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# The relationship between firm mobility and tax level: Empirical evidence of fiscal competition between local governments

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## Abstract

The mobility of the tax base may influence fiscal outcomes. The many theoretical contributions about the role of mobility are not matched by empirical evidence. Existing studies address strategic interaction between governments, but have little to say about mobility. We introduce a new measure of mobility conditions based on the geographic profit variability of industrial sectors. The econometric analysis shows a systematic negative relationship between mobility conditions and tax level among municipalities in Norway. The analysis takes into account neighborhood effects in a spatial model, and the endogeneity of mobility conditions is handled with instrumental variables.

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## 1. Introduction

The intensity of fiscal competition may vary with tax base mobility and thereby affect the fiscal decisions of governments. The main contribution of this analysis is to introduce an explicit measure of mobility and test whether this influences the behavior of local governments. The focus is set on the mobility of firms, a key concern of local politicians. The approach assumes that mobility of firms varies with industrial structure. Local governments with industries dominated by resource based production experience less firm mobility than local governments dominated by ‘footloose’ industries. The empirical question is whether this affects fiscal decisions, in particular the tax level.

The role of mobility is a core issue of local public finance, and the key reference is Tiebout [24] showing the conditions for efficient provision of local public goods. Fischel [12] extends this model of household mobility to explicit handling of competition for mobile firms in a setting where firms benefit from public services such as infrastructure. Efficient allocation of local public goods and firms is achieved when the tax rate reflects the costs of providing public services to the marginal firm. The obvious concern with this literature is that tax systems are not generally in accordance with such marginal cost pricing. The literature soon moved to inefficient tax setting and consequent disadvantage of tax competition described by Oates [18] and formalized by Wilson [25] and Zodrow and Mieszkowski [27]. Tax base mobility implies equilibrium with underprovision of services and too low taxes because of fiscal externalities. Brennan and Buchanan [4] leave the assumption of benevolent government and reach the more optimistic conclusion that tax competition can reduce excessive ‘Leviathan’ government. Whatever assumption made about government behavior, the main implication is that tax competition reduces the size of government. The recent theoretical literature deals with political economy aspects and market imperfections whereby tax competition may lead to higher taxes.

Wilson and Wildasin [26] note ‘the difficulty empirical work has encountered in identifying a relation between tax competition and the size of government.’ Their narrow definition of tax competition is that each government’s tax settings influence the allocation of a mobile tax base among governments. The governments consequently compete over firms, capital, workers, shoppers or else. The definition puts the attention to the mobility of the tax base, but interestingly the empirical literature generally has not applied direct measures of tax base mobility. Most empirical analyses of tax competition test for strategic interaction between local governments, that is, whether decisions by one local government are affected by decisions of others. The empirical evidence on fiscal competition and strategic interaction indicates that government decisions are not taken in isolation. But the estimation results are not easily interpreted in terms of mobility. The studies imply that fiscal decisions are affected by other governments, but mobility is not the only factor of potential importance for such interaction, which also may follow from yardstick competition, fiscal externalities, and common shocks. Empirical studies in this tradition of particular relevance to firm mobility are Brueckner and Saavedra [6] on property taxation in the US, Hayashi and Boadway [13] on business taxation in Canadian provinces, and Buettner [8] on business taxation in Germany. An overview of empirical studies is given in Brueckner [7]. Studies of tax competition between national governments have addressed differences in openness to trade in factors and goods. They have investigated relationships

between tax level and structure and broad measures of trade regimes and capital market regulations, notably Bretschger and Hettich [5], Quinn [20], and Slemrod [22].

We suggest a new approach with an explicit analysis of variation in mobility conditions between governments. We are not aware of any empirical study testing the effects of variation in mobility. Oates [19] investigates whether decentralization is important for the size of the public sector. His study is in the tradition of Brennan and Buchanan [4] implying that interjurisdictional mobility can work as a constraint on taxation. Oates' study compares centralization, when mobility is less important, with decentralization, when mobility is important. We concentrate on the horizontal differences in mobility across jurisdictions.

This study takes as a starting point the model of Devereux et al. [9] designed to understand competition between countries over corporate tax rates. They show theoretically how the mobility depends on the variation in relocation costs of industries and estimate tax reaction functions of OECD countries. We explicitly introduce variation in local mobility conditions and show that this affects the choice of tax rates in equilibrium. The hypothesis of a relationship between local mobility conditions and tax level is tested based on local government data in Norway. The basic empirical assumption is that firm mobility across municipalities differs between industries. Compared to local governments with a high share of industries with relatively immobile firms, local governments with a high share of industries with relatively mobile firms have stronger incentives to tailor fiscal decisions according to the needs of local firms. We expect firm mobility to put downward pressure on local government taxes and fees, i.e. that firm mobility is, *ceteris paribus*, negatively correlated with local taxes and fees. The financing of local governments in Norway is quite centralized with little local discretion. Fees for infrastructure services represent the main instrument of local tax discretion. We analyze the determination of the infrastructure fee level as the local tax subject to potential tax competition.

