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Working Paper

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Working Paper, No. 2000:17

Provided in Cooperation with:

Department of Economics, Uppsala University

Suggested Citation: Dahlberg, Matz; Jacob, Johanna (2000) : Sluggishness, Endogeneity and the Demand for Local Public Services, Working Paper, No. 2000:17, Uppsala University, Department of Economics, Uppsala, <http://nbn-resolving.de/urn:nbn:se:uu:diva-2502>

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Sluggishness, Endogeneity and the Demand for Local Public Services[†]

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October 2000

Abstract

Earlier studies estimating the demand for local public services by means of the median voter model have typically assumed exogenous regressors and static set-ups. Furthermore, the commonly used log-linear specification of the demand function has in most cases not been supported by a well-defined maximisation problem. In this paper, we investigate whether it is important to control for endogeneity and dynamics in empirical work. Using a panel of 266 Swedish municipalities over the period 1981-1987, our test results show that the regressors are endogenous and that the adjustment process is potentially sluggish. We get significantly lower price- and income elasticities when we control for endogeneity and dynamics. In addition, when we control for endogeneity and dynamics, we can no longer reject the hypothesis that observed behaviour can be rationalised by a Cobb-Douglas utility function. This implies that the log-linear specification of the demand function is valid as long as appropriate econometric techniques are used.

Keywords: Local public goods, Median voter, Panel data, Endogeneity, Sluggishness

JEL Classification: C33, D72, H72

[†] We are grateful for comments from Sören Blomquist, Peter Fredriksson, Nils Gottfries, Eva Johansson, Magnus Wikström, and seminar participants at University of Bonn, Uppsala University and at the 1999 European Public Choice Society Meeting in Lisbon. Matz Dahlberg gratefully acknowledges financial support from HSFR. Both authors can be reached at the following address: Department of Economics, Uppsala University, PO Box 513, SE-751 20 Uppsala, Sweden. E-mail: Matz.Dahlberg@nek.uu.se, Johanna.Jacob@nek.uu.se

1. Introduction

One of the most commonly used methods to analyse political decision-making is the median voter model (see Hotelling (1929), Bowen (1943), Downs (1957), and Black (1958)). Though building on quite strong assumptions, such as single peaked preferences, a single decision to vote on, and single majority voting, the model has proven to be a fruitful tool in the sense that it allows the investigator to take the model to data. Ever since the influential papers by Barr and Davis (1966) and Bergstrom and Goodman (1973), the median voter model has been the most frequently used method for estimating preferences for local public services.¹ However, recently the empirical work on estimating preferences for local public services by means of the median voter model has been under attack.

First, it has been criticised for inappropriate model specifications because dynamics have been neglected (see, e.g., Bailey and Connolly (1998)). Since most earlier work has used cross sectional data, the model specifications have, by their very nature, been static. There are however reasons to believe that the adjustment to changes in demand might be sluggish, not the least due to hiring and firing costs (Bailey and Connolly (1998) point out some other reasons why a dynamic approach would be more valid than the static set-up typically used). There is also ample empirical evidence that the adjustment process is quite sluggish in the local government sector, see, e.g., Holtz-Eakin, Newey and Rosen (1989) and Holtz-Eakin and Rosen (1989, 1991) on US data, Borge and Rattsø (1993, 1996) and Borge, Rattsø & Sørensen (1996) on Norwegian data, and Bergström, Dahlberg & Johansson (1998) and Dahlberg and Johansson (1998, 2000) on Swedish data.

Second, the empirical work has been criticised for inappropriate econometric techniques and lack of appropriate econometric tests (see, e.g., Becker (1996) and Bailey and Connolly (1998)). The argument goes that most of the right hand side variables might be endogenous, due to migration or other factors. These are assumed away theoretically, but if there exists for example Tiebout-related migration, the median income and the tax price as well as the demographic structure might be endogenous. In addition, intergovernmental grants might be endogenous since they often are functions of local government spending (see, e.g., Islam and

¹ It can be worth mentioning that even though it is hard to rigorously test the median voter model since there does not exist any clear alternative hypothesis, there is some evidence in favour of the median voter hypothesis to be found in, e.g., Pommerehne (1978), Inman (1978), Turnbull & Djoundourian (1994), and Aronsson & Wikström (1996).

