset for 1995, 112 local governments have residential property tax, 276 have not, and 47 have missing cost data (total of 435).[3] The property tax is voluntary and is decided by the local council. In practice the set of local governments with property tax is quite stable over time and represents historical decisions, local governments do not opt in and out of property tax. The tax is regulated in two ways. First, it is restricted to urban areas, The definition of an urban area is not that clear (decided by courts case for case), but it may explain why many small municipalities with decentralized

[2] The data set covers discharge of sewage and are collected by Statistics Norway. The collection started in 1993 and is described in several reports (Bersvendsen et al., 1999, document the 1997 survey). The cost measure includes capital costs, administrative costs, labor expenses and maintenance. Matching grants related to discharge of sewage are deducted. Capital costs are calculated in the same way for all local governments based on historical investments and the interest rate of the government bank for local governments (*Kommunalbanken*). In the analysis we focus on the unit cost, which is total costs divided by the number of standard users. A standard user is defined as a household consisting of three persons. Firms are converted into standard users based on their consumption of the service.

[3] In practice 200 of 435 municipalities have property tax, but only about 120 have residential property tax. Most of the property tax revenue (5-6 % of municipal tax revenue and 0.3% of GDP in all) relates to electric power production.

settlement pattern in the periphery do not have property tax. Second, the property tax rate is restricted to a narrow band, between 0.2 and 0.7 %. Most of the local governments with a property tax apply the maximum rate. The data describe the actual property tax revenue for a standardized house. In the local governments with residential property tax, the property tax on average is about NOK 1300 (USD 160) per standard house per year and does not vary that much with population size.

Table 1 offers a first look at the cost level when local governments are separated according to residential property taxation and population size. The raw cost difference is above 20% and to the advantage of the municipalities with a property tax. The average cost per standardized household is NOK 2055 (USD 250) in the 112 local governments with property tax and NOK 2535 (USD 310) in the 276 local governments without property tax. The data shows the importance of controlling for the lack of property tax among the many small local governments. Among the 129 local governments with less than 3000 inhabitants in the data, only 14 have residential property tax. On the other hand, a majority of 18 of the 29 local governments with more than 25000 inhabitants have property tax. Local governments with property tax have on average lower cost level in all size groups except for those between 3000 and 5000 inhabitants. The summary statistics consequently are broadly consistent with the hypothesis derived of the theoretical model.

Table 1 about here

Two main econometric challenges stand out. The first relates to the non-random selection into property taxation. Local governments have themselves chosen to have property taxation at some historical date, and there may be systematic differences between those with and without property tax that influence the cost level. In particular, the smaller rural communities tend not to have property taxation and may at the same time experience cost disadvantages in the provision of utility services. We apply two methods to improve comparability, including control variables and using propensity matching. The control variables are meant to represent economies of scale and decentralized settlement pattern and include population size (POP) and the share of the population living in rural areas (RURAL). The matching analysis is presented in section 5.

Second, the endogeneity of the choice of having residential property tax must be addressed. It should be noticed that this endogeneity does not necessarily work to bias our results towards a large cost impact of property taxation. If high cost local governments have chosen to introduce property taxation to control their cost problem, the 'true' effect of having property taxation is underestimated in the raw data in Table 1. In a discussion of the empirical evidence concerning the effects of budget institutions in the US states, Poterba (1994) questions the interpretations of the estimated correlations between budget rules and fiscal policy. They may reflect correlations between fiscal institutions, fiscal performance and background preference variables. Our analysis can be criticized on the same grounds since the residential property tax is voluntary and may reflect the result of political characteristics also important for the control of costs. Two methods are applied to get around the problem, inclusion of political background variables and use of instruments. Two variables represent the political leadership of the local government, the share of socialist members of the council (SOC) and a Herfindahl index of party fragmentation of the local council (HERF). The instrument approach addresses more long run characteristics of the local government that are relevant for the choice. The instrument is a similar dummy capturing whether the local government had residential property tax in 1991.[4]