A theoretical framework explaining the role of firm mobility and taxation of firms is outlined in Section 2. Section 3 discusses our measure of firm mobility and presents the data and econometric approach. We start the empirical analysis with a reduced form demand model of local taxation extended to include local mobility conditions in Section 4. A structural model of reaction functions consistent with the theory model is estimated using spatial econometric methods in Section 5. A short summary is given in Section 6.

## **2. Theoretical framework of firm mobility and taxation of firms**

The benchmark Wilson [25] and Zodrow–Mieszkowski [27] model studies a set of small identical jurisdictions with immobile labor. A fixed number of identical firms produce output under constant return with labor and mobile capital. Identical households own fixed endowments of capital and supply labor inelastically. Total capital is available in fixed supply, but can costlessly be allocated across jurisdictions. The government purchases the output to transform it into a public good, which is financed by a tax on domestic capital ('source-based'). The representative household has preferences for private and public goods, and the government is assumed to act in accordance with the representative consumer. Raising the tax rate in one jurisdiction implies a cost in terms of capital outflow,

and this fiscal externality is the source of an inefficiently low tax rate and public goods level.

Devereux et al. [9] have modified this benchmark to include the mobility of firms in an analysis of OECD tax competition. We introduce the degree of mobility explicitly into the Devereux et al. model to derive a relationship between local mobility conditions and the local tax level. Each jurisdiction has a unit measure of capitalists with capital  $k$  and a unit measure of entrepreneur owning firms. Capital is perfectly mobile across jurisdictions and entrepreneurs are mobile at a cost. A firm produces output with a conventional production function  $f(k)$  with price normalized to 1 and with interest rate  $r$ . The firm maximizes profits

$$\pi = f(k) - rk \quad (1)$$

to reach the standard first-order condition

$$f_k(k) = r. \quad (2)$$

It follows that the demand function for capital for a firm is  $k = k(r)$ . The firm pays tax  $\tau(f(k) - rk)$  with statutory tax rate  $\tau$  and the net of tax profit maximizing profit of the entrepreneur can be written  $(1 - \tau)\pi(r)$  with  $\pi_r = -k$ .

An entrepreneur in a jurisdiction can move to another jurisdiction with a relocation cost  $c$ . The entrepreneurs differ with respect to relocation costs. Different from Devereux et al., we want to focus on the variation in mobility conditions between the tax setting authorities. To handle this heterogeneity, we assume that the relocation costs in each jurisdiction are uniformly distributed on  $[0, \bar{c}]$ . The distribution has unit density and the distribution function is  $H(c) = c/\bar{c}$ . The parameter  $\bar{c}$  reflects the mobility conditions of the jurisdiction.

With two local governments, the entrepreneur in local government 1 with cost  $\hat{c}$  is indifferent between moving to local government 2 or not when

$$\hat{c} = (1 - \tau_2)\pi(r) - (1 - \tau_1)\pi(r). \quad (3)$$

The cutoff cost  $\hat{c}$  is a function of the tax parameters of the two local governments, and a higher statutory tax rate  $\tau_1$  in local government 1 will raise the cutoff cost level as the jurisdiction is less attractive for entrepreneurs. When the production functions are common, this is the only source of differences in net profits across jurisdictions.

The local government sets the tax rate to maximize the welfare of the residents, and the government can only tax the  $1 - \hat{c}/\bar{c}$  resident entrepreneurs. The government finances a pure local public good  $g$  with these taxes, and the budget constraint can be written:

$$g_1 = \left[1 - \frac{\hat{c}}{\bar{c}}\right] \tau_1 \pi. \quad (4)$$

The objective of the local government is to maximize the welfare of agents resident in the jurisdiction (the unit capitalist and the resident entrepreneurs):

$$W_1 = rk + \gamma g_1 + \left[1 - \frac{\hat{c}}{\bar{c}}\right] [(1 - \tau_1)\pi + \gamma g_1]. \quad (5)$$

The consumption of the private good is equal to the respective agent's after-tax income, equal to  $rk$  for the capitalist and  $(1 - \tau_1)\pi$  for the entrepreneurs. In addition we assume that both types of agents have linear utility from the public good (parameter  $\gamma$ ).

