THE RELATIONSHIPS BETWEEN COSTS AND USER CHARGES: THE CASE OF A NORWEGIAN UTILITY SERVICE

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Abstract

The paper investigates the relationships between costs and user charges in the sewage industry in Norwegian local governments. The purpose of the analysis is to answer the following questions: (i) To what extent is a higher unit cost passed on to consumers in terms of a higher user charge? (ii) Does user charge financing lead to higher or lower unit cost? The econometric analysis indicates that around 40 per cent of a cost increase is passed on to consumers in terms of higher user charge. Moreover, user charge financing has a significant negative effect on the unit cost. An increase in the degree of user charge financing by 10 per cent-points is predicted to reduce the unit cost by 5-8 per cent.

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1. Introduction

The purpose of this paper is to investigate the relationships between costs and user charges. The following two questions are addressed: (i) To what extent is a higher unit cost passed on to consumers in terms of a higher user charge? (ii) Does user charge financing lead to higher or lower unit cost?

The analysis is partly motivated by the recent interest in the incentive effects of tax financing. Glaeser (1996) develops the understanding of property taxes as a disciplining device for revenue maximizing governments.[1] In a situation of regulated taxes, he shows that property taxation creates incentives for local service provision, since the services raise housing values and thereby the property tax base. Hoxby (1999) relates property tax finance to costs and efforts in schools. In her model, property taxation links school quality to school financing and helps control costs and efforts in schools. In a companion paper (Borge and Rattsø 2003) we investigate the impact of property taxes on costs, and find empirical support for the hypothesis that property taxation contributes to lower costs. Here we concentrate on the incentive effects of user charges on utility services in Norwegian local governments.

The second motivation is the Norwegian debate on user charges, which to a large extent has focused on the revenue potential and possible adverse distributional effects. However, a government commission that reviewed the financing of local governments (NOU 1997) also emphasized the impact on costs. On the one hand they argued that user charge financing may contribute to increased cost efficiency because consumers get a more direct interest to keep costs low. On the other hand, the commission worried that user charge financing may lead to a softer budget constraint for the producers since higher costs more easily can be passed on to the consumers. The issue is also raised in the present election campaign, where the national government has proposed to limit utility charges by introducing maximum prices. They explicitly argue that maximum prices may give a harder budget constraint for the producers and thereby more efficient production. In this paper we throw light on these issues by analyzing both the impact of user charges on costs and the impact of costs on user charges.

[1] The broad understanding that the design of tax constitution may constrain revenue-maximizing governments was heavily emphasized by Brennan and Buchanan (1977). Edwards and Keen (1996) and Gordon and Wilson (2000) analyze the same issue in a tax competition context.

The theoretical background is a model describing the interaction between a political authority and a service-producing bureau. The user charge is set by the politicians, and the reaction function is derived by a representative voter model. We show that the impact of user charges on costs depends on the form of strategic interaction. In a Nash game where the bureau treats the user charge as fixed, user charge financing leads to lower costs because it makes slack more costly for the bureau. In a Stackelberg game the effect is opposite: A high degree of user charge financing signals that higher costs to large extent will be passed on to consumers with little effect on the bureaus budget.

The empirical analysis is based on a large panel data set of the sewage industry in Norwegian local governments. We find that around 40% of a cost increase is passed on to consumers in terms of higher user charge. Moreover, user charge financing has a significant negative effect on the unit cost. An increase in the degree of user charge financing by 10 %-points is predicted to reduce the unit cost by 5-8%.

The rest of the paper is organized as follows. Section 2 clarifies the institutional and empirical background. The modeling of the relationships between costs and user charges is presented in Section 3. The data and the econometric model are discussed in Section 4. Section 5 presents the estimation results, while Section 6 summarizes the main findings of the paper.

2. Empirical and institutional background

Norwegian local governments are important providers of welfare services like kindergartens, primary and lower secondary education, primary health-care and care for the elderly. Other important tasks are culture and infrastructure. The main revenue sources are taxes (45% of current revenues), grants from the central government (33%) and user charges (16%). Interest and other revenues account for the rest.

Compared to most other countries, the Norwegian system of financing is quite centralized. In principle local governments can choose tax rates within an interval for taxes on income, wealth and property. However, since the late 1970s all local governments have used the maximum tax rates in income and wealth taxation. In the following exogenously set income and wealth taxes are denoted regulated taxes. The opportunity to influence current revenues is limited to property tax and user charges.

User charges are applied for a wide range of services, but utilities, care for the elderly and kindergartens account for most of the revenues. This paper focuses on user charges and costs for a particular utility service, discharge of sewage. The market for utilities can be characterized as a local government monopoly where it is compulsory to make use of the service. It is a principal rule that user charges can not exceed total production costs, but local governments are free to subsidize most services. The user charge for discharge of sewage consists of a connection fee and an annual fee, where the annual fee depends on the level of consumption. However, the typical pricing scheme specifies a minimum quantity to be invoiced, implying that the relationship between the annual fee and actual consumption may be weak.

Table 1: The development of unit cost, user charge and share of costs covered by user charges. 1993-1998.

