

Testing for Vertical Fiscal Externalities*

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Abstract

The purpose of this paper is to design a test of whether the vertical external effects associated with tax base sharing among local and regional governments have become internalized via the intergovernmental transfer system. Such tests are important in the sense that the income tax rates chosen by different levels of government will generally be correlated, even if the resource allocation is optimal from society's point of view. By using panel data for the Swedish local and regional public sectors, the results imply that an increase in the regional income tax rate induces the municipalities in the region to decrease their income tax rates. In addition, we are able to reject the null hypothesis that the vertical external effects have become internalized.

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1 Introduction

The public sector is often organized in such a way, that different levels of government share one or several common tax bases. In the U.S., for instance, both the federal government and the state governments finance part of their expenditures by income taxation. Similarly, in the Nordic countries, the central government shares the income tax base with local and regional governments. It has been recognized that such 'vertical' interactions between the different levels of government may give rise to fiscal externalities. This result was brought to attention by Hansson and Stuart (1987) and Johnson (1988). The basic idea is that the local governments disregard the influence of their decisions on the central government's tax base when determining their own tax rate, which means that they tend to underestimate the marginal cost of public funds. Therefore, to reach the socially optimal resource allocation within the given fiscal structure, it is necessary for the central government to try to influence the decisions made by the local governments.

The policy options available to the central government have been addressed by several authors. The papers by Boadway and Keen (1996) and Boadway et al. (1998) are based on the assumption that the central government is acting Stackelberg leader and the local governments are acting followers. Their main result is that the central government should choose its income tax rate equal to zero and collect its revenues lump-sum from the local governments. As a consequence, all revenues from distortionary taxation will be collected by the local governments, in which case the vertical externality disappears. In contrast, Aronsson and Wikström (1999) show that taxation at both levels of government can be combined with an intergovernmental transfer scheme inducing the correct incentives. This latter result has been generalized by Aronsson and Wikström (2001) to apply in situations with more than two levels of government. In the context of commodity

taxation, Dahlby (1996) shows how to internalize a vertical externality by using Pigouvian taxation.¹

The idea behind the 'corrective' central government policy suggested by Aronsson and Wikström (2001) is to induce the lower levels of government to act as if they face the social optimization problem. To see what this may imply for the interaction between the lower levels of government, consider the Swedish economy where the central government shares the income tax base with local and regional governments. If the vertical external effect has become internalized via the intergovernmental transfer system chosen by the central government, the local governments will respond to a unit increase in the regional income tax rate by an equal reduction in their own tax rates. This is so because each local government will, in this case, behave as if its budget constraint coincides with the public resource constraint for society as a whole. If, on the other hand, the vertical externality remains uninternalized in the equilibrium, the local governments will reduce their income tax rates by less than the increase in the regional income tax rate, meaning that the effective tax rate increases. It is, therefore, possible to test for vertical fiscal externalities by quantifying the relationship between the income tax rates chosen by different levels of government. The main purpose of this paper is to design and implement a test of whether the potential external effects associated with tax base sharing have become internalized via the intergovernmental transfer system. The test is implemented by using data for the Swedish local and regional public sectors, where the regional governments (or county councils) represent a higher level of aggregation in the sense that each such region contains several localities (or municipalities).

To be able to test whether the vertical externalities have become in-

¹See also Keen (1998) for a review and some extensions of the literature on vertical fiscal externalities.

ternalized, it is necessary to control for horizontal interaction among the local governments. Horizontal interaction arises if the decisions made by one particular local government affect the utility or resources of residents in other localities. In previous studies, such interaction is often associated with mobility across localities or spillover effects of local public goods. The fiscal implications of labor mobility across regions have been addressed by e.g. Zodrow and Mieszkowski (1986) and Wildasin (1988, 1989). Wildasin (1991) suggests that the higher level jurisdiction intervenes to eliminate the externality from interjurisdictional migration. Implications of spillover effects of local public goods in the context of optimal income taxation in an economic federation are analyzed by Aronsson and Wikström (1999). In what follows, we disregard the potential spillover effects from local public goods, since these are very difficult to capture empirically, and assume that all horizontal interaction between the local governments is due to labor mobility across jurisdictions.

There are only a few previous empirical studies on vertical fiscal externalities. Besley and Rosen (1998) analyze the taxation of gasoline and cigarettes in the U.S. According to their results, there is a positive relationship between the taxes chosen by the federal government and the taxes set by the states. Goodspeed (2000a, 2000b) approaches the topic by studying the relationship between the income taxes chosen by a lower level of government and the income taxes chosen by the central government in a panel of OECD countries. To identify how the central government's income tax rate influences the local rates, Goodspeed also tries to control for horizontal external effects arguing that vertical and horizontal externalities interact. The latter is done by introducing an interaction term between the tax rate of the central government and a measure of tax base disparities. The most important result is a negative and statistically significant relationship be-

tween the income tax rates chosen by the lower levels of government and the income tax rate of the central government.

This paper contributes to the literature in at least two ways. First, we shall make a clear distinction between vertical interaction and vertical externalities. Vertical interaction arises whenever taxation at more than one level of government affects the tax base, whereas the externalities imply that all welfare effects of tax base sharing are not internalized in the decision problems of the different levels of government. To identify vertical externalities, it is by no means sufficient to regress the tax rate chosen by one level of government as a function of the rate chosen by the other, which is done by Goodspeed (2000a, 2000b). The reason is that the two tax rates will generally be correlated, even if the vertical external effects have become internalized. Second, the test is implemented using data for the Swedish local and regional public sector during the period 1981-1990, by analyzing how the income tax rate chosen by the regional government influences the local income tax rates. In comparison to previous empirical studies on vertical interaction, one advantage is that the lower levels of government in the Swedish public sector are only allowed to tax income. The tax base definition is the same for both the regional and the local governments, and the tax is proportional. This means that the tax rates observed by the researcher are measured without error. The data also contain information about mobility across jurisdictions, allowing us to explicitly control for horizontal interaction between the municipalities.

