



Using survey data to study capitalization of local public services

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ABSTRACT

We use surveys in which respondents evaluate local amenities in Norway to compute proxy variables for the quality of local public services as well as other local amenities relevant to location decisions. Average satisfaction reported by the respondents is computed for each amenity and each municipality, adjusted for sample variation in personal characteristics and included as explanatory variables in a cross-section study of house prices. We find that house prices are increasing in satisfaction with cultural activities, health care, care for the elderly and public transportation.

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1. Introduction

A large number of studies have examined the impact of local fiscal conditions on residential location decisions.¹ The empirical literature on Tiebout mobility includes studies of how local public services and taxes are capitalized into house prices and wages, and studies of the relation between local public services/taxes and migration flows or individual exit and/or entry decisions.

A major methodological challenge of this literature is to characterize how attractive the local bundle of government services and other local amenities are to households. The existing literature has produced good proxies for amenity levels for most amenities, including schools, environmental quality, safety and cultural amenities. Exceptions are some local public services for which output data are not readily available. Researchers have used input measures, such as spending or labour input per user, to characterize the quality of these services, which include health care, day care and care for the elderly. However, as the relation between input and quality is ambiguous, interpretation of the reported results is not straightforward.

In this paper, we argue that survey data may represent a valuable source of information about local amenities, in particular local public services for which good output measures are not available. The last years have brought a large number of studies by economists based on surveys in which respondents express how satisfied they are with

various aspects of life, including their job, their health, their marriage, housing conditions, the environment and their financial situation.² This paper adds to the small literature that uses survey data to characterize how attractive locations are to households. We use responses to questions about local amenities to compute proxy variables for the quality of local public services and other local amenities relevant to location decisions, such as recreation opportunities and safety.

For each of ten local amenities and each of the Norwegian municipalities included in our study, we compute average satisfaction reported by respondents residing in the municipality. The raw averages are adjusted for sample variation between municipalities in personal characteristics that may affect a respondent's propensity to form favourable judgements and included as explanatory variables in a cross-section study of house prices. Our results suggest that the attractiveness of a residential site is affected by the quality of local public services: house prices are increasing in satisfaction with cultural activities, health care, care for the elderly and public transportation. Our contribution improves on earlier Tiebout studies based on survey data in several respects: the analysis is based on a larger number of observations, we have data about several services not covered by earlier studies, we have more information about local job opportunities, and we control for several sources of measurement error in the variables computed from survey data.

To assess the potential contribution of survey data to studies of capitalization of local amenities, we have computed a set of variables

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¹ See Charney (1993) for a review of the early literature. Carlsen (2005) summarizes the main results from more recent contributions.

² Van Praag and Ferrer-i-Carbonell (2004) discuss the methodological foundations of satisfaction analyses.

similar to amenity variables used in earlier studies. Input measures are computed if data on output do not exist. The model with variables computed from survey data fits the data better than the model with input variables, but neither group of variables can be excluded from a general model with all explanatory variables of the two models, suggesting that researchers may benefit from using a mixture of survey variables and traditional amenity variables.

The rest of the paper is organized as follows. The next section presents a brief review of the literature, which also serves to motivate our analysis. A brief presentation of the local sector in Norway is included in Section 3. Section 4 describes our empirical strategy in more detail. The data set is presented in Section 5. Results are presented in Section 6, and Section 7 reports several robustness checks. In Section 8, we repeat the main analysis using a new set of amenity variables. Section 9 contains concluding remarks.

2. Literature review and motivation of paper

Empirical Tiebout studies need data that characterize how attractive local amenities are to households. Proxies for amenity levels are available for most amenities. For instance, the overall crime rate and the violent crime rate are used to characterize safety,³ proficiency test results, test scores adjusted for family background and value added measures are used as proxies for school quality,⁴ and temperature, precipitation, air quality and distance from an environmental hazard are used as proxies for environmental quality.⁵

For some local public services, direct measures of output are not readily available, and input measures are used to characterize service levels. For instance, the number of doctors and hospital beds per capita are used as proxies for the quality of health care services, and spending per user is used to characterize the quality of day care and care for the elderly.⁶

As the quality of local public services is a function of inputs, needs and production technology, input measures should be supplemented with information about those who benefit from the services and environmental factors that affect the production process. However, virtually all studies lack data about users and environmental factors. This may explain why the literature has not produced unambiguous conclusions about the effects of input measures on mobility and local house prices/wages.⁷ Moreover, interpretation of results is not straightforward as the authors are testing two hypotheses jointly: that location decisions are sensitive to the level and/or mix of local public services and that inputs are appropriate proxies for service levels. Insignificant effects of inputs may reflect that services are not important for location decisions, but also that the input measures used by the authors are not good proxies for service levels.

Survey data represent a largely untapped source of information about local amenities. Entry and exit decisions of households depend on their assessments of living conditions in the resident communities and potential destination communities. Surveys provide direct information about these assessments.