Year	Number of local governments	Unit cost (NOK)	User charge (NOK)	Share of costs covered by user charges
1993	313	2 117	1 713	80.9
1994	354	2 107	1 812	86.0
1995	388	2 276	2 008	88.2
1996	384	2 211	2 057	93.0
1997	297	2 189	2 197	100.4
1998	295	2 490	2 300	92.4

Notes: Unit cost and user charge are measured in Norwegian kroner (NOK) per standard user. The figures are weighted averages.

The analysis focuses on costs and user charges per standard user. The cost measure includes operating and capital costs, and the user charge includes connection fees and annual fees paid by both households and firms.[2] The development of unit cost and user charge during the period under study (1993-1998) is displayed in Table 1. Until 1997 average unit cost was quite stable in nominal terms, whereas the average user charge increased steadily. As a consequence, the share of costs covered (or the degree of user charge financing) increased from 80% in 1993 to 100% in 1997. From 1997 to 1998 the average unit cost increased

[2] We refer the reader to Section 4 for more details about the data.

sharply (14%). The increase in the user charge was more modest (5%), and the share of costs covered dropped back to 92%.[3]

In addition to the time series variation shown in Table 1, there is substantial variation across local governments. In 1998 the unit cost varied from Norwegian kroner (NOK) 500 to 10 000. Around half of the local governments have a unit cost between NOK 2 000 and 4 000. There is a positive correlation between the unit cost and the user charge, and the user charge varies from NOK 120 to 20 000. In roughly half of the local governments a standard user is charged between NOK 1 500 and 3 000. The share of costs covered by user charges varies from 5% to more than 400%. In 1998 the user charge exceeded the unit cost in 25% of the local governments in the sample.

Although it a principal rule that user charges can not exceed total production costs, the share of costs covered may exceed 100% in a single year as long as user charges do not exceed total production costs over a period of 3-5 years. However, more than 25% of the 224 local governments with reliable data for all years had an average degree of user charge financing above 100% for the six-year period. In 14 local governments user charges exceeded costs each and every year. These figures suggest that local governments, at least to some extent, are able to circumvent the national regulation.

3. Modeling the relationships between user charges and costs

We address the determination of costs and prices when a political institution is responsible for service provision delegated to a bureau. This is the standard design of government service production across the world. The political side consists of a local council elected to arrange financing and production of local services. User fees are determined at the local government level. The service production investigated is decentralized to a lower-level agency, which is given a budget by the local government. The bureau is assumed to have an information advantage and to enjoy budgetary slack. The costs financed by the local government are determined in a budget process involving the agency. The working of the local government and the relationship to the agency form the outcomes of this game.

[3] The trends in Table 1 are not driven by the fact that the number of local governments with reliable data varies somewhat from year to year. If we instead use a balanced panel data set, the same pattern emerges.

User charges and agencies have been addressed in previous analyses of local government financing, notably Inman (1989). In his model, however, the agency charges the consumers and has preferences over its own supply and fee level, while agency costs are exogenous. We study a situation where the agency costs are endogenously determined under asymmetric information and the local government sets the fee level taking the cost-determination into account. This leads to a model of bureaucratic interaction in the post-Niskanen tradition as developed by Migue and Belanger (1974), Miller and Moe (1983) and Moene (1986).

The conventional way of analyzing local government decision-making is a demand model of local public services. Individual inhabitants of a community demand public services dependent of private income and tax-prices of the services. The individual demands enter a political process whereby the local council makes a collective decision about financing and provision. The median voter model is the most common representation of the political process; see the surveys by Inman (1979) and Rubinfeld (1987). Borge (1995, 2000) has analyzed user charges in a demand model. Control of administrative costs related to service demand has been analyzed by Kalseth and Rattsø (1998). The demand framework is extended below to capture the interaction with an agency.

The key decision concerns a local service produced by a bureau. Here this local utility service is private in character and is distributed to households in the community for a user charge. It follows that the use of the individual service can be restricted to paying customers. Services subject to user charges, typically related to infrastructure, compete with welfare services within the local government budget. The local government sets the priority between the utility service and the welfare service and applies the user charge to regulate the financing on the margin. To concentrate on costs and charges for the utility with production delegated to a bureau, we assume that user charge is the key instrument of financing and that other taxes are regulated. This formulation captures the centralized financing in Norway (see Section 2), but may be realistic under the widespread use of tax limits in other countries.

The decision making at the local government level is described by a representative voter model where three types of services are separated out; an all-purpose private good (q), utility services (x) and other local public services (w, hereafter denoted welfare services). The preference of the representative voter is given by the utility function

$$u = u(q, x, w; z) \quad (1)$$

which is assumed to have the regular properties, i.e. strictly quasi-concave with positive marginal utilities. The preferences are conditioned on the size of the client groups of the welfare services (*z*). We assume that an increase in the size of client groups raises the marginal utility of welfare services.

The resources available to the local government are grants and regulated taxes (*r*, hereafter denoted exogenous local government revenue) and user charge revenue (*fx*, where *f* is the user charge per unit). The production of the utility is delegated to a bureau, and the bureau asks a unit cost *c*. The true costs are unknown to the local government and it must act according to the reported and therefore actual costs. When the unit cost of welfare services is normalized to unity, the local government budget constraint reads:

$$r + (f - c)x - w = 0 \quad (2)$$

We assume that the consumption of utility services is determined by the local government. This seems realistic for most utilities where discretion at the household level is limited, see Section 2. This setup implies that the user charge functions as a tax instrument. The consumption of the all-purpose private good is determined by the budget constraint of the representative voter

$$q = y - fx \quad (3)$$

where *y* is exogenous private income.