Choudhury (1990) and Becker (1996)). If dynamics and endogeneity are important to control for, most earlier work suffer from biased and inconsistent results.

Furthermore, the theoretical underpinning of the typical log-linear demand function is questionable since most empirical evidence implicitly rejects the underlying utility function when one exists (see, e.g., the results in Bergstrom and Goodman (1973) and Pommerehne (1978)) and some often used specifications of the demand function do not even have a well-defined utility function (see Section 2 for further discussion about this).

The purpose of this study is to investigate whether endogeneity and dynamics are important to control for in empirical work and to test the hypothesis that observed behaviour can be rationalised by a well-defined maximisation problem.

We find that all the important regressors are endogenous and that the adjustment process is potentially sluggish. When we neglect endogeneity and sluggishness and estimate a log-linear model with the fixed effects estimator, we have to reject the hypothesis that observed behaviour can be rationalised by the maximisation of a Cobb-Douglas utility function. However, when we control for endogeneity and dynamics, we can no longer reject the restrictions imposed on the demand function by the Cobb-Douglas utility function. This means that it seems to be valid to use a log-linear specification of the demand function as long as appropriate econometric techniques are used. Furthermore, when comparing our results, when endogeneity and dynamics are controlled for, to those obtained when endogeneity and dynamics are neglected, we get significantly lower price- and income elasticities. This result indicates that the estimated elasticities might be upward biased in earlier studies where static set-ups and exogenous regressors have been assumed.

The remainder of the paper is organised as follows. Section 2 presents the theoretical model and Section 3 contains a brief presentation of the data set. Section 4 describes the econometric method and Section 5 presents our empirical results. Finally, Section 6 concludes.

2. Theoretical Model

Let us first begin by specifying the median voter model within a system of income taxes.² Let $i = 1, \dots, M$ denote municipalities and $t = 1, \dots, T$ time periods. The preferences of the median voter are captured by the quasi-concave utility function

$$U_{it} = U(C_{it}, e_{it}), \quad (2.1)$$

where C_{it} is a composite private good (with a price normalised to one) and $e_{it} = E_{it}/N_{it}$ is per capita local public provision of a private good. The median voter maximises the utility function subject to two budget constraints, his or her individual budget constraint and the municipality's budget constraint. The median voter's budget constraint is given by

$$C_{it} = (1 - t_{it})y_{it}^m, \quad (2.2)$$

where t_{it} is the local tax rate and y_{it}^m is the median voter's (before tax) income. The municipality's budget constraint is given by

$$t_{it}N_{it}\bar{y}_{it} + G_{it} = E_{it}, \quad (2.3)$$

where N_{it} is the number of inhabitants in municipality i in period t , \bar{y}_{it} is the mean individual (before tax) income, and G_{it} is intergovernmental grants received by the municipality³. Solving (2.2) for the local tax rate, and substituting into (2.3) yields

$$C_{it} = y_{it}^m + \mathbf{t}_{it}(g_{it} - e_{it}), \quad (2.4)$$

where $\mathbf{t}_{it} = \frac{y_{it}^m}{\bar{y}_{it}}$ is the tax price paid by each median voter and g_{it} is intergovernmental grants

² This is the proper specification for Sweden since approximately 99% of the taxes raised at the municipal level come from income taxation.