We would expect survey data to be particularly valuable when input measures are used to characterize service levels due to lack of output data. Whereas input measures should be supplemented with

data about users and the production technology, variables computed from survey data do not require this additional information; respondents consider whether the volume and quality of inputs are sufficient given needs and the production technology when asked to evaluate local public services.

To our knowledge, Linneman (1980) and Arguea and Hsiao (2000) are the only studies that use survey data to characterize local amenities. Both studies use data from the Annual Housing Survey. Arguea and Hsiao (2000) compute a latent measure of neighbourhood quality from responses to questions about crime and other neighbourhood characteristics. The authors find a positive and significant effect of neighbourhood quality on house prices. Linneman (1980) includes responses to questions about crime, school quality, traffic conditions and various sources of pollution as explanatory variables in analyses of house prices and rents. The author finds negative effects of odour, litter and bad traffic conditions, no effect of crime and no or negative effects of good schools.

In this paper, we use survey data from Norway to characterize local public services and other local amenities. We take advantage of a large nationwide survey conducted by TNS Gallup in which respondents evaluate a range of local amenities, including most local public services. For each amenity and municipality, we compute average satisfaction reported by the respondents residing in the municipality and include these variables as regressors in an analysis of house prices.

Our analysis improves on the studies that use the Annual Housing Survey (AHS) in several respects. First, since we have access to a data base that covers most house transactions in Norway, our analysis is based on a larger number of observations. Second, the TNS Gallup survey has questions about several services that are not covered by the AHS, including health care, care for the elderly, day care and cultural activities. Third, whereas the AHS does not have information about local job opportunities, we include variables that describe travel time to the centre of the travel-to-work area. Fourth, since the propensity to make favourable judgements depends on personality traits, unobserved variation in personality traits may cause measurement error in the level of satisfaction reported by respondents. The studies that use the AHS do not include controls for personality traits. We adjust average reported satisfaction for variation in personal attributes of respondents (age, gender and education level) and use responses to a question about an amenity that do not vary between municipalities to compute a proxy for unobservable personality traits. We also use information about past moves to assess whether responses are affected by cognitive dissonance.

During the last years, economists have used subjective measures of well-being, such as reported satisfaction with life or domains of life, to examine a wide range of issues, including the monetary valuation of unemployment, bad health, terrorism, direct democracy, becoming widowed or divorced and becoming a crime victim,⁸ the weights of inflation and unemployment in society's welfare function,⁹ the effects of job attributes including safety and racial harassment on job turnover,¹⁰ the impact of local labour market conditions on wage formation and interregional migration¹¹ and the impact of school dissatisfaction on risky behaviour of adolescents.¹² These and other contributions have shown that responses to questions about well-being are not random numbers but correlated with objective events and actions. The present paper adds to this literature by showing that house prices depend on subjective assessments of local amenities.

³ Blomquist et al. (1988), Voith (1991), Clark and Hunter (1992), Brasington and Haurin (2006).

⁴ Black (1999), Gibbons and Machin (2003), Figlio and Lucas (2004), Kåne et al. (2006), Brasington and Haurin (2006), Clapp et al. (2008).

⁵ Stover and Leven (1992), Herzog and Schlottmann (1993), Brasington and Hite (2005).

⁶ Porell (1982), Gyourko and Tracy (1989, 1991), Day (1992), Dahlberg and Fredriksson (2001), Berger et al. (2008).

⁷ For instance, Gyourko and Tracy (1989) and Day (1992) find that locations become more attractive when there is an increase in the number of hospital beds or in hospital spending per capita, whereas Porell (1982) finds no effect of health care on household mobility.

⁸ Winkelmann and Winkelmann (1998), Frey and Stutzer (2000), Clark and Oswald (2002), Frey et al. (2004), Powdthavee (2005).

⁹ Di Tella et al. (2001).

¹⁰ Clark (2001), Shields and Wheatley Price (2002), Kristensen and Westergård-Nielsen (2004).

¹¹ Carlsen and Johansen (2004, 2005).

¹² Lévy-Garboua et al. (2006).

3. The local sector in Norway

Local government plays an important role in providing public services in Norway. About two-thirds of all government employees work in the local sector, of which the majority are employed by the municipalities. The main services provided by the municipalities are: day care, schools, cultural services, primary health care, care for the elderly, public transportation and infrastructure (water supply, garbage collection and sewage). The municipalities have considerable discretion to determine the spending mix between services; schools are an exception as the allocation of resources to schools as well as how resources are spent by the schools are heavily regulated by central government. The TNS Gallup survey data set includes questions about all services provided by the municipalities with the exception of infrastructure.

The financing system is quite centralized. The main revenue sources of the municipalities are state grants, income and wealth taxes and infrastructure fees. In principle, the municipalities can choose income and wealth tax rates within an interval, but since the late 70s, all municipalities have used the maximum rates. Income and wealth taxes are therefore in practice shared taxes, leaving infrastructure fees the main revenue source for which municipalities have discretion.