Because of the permanent character of the property tax, the analysis of cost differences according to property taxation mainly exploits cross-sectional variation among the local governments. Since cost data are available for a longer period, we analyze an unbalanced panel data set covering the years 1993-1998. The number of cross section units varies from 295 in 1998 to 388 in 1995. The total number of observations is 2031. During the period under study, the unit cost has been quite stable in nominal terms on average. The empirical analysis study alternative specifications of the following general econometric model (where variables from the theory model are in small letters and the econometric extensions are in large letters):

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[4] There is no official data on the use of residential property tax before 1996, and the instrument is a proxy variable that is constructed using information about whether the local government had property tax revenue in 1991 and the share of the property tax paid by power stations. Data on property taxes paid by power stations in 1991 are available from a survey conducted by a government commission proposing a new tax system for power stations. Local governments with a 'power station share' less than 75% and a population size above 3000, where defined as having residential property tax in 1991.

$$\log c_{it} = \beta_t + \beta_1 \log y_{it} + \beta_2 \log g_{it} + \beta_3 RURAL_t + \beta_4 \log POP_{it} + \beta_5 SOC_{it} + \beta_6 HERF_{it} + \beta_7 CONTROLS + \beta_8 PRTAX_i + \Sigma_j \gamma_j CD(j) + u_{it} \quad (13)$$

where c_{it} is the unit cost in community i in year t, etc. As control variables (CONTROLS) we have included two types of variables shown to important in local public finance in Norway (Borge and Rattsø, 1995). The welfare services are mandated and oriented towards specific age groups of the population. This is captured by three variables describing the age composition of the population: the share of children 0-6 years of age (CH), youths 7-15 years (YO) and elderly 80 years and above (EL). The true budget constraint is intertemporal, and we have included net interest payment as share of revenue (IP) to take this into account.

Since the main variable of interest, the property tax dummy (PRTAX), has no time series variation at all, we cannot rely on estimation methods that only make use of the time series variation in the data. Common trend is captured by time specific constant terms (β_t), and a set of county dummies (CD) is included to represent regional fixed effects. u is an error term. Summary statistics of the variables are reported in Appendix Table A1.

4. Regression analysis

We start out by estimating a benchmark model including private income, grants, a dummy variable for existence of residential property taxation, and the age and budget controls. The results are reported in Table 2 (Model A). The property tax dummy is highly significant, and the estimate implies that local governments with residential property tax, all else equal, have 8.5 % lower unit cost than local governments without a property tax. As expected, this estimate is substantially lower than indicated by Table 1.

In the next step, Model B, we include population size and settlement pattern as cost controls. The estimates show the importance of accounting for structural cost conditions of the localities. A more decentralized settlement pattern clearly leads to higher costs. If the share of the population living in rural areas increases by 10 %-points, the unit cost increases by nearly

5 %. No evidence of economies of scale for utilities are captured by the population size variable, but the settlement pattern may capture some economies of scale. Inclusion of the cost controls reduces the effect of property taxation to 3.7 %, and the estimate becomes insignificant. Our interpretation is that unfavorable cost conditions in rural municipalities explain some of the high cost effect of not having property tax.

Table 2 about here

Political characteristics are included to account for background preference factors possibly influencing the choice of property taxation. The estimates reported for Model C shows that socialist orientation of the local council contributes to higher cost level. An increase in the share of socialists by 10 %-points will increase the unit cost by about 4 %. The Herfindahl index comes out with the expected negative sign, but is not statistically significant. The impact of ideology is consistent with other studies of political characteristics in Norway, notably Kalseth and Rattsø (1998) and Falch and Rattsø (1999). Kalseth and Rattsø show that administrative costs go up with socialist orientation, whereas Falch and Rattsø relate socialist orientation to high spending per student in high schools. When the political controls are included, the effect of the property tax dummy becomes significant. In this case the effect of having property tax is 5 % lower costs.

To investigate the robustness of this complete model, the dummy variable for property taxation is excluded in Model D. A comparison of Models C and Model D shows that the impact of the local cost factors (RURAL and POP) and the political variables (SOC and HERF) are very robust to whether the property tax dummy is included or not. This indicates that the estimate of the property tax dummy does not capture the impact of (observed) background cost conditions and political preferences.