³ During the 1980's specific grants constituted the major part of intergovernmental grants in Sweden. There existed many different kinds of specific grants. (In 1990 there existed over 100 such grants.) Following Aronsson & Wikström (2000), we assume that the specific grants are lump sum. A minor part of the intergovernmental grants were aimed at helping the municipalities with small per capita tax bases (tax equalization grants). For simplicity we assume that these grants are lump sum as well.

per capita. Substituting (2.4) into (2.1) yields the following maximisation problem

$$\max_{e_{it}} U = U\left[y_{it}^m + \mathbf{t}_{it}(g_{it} - e_{it}), e_{it}\right]. \quad (2.5)$$

Assuming a Cobb-Douglas utility function, eq. (2.5) is re-written as

$$\max_{e_{it}} U = A\left(y_{it}^m + \mathbf{t}_{it}(g_{it} - e_{it})\right)^{q_1} e_{it}^{q_2}. \quad (2.6)$$

The maximisation problem (2.6) yields the following log-linear demand function for municipal expenditures

$$\ln e_{it}^* = \ln\left(\frac{q_2}{q_1 + q_2}\right) + \ln(y_{it}^m + \mathbf{t}_{it} g_{it}) - \ln \mathbf{t}_{it}. \quad (2.7)$$

The demand function most frequently used in earlier empirical work has typically been of the form

$$\ln e_{it}^* = \mathbf{y}_0 + \mathbf{y}_1 \ln(y_{it}^m + \mathbf{t}_{it} g_{it}) + \mathbf{y}_2 \ln \mathbf{t}_{it}. \quad (2.8)$$

A problem is though that the only utility function that is globally consistent with the log-linear specification given in (2.8) is the Cobb-Douglas with price- and income elasticities equal to one (i.e., with $\mathbf{y}_1 = 1$ and $\mathbf{y}_2 = -1$) (see Rubinfeld (1987)). This is not explicitly discussed in earlier papers, but an examination of the obtained results reveals that the log-linear specification is clearly rejected in most applications since the price- and income elasticities typically differ from one (see, e.g., Bergstrom and Goodman (1973), Pommerehne (1978) or Inman (1979) where results from several studies are summarized). In the empirical part of the paper, we will estimate a statistical specification of equation (2.8) and test whether observed behaviour is in accordance with the behaviour postulated in the maximisation problem (2.6) (that is, we will test the null hypotheses that $\mathbf{y}_1 = 1$ and $\mathbf{y}_2 = -1$).⁴

⁴ In the model outlined here, it is assumed that income from grants will have the same impact on municipal spending as income from tax revenue. Potential flypaper effects have made several researchers to estimate separate coefficients for grants and median income in the log-linear specification (see, e.g., Becker (1996) and Turnbull & Djoundourian (1994)). That is however not a valid re-specification of the model since $\mathbf{y}_1 \ln(y_{it}^m + g_{it} \mathbf{t}_{it})$ is not equal to $\mathbf{y}_{11} \ln y_{it}^m + \mathbf{y}_{12} \ln g_{it} \mathbf{t}_{it}$. The latter specification is, as long as grants are not equal to zero, not supported by any utility function.

Accounting for dynamics

As noted above, some earlier studies in the literature on local public expenditures indicate some kind of dynamic behaviour of local governments (see, e.g., Holtz-Eakin *et al.* and Holtz-Eakin & Rosen (1989, 1991) on US data, Bergström *et al.* (1998) and Dahlberg & Johansson (1998, 2000) on Swedish data, and Borge & Rattsø (1993, 1996) and Borge *et al.* (1996) on Norwegian data).⁵ We introduce dynamics by combining the static median voter model with a partial adjustment rule. The dynamic formulation separates between the desired level of expenditures (e_{it}^*) and the actual level of expenditures (e_{it}) for each year. The desired level of expenditures is determined by equation (2.8). The relationship between the desired and the actual level of expenditures is formulated as a partial adjustment process. The actual change between periods t and $t-1$ is a fraction, I , of the desired change

$$\ln e_{it} - \ln e_{it-1} = I(\ln e_{it}^* - \ln e_{it-1}). \quad (2.9)$$

The adjustment coefficient I indicates the sluggishness of the local government responses to changing demand. A small value of the coefficient means that only a small fraction of the desired change in expenditures is implemented in the first year.

Substituting (2.8) into (2.9) yields

$$\ln e_{it} = \Gamma_0 + \Gamma_1 \ln(y_{it}^m + t_{it} g_{it}) - \Gamma_2 \ln t_{it} + (1 - I) \ln e_{it-1}, \quad (2.10)$$

where $\Gamma_0 = I\mathbf{y}_0$, $\Gamma_1 = I\mathbf{y}_1$, and $\Gamma_2 = I\mathbf{y}_2$. When taking the model to the data, we follow earlier studies and characterise the median voter as the voter with median income (see Theorem 1 in Bergstrom & Goodman (1973)).