4. Empirical strategy

House prices in a municipality depend on local amenities, including local public services, and the labour market opportunities within commuting distance. Local labour market conditions in turn depend on labour supply and therefore on the factors which affect household location decisions, including house prices and amenities. Following the seminal contribution by Roback (1982), most empirical studies of capitalization handle the two-way causality between amenities and job opportunities by estimating two equations explaining house prices and wages as functions of amenities. The value of an amenity is imputed from the estimated coefficients of the amenity in both equations.

The Roback approach rests on the assumption that the local wage rate is the only relevant attribute of local labour markets to potential movers. However, in practice there are several other job and community attributes which may affect households' evaluations of the local job market, including non-financial job attributes, future career opportunities, the risk of job loss and the prospects of getting a new job in case of unemployment. If one or more of these attributes affect workers' reservation wages and are correlated with the quality of local amenities, the Roback approach may produce biased estimates of amenity values.

In this paper, we use an alternative empirical strategy which takes into account that local labour market opportunities may depend on unobservable job and community attributes. Our methodological innovation is to identify the value of amenities from variation in house prices between municipalities where residents face roughly similar job prospects. The following simple model serves to illustrate our approach. We consider a travel-to-work area consisting of a centre and surrounding municipalities. All jobs are located at the centre, and all households live in the municipalities. Consider a representative household whose utility function is separable in disposable income and a local amenity:

$$U(w_i, a_i) = u(\hat{w} - \delta t_i - r_i) + v(a_i), u' > 0, v' > 0,$$

where \hat{w} is the wage rate offered by firms at the centre (suitably adjusted for non-financial job attributes and the risk of unemployment), t_i is commuting time from municipality i to the centre, δ is the cost per unit time of commuting, r_i is the cost of housing in

municipality i , and a_i is the amenity level in municipality i . When households are free to move, utility is equalized across municipalities:

$$u(\hat{w} - \delta t_i - r_i) + v(a_i) = \text{constant}.$$

It follows from this equilibrium condition that, within the travel-to-work area, the cost of housing is decreasing in commuting time and increasing in the amenity level: $\partial r_i / \partial t_i < 0$, $\partial r_i / \partial a_i > 0$. The value of local amenities can be identified by examining how the cost of housing varies between municipalities within travel-to-work areas as a function of commuting time to the centre and amenity levels. We implement the model by estimating a house price equation with amenity variables, fixed effects for each travel-to-work area and controls for commuting time and house characteristics as explanatory variables.

A potential problem of our approach is that some municipalities may have commuting to more than one travel-to-work area or to several municipalities within a travel-to-work area. For these municipalities, travel-to-work fixed effects and commuting time to the centre are insufficient controls for the job prospects of the municipality's residents. We expect this problem to be most important for municipalities situated at the border between travel-to-work areas. Our remedy is to include in the sample only municipalities for which commuting is towards the centre of the travel-to-work area.

5. Data description

5.1. Travel-to-work areas

To construct travel-to-work areas, we use data collected by Statistics Norway about commuting between each pair of municipalities in the year 2000. We first identify potential centre municipalities. These are municipalities that have more inhabitants than their neighbours and receive a positive net inflow of commuters. We then add municipalities that satisfy two criteria: i) at least 5% of the work force commutes to the centre municipality or to municipalities closer to the centre than the municipality itself, and ii) less than 3% of the work force commutes to municipalities outside the travel-to-work area or to municipalities located further away from the centre. This procedure produces 50 travel-to-work areas, denoted regions, with 205 out of Norway's 435 municipalities. The other 230 municipalities either have few commuters or belong to regions with more than one commuting centre.

The capital, Oslo, is not included in our sample as the municipalities of the Oslo region do not meet our two criteria due to the existence of several travel-to-work centers within the region. The sample includes the labour market regions of the three largest cities outside Oslo: Bergen, Trondheim and Stavanger.

From the Norwegian national transport model, developed by the Institute of Transport Economics, we have obtained data for 1997/98 about average travel time by car and/or ferry from the municipality centre to the centre of the region's centre municipality (Hamre et al., 2001). We do not know the travel time from the different parts of the centre municipality or from outside the centre of other municipalities. In the following, we assume that the commuting time of all inhabitants of a municipality is equal to the travel time from the municipality centre to the centre of the centre municipality. The travel time is assumed to be 20 min or less for all inhabitants in the centre municipality.¹³

5.2. House transactions

Since owner-occupied houses comprise 77% of all houses in Norway (Stm 23 (2003–2004)) and micro data on rents are scarce, we consider house transactions. The house transaction data base of

¹³ Travel time ≤ 20 min is our reference category in the empirical analysis.

Statistics Norway contains information about every house transaction in Norway with the exception of transactions administered by the housing co-operatives. To increase the number of observations in small municipalities, we pool data for three years, 1996–1998. During this period, 44,232 transactions were registered in the 205 municipalities considered in this study. Information about one or more house characteristics is missing for 2869 transactions. We have omitted 94 transactions for which the house size is reported to be below 5 m², leaving a total sample of 41,269 observations. The data base contains information about house type (villa, flat, etc), house size, age, whether the house has a carport and the number of bathrooms and water closets. Unfortunately, we do not have data about lot size. The data base does not identify the location of the house within the municipality, but there is information about travel distance in kilometers to the municipality centre.