Model E deals more explicitly with the possible bias due to endogenous property taxation. Here a residential property tax dummy for 1991 is used as instrument for the corresponding dummy for 1996. The property tax dummy is still highly significant, and the quantitative effect increases from 5% to 14%. OLS seems to underestimate the effect of property taxation, possibly reflecting that high cost communities introduce property taxation to avoid lower service standards.

The budget constraint facing the bureau also is influenced by exogenous grants and welfare service spending. According to the theory model in section 2, more grants give room for a higher budget for the bureau and thereby also higher costs. Mandated welfare spending is related to the age composition of the population, since welfare services are directed to specific age groups (primary school and care for the elderly). A shift in the age composition motivating higher welfare spending may reduce the budget of the bureau and also the costs. The private income level has an indirect effect through the individual demand function for housing. This channel implies that higher private income may drive up the cost level since the housing price and the property tax base go up.

The results in Model C show that the support for the main economic predictions of the model is quite solid. The costs certainly reflect the economic conditions of the local governments. The main source of local government financing is exogenous revenue (grants and regulated taxes). High exogenous revenue allows a high budget for the bureau and contributes to high costs. The elasticity is about 0.4 and has economic significance since exogenous revenue varies strongly (standard deviation of NOK 5000 per capita around an average of NOK 19000). The variation in grants and regulated income tax revenue explain a large part of the differences in costs. Interest payments as share of exogenous revenue is another measure of fiscal conditions and comes out with the expected sign. Higher interest payments reduce costs.

Demand pressure represents yet another aspect of the fiscal conditions. A comprehensive literature has addressed the economic consequences of demographic shift (see Borge and Rattsø, 1995 and Poterba, 1997). Welfare services directed towards specific age groups of the population (kindergartens, schooling, care for the elderly) compete with local services like the utilities investigated here. Higher share of the population in the relevant age groups represents high demand for welfare services and fiscal pressure elsewhere. The shares of young and elderly have the expected negative effects on the unit cost, and the share of elderly is statistically significant. A 1 %-point increase in the share of elderly will reduce the unit cost by nearly 3-4 %.

5. Matching analysis

Local governments are not randomly selected into having property taxation and consequently we do not have a clean natural experiment. The background heterogeneity may disturb the comparison with respect to property taxation. As an alternative to the control variable method applied in the regression analysis, we here apply the matching method. The assumptions behind matching based on selection on observables are probably not strictly satisfied, but we do think that this analysis provides new information and is a check on the robustness of our regression results.

We compare the results of regression analysis and matching based on the propensity score. As shown by Angrist (1998), regression estimates controlling for the same characteristics lead to different results from matching basically because the two methods represent different weights of the observed units. While the estimated coefficients of a regression reflect variance-weighted averages, the matching estimator generates weights that are proportional to the probability of property taxation given the observed characteristics.

In the terminology of matching, the outcome studied is the measured cost level, C_i, for local government i. Having property tax is considered as a treatment, and the treated units can be compared with those without treatment, that is without property tax. Local government i either has property taxation ($P_i = 1$) or does not ($P_i = 0$). Local government i can have cost level with property tax $C_i(1)$ or without $C_i(0)$. The issue is whether property taxation influences the cost level, that is the effect of P on C. The analysis addresses the difference between the cost level of the local governments with property taxation and what cost level they would have had if they had not had property tax. In the program evaluation literature, this is called the effect of the treatment on the treated.

We would like to know the difference $C_i(1) – C_i(0)$ for all observed local governments, but the fundamental problem is that we cannot observe both $C_i(0)$ and $C_i(1)$ for local government i. Our observations cover some local governments with property tax and some without. Since the difference cannot be observed for any local government, we must estimate some average difference based on observations of local governments with and without property tax. The statistical challenge is the possible sample selection bias since those without property tax are not representative of the performance of those with property tax in the counterfactual situation of no property tax. The cost level of those with property tax and those without are not identical in the situation of no property tax.