Assuming that local government 1 takes the tax level in 2 as given, the first order condition for optimal taxation is

$$\left(2 - \frac{\hat{c}}{\bar{c}}\right)\left(1 - \frac{\hat{c}}{\bar{c}}\right)\gamma\pi - \left(1 - \frac{\hat{c}}{\bar{c}}\right)\pi + \frac{dW_1}{d\hat{c}} \frac{d\hat{c}}{d\tau_1} = 0. \tag{6}$$

Using the relationship between  $\hat{c}$  and  $\tau_1$  from (3) and the budget constraint (4), we have

$$\frac{dW}{d\hat{c}} = -\left[(1 - \tau_1) + \gamma\tau_1\left(3 - 2\frac{\hat{c}}{\bar{c}}\right)\right]\frac{1}{\bar{c}}\pi. \tag{7}$$

We reach the following reaction function for local government 1:

$$\left(2 - \frac{\hat{c}}{\bar{c}}\right)\left(1 - \frac{\hat{c}}{\bar{c}}\right)\gamma - \left(1 - \frac{\hat{c}}{\bar{c}}\right) - \left[(1 - \tau_1) + \gamma\tau_1\left(3 - 2\frac{\hat{c}}{\bar{c}}\right)\right]\frac{1}{\bar{c}}\pi = 0. \tag{8}$$

This is a reaction function since  $\hat{c}$  depends on  $\tau_2$  in (3). The marginal gain of increasing the tax is more public services (first term), and this must be traded off against the marginal cost represented by less consumption (second term) and less entrepreneurs (third term). In the symmetric Nash equilibrium, the tax rates of the two jurisdictions are equal and  $\hat{c} = 0$ , so that:

$$2\gamma - 1 - (1 - \tau_1)\pi\frac{1}{\bar{c}} - 3\gamma\tau_1\pi\frac{1}{\bar{c}} = 0. \tag{9}$$

The distribution function chosen makes the common tax rate  $\tau_1$  explicitly dependent on the local cost conditions  $\bar{c}$ :

$$\tau_1 = \frac{(2\gamma - 1)\bar{c} - \pi}{(3\gamma - 1)\pi}. \tag{10}$$

The condition for a tax rate between 0 and 1 (interior solution) is  $\bar{c}/(2\bar{c} - 3\pi) > \gamma > (\pi + \bar{c})/(2\bar{c})$ . The marginal benefit of public services must not be ‘too low’ or ‘too high.’ There is a positive relationship between  $\tau_1$  and  $\bar{c}$  when  $\gamma > 1/2$ . Higher relocation costs  $\bar{c}$  in a jurisdiction affect the location of entrepreneurs and therefore both tax revenues and benefits of spending, as identified in (9). When more entrepreneurs are held back in the jurisdiction, the tax rate will be increased if their benefit from public services is not too small.

The reaction functions derived are expected to have positive slope. If jurisdiction 1 reduces its tax rate, the cutoff cost  $\hat{c}$  is increased in (3) and the tax revenues of jurisdiction 2 go down. The higher the initial tax level in jurisdiction 2, the stronger is the incentive to reduce the tax rate to win back the tax base.

The original Devereux et al. [9] model derives tax reaction functions when the relocation costs are uniformly distributed and the same in both jurisdictions. We have introduced mobility conditions affecting the relocation costs explicitly in the model and reach an equilibrium where the tax rate of each jurisdiction depends on the specific mobility conditions as measured by  $\bar{c}$ . The equilibrium relationship is derived under symmetry and then with equal mobility conditions ( $\bar{c}$ ) in the jurisdictions. The main lesson from the theoretical model is that different mobility conditions may lead to different fiscal outcomes. We hypothesize that higher expected relocation costs, less mobility, lead to a higher tax level as

the marginal costs of increasing taxes are lower. In the empirical part we leave the theoretical assumption of symmetry and open up for variation in other determinants of the local tax level.

### 3. Empirical specification

The empirical analysis addresses the relationship between local mobility conditions and the local tax level. Using data for Norwegian municipalities the analysis is designed to identify the relationship between the degree of mobility of firms in the municipality and the fees for infrastructure affecting firms. The financing of local governments in Norway is centralized and dominated by grants and regulated income and wealth taxes. Fees for infrastructure services represent the main instrument of local tax discretion. The fees are regulated by central government and cannot exceed production costs of the services, but as shown below they vary significantly between local governments.

We have access to unique data about the infrastructure fee level that is standardized and therefore comparable across municipalities. Our measure of the tax level (*TAXLEVEL*) is average annual fees for sewerage paid for a standardized house in each municipality. The fees paid by firms are included in this measure and their payments are related to the standardized house unit based on their water consumption. The variable is available for the period 1996–1998 and the data are collected and arranged by Statistics Norway. Borge [1] and Borge and Rattsø [3] show how the fee level works as local tax discretion and how it varies systematically with local economic and political conditions. The analysis below extends these studies to include mobility aspects.