5.3. Satisfaction with local amenities

Amenity variables at the municipal level, denoted satisfaction variables, are computed from three waves (1996–1998) of a survey conducted by TNS Gallup. Each year, a random sample of 25,000–50,000 persons received a questionnaire with questions about their resident municipality. Respondents were asked to rank various local amenities on a scale from 1 (very dissatisfied) to 6 (very satisfied). About 50% returned the questionnaire. Pooling data from three waves produces 29,612 respondents residing in the 205 municipalities considered in our study. 1618 respondents did not provide information about personal characteristics, leaving a total sample of 28,094.

Table 1 presents the questions we use to compute satisfaction variables. Seven of the questions cover the main services provided by Norwegian municipalities except infrastructure. The questionnaire has two questions about local schools, one about primary education (1st to 7th grade) and one about lower secondary education (8th to 10th grade). We use the average of the responses to the two questions to compute our school variable. There are also questions about outdoor recreation, shopping opportunities, safety and living conditions for children and youth. The response rate varies between 96.6% (recreation) and 49.6% (lower secondary education). Respondents are

Table 1
Description of questions used to compute satisfaction variables.

Variable	Question	Mean (st. dev)	Respondents
<i>Municipal services</i>			
Day care	The supply of day care services	3.96 (1.33)	19,967
Schools	Primary education	4.36 (1.10)	15,844
	Lower secondary education	3.97 (1.11)	13,927
Culture	The supply of cultural services in the municipality	4.04 (1.16)	24,812
Health care	The supply of primary physician services in the municipality	3.78 (1.41)	26,200
Care for the elderly	The supply of care for the elderly in the municipality	3.46 (1.36)	23,269
Transport	Public transportation services within the municipality	3.58 (1.52)	25,718
<i>Other amenities</i>			
Recreation	The opportunities for outdoor recreation in the municipality and the surroundings	5.49 (0.86)	27,148
Shopping	The variety of shops and goods	4.81 (1.29)	26,862
Safety	Safety in your living area	5.26 (1.00)	27,017
Children	Living conditions for children and youth	4.43 (1.09)	24,734

most satisfied with recreation opportunities and safety, and least satisfied with care for the elderly and public transportation.

A natural choice of satisfaction variable is average satisfaction reported by the respondents in the municipality. However, we find that the propensity to report a high level of satisfaction is systematically related to personal characteristics. For instance, young and highly educated people are generally less satisfied than elderly people with little education. To control for variation between municipalities in the composition of respondents, we compute municipal satisfaction variables from OLS regressions explaining reported satisfaction as a function of personal characteristics (dummy variables for age, gender and education level) and dummy variables for each municipality. The coefficients of the municipal dummy variables can be interpreted as municipal averages adjusted for sample variation in personal characteristics.¹⁴

5.4. Infrastructure fees

Since municipal income and wealth tax rates are the same in all municipalities, infrastructure fees represent the main source of variation in local taxes and fees paid by residents. We include annual infrastructure fees paid by the owner of a standardized apartment as explanatory variable. We expect house prices to be decreasing in the fee level for a given level of municipal services. However, since the Gallup survey does not include questions about infrastructure, and infrastructure is wholly or partly financed by user fees, the impact of infrastructure fees on house prices is ambiguous in our empirical framework.

6. Results¹⁵

The Bera–McAleer test rejects the linear functional form in favour of the log-linear model, and the log-linear specification performs better than the log-log specification in terms of adjusted R². We therefore estimate the following regression for our sample of house transactions:

$$\log(\text{Price}_{jirt}) = \alpha_r + \alpha_t + \text{House characteristics}_{jirt}\alpha_1 + \text{Travel time}_{jr}\alpha_2 + \text{Satisfaction}_{ir}\alpha_3 + \alpha_4 \text{Infrastructure fees}_{ir} + \text{Municipality size}_{ir}\alpha_5 + \epsilon_{jirt}$$

where Price_{jirt} is the sale price of house j in municipality i, region r and year t, α_r are regional effects, α_t are year effects, House characteristics_{jirt} is a vector of house characteristics, Travel time_{jr} is a set of dummy variables describing the travel time from the centre of municipality j to the centre of region r and Satisfaction_{ir} is the vector of satisfaction variables. Infrastructure fees_{ir} is annual infrastructure fees paid by the owner of a standardized apartment. Municipality size_{ir} is a vector of dummy variables for population size included to control for unobserved amenities related to the size of the municipality as well as interregional variation in job opportunities not handled by the commuting time variables. ε_{jirt} is the error term.

In preliminary analyses, we have included linear and quadratic terms of the satisfaction variables. With one exception, average satisfaction with safety, the coefficients of the quadratic terms were insignificant. The coefficient of the square of average satisfaction with safety was negative and significant, and we therefore enter the quadratic term of this variable in the reported specification.

The two first columns of Table 2 present summary statistics for the explanatory variables. The two last columns present the estimated coefficients and standard errors corrected for clustering of residuals at the municipal level.