We have shown the raw comparison of average cost levels of the local governments with and without property taxation in Table 1. Decomposition of the raw comparison of average cost levels between local governments with and without property tax clarifies the selection bias:

$$\begin{aligned} &E\left[C_i(1)/P_i=1\right]-E\left[C_i(0)/P_i=0\right] \\ &=E\left[C_i(1)-C_i(0)/P_i=1\right]+\left\{E\left[C_i(0)/P_i=1\right]-E\left[C_i(0)/P_i=0\right]\right\} \end{aligned} \tag{13}$$

The first term on the right hand side shows what we are looking for, the average causal effect of property tax on the cost level in local governments with property tax (average treatment effect on the treated). The second term reflects the bias following when the cost level of those without property taxation is not necessarily representative of the cost level of the local governments with property taxation if they have not had property tax. There may be systematic differences in relevant characteristics between the two groups of local governments.

If the assignment of local governments to property taxation is random, we will have no bias, as:

$$E\left[C_i(0)/P_i=1\right]=E\left[C_i(0)/P_i=0\right] \tag{14}$$

Since the economic, political and historical background of having property tax is not random, we need to control for observed differences X_i between local governments with and without property tax. The aim is to have observations of local governments without property tax that serve as valid control group for those with property tax. Identification of the causal effect (average effect of treatment on the treated, ATT) is achieved when conditioning on the observed characteristics make local governments with and without property tax comparable.

Since the observed characteristics X_i are continuous, we apply the propensity score suggested by Rosenbaum and Rubin (1983). The propensity score is the conditional probability of having property taxation:

$$p(X_i) = P(P_i = 1 / X_i) \tag{15}$$

The assumption behind this method is that assignment to property taxation depends only on observable variables. Rosenbaum and Rubin show that if conditioning of X_i eliminates the selection bias, then conditioning on $p(X_i)$ achieves the same:

$$E\left[C_i(0) / p(X_i), P_i = 1\right] = E\left[C_i(0) / p(X_i), P_i = 0\right] \tag{16}$$

Given this condition, we can identify the causal effect of property taxation:

$$E\left[C_i(1) - C_i(0) / P_i = 1\right] = E\left\{E\left[C_i(1) / p(X_i), P_i = 1\right] - E\left[C_i(0) / p(X_i), P_i = 0\right] / P_i = 1\right\} \tag{17}$$

The outer expectation is over the distribution of the characteristics of the local governments with property taxation. Our dataset offers information about the cost levels of the two groups of local governments and their characteristics, and the expression above can be calculated as comparison of averages given the estimated propensity scores. With the assumption above, observations with the same propensity score have the same distribution of the full vector of covariates X. Conditioning on the propensity score, each local government has the same probability of having property tax, as in a randomized experiment. The propensity score sorts out which comparison local governments are most relevant considering all the characteristics included.

The main problem in our dataset is the lack of observations about the pre-treatment situation. The property tax has existed since the first half of the 19th century and has changed in form over time. Some local governments have opted in and out of property taxation over more than 150 years. The local governments we have today are basically constructed in the mid 1960s as the result of a reform consolidating about 750 units into about 450, and with implications for property taxation. It follows that we cannot claim a selection on observables, but we can still use the method to allow for different comparisons of local governments with and without property tax. Persson and Tabellini (2002) apply matching with a similar situation of no pre-treatment observation of countries with different constitutions.

The propensity score function is estimated using pre-dated (1991) explanatory variables and the balancing properties of the function are investigated. Based on previous positive analyses of taxation in Norway, four variables are included: First, local governments receive block grants and regulated income taxes from the central government, and the size of these exogenous revenues influence the need for additional funding through property taxation. Second, since the property tax is restricted to urban areas, the settlement pattern and the population size are included to represent the relevance of the property tax for the municipality. Third, ideological orientation of the voters is expected to matter, and socialists are generally in favor of property taxation.

We apply the strata program developed by Becker and Ichino (2003), and the standard probability model used to estimate the propensity score is the probit model. The estimation results using the 1995-data are reported in Table 3. They show that exogenous revenue, settlement pattern and socialist orientation are important determinants of the probability of having property taxation. Local governments with high exogenous revenues, rural settlement pattern and low socialist orientation are less likely to have property tax.