The infrastructure fee studied is small on average, only about 3% of local government revenue, but represents the key marginal financing of local governments. The average annual fee level per standardized house is NOK 1710, or USD 275. About 2/3 of the municipalities have fee level between NOK 1000 and 2600 (USD 160 to 400). The raw data indicate a geographic pattern of the fee level which has motivated our fiscal competition analysis.

The core idea of the paper is that local governments experience different mobility conditions because they have different industrial structures. Geographic mobility of firms depends on the specificity of capital, that is, the costs of moving factors of production. Different industries face different costs of relocation and municipalities with different industries consequently have different mobility conditions. Ederington et al. [10] analyze the geographic mobility of firms ('footloose industries') in the context of environmental regulation. They explore several determinants of geographic mobility, in particular transport costs and fixed plant costs. We suggest an alternative measure based on geographic profit-variability.

Our empirical measure of mobility is constructed in two steps. First, we study differences in geographic mobility between industrial sectors. The assumption is that industrial sectors with high profit variability across municipalities are less mobile. Such a relationship is consistent with standard theory of investment allocation, but we do not supply evidence that high-variability industries exhibit low firm mobility. For each of nine two-digit manufacturing industries and each municipality we compute an estimate of the return to capital

in 1990 (using three-digit industries generate too few observations). Estimates of the value of each type of capital (buildings, vehicles and equipment) are computed from investment data 1972–1990 for each industry and municipality using the perpetual inventory method. Return to capital is defined as value added at factor prices less wage costs divided by the total value of capital. The standard deviation of the return to capital across municipalities measures profit variability at the industry level. This first step identifies mobile and less mobile industries. The differences between industrial sectors are documented in an Appendix Table. The important sectors with high profit variability and therefore low mobility are ‘food manufacturing, beverages, tobacco,’ ‘textiles and wearing apparel’ and ‘iron, steel and ferroalloys,’ while the high mobility sectors include ‘paper, paper products’ and ‘machinery, electrical apparels, transport equipment.’ The low mobility sectors are typically more closely related to local resources.

Second, we characterize degree of mobility at the municipal level based on the composition of industries. Mobility for each municipality is described by the weighted average across industrial sectors of the standard deviation of the return to capital, with the 1990 capital shares of the industries in the municipality as weights. As we use historical data back to 1970 to estimate the capital stock, we exclude municipalities that are affected by border adjustments during the period. Given the variance of the return to capital across industries, the measure of profit variability reflects the industrial structure in the municipality. The variable *MOBILITY* applied in the econometric analysis below is signed so that high mobility represents low profit variability. Summary statistics for the mobility variable as well as variable definitions and summary statistics for the dependent variable and the other explanatory variables are presented in Table 1. Documentation of the municipal mobility variable is available from the authors. In earlier versions of the paper we have described mobility at the regional level, where regions are defined by local commuting between municipalities. The results reported below for mobility at the municipal level are basically the same as when mobility is measured at the regional level.

The main hypothesis to be tested is that municipalities with high mobility industries have lower tax levels. We start out estimating a reduced form fiscal demand model of the local tax level extended to take into account mobility. Then we estimate a structural model consistent with the theory model in Section 2 and interpreted as the equilibrium of a fiscal competition model.

The standard demand model has the following form (time subscripts suppressed):

$$\begin{aligned} \log(\text{TAXLEVEL}_i) = & \alpha_0 + \alpha_1 \log(\text{MOBILITY}_i) + \alpha_2 \log(\text{PINCOME}_i) \\ & + \alpha_3 \log(\text{GRANTS}_i) + \alpha_4 \text{CONTROL}_i + u_i \end{aligned} \quad (11)$$

where  $u_i$  is a random variable.

This reduced form is consistent with the empirical literature estimating demand functions for fiscal policy. The demand model emphasizes private income (*PINCOME*) and grants (*GRANTS*) as the main determinants of the local tax level, and typically includes control variables (*CONTROL*) affecting preferences and costs. Controls are discussed below. The demand is best interpreted as the result of a community preference function and the relevant budget constraint at the local government level.