¹⁴ Di Tella, MacCulloch and Oswald (2001) use this technique to compute a measure of life satisfaction in a particular country and year from individual survey data.

¹⁵ Readers that would like to replicate the analysis may contact the corresponding author.

Table 2
Regression analysis.

	Mean	St. dev	Coefficient	St. error
<i>Satisfaction variables</i>				
Day care	4.44	0.59	0.014	0.024
Schools	4.48	0.38	−0.050	0.032
Culture	3.80	0.42	0.063*	0.027
Health care	3.77	0.73	0.045**	0.015
Care for the elderly	3.92	0.64	0.039*	0.020
Transport	3.03	0.59	0.051*	0.022
Recreation	5.58	0.22	0.060	0.048
Shopping	4.08	0.78	0.022	0.015
Safety ^a	5.52	0.23	3.749**	1.376
(Safety) ²			−0.318**	0.119
Children	4.72	0.34	−0.069	0.048
<i>Local government revenues</i>				
Infrastructure fees (10 ⁴ NOK)	0.54	0.15	0.057	0.070
<i>Travel time to regional centre</i>				
<20 min	Reference category			
20–30 min	0.088		−0.095**	0.023
30–45 min	0.058		−0.119**	0.027
45–60 min	0.026		−0.185**	0.031
60–90 min	0.021		−0.293**	0.036
90–120 min	0.013		−0.274**	0.043
>120 min	0.006		−0.504**	0.067
<i>Distance to municipality centre</i>				
<3 km	Reference category			
3–8 km	0.142		−0.085**	0.011
>8 km	0.051		−0.242**	0.020
<i>House characteristics</i>				
Age of house	33.1	33.2	−0.004**	0.0008
(Age of house) ² /100	22.0	54.7	0.001**	0.0003
Size of house (m ²)	149.6	70.5	0.004**	0.0003
(Size of house) ² /1000	27.4	33.3	−0.005**	0.0005
Carport	0.568		0.071**	0.015
0–1 bathroom	Reference category			
2 bathrooms	0.327		0.083**	0.031
>2 bathrooms	0.027		0.097**	0.022
0–1 water closet	Reference category			
2 water closets	0.438		0.159**	0.026
>2 water closets	0.106		0.200**	0.014
<i>Municipality population</i>				
<1000	Reference category			
1–5000	0.060		0.322**	0.079
5–10,000	0.089		0.326**	0.081
10–50,000	0.434		0.389**	0.087
50–100,000	0.112		0.489**	0.098
100–150,000	0.201		0.596**	0.099
>150,000	0.104		0.490**	0.101

**Statistically significant at 0.01. *Statistically significant at 0.05. Fixed effects for region, year and house type (villa, terrace house, flat, etc) are included. Number of house transactions: 41,269. $R^2 = 0.5496$. Standard errors are adjusted for clustering at the municipal level. Mean and standard deviation of satisfaction variables are at the municipal level (205 data points).

Dependent variable: $\log(\text{house price})$ (Mean house price = 8.78×10^5 NOK, St. dev of house price = 4.17×10^5 NOK).

^a Semi-elasticity at mean: 0.238.

6.1. Satisfaction variables

Eight amenities have positive coefficients of which two coefficients are significant at the 1% level and three are significant at the 5% level. Two of the amenities have negative and insignificant coefficients. Four local public services have significant and positive effects on house prices: cultural services, health care, care for the elderly and public transportation. Satisfaction with safety has a positive and non-linear effect on house prices. The quantitative effects of the four local public services that have significant and positive coefficients are of the same magnitude: an increase of one unit raises the price of a house by 4–7%, implying elasticities at mean in the interval 0.15–0.3. The

quantitative effect of satisfaction with safety is somewhat stronger; the semi-elasticity at mean is 0.24. For each of the four local public services, the difference between the municipalities in our sample with the highest and the lowest levels of satisfaction corresponds to house price differentials of 15–18%. By comparison, an increase in the commuting time from 20 min or less to 45–60 min lowers house prices by 19%.

6.2. Other covariates

The estimated effects of the other covariates are consistent with expectations. The sale price is decreasing in travel time from the municipality centre to the regional centre and decreasing in the distance from the house to the municipality centre.

The sale price is an increasing function of house size, the number of bathrooms and water closets and decreasing in the age of the house. Infrastructure fees have a positive but insignificant effect on house prices, suggesting that any negative effect of higher local taxes/fees on house prices is offset by a positive effect of better infrastructure services. Another possible explanation for the positive coefficient is that respondents take the local level of local taxes/fees into account when evaluating the quality of local public services, we will return to this hypothesis in the next section.

7. Sensitivity analysis

Table 3 presents coefficients and standard errors of the satisfaction variables and infrastructure fees for eight alternative specifications. The covariates are the same as in Table 2; the results for other covariates than the satisfaction variables are not reported in order to save space.¹⁶

7.1. Number of respondents

The first issue we consider is the number of respondents in each municipality. Average reported satisfaction is likely to be a less noisy measure of amenity levels in municipalities with many respondents than in municipalities with few respondents. In column (1), we have omitted municipalities with less than 20 respondents. Column (2) presents results for municipalities with 40 or more respondents.