Table 3 about here

The balancing property of the estimation of the propensity score is essential for the comparison of cost levels. To test for the balancing, the propensity score is stratified in six blocks of equal range and the mean scores of those with property tax and those without are compared in each block. In the estimation, common support is assumed, and local governments without property tax with propensity score lower than the local government with lowest propensity score are excluded. We test whether the means of each characteristic for those with and without property tax are equal in each block. It appears that the equation shown in Table 3 is balanced.

Given the propensity scores satisfying the balancing property, we apply the four different methods of comparison programmed by Becker and Ichino: nearest neighbor, radius, kernel, and stratification. They represent alternative approaches to the selection of comparable units. We refer to their description of the methods. Table 4 reports the results using cost data for 1995, the year with the largest number of observations.[5] It appears that the cost difference between local governments with and without property tax is estimated to about 10% in most alternatives and up to 18% under nearest neighbor matching. The statistical significance of the estimated difference varies, but the size of the effect is fairly stable. The standard errors are calculated assuming fixed weights and independent units.

Tables 4 and 5 about here

The number of comparison units varies according to method in Table 4. Basically all 109 local governments with property tax are included, and they are compared with most of the 271 local governments without property tax.[6] The weights of the different units differ with respect to method. In the nearest neighbor alternative only 68 neighbors without property tax serve as comparison. To check for the robustness of the comparison, we have made matching with different assumptions about the size of the radius in Table 5. In this case, the number of local governments both with and without property tax varies depends on the size of the radius, from 106 and down to 54 with property tax and from 256 down to 74 without. Even with this variation of comparable units the estimated cost effect is quite stable. The estimates with Kernel and stratification matching are also in the same order. We conclude that there seems to be a robust difference in unit costs between local governments with and without property tax and using alternative assumptions of matching comparisons.

6. Concluding remarks

[5] We have done the matching analysis also for other years and with similar results.

[6] The number of local governments with and without residential property tax is somewhat lower in Table 3 than in Table 1. The reason is that pre-dated explanatory variables could not be constructed for all local governments due to consolidations during the first half of the 1990s.

The paper analyzes the incentive effects of property taxation with respect to control of costs. The problem of cost control relates to a political institution that has delegated the production of a service to a bureau. Our theoretical framework focuses on a bureau producing utilities that are complementary to housing. In a world with mobile households, property tax financing establishes a link between provision of utilities and the property tax base. It is shown how property taxation may make slack more expensive for the bureau, thereby contributing to lower costs in provision of utilities.

Local governments in Norway allow for testing the proposition since about 30% of them have residential property tax while the rest have not. The raw data show that local governments with property tax have about 20% lower unit costs of utilities than local governments without property tax. The econometric analysis addresses issues of non-random selection into property tax and endogeneity of having property tax using standard regression and matching methods. The alternative controls and comparisons are not able to wash out the difference in unit costs and indicate that property taxation has significant negative effect on costs.

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Table 1: Cost per standard user in discharge of sewage, local governments with and without residential property tax according to population size, Norwegian kroner (NOK), 1995-data.

Population size	Without property tax			With property tax		
	Cost	Population	# obs	Cost	Population	# obs
Less than 3 000	2 982	1786	115	2 675	2 162	14
3 000 – 5 000	2 402	3 846	59	2 617	4 024	26
5 000 – 10 000	2 704	6 971	50	2 167	7 122	32
10 000 – 25 000	2 531	14 936	41	2 175	15 738	22
More than 25 000	2 395	43 975	11	1 947	56 473	18
All	2 535	6 801	276	2 055	15 407	112