The reduced form model is pooled for the period 1996 to 1998 including time dummies and estimated for each year for about 335 local governments (out of 435). Since firms

Table 1  
Variable definitions and summary statistics, 1005 observations

Variable	Definition	Mean (st. dev.)
<i>Dependent variables</i>		
<i>TAXLEVEL</i>	Annual fees paid for sewerage per standardized house, in 10 <sup>3</sup> NOK in 1998 prices	1.71 (0.78)
<i>Mobility variable</i>		
<i>MOBILITY</i>	The municipalities' weighted average standard deviation of return on capital in 1990 across two-digit industrial sectors, the variable is used in log form and then with negative values so that higher mobility reflects lower average standard deviation.	0.60 (0.17)
<i>Other explanatory variables</i>		
<i>GRANTS</i>	Grants and regulated tax sharing revenues per capita, in 10 <sup>3</sup> NOK in 1998 prices	20.92 (5.20)
<i>PINCOME</i>	Average private income after tax per capita, in 10 <sup>3</sup> NOK in 1998 prices	72.57 (7.94)
<i>CHILD</i>	Population share of children aged 0–6 (Percentage), January 1st	9.45 (1.27)
<i>YOUNG</i>	Population share of persons aged 7–15 (Percentage), January 1st	11.80 (1.43)
<i>OLD</i>	Population share of persons > 66 years of age (Percentage), January 1st	15.48 (3.76)
<i>TRAVEL</i>	Index of distance to the local center (based on 1995 data)	1.91 (1.78)
<i>W-LEVEL</i>	Relative wage level in the municipal sector (Percentage)	99.63 (1.48)
<i>HERF</i>	Herfindahl index, party fragmentation of local council (Percentage)	26.33 (7.09)

are assumed to respond to the local tax policy, the industrial structure is endogenous when firms sort themselves according to local fiscal conditions. Our measure of mobility is based on geographic profit variability of industries, and the endogeneity problem is reduced by the fact that changes in industrial structure takes time. We instrument the mobility variable by using industrial descriptive variables dated more than 20 years before the description of the tax level. Instrumental variables are employment shares in seven industrial sectors at the municipal level in 1970 (see Table 2).

The theoretical model of fiscal competition in Section 2 defines reaction functions of the local governments, and outside equilibrium tax setting of a local government is affected by others. The reaction function describes the tax level in municipality  $i$  as a function of the tax level of the neighbors in a spatial lag formulation. A spatial weight matrix  $w_{ij}$  defines the neighbors. According to the theory model of Section 2, the municipalities are more sensitive to changes in neighboring taxes the higher mobility they have. This is taken care of by an interaction term between the tax level of neighbors and their own mobility. The mobility conditions also are represented by a separate variable. As controls we include the standard fiscal demand variables, private income level and grants, and other variables representing local preferences and costs (see below).

The structural model estimated is:

$$\begin{aligned} \log(\text{TAXLEVEL}_i) &= \beta_0 + \beta_1 \log(\text{MOBILITY}_i) + \rho \sum_{j \neq i} w_{ij} \log(\text{TAXLEVEL}_j) \\ &+ \rho_I \sum_{j \neq i} w_{ij} \log(\text{TAXLEVEL}_j) \log(\text{MOBILITY}_i) + \beta_2 \log(\text{PINCOME}_i) \\ &+ \beta_3 \log(\text{GRANTS}_i) + \beta_4 \text{CONTROL}_i + u_i \end{aligned} \quad (12)$$

where the parameter  $\rho$  measures the direct reaction to neighboring taxes and  $\rho_I$  measures the interaction effect with mobility. The spatial weights are determined a priori, and the reported estimates are based on a definition of neighbors as municipalities with a common border. The neighborhood matrix is row-standardized, and the neighborhood variable (weights multiplied by local taxes) represents the spatially weighted average of the infrastructure fee of the neighboring municipalities. The model is estimated using an IV method suggested by Kelejian and Robinson [17], using the spatial lagged exogenous variables in each municipality as instruments for the spatial lagged variable.

Private income (*PINCOME*) is measured as ordinary income after tax per capita. The grants (*GRANTS*) consist of tax equalization grants and expenditure equalization grants and also regulated income and wealth taxes measured per capita. Other explanatory variables are selected based on recent empirical analyses of Norwegian local government behavior (see Borge and Rattsø [2]). The population shares of the main user groups of municipal services—children (*CHILD*), young people (*YOUNG*) and the elderly (*OLD*)—are included to control for demographic effects on demand, whereas population density (*TRAVEL*) and the wage level (*W-LEVEL*) are proxy variables for local cost factors. *TRAVEL* is an index that measures average travel distance to the nearest local center. *TRAVEL* is computed by the Norwegian Institute of Transport Economics from detailed information about the population pattern in each municipality and is considered the best available indicator of population density. *W-LEVEL* is computed from a large micro data set that comprises most workers in the municipal sector during the period covered by this study. Technically, *W-LEVEL* is the estimated fixed effects in annual regressions explaining municipal wages as a function of personal characteristics and municipal fixed effects. The variable is the fixed effect divided by the county average.