3. Data

The data used in this study has been compiled by Statistics Sweden.⁶ Data covers the years

⁵ A dynamic specification was also used by Becker (1996). She did however use an estimator that yields biased and inconsistent results.

⁶ Data has, except for the income and grant variables, generously been provided to us by Thomas Aronsson,

1981-1987, and contains a number of economic, demographic, and socio-economic variables on municipal level. The time period is chosen so that the variable definitions are constant throughout the period (there was a change in definitions in 1988), the grant system is approximately the same for the whole period (there was a grant reform in 1989), and the municipalities were free to set their own taxes for the whole period (there was a tax ceiling between 1991 and 1994).

The economic variables used in the empirical analysis are total municipal operating costs net of user fees, mean and median household income before tax, tax price and intergovernmental grants (which consist of operating grants, investment grants, and grants for tax equalisation), all expressed in per capita terms. Since the municipalities in Sweden mainly are responsible for such services as day-care, schooling, and care for the elderly, it is important to control for the demographic structure in the municipalities. As control variables we use the share of inhabitants younger than 16 years of age (Young), the share of inhabitants older than 65 years of age (Old) and the number of inhabitants per square meter (Density). For a summary of the variables used in the estimation, see Table 3.1.

Table 3.1. Variables used in the estimations.

Income	Median income + tax price * grants
Tax price	Median/mean income
Young	Share of inhabitants younger than 16
Old	Share of inhabitants older than 65
Density	Number of inhabitants per square meter

Our balanced panel consists of 266 municipalities, which are observed over the seven years. This gives us a total number of 1862 observations. Removed from the sample were municipalities that were split, or had missing values for one or more of the key variables. Excluded were also three municipalities with responsibilities usually handled by the county council.⁷

4. Econometric Method

Johan Lundberg and Magnus Wikström at the Department of Economics at Umeå University.

⁷ A more detailed description of the data and some summary statistics can be found in the Appendix.

In the empirical part of the paper, we will test for exogeneity and dynamics. When we estimate a model that has endogenous regressors and/or is dynamic, we cannot use the within estimator (see, e.g., Nickell (1981)). In this section we will describe our choice of estimation method for the dynamic model derived in equation (2.10).⁸ The econometric specification of that model is given by

$$\ln e_{it} = \mathbf{i}_t + \Gamma_0 + \Gamma_1 \ln(y_{it}^m + g_{it} \mathbf{t}_{it}) - \Gamma_2 \ln \mathbf{t}_{it} + (1 - \mathbf{I}) \ln e_{it-1} + f_i + u_{it}, \quad (4.1)$$

where \mathbf{i}_t is a time-dummy, f_i is an unobserved municipality specific effect, and u_{it} is the error term.

By assumption, u_{it} satisfies the orthogonality conditions

$$E[\ln e_{is} u_{it}] = E[\ln(y_{is}^m + g_{is} \mathbf{t}_{is}) u_{it}] = E[\ln \mathbf{t}_{is} u_{it}] = E[f_i u_{it}] = 0, \quad (s < t) \quad (4.2)$$

where an E without subscripts denotes the expectational operator. Nickell (1981) has shown that, for models with lagged dependent variables, treating individual effects as constants to be estimated or using within transformation yields inconsistent estimates. Following the tradition of Anderson & Hsiao (1981), we remove the individual effect by taking first difference of equation (4.1). This leaves us with the following equation

$$\Delta \ln e_{it} = \Delta \mathbf{i}_t + \Gamma_1 \Delta \ln(y_{it}^m + g_{it} \mathbf{t}_{it}) - \Gamma_2 \Delta \ln \mathbf{t}_{it} + (1 - \mathbf{I}) \Delta \ln e_{it-1} + \Delta u_{it}, \quad (s < t - 1) \quad (4.3)$$

where Δ denotes the difference operator, (i.e., $\Delta \ln e_{it} = \ln e_{it} - \ln e_{it-1}$, etc.). The differenced residuals satisfy the following orthogonality conditions:

$$E[\ln e_{is} \Delta u_{it}] = E[\ln(y_{is}^m + g_{is} \mathbf{t}_{is}) \Delta u_{it}] = E[\ln \mathbf{t}_{is} \Delta u_{it}] = 0 \quad (4.4)$$

Equation (4.3) will be estimated using a GMM estimator exploiting the orthogonality conditions in (4.4).