The local government decides the provision of utilities, the user charge and the provision of welfare services so as to maximize the utility function of the representative voter subject to the private and the local government budget constraints. We have not imposed any restriction on the fee setting, like $f \leq c$, since the discussion in Section 2 suggests that local governments are able to circumvent the national regulation. The utility maximization results in the following equations for utility demand and fee setting:[4]

$$x = \underset{-\;+\;+\;-}{x(c, r, y, z)} \tag{4}$$

$$f = \underset{?\;-\;?\;+}{f(c, r, y, z)} \tag{5}$$

The demand for utilities and the fee level are dependent on the unit cost asked by the bureau, exogenous revenue, private income and the size of the client groups. The indicated signs of the partial effects are derived under the assumption of an additive separable utility function (see Appendix 1). If the bureau reports a higher unit cost, the response of the local government is to reduce the demand for utilities. The effect on the user charge will most likely be positive, but it might be negative if the user charge is lower than the unit cost at the outset. This somewhat surprising result can be explained as follows: Suppose that the user charge is kept unchanged as the provision of utilities decreases. Then, if the user charge is lower than the unit cost, more resources are available for provision of welfare services. If the desired increase in welfare services is less than this 'automatic' increase, it is optimal for the local government to reduce the user charge when the unit cost increases.

Increases in private income or exogenous local government revenue have a positive income effect that increases the provision of utilities, as well as welfare services and private consumption. When local government revenue increases, the user charge must be reduced in order to facilitate an increase in private consumption. On the other hand, higher private income will most likely raise the user charge. A sufficient condition for this result to hold is that user charge is lower than or equal to the unit cost. If the user charge exceeds the unit cost, higher private income might lower the user charge. The intuition goes as follows: If the user charge is kept unchanged as the provision of utilities increases, more resources will be available for provision of welfare services. And if this 'automatic' increase in provision of welfare services is less than the desired increase, the user charge will be reduced. Finally, a demographic shift towards welfare clients will reduce the provision of utilities and drive up the user charge to finance the expansion of welfare services.

[4] The equations for private consumption and provision of welfare services are suppressed since they play no role in the interaction between the local government and the bureau.

The actual cost and the allocation of resources are determined by strategic interaction between the local government and the bureau. We will study two forms of strategic interaction. The first is a Stackelberg game where the bureau acts as leader. The bureau reports a unit cost for the utility service and the local government consequently chooses service level, user fee and grants the bureau a lump-sum budget to cover costs in excess of user fees. The second is a Nash game where the local government has a stronger hand, and where the bureau faces a fixed user fee and fixed lump-sum budget.

In accordance with the conventional formulation as in Moene (1986), the bureau has preferences for service production (*x*) and slack per unit (*s*). Slack per unit is defined as actual or reported cost (*c*) in excess of minimum cost (c_0):

$$b = b(x, s), \quad s = c - c_0 \tag{6}$$

Both production and slack are assumed to be normal goods in the bureau's utility function. The bureau has two sources of revenue, user charges as well as a fixed budget to cover costs in excess of user charges. The expression for the fixed budget (*l*) is given by:

$$l = (c - f)x \tag{7}$$

Consider first the Nash game with simultaneous moves where the bureau determines the actual cost treating both *f* and *l* as fixed. The bureau's optimization problem is:

$$\underset{c}{Max}\; b(\frac{l}{c - f}, c - c_0) \tag{8}$$

The first order condition reads:

$$\frac{b_s}{b_x} = \frac{x}{c - f} \tag{9}$$

It appears that the user charge affects the relative 'price' between slack and output. From the bureau's point of view an increase in the user charge makes slack more costly (in terms of lower production), and this substitution effect leads to lower reported cost. But if the lump-sum grant is fixed, there will also be a positive income effect that works in the opposite direction.[5] In relation to the empirical analysis it is not the partial effect of higher user charge that is of main interest, but rather the combined effect of higher user charge and lower fixed budget. The impact of a revenue neutral combination of higher user charge and lower fixed budget is given by[6]

$$dc = \frac{1}{D_2}\frac{x}{(c-f)^2} b_x df < 0, \tag{10}$$

where the denominator D_2 is negative from the second order condition. A revenue neutral increase in user charge financing has no income effect, and thereby an unambiguously negative effect on reported cost.

In the Stackelberg game the bureau acts as leader and does not consider l as fixed. It takes the demand function (4) into account and foresees that the local government will grant a total budget sufficient to cover the reported costs. The bureau's optimization problem becomes:

$$\underset{c}{Max}\, b(x(c,r,y,z), c - c_0) \tag{11}$$

The first order condition reads:

$$\frac{b_s}{b_x} = \varepsilon \frac{x}{c}, \quad \varepsilon = -\frac{\partial x}{\partial c}\frac{c}{x} \tag{12}$$

The user charge does appear directly in the bureau's optimization problem. It may, however, have an indirect effect through the elasticity of demand (ε). A high degree of user charge financing means that increased costs to a large extent are passed over to the consumers with little effect on the bureau's output. Then, a high degree of user charge financing implies that

[5] There is an additional effect due to the non-linear budget constraint. The effect is not emphasized here because it cancels out when we consider the combined effect of higher user charge and lower fixed budget.

the elasticity of demand is low and that the bureau's cost of slack (in terms of reduced production) is low. Consequently, the model predicts that a high degree of user charge financing leads to higher costs.