Positive analyses of taxation often address the role of the political structure. Influential contributions rationalize the background aggregate preference function with a probabilistic voting model, where the political system takes into account marginal effects on voting when the budget package is decided (Hettich and Winer [14]), or with an interest group model, where a kind of bargaining compromise between interest groups is reached (Inman [15]). We do not address the political decision making explicitly, but include party fragmentation of the local council as control in accordance with the existing studies of Norwegian local governments (see Kalseth and Rattsø [16]). Party fragmentation of the municipal council (*HERF*) is of interest in a multi-party system where coalition formation is difficult. Other controls such as the population size representing costs, and share of socialist representatives in the municipal council representing election outcome and thereby

the ideological preferences of the electorate, have been investigated, but are excluded below because of insignificant effects.

#### 4. Reduced form demand model of local taxation

The estimates of the benchmark demand model are reported in Table 2. As seen along the first row of OLS and IV variants, the mobility variable has a significant negative effect on the tax level. Increased mobility is associated with lower local government tax level.

A benchmark OLS model is presented in the first column, while the estimates of the IV model are reported in column two in Table 2. The elasticity of the tax level with respect

Table 2  
Effect of firm mobility on the local tax level (infrastructure fee, variable in log form), reduced form demand model

Variable	OLS	IV- estimates	IV- random effect	IV 1996	IV 1997	IV 1998
log(MOBILITY)	-0.263*** (0.075)	-0.797*** (0.128)	-1.036*** (0.136)	-0.857*** (0.140)	-0.776*** (0.139)	-0.749*** (0.137)
log(GRANTS)	-1.086*** (0.116)	-0.985*** (0.114)	-0.428*** (0.095)	-1.010*** (0.134)	-1.031*** (0.135)	-0.899*** (0.139)
log(PINCOME)	-0.502** (0.249)	-0.509* (0.278)	-0.092 (0.181)	-0.441 (0.328)	-0.406 (0.305)	-0.705** (0.299)
CHILD	-0.077*** (0.024)	-0.049* (0.027)	-0.060*** (0.017)	-0.044 (0.029)	-0.045 (0.029)	-0.057** (0.028)
YOUNG	-0.083*** (0.018)	-0.089*** (0.021)	-0.058*** (0.014)	-0.103*** (0.022)	-0.084*** (0.022)	-0.077*** (0.023)
OLD	-0.019** (0.009)	-0.016 (0.010)	-0.020** (0.009)	-0.011 (0.011)	-0.015 (0.011)	-0.023** (0.011)
TRAVEL	-0.007 (0.011)	0.008 (0.012)	-0.006 (0.014)	0.003 (0.015)	0.014 (0.015)	0.004 (0.015)
W-LEVEL	0.033** (0.014)	0.025* (0.015)	0.004 (0.009)	0.028 (0.018)	0.023 (0.016)	0.022 (0.017)
HERF	0.006* (0.004)	0.010*** (0.004)	0.009*** (0.004)	0.006* (0.004)	0.012*** (0.004)	0.010*** (0.004)
Time dummy	yes	yes	yes			
Shea's $R^2$		0.34		0.35	0.34	0.34
F-test first step		42.16***		24.99***	23.02***	23.05***
Hansen-Sargan		9.05		8.61	10.09	8.41
Observations (period)	1005 (1996–98)	1005 (1996–98)	1005 (1996–98)	336 (1996)	334 (1997)	335 (1998)

Notes. Standard errors in parentheses. Instrumental variables: employment shares for 7 industrial sectors at the municipal level, selected industries: 'agriculture,' 'fishery,' 'food manufacturing,' 'manufacture of textiles,' 'manufacture of paper and paper products, printing and publishing,' 'manufacture of basic metals' and 'construction.' Instrumental variables are registered in 1970. Cluster corrected standard errors when repeated years.

\*  $p < 0.1$ .

\*\*  $p < 0.05$ .

\*\*\*  $p < 0.01$ .

to mobility is about  $-0.8$  in the IV estimation. Higher firm mobility as measured by one standard deviation (= 16.8 percentage points) reduction in profit variability reduces the annual infrastructure fee per standardized house by NOK 375 (USD 60). The amount is small, but it should be noticed that this is the marginal effect on the tax level in a very centralized system of financing. Compared to the OLS estimate, the quantitative effect of the mobility variable is three times higher when we use instrumental variables to represent mobility. The instrumental variables in principle both correct for endogenous industrial structure and omitted variables. It is a concern that the mobility variable may represent factors unrelated to mobility. The negative OLS bias may reflect a background factor that is positively correlated with mobility and negatively correlated with local tax level. Presumably the old industrial structure used as instrument is able to sort out the differences in background mobility conditions.