Comparison with Table 2 shows that the main conclusions do not change. The coefficients of health care and care for the elderly do not change much, and the coefficients of cultural services and public transportation increase somewhat. As standard errors increase, the coefficients of health care and care for the elderly become insignificant in column (2).

7.2. Omitting the largest cities

Bergen, Trondheim and Stavanger together comprise almost one third of our sample of house transactions. To check how our conclusions are affected by the largest municipalities, we have estimated the house price equation without these three municipalities (column 3). The main conclusions are robust. The estimated effects of the local public services change very little.

7.3. Personality traits

We next consider two potential sources of simultaneity bias, personality traits and cognitive dissonance. It is well known from research by psychologists that subjective assessments depend on personality traits of the respondents, such as extroversion, neuroticism and self-esteem (Diener et al., 1999). A person who is disposed

¹⁶ Complete results are available upon requests.

Table 3
Robustness analysis.

	(1)	(2)	(3)		
Day care	0.012	0.025	0.015	0.031	0.007
Schools	−0.058	0.036	−0.077	0.047	−0.052
Culture	0.065*	0.027	0.081*	0.036	0.069**
Health care	0.045**	0.016	0.038	0.020	0.043**
Care for the elderly	0.042*	0.021	0.040	0.023	0.035
Transport	0.054*	0.022	0.080**	0.025	0.054**
Recreation	0.064	0.052	0.017	0.068	0.038
Shopping	0.020	0.016	0.039*	0.018	0.020
Safety	3.892**	1.387	3.136	1.836	3.045*
(Safety) ²	−0.330**	0.120	−0.250	0.160	−0.260*
Children	−0.070	0.050	−0.082	0.062	−0.058
Infrastructure fees	0.053	0.071	0.064	0.073	0.078
	(4)	(5)	(6)		
Day care	0.010	0.024	0.017	0.024	0.018
Schools	−0.055	0.031	−0.053	0.032	−0.037
Culture	0.050	0.026	0.057*	0.027	0.057*
Health care	0.052**	0.016	0.043**	0.015	0.041*
Care for the elderly	0.037	0.020	0.041*	0.020	0.028
Transport	0.050*	0.022	0.048*	0.021	0.053*
Recreation	0.061	0.050	0.069	0.050	0.055
Shopping	0.020	0.015	0.027	0.015	0.025
Safety	4.725**	1.213	3.394*	1.319	3.437*
(Safety) ²	−0.405**	0.106	−0.285*	0.115	−0.291*
Children	−0.048	0.046	−0.079	0.047	−0.085
Infrastructure fees	0.042	0.072	0.062	0.068	0.053
Wage rate					0.475*
Unemployment rate					−0.016
	(7)	(8)			
Day care	0.014	0.024	0.012	0.023	
Schools	−0.052	0.034	−0.051	0.032	
Culture	0.062*	0.026	0.065*	0.027	
Health care	0.045**	0.015	0.047**	0.015	
Care for the elderly	0.039*	0.020	0.040*	0.020	
Transport	0.052*	0.022	0.057**	0.022	
Recreation	0.061	0.048	0.061	0.048	
Shopping	0.023	0.017	0.021	0.015	
Safety	3.809**	1.416	3.247*	1.500	
(Safety) ²	−0.323*	0.123	−0.275*	0.130	
Children	−0.067	0.049	−0.078	0.054	
Infrastructure fees	0.059	0.070	0.065	0.070	
Spending	0.006	0.017			
Immigrants			−1.154	0.985	
Social assistance beneficiaries			−0.881	0.931	

**Statistically significant at 0.01. *Statistically significant at 0.05. Other covariates as in Table 2. Standard errors are adjusted for clustering at the municipal level.

- (1) Only municipalities with at least 20 respondents
- (2) Only municipalities with at least 40 respondents
- (3) Without the three largest cities
- (4) Satisfaction variables adjusted for personality traits
- (5) Satisfaction variables computed for non-movers
- (6) Wage rate and unemployment rate of municipality included as covariates. The wage rate is scaled by the wage rate of the capital, Oslo. Unemployment rate is in percentage points
- (7) Municipal spending per capita (in 10⁴ NOK) included as covariate
- (8) Population share of non-western immigrants in municipality and share of social assistance beneficiaries among persons aged 16 and above in municipality included as covariates.

Coefficients and standard errors of satisfaction variables and infrastructure fees.

towards making favourable judgments of amenities may also have a tendency to make favourable judgments of properties. Variation in personality traits between municipalities within a region may therefore cause spurious correlations between our satisfaction variables and house prices.

To control for variation in personality traits between respondents, we use a question in the questionnaire about local weather conditions. As weather conditions are approximately the same for all inhabitants in a region, variation within regions in reported satisfaction with the

weather provides information about the respondents' general propensity to make favourable judgments.