The conclusion from the analyses above is that the effect of user charge financing on costs depends on the form of strategic interaction between the bureau and the local government. The Nash game with simultaneous moves predicts that a high degree of user charge financing leads to lower costs, whereas the prediction from the Stackelberg game is the opposite. The theoretical ambiguity calls for an econometric analysis of the issue.

4. Data and empirical specification

The empirical analysis of user charges and unit costs of the utility service under study (discharge of sewage) is based on a data set prepared by Statistics Norway. The collection of these data started in 1993, and is described in several reports from Statistics Norway. Bersvendsen et al. (1999) documents the 1997 survey. The cost measure is very inclusive, as it includes capital costs, administrative costs, labor expenses and maintenance. Conditional 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 costs, 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. The user charge per standard user is calculated as collected user charges (connection fee and annual fee) from households and firms per standard user.

The number of local governments that have reported sufficient and reliable information to calculate unit cost and user charge varies substantially from year to year, from a low of 295 in 1988 to a high of 388 in 1995.[7] The data set is an unbalanced panel data set with a total of 2031 observations.

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[6] See Appendix 1 for details.
[7] The total number of local governments is 435.

The empirical analysis is based on the following econometric model

$$
\begin{aligned}
\log f_{it} &= \alpha_t + \alpha_1 \log c_{it} + \alpha_2 \log y_{it} + \alpha_3 \log r_{it} + \alpha_4 INTR_{it} + \alpha_5 RURAL_i + \alpha_6 \log P_{it} \\
&\quad + \alpha_7 CH_{it} + \alpha_8 YO_{it} + \alpha_9 EL_{it} + \alpha_{10} SOC_{it} + \alpha_{11} HERF_{it} + \gamma_i + u_{it} \\
\log c_{it} &= \beta_t + \beta_1 \frac{f_{it}}{c_{it}} + \beta_2 \log y_{it} + \beta_3 \log r_{it} + \beta_4 INTR_{it} + \beta_5 RURAL_i + \beta_6 \log P_{it} \\
&\quad + \beta_7 CH_{it} + \beta_8 YO_{it} + \beta_9 EL_{it} + \beta_{10} SOC_{it} + \beta_{11} HERF_{it} + \eta_i + v_{it},
\end{aligned}
\tag{13}
$$

where f_{it} is the user charge in community *i* in year *t*, etc. The user charge equation and cost equation are the reaction functions of respectively the local government and the bureau. Compared to the theoretical model discussed in Section 2, the following modifications are made. First, the vector *z* comprises three variables describing the age composition of the population. These are the shares of children 0-6 years (*CH*), youths 7-15 years (*YO*) and elderly 80 years and above (*EL*). Second, net interest payment as share of revenue (*INTR*) is included as an additional variable describing the economic situation of the local government. It is expected to have the opposite effect of exogenous local government revenue (*r*). Third, the share of the population living in rural areas (*RURAL*) and the population size (*P*) are included in the cost equation to capture cost disadvantages in sparsely populated communities and possible economies of scale. Fourth, two variables capturing political institutions are included. These are the share of socialists in the local council (*SOC)* and a Herfindahl-index (*HERF*) measuring the (inverse of) the party fragmentation in the local council. Fifth, time specific constant terms (α_t and β_t) are included in both equations. Finally, *u* and *v* are error terms. Summary statistics of the variables are reported in Appendix 2.

Different assumptions are made about the community specific terms (γ_i and η_i). We start out by estimating the equations by ordinary least squares where 18 county dummies are included to capture regional effects. Then we check whether the results are robust to the inclusion of random and fixed community specific effects. Finally, we also take account of the simultaneity problem related to the fact that the unit cost is a possible endogenous variable in the user charge equation and that the degree of user charge financing is a possible endogenous variable in the cost equation. The simultaneity problem is handled in two different ways, by using lagged values of the unit cost and the degree of user charge financing when they are entered as explanatory variables, and by using instruments.

5. Estimation results

The basic estimation results are shown in Table 2, where the equations are estimated by respectively ordinary least squares, random effects and fixed effects without taking the possible simultaneity problem into account. We comment on the OLS regressions first.

Table 2: Basic estimation results
Heteroskedasticity-consistent t-values in parentheses