⁸ This estimator is also applicable when we have a static model with endogenous regressors.

Doing the above transformation, we have induced a first order MA-process in the residuals and, since we have a lagged dependent variable on the right-hand side, we must rely on instrumental variable techniques. In the GMM context, it is assumed that the following

moment-restrictions (in matrix form) are fulfilled

$$E[Z'(y - XB)] = \mathbf{0}, \quad (4.5)$$

where $\mathbf{0}$ is a $J \times 1$ vector of zeros and X is a stacked vector of all regressors, y is a vector of the dependent variable (i.e., $\Delta \ln e_{it}$), Z is the matrix of instruments, and B is the vector of parameters. The orthogonality conditions in (4.4) imply that values of the right hand side-variables lagged two periods back and more can be used as instruments. The number of instruments grows with t , implying that Z is block-diagonal.

The GMM estimation technique is to minimise the loss-function

$$Q = N^{-1}[y - XB]'ZW_N Z'[y - XB], \quad (4.6)$$

which will be small if the moments are close to being fulfilled. W_N is a $J \times J$ symmetric and positive semi-definite weighting matrix, which is needed if the model is over identified, that is, if there exist more instruments than parameters to be estimated. Differentiation of (4.6) and manipulation of the first order condition yields the following estimator

$$\hat{B} = (X'ZW_N Z'X)^{-1} X'ZW_N Z'y. \quad (4.7)$$

As proposed by Hansen (1982), we will do the estimation in two steps. In the first step we use the weighting matrix proposed by Arellano & Bond (1991), while we in the second allow for cross-equation correlation and use the residuals from the first step to form the weighting matrix. This estimator is identical to the one proposed and used by Arellano & Bond (1991).⁹

The fact that we have an over identified model allows us to conduct a joint test of the model specification and the validity of the instruments. The Sargan-statistic (hereafter Q) is formed by evaluating the loss-function (4.6) at the estimated parameters from (4.7). Under the null, Q is χ^2 -distributed with degrees of freedom (Df) equal to the number of instruments minus the

⁹ A similar GMM estimator has been developed by Holtz-Eakin, Newey & Rosen (1988). The only difference between the two estimators is the weighting matrix used in the first step.

number of estimated parameters, that is, we have as many degrees of freedom as we have over identifying restrictions. An extension of the Sargan-statistic can also be used in tests of more specific hypotheses. The difference Sargan (ds) statistic is formed by estimating both the restricted (R) and the unrestricted (U) model and then calculate $ds = Q_R - Q_U$. Under the null, ds is χ^2 -distributed with $Df_{ds} = Df_{Q_R} - Df_{Q_U}$.¹⁰

5. Results

In this section we will, first, test the hypothesis of exogenous regressors, and, second, estimate a dynamic model and test the hypothesis that there is no sluggishness. If any one or both of these hypotheses are rejected, this casts doubt on earlier work on cross sectional data that has assumed exogenous regressors.