Table 2: Regression analysis, cost per standard user, data for 1993-1998

	A	B	C	D	E
PRTAX	-0.085	-0.037	-0.050		-0.141
	(-3.55)	(-1.55)	(-2.07)		(-2.56)
log y	-1.181	-0.677	-0.590	-0.587	-0.554
	(-6.61)	(-3.87)	(-3.46)	(-3.45)	(-3.26)
log g	0.587	0.341	0.399	0.405	0.349
	(5.78)	(3.06)	(3.54)	(3.62)	(3.18)
IP	-0.638	-0.593	-0.566	-0.557	-0.593
	(-1.14)	(-1.14)	(-1.04)	(-1.02)	(-1.37)
CH	-1.243	-0.284	0.555	0.573	0.777
	(-0.95)	(-0.22)	(0.41)	(0.42)	(0.58)
YO	0.230	-2.087	-0.988	-0.856	-1.060
	(0.18)	(-1.62)	(-2.40)	(-0.66)	(-0.82)
EL	-1.878	-4.612	-3.728	-3.867	-3.246
	(-1.19)	(-2.99)	(-2.40)	(-2.49)	(-2.12)
RURAL		0.477	0.517	0.534	0.492
		(7.80)	(8.40)	(8.71)	(7.74)
log POP		-0.013	-0.011	-0.016	-0.004
		(-0.71)	(-0.59)	(-0.83)	(-0.22)
SOC			0.410	0.387	0.459
			(3.94)	(3.78)	(4.41)
HERF			-0.199	-0.196	-0.156
			(-0.89)	(-0.89)	(-0.70)
Estimation method	OLS	OLS	OLS	OLS	IV
# obs	2031	2031	2031	2031	1999
R^2_{adj}	0.442	0.461	0.465	0.464	0.435

Notes: The dependent variable is the log of the cost per standard user. Time and county dummies (not reported) are included in all equations estimated. The t-values in parentheses are based on heteroskedasticity consistent standard errors.

Table 3: Propensity score equation, probit estimates with t-values in parentheses, 1991-data for the explanatory variables

Variable	Coefficient (t-value)
Exogenous local government revenue (g)	-0.000035
	(-1.87)
Settlement pattern (RURAL)	-0.936
	(-2.88)
Population size (POP)	0.00000093
	(1.51)
The share of socialists (SOC)	2.116
	(4.28)
Log likelihood	-196.7
# of treated	109
# of untreated	271
Final number of blocks	6
Common support	Yes
Balancing property satisfied (1 %)	Yes

Table 4: Matching estimates, 1995-data.

	Nearest neighbor	Radius	Kernel	Stratification
Estimate (ATT)	-0.131	-0.129	-0.123	-0.089
t-value	-1.35	-1.91	-	-1.30
# of treated	109	106	109	107
# of controls	68	256	256	258
Common support	Yes	Yes	Yes	Yes

ATT: Average effect of treatment on the treated

Table 5: Radius matching with different sizes of the radius, 1995-data.

	r = 0.1	r = 0.05	r = 0.01	r = 0.005	r = 0.001
Estimate (ATT)	-0.129	-0.116	-0.126	-0.115	-0.192
t-value	-1.91	-1.69	-1.76	-1.51	-1.82
# of treated	106	105	101	95	54
# of controls	256	256	236	194	74
Common support	Yes	Yes	Yes	Yes	Yes

ATT: Average effect of treatment on the treated

Table A1: Data description and descriptive statistics.

Variable	Description	Mean (st. dev.)
Unit cost (c)	Total costs per standard user for discharge of sewage, Norwegian kroner (NOK)	2874 (1762)
Private disposable income (y)	Taxable income minus income and wealth taxes to local, county and central government, NOK per capita	64468 (9619)
Exogenous local government revenue (r)	The sum of lump-sum grants from the central government and regulated income and wealth taxes, NOK per capita NOK	19125 (5167)
Net interest payment (ip)	Net interest payment as fraction of exogenous local government revenue	0.023 (0.052)
Settlement pattern (rural)	The share of the population living in rural areas (1990)	0.533 (0.286)
Population size (pop)	Total population, January 1	10145 (18442)
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	0.117 (0.015)
The share of elderly (el)	The share of the population 80 years and above, January 1	0.047 (0.015)
The share of socialists (SOC)	The share of socialist representatives in the local council	0.397 (0.149)
Party fragmentation (HERF)	Herfindahl-index measuring the party fragmentation of the local council	0.268 (0.081)
Property tax (PRTAX)	A dummy variable that equals 1 if more than 50% of residential property is subject to property tax	0.305 (0.461)