The augmented Davidson–MacKinnon regression test shows a test statistic of  $F(1340) = 31.2$ , indicating that OLS is not appropriate for our model estimation. The standard Shea's  $R^2$  and  $F$ -test reported for the first step IV model confirm the importance of the instruments. As we use instrumental variables dated more than 20 years prior to our estimation period, problems of weak instruments are still of concern. If the instruments are weak, IV estimates, tests and confidence intervals are generally unreliable. The Hansen–Sargan test for overidentification reported uses the null hypothesis that the instruments are valid and the null hypothesis cannot be rejected. Stock and Yogo [23] suggest a quantitative definition of weak instruments based on relative bias or size distortion. They tabulate critical values using first-stage  $F$ -statistic to test whether the instruments are weak or not. The high  $F$ -statistic in column 2 rejects the hypothesis of weak instruments in both definitions.

As we use data from municipalities in three following years, repeated sampling may influence the results. The standard errors are cluster corrected to take into account the possible effect of repetition. To check for the dynamics of the specification, we report random effect estimates in the third column. In this alternative the effect of the mobility variable is higher compared to the ordinary IV estimates. We conclude that the mobility effect on local taxation is quite convincing in the demand framework, although the quantitative effect is dependent of specification. The last three columns in Table 2 document that the estimated effect of the firm mobility variable is reasonably stable over years. Mobility is highly significant all years, but is reduced slightly in effect over time. The statistics reported, Shea's  $R^2$ , first step  $F$ -test and the Hansen–Sargan test statistic are all consistent with the whole-period model of column two.

It is also reassuring that the effects of the control variables are stable across model specifications. The economic and political determinants of the tax level are broadly consistent with other Norwegian studies (Borge [1] and Borge and Rattsø [3]). The exogenous revenues of local governments, *GRANTS*, are the major determinant of the tax level. Higher exogenous revenue is associated with lower tax level. Demographics are also important. The interpretation of the negative coefficients of *CHILD* and *YOUNG* is that local governments with age structure biased towards children and youth have less emphasis on infrastructure. The Herfindahl index of party fragmentation is always statistically significant. Less party fragmentation is associated with higher tax level.

## 5. Reaction function of local taxation

The structural model (12) estimated is a reaction function derived from fiscal competition and extended to include mobility as shown in Section 2. The effect of neighboring taxes is dependent on the mobility conditions and consequently the two factors enter in an interaction term. Local governments are more sensitive to changes in neighboring taxes if the local firms are more mobile. We investigate alternative specifications of neighboring taxes and mobility below.

We start out with the formulation consistent with the theory model, the spatial lag enters separately and the mobility effect interacts with the spatial lag (neighboring taxes). The first column in Table 3 confirms that mobility is important and influences the neighborhood effect. The mobility effect is negative and holds the tax level down. The elasticity is about  $-0.15$  for the average neighboring tax level, significantly lower than the estimate of the fiscal demand model above. The mobility effect is stronger the higher the tax level of the neighbors. The reaction coefficient in this specification is a bit high. The direct elasticity is about 1, and the interaction effect implies that higher mobility raises the tax response to neighboring taxes, in accordance with the theory model. The reaction coefficient is about 1.1 with average mobility conditions. The reaction curves are upward sloping, implying that higher taxes in neighboring municipalities lead to higher taxes in the municipality considered. The standard Shea's  $R^2$  and  $F$ -test reported for spatial lag and interaction in the first step IV model show that the model specification is acceptable. The Hansen–Sargan test for overidentification implies that the null hypothesis of valid instruments cannot be rejected.

When mobility is entered as a separate variable, column two, mobility has a statistically significant effect on the local tax level and the elasticity of the local tax level with respect to mobility is  $-0.3$ . The reaction coefficient is 0.7, which is more in line with other studies of strategic interaction referred to in the introduction. The quantitative effect implies that a higher tax level of NOK 1000 per standard house on average for the neighbors increases the tax level in the municipality by about NOK 700 per standard house. This size of the reaction coefficient is similar to the welfare competition among Norwegian municipalities analyzed by Fiva and Rattsø [11]. Column three excludes mobility altogether, and the estimated reaction function coefficient is stable. When mobility is specified as a separate variable as well as in interaction with neighboring taxes, columns four and five using IV and OLS respectively, no statistically significant effect of mobility is found. In the IV estimation mobility, spatial lag and the interaction between the two are all instrumented. Obviously the three variables are strongly multicorrelated, and the insignificance is to be expected. The Shea's  $R^2$ ,  $F$ -tests, and Hansen–Sargan tests reported are all consistent with column one.