	Ordinary least squares		Random effects		Fixed effects	
	User charge	Unit cost	User charge	Unit cost	User charge	Unit cost
log *c*	0.414		0.389		0.379	
	(17.82)		(19.32)		(12.75)	
$\frac{f}{c}$		-0.751		-0.611		-0.579
		(-18.99)		(-31.87)		(-20.21)
log *y*	-0.019	-0.416	0.066	-0.045	0.158	0.1222
	(-0.12)	(-2.79)	(0.45)	(-0.30)	(0.70)	(0.69)
log *r*	-0.428	0.210	-0.051	0.155	0.196	0.117
	(-4.06)	(2.31)	(-0.63)	(2.12)	(1.29)	(0.93)
INTR	0.424	-0.202	0.241	-0.076	0.150	-0.047
	(1.94)	(-0.62)	(1.94)	(-0.71)	(1.07)	(-0.42)
RURAL	-0.458	0.135	-0.449	0.246		
	(-8.47)	(2.56)	(-5.27)	(2.69)		
log *P*	0.0058	-0.004	0.046	-0.026	-1.070	-0.362
	(0.35)	(-0.25)	(1.80)	(-0.99)	(-2.50)	(-1.15)
CH	0.256	0.688	3.887	3.207	9.658	5.491
	(0.20)	(0.57)	(3.09)	(2.73)	(2.91)	(2.64)
YO	-0.689	-0.976	-0.426	-1.585	1.420	-0.946
	(-0.63)	(-0.92)	(-0.40)	(-1.59)	(0.67)	(-0.58)
EL	1.363	-2.029	1.216	-2.288	-1.401	-3.699
	(1.23)	(-1.70)	(0.86)	(-1.66)	(-0.44)	(-1.56)
SOC	-0.109	0.216	-0.053	0.125	-0.078	0.036
	(-1.39)	(2.61)	(0.53)	(1.35)	(-0.55)	(0.31)
HERF	-0.395	-0.204	-0.349	-0.289	-0.077	-0.332
	(-2.30)	(-1.15)	(-2.16)	(-1.94)	(-0.55)	(-1.72)
R^2_{adj}	0.551	0.644	0.513	0.633	0.823	0.905

Note: Time dummies (included in all equations) and county dummies (included in the OLS and RE equations) are not reported.

The estimated fee equation, or the reaction function of the local government, shows that a cost increase is partly passed over to the consumers. The estimated elasticity is around 0.40 and highly significant. Given that the elasticity is below unity, the share of costs covered by user charges is reduced as costs increases.

Exogenous revenue (grants and regulated taxes) comes out as significant and with the expected negative effect on the user charge. When grants and regulated taxes become more limited, the local governments respond by increasing the user charge. The estimated elasticity is around 0.4. This effect confirms the results of Borge (2000) and is consistent with the widespread view that tax and grant limitations induce a shift towards user charges. Fiscal pressure from high interest payments has a positive and significant impact on the user charge. An increase in net interest payment that amounts to 10% of exogenous revenue will increase the user charge by nearly 4.5%.

A comprehensive literature has addressed the political response to demographic shift (see e.g. Borge and Rattsø 1995, Poterba 1997). An increase in the share of children, youths or elderly was expected to increase the provision of welfare services and thereby the user charge. This prediction receives little support in the data as none of the three variables has a significant impact in the user charge equation.

The share of the population residing in rural areas has a negative effect on the user charge. Given that costs are directly controlled for, this must be interpreted as a broader effect of structural factors related to the settlement pattern. Population size and private income do not have any significant impact in the user charge equation.

Other studies of fee setting in Norwegian local governments (Borge 1995, 2000) have shown that socialist influence and a fragmented local council leads to higher user charges. The negative and significant effect of the Herfindahl-index is consistent with the outcome of the earlier studies, whereas the negative, although not significant, effect of the share of socialists is not.

For the cost equation, or the reaction function of the bureau, the underlying theoretical model basically predicts that increased demand for the utility service provided by the bureau leads to more slack and lower costs, whereas fiscal pressure and lower demand has the opposite effect. The positive and significant effect of exogenous local government revenue is consistent with this hypothesis. According to the estimated coefficient, a revenue increase of 10% will increase the unit cost by 2%. This implies that exogenous local government revenue has two contradicting effects on the user charge, a negative direct effect through the user charge equation and a positive indirect effect through the cost equation. However, the direct effect dominates, and the total elasticity is -0.34.

The impacts of the other variables capturing demand and fiscal pressure are mixed. The share of elderly is borderline significant with the expected sign. An increase in the share of elderly by 1 %-point is expected to reduce the unit cost by 2%. The two other demographic variables and net interest payment do not have any significant impact on the unit cost.

The population size and the share of population in rural areas were included to capture cost disadvantages in small and sparsely populated communities. A cost disadvantage due to sparse settlement pattern is confirmed, while the population size has no significant impact on costs. The estimated coefficient predicts that an increase in the share of the population living in rural areas by 10 %-points will increase the unit cost by 1.4%.

The share of socialists in the local council comes out with a positive and significant coefficient in the cost equation. An increase in the share of socialists by 10 %-points is predicted to increase the unit cost by 2%. This result is consistent with the study of Kalseth and Rattsø (1998) who find that socialist influence increases administrative costs in Norwegian local governments. The other political variable, the Herfindahl-index, is insignificant in the cost equation.

The analyses in Section 2 indicated that the impact of user charge financing on costs would depend on the form of strategic interaction between the local government and the bureau. The Nash game with simultaneous moves predicted a negative effect, whereas the prediction from the Stackelberg game (with the bureau as leader) was the opposite. The negative and highly significant coefficient in the basic OLS regression is consistent with the Nash game. User charge financing helps to keep costs low, and the effect also is of economic significance. An increase in the degree of user charge financing by 10 %-points will reduce the unit cost by 7.5%.

In the appendix table A2 we report some sensitivity analysis with the basic OLS regression as benchmark. The first sensitivity analysis is to extend the equations with a dummy variable that equals 1 if the local government levies property tax on residential property. The motivation is that we in a companion paper (Borge and Rattsø 2003) find evidence that residential property tax contributes to lower costs, and the primary interest is to check whether the impact of the degree of user charge financing in the cost equation is robust to the inclusion of the property tax variable. As in Borge and Rattsø (2003) we find that property tax has a significantly negative effect on the unit cost, but the inclusion of the property tax variable does not change the significance and the quantitative effect of the degree of user charge financing.