We estimate an OLS regression explaining reported satisfaction with the local weather as a function of personal characteristics and dummy variables for regions. Our proxy for a respondent's personality traits is the residual from this regression. A new set of satisfaction variables is computed from regressions explaining reported satisfaction with the amenities as a function of the weather residual, controls for age, gender and education level and municipal dummy variables. The coefficients of the municipal dummy variables can be interpreted as average satisfaction adjusted for observable personal characteristics and personality traits. The regressions confirm that personality traits indeed matter for evaluations of amenities: the coefficient of the residual is positive (in the range 0.15–0.20) and very significant (*t*-values ~ 30) for all amenities.

In column (4), the new satisfaction variables are included as explanatory variables. As is evident from a comparison between Table 2 and column (4) of Table 3, adjusting the satisfaction variables for personality traits has limited impact on the estimated effects of amenities on house prices. The coefficient of health care increases slightly, whereas the coefficients of culture and care for the elderly decrease somewhat.

7.4. Cognitive dissonance

The second source of simultaneity bias is cognitive dissonance.¹⁷ Persons like to view themselves as having made correct decisions. Suppose movers attempt to legitimize their location choice by forming positive judgments about the destination municipality and negative judgments about the origin municipality. Then inhabitants of municipalities with a large share of in-migrants *ceteris paribus* will tend to have a positive view of their municipality whereas the opposite will be the case for municipalities with a large share of inhabitants who plan to exit the municipality. Since migration affects the demand for housing, cognitive dissonance may create a spurious correlation between house prices and the respondents' evaluations of their resident municipality.

To explore the practical relevance of this bias, we use information from the survey about when respondents moved to the resident municipality. We would expect cognitive dissonance to be most important for recent movers, both because the probability of out-migration depends on the number of years a respondent has lived in the municipality and because incorrect beliefs about the resident municipality are likely to be adjusted over time. In column (5) we have included satisfaction variables computed from the subsample of respondents who reported to have lived in the municipality for five years or longer. Comparison with Table 2 shows that the estimated effects of amenities are not much affected.

7.5. Municipal labour markets

In column (6) of Table 3, we have included two labour market variables computed at the municipal level, the wage rate and the unemployment rate.¹⁸ The positive effect of wages and the negative effect of unemployment suggest that house prices are affected by labour market conditions in the municipality in addition to commuting time to the regional centre. With the exception of care for the elderly, the estimated effects of the satisfaction variables are not much affected when municipal wage and unemployment variables are included. The coefficient of care for the elderly decreases and becomes insignificant.

¹⁷ Akerlof and Dickens (1982) is the pioneering application of cognitive dissonance in economics.

¹⁸ The wage and unemployment variables are computed from register data provided by Statistics Norway about all employees aged 20–50. Details about our procedure are available upon request.

Table 4
Correlations between satisfaction variables and other amenity variables.

Other amenity variables	Satisfaction variables					
	Day care	Schools	Culture	Health care	Care for the elderly	Safety
Man-years in day care/population aged 0–6	0.494**					
Adjusted test score		0.206**				
Spending on culture/population			0.133			
Physician man-years/population				0.229**		
Man-years in care for the elderly/population aged 67+					0.400**	
Reported crimes/population						–0.580**

All variables are the municipal level (205 data points). **Statistically significant at 0.01. *Statistically significant at 0.05.

Table 5
Regression analysis with other amenity variables.

	Mean	St. dev	Coefficient	St. error
Man-years in day care/population aged 0–6	0.102	0.028	0.764	0.545
Adjusted test score	3.510	0.187	0.013	0.060
Spending on culture/population (in 10 ³ NOK)	0.154	0.063	0.397	0.241
Physician man-years/population*10 ³	0.920	0.335	–0.061	0.064
Man-years in care for the elderly/population aged 67+	0.166	0.064	–0.111	0.142
Reported crimes/population	0.052	0.028	–0.381	0.372

**Statistically significant at 0.01. *Statistically significant at 0.05. Distance variables, house characteristics and fixed effects for municipal size, region, year and house type as in Table 2. Mean and St. dev are at the municipal level. Number of observations: 41,186. $R^2 = 0.5463$. Standard errors are adjusted for clustering at the municipal level.

7.6. Municipal revenues and spending

Suppose respondents answer the questions about local public services by evaluating how satisfied they are with the quality of local public services, given the local tax level and/or the local spending level, i.e. they evaluate how effective municipal authorities are in transforming the local tax burden and/or budget into services. If this is the case, survey responses will underestimate the true quality of local public services in municipalities with high local taxes/spending, and local taxes/spending may be positively correlated with house prices for a given level of reported satisfaction with local public services.

Infrastructure fees, which are the main source of variation in the local tax burden, are included in our regressions, and the estimated effect is always positive and insignificant. In column (7) we have also included municipal spending per capita. As for infrastructure fees, the coefficient is positive and insignificant. Comparison with Table 2 shows that the coefficients of the satisfaction variables are hardly affected. Hence, there is some evidence that survey responses depend on the tax burden and the spending level, but the effects are insignificant and do not affect our conclusions.