Testing for exogeneity (static model)

If there exist some unobserved municipality specific effects that do not vary over time, we would like to control for this in the estimations. Performing an F-test, testing the null hypothesis that the intercept is identical for all municipalities, we clearly reject the null.¹¹ This indicates that some unobserved heterogeneity exist in the data. The question is then whether this unobserved heterogeneity should be treated as random or fixed effects. Using a Hausman test, testing the null of random effects, the null is rejected, a result that indicates that a fixed effect estimator must be used.¹² However, the regular fixed effects estimator (in which OLS is conducted on deviations from individual time-means) requires that all the independent variables are exogenous. Whether this is the case can be tested by means of a Hausman test, testing the null of exogenous regressors. Under the null, the fixed effects estimator is consistent and efficient, but under the alternative it is inconsistent. The GMM estimator is consistent under both the null and the alternative. Carrying out the test, we obtain a test statistic of 942.06 (with 10 degrees of freedom), which clearly rejects the null. Furthermore, using the ds -statistic and testing the regressors separately for exogeneity, it turns out that we have to reject the null of exogeneity for all of the explanatory variables.¹³ Thus, endogeneity seems to be a serious problem, and we will therefore use the GMM estimator discussed in Section 4.

¹⁰ For derivation of ds , see Arellano & Bond (1991).

¹¹ $F(265, 1591) = 19.743$, implying that the null hypothesis is rejected at the 1% level.

¹² The chi-squared statistic is 60.91 with 5 degrees of freedom.

¹³ This is the case for all models estimated in this paper.

Testing for dynamics

The next step is to test for dynamics. The estimation results for the dynamic model (equation (2.13)) are presented in Table 5.1. We can note from the specification tests that we cannot reject the validity of the instruments/the model specification in any of the two estimation steps: the p-value for the Sargan-statistic is over 0.4 in both cases. Furthermore, we have to reject the null of no first order serial correlation (the p-value for AR(1) is 0.0035 in the first-step estimates and 0.0085 in the second step), but accept those of higher order (AR(2)-AR(4)) when testing at the five percent significance level. This is in accordance with theory. Testing for dynamics (i.e., testing whether the lagged dependent variable is significant or not), it turns out that it is statistically insignificant in the second-step estimates (GMM2) but significant at the ten percent level in the first-step estimates (GMM1). Even though the results don't give a clear-cut answer, there is some indication that it might be important to consider dynamic specifications in applied work. Turning to the income- and price elasticities, we note that they are not significantly different from plus one and minus one respectively in any of the estimation steps. Hence, we cannot reject the null that the observed behaviour is in accordance with the maximisation of a Cobb-Douglas utility function in the dynamic specification.

Table 5.1 Dynamic specification.

Variable	GMM1			GMM2		
	Coefficient	SE	T-ratio	Coefficient	SE	T-ratio
COST ($t-1$)	0.2410	0.1436	1.6785	0.1252	0.1139	1.0986
INCOME	0.5932	0.3537	1.6769	0.4699	0.2622	1.7919
TAXPRICE	-0.7713	0.3615	-2.1336	-0.7431	0.2542	-2.9227
YOUNG	0.2838	0.0987	2.8750	0.2717	0.0790	3.4372
OLD	-0.0077	0.1154	-0.0663	-0.0638	0.1000	-0.6377
DENSITY	-0.4280	0.1298	-3.2963	-0.5375	0.1058	-5.0801
Specification tests						
Test	Statistic	P-value	Df	Statistic	P-value	Df
Sargan	38.322	0.4094	37	37.252	0.4575	37
AR(1)	-2.9214	0.0035		-2.6310	0.0085	
AR(2)	1.7250	0.0845		1.2668	0.2052	
AR(3)	0.0202	0.9839		-0.0125	0.9900	
AR(4)	-0.1634	0.8702		-0.0707	0.9437	

Notes:

- (i) The GMM estimates have been obtained using DPD for Ox 1.20.
(ii) Dependent variable is the natural logarithm of costs (ln(Costs)).
(iii) Instruments used are ln(old), ln(young), ln(density), ln(taxprice) and ln(income) lagged one period and more, and ln(costs) lagged three periods and more.
(iv) The estimations include time dummies and a constant.
(v) AR are the test statistics for first to fourth order serial correlation in the first differenced residuals. The null hypothesis is that there is no serial correlation of the order in question.
(vi) Sargan gives the test statistic and p-value of the Sargan test for over-identifying restrictions. The statistic is asymptotically $\chi^2(p-k)$ distributed, where p is the number of moment conditions and k is the number of coefficients estimated. The null hypothesis is that the instruments are valid/the model is correctly specified.