The property tax dummy also comes out with a negative and significant impact in the user charge equation, which probably reflects that property tax and user charges are alternative means of financing. Taken together, the user charge equation and the cost equation implies that the existence of property tax has two effects on the user charge. A direct effect in the user charge equation and an indirect effect through the cost equation. The total effect of residential property tax is to reduce the user charge by 10%.

The second sensitivity analysis is to exclude extreme observations. As discussed in Section 2, there is large variation in unit cost and user charge across local governments even when obviously unreliable observations are excluded. To a great extent this large variation reflects that Norwegian local governments are very different in terms of topography and population, varying from rural communities with a few hundred inhabitants to larger cities. In the third panel of Table A2 we excluded the 10% of the observations with the highest and lowest values for unit cost and user charge for each of the six years. It appears that this modification of the sample only has minor effect on the estimates. In particular, the estimate of the unit cost in the user charge equation and the estimate of the degree of user charge financing in the cost equation seem very robust.

The second and third panels of Table 2 report random and fixed effect estimates respectively.[8] It appears that the relationships between unit cost and user charge are very robust to the inclusion of community specific effects. The unit cost is still positive and significant in the user charge equation and the degree of user charge financing is significantly negative in the cost equation. The estimates predict that nearly 40% of a cost increase is passed on to consumers in terms of higher user charges (roughly the same as in the OLS regression) and

[8] The share of the population living in rural areas (*RURAL*), which is based on census data from 1990 and has no time series variation, is not included in the fixed effects equation.

that an increase in the degree of user charge financing by 10 %-points will reduce the unit cost by 6% (somewhat lower than in the OLS regression).

Table 3: Estimation results taking the simultaneity problem into account
Heteroskedasticity-consistent t-values in parentheses

	OLS with lags		IV1		IV2		IV3	
	User ch.	Unit cost	User ch.	Unit cost	User ch.	Unit cost	User ch.	Unit cost
$\log c$ / $\log c(-1)$	0.285		0.401		0.407		0.020	
	(11.54)		(13.02)		(10.37)		(0.08)	
$\frac{f}{c}$ / $\frac{f(-1)}{c(-1)}$		-0.532		-0.792		-0.804		-0.830
		(-8.27)		(-16.25)		(-16.82)		(-2.57)
$\log y$	-0.062	-0.486	-0.008	-0.469	-0.033	-0.473	-0.011	0.109
	(-0.33)	(-2.81)	(-0.05)	(-2.88)	(-0.19)	(-2.66)	(-0.04)	(0.49)
$\log r$	-0.402	0.285	-0.469	0.227	-0.504	0.183	0.313	0.248
	(-3.28)	(2.50)	(-4.02)	(2.29)	(-3.76)	(1.63)	(1.63)	(1.48)
INTR	0.165	-0.219	0.215	-0.168	0.053	-0.110	0.089	0.001
	(0.96)	(-0.49)	(1.48)	(-0.62)	(0.40)	(-0.41)	(0.79)	(0.01)
RURAL	-0.349	0.217	-0.394	0.131	-0.338	0.162		
	(-5.62)	(3.43)	(-6.86)	(2.29)	(-5.40)	(2.59)		
log *POP*	0.0006	-0.0026	0.0031	0.0033	0.0039	0.0003	-0.9999	-0.4152
	(0.02)	(-0.14)	(0.18)	(0.19)	(0.20)	(0.01)	(-1.86)	(-0.94)
CH	1.320	0.025	1.411	1.019	1.893	1.667	11.913	5.816
	(0.92)	(0.02)	(1.02)	(0.78)	(1.25)	(1.15)	(3.01)	(2.50)
YO	-1.580	-0.992	-1.312	-1.541	-2.746	-2.310	1.503	-1.312
	(-1.22)	(-0.82)	(-1.08)	(-1.34)	(-2.00)	(-1.75)	(0.62)	(-0.58)
EL	0.925	-2.937	-1.708	-2.198	1.323	-2.209	3.025	-0.605
	(0.73)	(-2.02)	(1.44)	(-1.72)	(1.02)	(-1.54)	(0.86)	(-0.20)
SOC	-0.058	0.260	-0.114	0.214	-0.209	0.197	0.134	0.165
	(0.53)	(2.51)	(-1.43)	(2.44)	(-2.51)	(2.02)	(0.89)	(1.14)
HERF	-0.397	-0.197	-0.332	-0.218	-0.230	-0.205	-0.791	-0.506
	(-2.15)	(-0.84)	(-1.97)	(-1.13)	(-1.45)	(-1.01)	(-2.81)	(-2.00)
Fixed effects	No	No	No	No	No	No	Yes	Yes
Instru-ments			$\log c(-1)$ $\log y(-1)$ $\log r(-1)$ *INTR*(-1) log *P*(-1) *CH*(-1) *YO*(-1) *EL*(-1)	$\frac{f(-1)}{c(-1)}$ $\log y(-1)$ $\log r(-1)$ *INTR*(-1) log *P*(-1) *CH*(-1) *YO*(-1) *EL*(-1)	$\log c(-2)$ $\log y(-2)$ $\log r(-2)$ *INTR*(-2) log *P*(-2) *CH*(-2) *YO*(-2) *EL*(-2)	$\frac{f(-2)}{c(-2)}$ $\log y(-2)$ $\log r(-2)$ *INTR*(-2) log *P*(-2) *CH*(-2) *YO*(-2) *EL*(-2)	$\log c(-1)$ $\log y(-1)$ $\log r(-1)$ *INTR*(-1) log *P(-1)* *CH*(-1) *YO*(-1) *EL*(-1)	$\frac{f(-1)}{c(-1)}$ $\log y(-1)$ $\log r(-1)$ *INTR*(-1) log *P(-1)* *CH*(-1) *YO*(-1) *EL*(-1)
# of obs.	1678	1678	1678	1678	1305	1305	1678	1678
R^2_{adj}	0.472	0.549	0.540	0.631	0.543	0.632	0.825	0.974