We notice that the neighbor-effect on the local tax level is about 0.7 and strongly significant in all model formulations (except for column one of Table 3 when mobility only enters in the interaction term). The effects of the control variables also are stable across model specifications. The effects are similar in the reduced form demand model (Table 2) and the structural model (Table 3). Grants are the major determinant of the local tax level. In the reaction function formulation the spatial lag effect reduces the size of the coefficient, but it is still highly statistically significant. Private income is borderline significant

Table 3

Effects of firm mobility on tax level (infrastructure fee, variable in log form), structural model with reaction functions

Variable	IV	IV	IV	IV	OLS
log(MOBILITY)		−0.330*** (0.122)		−0.301 (0.200)	−0.073 (0.098)
$\sum w_{ij}^*$	1.020*** (0.113)	0.705*** (0.098)	0.743*** (0.091)	0.744*** (0.206)	0.723*** (0.110)
log(TAXLEVEL <sub>j</sub> )				−0.079 (0.383)	−0.249 (0.178)
$\sum w_{ij}^*$	−0.529*** (0.235)				
log(MOBILITY)					
log(GRANTS)	−0.521*** (0.129)	−0.502*** (0.123)	−0.533*** (0.126)	−0.508*** (0.125)	−0.635*** (0.121)
log(PINCOME)	−0.403* (0.235)	−0.336 (0.230)	−0.322 (0.224)	−0.348 (0.244)	−0.396* (0.226)
CHILD	−0.015 (0.023)	−0.007 (0.022)	−0.021 (0.022)	−0.008 (0.023)	−0.028 (0.022)
YOUNG	−0.052*** (0.017)	−0.057*** (0.018)	−0.052*** (0.017)	−0.057*** (0.017)	−0.058*** (0.016)
OLD	−0.008 (0.009)	−0.007 (0.009)	−0.009 (0.009)	−0.007 (0.009)	−0.010 (0.008)
TRAVEL	0.002 (0.010)	0.006 (0.010)	−0.002 (0.010)	0.006 (0.010)	−0.001 (0.010)
W-LEVEL	0.014 (0.012)	0.014 (0.012)	0.018 (0.012)	0.013 (0.012)	0.019 (0.012)
HERF	−0.002 (0.003)	−0.0003 (0.003)	−0.003 (0.003)	−0.0003 (0.003)	−0.000 (0.003)
R <sup>2</sup> -adj.					0.50
Shea's R <sup>2</sup> :					
mobility		0.30		0.28	
spatial lag	0.48	0.39	0.43	0.30	
interaction	0.25			0.24	
F-test:					
mobility		24.67***	36.26***	24.67***	
spatial lag	28.37***	28.34***		28.37***	
interaction	9.86***			9.86***	
Hansen–Sargan	11.13	9.89	5.41	9.67	

Notes. 1004 observations. Standard errors in parentheses. Mobility and spatial lag are instrumented when included. Instruments: employment shares in seven industrial sectors registered in 1970, and neighbor variables. Cluster corrected errors.

\*  $p < 0.1$ .

\*\*  $p < 0.05$ .

\*\*\*  $p < 0.01$ .

and the effect is also somewhat smaller in magnitude. Among the demographic variables, the share of youth in the population comes out as the most important. Political effects now are insignificant.

Revelli [21] includes explicit measures for fiscal externalities between county and district levels, and find that this specification reduces the effect of the neighbor variables. To investigate the robustness of our results in this respect, we have estimated the model with 17 county dummies. This change in specification did not influence the neighborhood effects and is not reported.

## 6. Concluding remarks

The econometric analysis presented investigates the relationship between tax level and mobility conditions in local governments. We suggest an approach where the effects of mobility conditions for local government behavior are investigated directly. A data set for Norway allows the calculation of variation in mobility between municipalities based on geographic profit variability within industrial sectors and different sectoral composition between municipalities. The results confirm that firm mobility measured in this way influences local taxation. Local governments experiencing high firm mobility tend to have lower tax levels. The analysis applies instrumental variables for mobility and takes into account neighborhood effects in a spatial model.

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Appendix Table

Mobility across industrial sectors, profit variability by industrial sector

	Standard deviation	No. of local governments
Food manufacturing, beverage	0.35	261
Textiles and wearing apparel	0.28	89
Wood and wood products	0.63	230
Paper, paper products	0.99	118
Chemicals, plastic	1.05	82
Glass, mineral products	0.72	85
Iron, steel, ferroalloys	0.38	43
Machinery, electrical apparel	0.75	244
Other manufacturing	2.48	20
Total manufacturing		364

*Source:* Statistics Norway, based on municipalities with manufacturing industry 1972–1990, municipalities affected by border adjustments excluded. Capital stocks estimated by inventory method, separated between three types of investment: machinery and inventory, transport equipment, construction; depreciation rates are 0.067, 0.1 and 0.02 respectively.

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