Since the presence of dynamics is not fully clear, we also estimate a static specification of the log-linear demand function. These results are presented in Table 5.2. In the first step of the GMM estimation (GMM1) we have to reject the model specification by means of the Sargan test, but moving on to the second step (GMM2) the validity of the instruments/the model specification cannot be rejected (the p-value for the Sargan statistic is 0.25). In accordance with theory, we have to reject the null of no first order serial correlation (the p-value for AR(1) is 0.0002), but accept those of higher order (AR(2)-AR(4)) for the second-step estimates. This leads us to rely on the second step estimates.

In the results for GMM2 we find, as for the dynamic specification, that we cannot reject the null that the income- and price elasticities are equal to plus one and minus one respectively. The

conclusion is that a log-linear specification of the demand function can be used in empirical work as long as it is accompanied by appropriate econometric techniques. Looking at the parameter estimates for the other variables, we note that YOUNG and DENSITY are significant with their expected signs (even though YOUNG is insignificant in the first-stage estimation¹⁴) while OLD enters with an unexpected sign but insignificantly so.

Table 5.2 Static specification.

Variable	GMM1			GMM2		
	Coefficient	SE	T-ratio	Coefficient	SE	T-ratio
INCOME	0.8272	0.4225	1.9580	0.4496	0.3003	1.4974
TAXPRICE	-0.9976	0.4533	-2.2008	-0.6708	0.2895	-2.3174
YOUNG	0.1660	0.1139	1.4572	0.2211	0.0720	3.0722
OLD	-0.1510	0.1057	-1.4290	-0.1186	0.0784	-1.5119
DENSITY	-0.6674	0.1470	-4.5397	-0.6480	0.1050	-6.1686
Specification tests						
Test	Statistic	P-value	Df	Statistic	P-value	Df
Sargan	62.514	0.0129	40	45.558	0.2519	40
AR(1)	-3.9060	0.0001		-3.7763	0.0002	
AR(2)	0.4372	0.6619		0.6598	0.5094	
AR(3)	-1.2439	0.2135		-1.4199	0.1556	
AR(4)	0.1320	0.8950		0.3051	0.7603	

Notes:

- (i) Instruments used are $\ln(\text{old})$, $\ln(\text{young})$, $\ln(\text{density})$, and $\ln(\text{taxprice})$ and $\ln(\text{income})$ lagged one period and more, and $\ln(\text{costs})$ lagged three periods and more.
- (ii) See further the notes to Table 5.1.

Assuming a static model and exogenous regressors: Fixed effect estimation

It is of interest to investigate whether the elasticities are significantly different when allowing for endogeneity and dynamics compared to the results obtained when these two factors are neglected. We will therefore estimate, by means of a fixed effects model, the price- and income elasticities in a traditional, static model where the explanatory variables are assumed to be exogenous, and compare them with the GMM-estimated elasticities. Since we have found that endogeneity, and potentially also lagged spending, *must* be controlled for, we should not be surprised if the results differ from each other.

¹⁴ The reason for looking at the estimated standard errors in the first stage is that the estimated standard errors in the second stage are downward biased (see, e.g., Arellano & Bond (1991)).

The results from the fixed effect estimation of the log-linear model are found in table 5.3 (where we also, for ease of comparison, present the GMM results). The income- and tax variables enter significantly and with expected signs. So does also DENSITY, while YOUNG and OLD have unexpected signs (YOUNG significantly so). The interesting point to note is though that the price- and income elasticities are significantly higher in the fixed effect estimations than in the GMM estimations: the income elasticity is significantly higher at the 5 percent level when comparing with the dynamic case and at the 10 percent level when comparing with the static case while the price elasticity is significantly higher at the 10 percent level when comparing both with the dynamic and the static case. This finding indicates that the price- and income elasticities might be upward biased in earlier studies where endogeneity and dynamics have been neglected.