Notes: Time dummies (included in all equations) and county dummies (included in all equations except IV3) are not reported. (-1) denotes that a variable is lagged one year.

Table 3 deals with the simultaneity problem related to the fact that the unit cost is a possible endogenous variable in the user charge equation and that the degree of user charge financing is a possible endogenous variable in the cost equation. In the first panel we simply use lagged values of the variables, i.e. $c(-1)$ in the user charge equation and $\frac{f(-1)}{c(-1)}$ in the cost equation, instead of the contemporaneous variables. The two variables are highly significant, but the quantitative impact is reduced compared to the OLS regressions in Table 2. The estimates indicate that close to 30% of a cost increase is passed on to consumers in terms of higher user charges and that an increase in the degree of user charge financing by 10 %-points will reduce the unit cost by 5%.

The second panel shows the results when one year lag of the exogenous variables and the possible endogenous variable are used as instruments.[9] In this case the results come very close to the OLS results. The elasticity of the user charge with respect to the unit cost is estimated to 0.4 and the coefficient of the degree of user charge financing in the cost equation is around 0.8. Similar results are obtained in the third panel where two years lag of the same variables are used as instruments. It should be noticed that the similarity with the OLS estimates is not due to 'overfitting' in the first stage regression. The R^2-s in first stage regressions are in the range 0.5-0.8.

Finally, we combine instruments and fixed effects. The point of departure is the second panel of Table 3 where one year lags are used as instruments, and the results are shown in the fourth panel of Table 3. It appears that the quantitative impact of the degree of user charge financing in the cost equation is very robust to inclusion of fixed effects. Although the estimate is less precise than in the other regressions, it is still significant at conventional levels. The elasticity of the user charge with respect to the unit cost becomes insignificant and close to zero.

6. Concluding remarks

The purpose of the paper was to investigate the relationships between costs and user charges in the sewage industry in Norwegian local governments. The main questions addressed are: (i)

[9] The political variables, the share of socialists and the Herfindahl-index are not included in the set of instruments since they only change every fourth year.

To what extent is a higher unit cost passed on to consumers in terms of a higher user charge? (ii) Does user charge financing lead to higher or lower unit cost?

Theoretical predictions are derived within a game theoretical model describing the interaction between a political authority and a service-producing bureau. The politicians set the user charge, and their reaction function is derived from a representative voter model. The impact of user charges on costs depends on the form of strategic interaction. In a Nash game where the bureau treats the user charge as fixed, user charge financing leads to lower costs because it makes slack more costly for the bureau. In a Stackelberg game the effect is opposite: A high degree charge financing signals that higher costs to large extent will be passed on to consumers with little effect on the bureaus budget.

The empirical analysis is based on a panel data set for a sample of Norwegian local governments over the years 1993-1998. The estimates indicate that around 40% of a cost increase is passed on to consumers in terms of higher user charge. Moreover, user charge financing has a significant negative effect on the unit cost. An increase in the degree of user charge financing by 10 %-points is predicted to reduce the unit cost by 5-8%. The latter result stands up even when we include fixed effects and take into account that the degree of user charge financing is endogenous.

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Appendix 1. Comparative statics

The first order conditions for the local government's decision-making problem can be found by inserting the budget constraints (3) and (4) into the utility function and maximizing with respect to *x* and *f*:

$$u_q = \frac{u_x}{c} = u_w \tag{A1}$$

By differentiating the first order conditions and assuming an additive separable utility function, we obtain the following results:

$$\begin{aligned} \frac{\partial x}{\partial c} &= -\frac{x}{D_1}\left[(u_{qq}+u_{ww})u_w - cxu_{qq}u_{ww}\right] > 0 \\ \frac{\partial f}{\partial c} &= \frac{x}{D_1}\left[(fu_{qq}-(c-f)u_{ww})u_w - x(cu_{qq}+u_{xx})u_{ww}\right] > 0 \text{ if } c \le f \end{aligned} \tag{A2}$$

$$\begin{aligned} \frac{\partial x}{\partial r} &= -\frac{cx}{D_1}u_{qq}u_{ww} > 0 \\ \frac{\partial f}{\partial r} &= \frac{1}{D_1}(cfu_{qq}+u_{xx})u_{ww} < 0 \end{aligned} \tag{A3}$$

$$\begin{aligned} \frac{\partial x}{\partial y} &= -\frac{cx}{D_1}u_{qq}u_{ww} > 0 \\ \frac{\partial f}{\partial y} &= -\frac{1}{D_1}(u_{xx}+c(c-f)u_{ww})u_{xx} > 0 \text{ if } c \ge f \end{aligned} \tag{A4}$$

$$\begin{aligned} \frac{\partial x}{\partial z} &= -\frac{cx}{D_1}u_{qq}u_{wz} > 0 \\ \frac{\partial f}{\partial z} &= \frac{1}{D_1}(cfu_{qq}+u_{xx})u_{wz} > 0 \end{aligned} \tag{A5}$$