7.7. Neighbourhood composition

If the socio-economic composition of the neighbourhood has a direct effect on house prices, in addition to any indirect effects on local amenities, and socio-economic composition is correlated with local amenities across municipalities, our satisfaction variables may pick up omitted effects of variation in socio-economic composition between municipalities. In column (8), we have included two measures of socio-economic composition, the population share of non-western immigrants, and the share of adults that receive social assistance benefits. Both variables have, as could be expected, negative effects on house prices, but the effects are insignificant, and the coefficients and standard errors of the satisfaction variables are not much affected.

8. Comparison with other amenity variables

In this section, we compare the performance of our satisfaction variables with the performance of a set of variables similar to amenity variables used in earlier Tiebout studies. To characterize school quality, we compute a measure of student performance adjusted for variation in family background. We take advantage of a national database with

information about examination results and family characteristics of students in the final year of lower secondary education.¹⁹ A regression is estimated explaining the exam result as a function of student and family characteristics, dummy variables for each subject and municipal dummy variables. The coefficient of a municipal dummy variable can be interpreted as the average test score of the municipality's students adjusted for variation between municipalities in student and family characteristics and the student shares of the subjects.

For the other local public services, input measures are computed as output measures are not available.²⁰ For three of the services – day care, health care and care for the elderly – we are able to compute labour input per user. For cultural activities, we use per capita municipal spending on cultural activities rather than municipal labour input as amenity variable because many municipalities subsidize private cultural activities.²¹ To characterize public safety, we use the overall crime rate; our conclusions are not affected if the violent and property crime rates are included as separate amenity variables. All variables are registered in 1997 except our measure of school quality which is based on data for 2001/2002 and 2002/2003 as information about examination results for earlier years is not available.

Table 4 presents correlations between the satisfaction variables and the new amenity variables. The input measures are positively correlated with the satisfaction variables, but not all correlations are large, suggesting that input measures are not necessarily good proxies for service quality. The crime rate is as expected strongly negatively correlated with satisfaction with safety.

Table 5 presents regression results for a specification where the new amenity variables are included instead of the satisfaction variables whereas the other explanatory variables are as in Table 2. For four local amenities – cultural activities, health care, care for the elderly and safety – the coefficients of the new amenity variables are insignificant, whereas the effects of the corresponding satisfaction

¹⁹ National exams are arranged in several subjects, but each student is only examined in one subject. The database has information about approximately 100,000 10th-graders (98% of the students) in the academic years 2001/2002 and 2002/2003. Borge and Naper (2006) provide more details about the data set.

²⁰ For public transportation, information about labour input or spending at the municipal level is not available.

²¹ For day care and care for the elderly, we assume that the number of users is proportional to, respectively, the number of children aged 0–6 and the population aged 67 years and older. For health care and cultural services, we assume that the number of users is proportional to the population.

variables reported in Table 2 are positive and significant. For day care and schools, the coefficients of the satisfaction variables and the new amenity variables are all statistically insignificant.

The model with satisfaction variables reported in Table 2 performs better than the model presented in Table 5 in terms of the adjusted R^2 and Akaike information criteria. On the other hand, tests of nonnested models do not pick a clear winner. When we estimate a composite model that contains all explanatory variables of the two models, F -tests reject the null hypotheses that variables specific to one of the models can be excluded. The J -test proposed by Davidson and MacKinnon (1981) produces the same conclusion: the fitted values from one model have explanatory power in the other model. The estimated composite model has four satisfaction variables and one input variable (day care) with positive and significant coefficients. Although the model with satisfaction variables fits the data best, a prudent conclusion is that both variables computed from survey data and traditional amenity variables, including input variables, may provide useful information about local amenities. Neither group of variables should be excluded a priori from analyses of the valuation of local public services.

9. Conclusion

We find positive, significant and robust effects on house prices of average satisfaction with cultural activities, health care and public transportation, suggesting that local authorities can make their municipalities more attractive to households by improving these services. There is also a positive and significant relation between house prices and average satisfaction with care for the elderly in most specifications. In contrast, when labour input or spending per user is used to characterize the service levels of culture, health care and care for the elderly, we do not find effects on house prices. These results indicate that survey data may represent a valuable source of information about the quality of local public services. Although the model with satisfaction variables fits the data better than the model with input variables, neither group of variables can be excluded from the composite model, suggesting that researchers may benefit from using a mixture of traditional amenity variables and variables computed from survey data.

Somewhat surprisingly, we do not find significant effects of average test score or satisfaction with schools on house prices. Although consistent with results reported by Linneman (1980) based on the AHS, these results are inconsistent with most international studies of housing values and school performance. One possible explanation is that Norwegian municipalities have limited discretion over the allocation of resources to schools as well as how resources are spent due to central government regulations. It is also possible that the quality of schools is more difficult to observe for the general public than the quality of other municipal services.

The positive effect of average satisfaction with safety on house prices is consistent with results reported by Arguea and Hsiao (2000) but inconsistent with the findings of Linneman (1980). We find no effect of the crime rate on house prices; a possible explanation is that the crime rate is an imperfect measure of victimization risk because the number of reported crimes is not proportional to the number of victimizations.

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