Table 5.3 Comparison between the GMM and the fixed effect estimations

	Income	Taxprice	Young	Old	Density
Fixed effects	1.30 (0.0453)	-1.48 (0.1293)	-0.76 (0.0613)	-0.07 (0.0621)	-0.59 (0.0772)
GMM: Static	0.45 (0.3003)	-0.67 (0.2895)	0.22 (0.0720)	-0.12 (0.0784)	-0.65 (0.1050)
GMM: Dynamic	0.47 (0.2622)	-0.74 (0.2542)	0.27 (0.0790)	-0.06 (0.1000)	-0.54 (0.1058)

Note: Standard errors within parenthesis.

6. Summary and Conclusion

Earlier studies estimating the demand for local public services by means of the median voter model have typically assumed exogenous regressors and static set-ups. Furthermore, the commonly used log-linear specification of the demand function has in most cases not been supported by a well-defined maximisation problem. In this paper, we investigate whether endogeneity and dynamics are important to control for in empirical work and test the hypothesis that observed behaviour can be rationalized by a well-defined maximization problem.

Using a panel of 266 Swedish municipalities over the period 1981-1987, our test results show that the regressors are endogenous and that the adjustment process is potentially sluggish. When we assume exogenous regressors and a static set-up and estimate the model with the fixed effect estimator, we have to reject the hypothesis that observed behaviour can be rationalized by the maximization of a Cobb-Douglas utility function. However, when we control for endogeneity

and dynamics, we can no longer reject the constraints imposed on the demand function by the Cobb-Douglas utility function. Hence, it seems to be valid to use a log-linear specification of the demand function as long as appropriate econometric techniques are used.

When comparing our GMM-estimates, in which endogeneity and dynamics are controlled for, to those obtained when endogeneity and dynamics are neglected, we get significantly lower price- and income elasticities. This result indicates that the estimated elasticities might be upward biased in earlier studies where static set-ups and exogenous regressors typically have been assumed.

The results in this paper indicate that when estimating demand functions by means of the median voter model, one should bear in mind that the explanatory variables might be endogenous (calling for some IV-estimator), that dynamics might be important to control for (due to a sluggish adjustment process), and that a log-linear specification of the demand function seems to be a valid approach (in the sense that we cannot reject the constraints imposed by microeconomic theory) when appropriate econometric techniques are used. Of course, these results might well be a function of the country and time period under study. The general recommendation is that these things are tested and, if needed, controlled for in each application. If not, the obtained results are likely to be biased.

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Appendix

All monetary variables are expressed in 1980 SEK (deflated by the Consumer Price Index).

Municipalities

The number of municipalities included in this data set is 266. Excluded are municipalities that have been split or merged during the sample period. Three municipalities (Gotland, Göteborg, and Malmö) were excluded because their responsibilities differ from the rest of the sample. 15 municipalities were excluded due to missing observations. This leaves us with a balanced panel of 266 municipalities over 7 years, 1981-1987.

Cost (e_{it})

Total operating costs, net of user fees, expressed in Millions of SEK.

Mean: 378.1297, st.dev.: 907.5507

Source: Kommunernas Finanser.

Median income (y_{it}^m)

Median household income for inhabitants older than 20 years who are working more than 20 hours per week. Expressed in thousands of SEK

Mean: 67.53822, st. dev.: 8.205294

Source: Statistiska Meddelanden, serie Be.

Mean income

Average household income for inhabitants older than 20 years who are working more than 20 hours per week. Expressed in thousands of SEK

Mean: 77.18378, st. dev.: 10.47717

Source: Statistiska meddelanden, serie Be

Grants (g_{it})

Operating grants, investment grants and tax equalisation grants expressed in millions of SEK.

Mean: 91.80695 st.dev.: 141.2289

Source: Kommunernas Finanser.

Tax price (t_{it})

Median income / mean income

Mean: 0.8766739 st. dev.: 0.025636

Socio-economic and demographic variables (Z_{it})

Young

Share of population younger than 16 years of age.

Mean: 0.2053734, st. dev.: 0.026249

Old

Share of population of age 65 and over.

Mean: 0.1804379, st. dev.: 0.041458

Density

Number of inhabitants per square kilometre

Mean: 106.9111, st. dev.: 355.3878