The denominator D_1 is given by:

$$D_1 = -x(u_{qq}u_{xx} + c^2 u_{qq}u_{ww} + u_{xx}u_{ww}) < 0 \tag{A6}$$

By differentiating the bureau's first order condition, given by equation (9), and assuming an additive separable utility function, we obtain the following comparative static results:

$$\begin{aligned} \frac{\partial c}{\partial f} &= \frac{1}{D_2}\left[\frac{2x}{(c-f)^2}b_x + \frac{x^2}{(c-f)^2}b_{xx}\right] \\ \frac{\partial c}{\partial l} &= \frac{1}{D_2}\left[\frac{1}{(c-f)^2}b_x + \frac{x}{(c-f)^2}b_{xx}\right] \end{aligned} \tag{A7}$$

$D_2 = \frac{x^2}{(c-f)^2}b_{xx} + b_{ss} - \frac{x}{c-f}b_x$ is negative from the second order condition. The combined effect of increased user charge and lower fixed budget is revenue neutral if $dl = -xdf$. By utilizing equation (A7), we then arrive at equation (10) in the main text.

Appendix 2. Documentation of the variables

Table A1: Data description and descriptive statistics

Variable	Description	Mean (st. dev.)
User charge (*f*)	Collected user charges (connection fees and yearly fees) per standard users, NOK	1 876 (970)
Unit cost (*c*)	Total costs per standard user for discharge of sewage, NOK	2 874 (1 762)
Degree of user charge financing ($\frac{f}{c}$)	Collected user charges divided by total costs	0.779 (0.391)
Private disposable income (*y*)	Taxable income minus income and wealth taxes to local, county and central government, measured per capita and deflated by the consumer price index, NOK	64 468 (9 619)
Exogenous local government revenue (*r*)	The sum of lump-sum grants from the central government and regulated income and wealth taxes, measured per capita and deflated by a price index for local government purchases and adjusted for minor changes in the functional responsibility, NOK	19 125 (5 167)
Net interest payment (*INTR*)	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	10 145 (18 442)
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 dummy (*PRTAX*)	A dummy variable that is equal to unity if the local government levies property tax on residential property	0.305 (0.461)

Appendix 3. Sensitivity analysis

Table A2: Sensitivity analysis with the basic OLS regression as benchmark
Heteroskedasticity-consistent t-values in parentheses

	Basic OLS regression		Property tax dummy		Excluding extreme obs.	
	User charge	Unit cost	User charge	Unit cost	User charge	Unit cost
log *c*	0.414		0.412		0.349	
	(17.82)		(17.67)		(13.70)	
$\frac{f}{c}$		-0.751		-0.753		-0.703
		(-18.99)		(-18.95)		(-20.21)
log *y*	-0.019	-0.416	0.024	-0.418	-0.113	-0.270
	(-0.12)	(-2.79)	(0.15)	(-2.81)	(-0.70)	(-2.10)
log *r*	-0.428	0.210	-0.436	0.201	-0.255	0.068
	(-4.06)	(2.31)	(-4.13)	(2.20)	(-2.77)	(0.85)
INTR	0.424	-0.202	0.409	-0.214	0.128	0.102
	(1.94)	(-0.62)	(1.90)	(-0.65)	(0.52)	(0.63)
RURAL	-0.458	0.135	-0.480	0.110	-0.307	0.090
	(-8.47)	(2.56)	(-8.85)	(2.08)	(-6.18)	(2.07)
log *P*	0.006	-0.004	0.012	0.003	0.034	0.007
	(0.35)	(-0.25)	(0.77)	(0.17)	(2.13)	(0.52)
CH	0.256	0.688	0.233	0.663	0.606	2.551
	(0.20)	(0.57)	(0.18)	(0.55)	(0.60)	(2.71)
YO	-0.689	-0.976	-0.877	-1.160	-0.251	-0.801
	(-0.63)	(-0.92)	(-0.80)	(-1.08)	(-0.27)	(-0.96)
EL	1.363	-2.029	1.547	-1.832	0.575	1.185
	(1.23)	(-1.70)	(1.39)	(-1.54)	(0.54)	(1.20)
SOC	-0.109	0.216	-0.075	0.248	-0.076	0.092
	(-1.39)	(2.61)	(-0.96)	(2.95)	(-0.95)	(1.27)
HERF	-0.395	-0.204	-0.399	-0.208	-0.250	-0.290
	(-2.30)	(-1.15)	(-2.32)	(-1.15)	(-1.47)	(-1.79)
PRTAX			-0.070	-0.069		
			(-3.77)	(-3.47)		
# of obs.	2031	2031	2031	2031	1371	1371
R^2_{adj}	0.551	0.644	0.553	0.646	0.472	0.576

Note: Time and county dummies (not reported) are included in all equations.

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