The paper is organized as follows. In Section 2, we describe the model and the test for vertical externalities. The test is derived by observing that the relationship the regional income tax rate and the income tax rates chosen by the municipalities in the region depends on the intergovernmental transfer system. In Section 3, we present the data and the empirical results. The

paper concludes with section 4.

2 The model

Local residents are assumed to have preferences over private consumption, labor supply and public consumption. Following Boadway and Keen (1996), Boadway et al. (1998) and Aronsson and Wikström (1999), by assuming that private and public goods are separable in terms of the utility functions², the utility of local resident j in locality i is written

$$U_j^i = u(c^i, l^i) + \phi(x^i, r) + \theta_j^i \quad (1)$$

where c is private consumption, l labor supply, whereas x and r are public goods provided by the local and regional governments, respectively. We have written the utility function such that the local and regional public goods are not separable from each other, and the results presented by Aronsson et al. (2000) give some support to this assumption. The utility function is assumed to be increasing in c^i , x^i , and r , decreasing in l^i , and strictly concave. Note also that the local residents are assumed to have the same preferences with the exception that they differ with respect to their attachment to the home locality, which is captured by the parameter θ_j^i . This means that those who decide to stay in locality i will make identical choices of labor supply and consumption, which explains our choice not to use subindex j on these variables.

If deciding to stay in locality i , the local resident is choosing consumption and labor supply to maximize the utility subject to the budget constraint

$$w^i(1 - \tau_l^i - \tau_r)l^i = c^i \quad (2)$$

²Separability simplifies the calculations. It has no implications for the null hypotheses to be derived below.

where w is the real wage rate, τ_l the local income tax rate, and τ_r the regional income tax rate. The optimal consumption and labor supply of each individual will be $c^i = c(w^i(1 - \tau_l^i - \tau_r))$ and $l^i = l(w^i(1 - \tau_l^i - \tau_r))$. The conditional indirect utility is written³

$$V_j^i = v(w^i(1 - \tau_l^i - \tau_r)) + \phi(x^i, r) + \theta_j^i \quad (3)$$

We shall begin by studying the optimal policy for the local government when the population is immobile, which is interpretable such that the attachment to the home locality is so strong that the local government needs not take the mobility incentives into account. This situation provides a convenient reference case in the sense that the test for vertical external effects becomes easy to design. We will then continue with the general case where the population is mobile.

2.1 Results when the population is immobile

To simplify the notations as much as possible, let us normalize the population in the locality to equal one. For purposes of simplification, we shall also assume that the localities are identical and drop the superindex i . The budget constraint of the local government is written

$$\tau_l w l(w(1 - \tau_l - \tau_r)) + S_l - x = 0 \quad (4)$$

where S_l is a transfer payment from the central government. In a similar way, if there are n localities in each region, the budget constraint of each regional government is given by

$$n\tau_r w l(w(1 - \tau_l - \tau_r)) + S_r - r = 0 \quad (5)$$

³The term "conditional indirect utility" is used to indicate that the private optimization problem is defined conditional on τ_l^i , τ_r , x^i and r .

where S_r is a transfer payment from the central government. In the theoretical analysis, we disregard the taxation and provision of public goods by the central government, since these do not add to the principal findings. Therefore, if there are N regions, the budget constraint of the central government becomes

$$nNS_l + NS_r = 0 \quad (6)$$

Our concern will be to analyze how the local government's choice of income tax rate is related to the tax rate chosen by the regional government. It is convenient to start by solving the decision problem of the local government conditional on τ_r and r . Consider first the situation where the central government does not try to internalize the vertical external effect, in which case S_l and S_r will be treated as constants. The objective of the local government will be to maximize equation (3) subject to the budget constraint given by equation (4). Since the population is assumed to be immobile, the distribution of the attachment to home parameters is not important for the resource allocation. By substituting the budget constraint into the objective function, the decision problem of the local government can be written

$$Max_{\tau_l} [v(w(1 - \tau_l - \tau_r)) + \phi(\tau_l w l(w(1 - \tau_l - \tau_r)) + S_l, r)]$$

The first order condition for the local income tax rate is given by

$$-v_\omega w + \phi_x [w l - \tau_l w^2 l_\omega] = 0 \quad (7)$$

where $\omega = w(1 - \tau_l - \tau_r)$. Having derived the income tax rate by solving equation (7), we can determine the provision of the local public good residually from the budget constraint.

Equation (7) implicitly defines a best response function, $\tau_l = b(\tau_r, w, r, S_l)$, measuring how the local government adjusts its income tax rate as a response

to a change in the regional income tax rate. Differentiating equation (7) with respect to τ_l and τ_r gives

$$-1 < \frac{\partial \tau_l}{\partial \tau_r} < 0 \quad (8)$$

which is the slope of the best response function, i.e., it measures how the local income tax rate responds to an increase in the regional income tax rate, when the central government does not try to internalize the vertical externality.

Let us now turn to the situation where the vertical externality has become internalized. Aronsson and Wikström (2001) show how the central government can implement the socially optimal resource allocation. The authors also make a distinction between the case where the local and regional governments act as Nash competitors to one another, and the case where the regional government is acting Stackelberg leader. If the regional government and the local governments in the region are acting Nash competitors to one another, the central government can design the transfer payments, S_l and S_r , in such a way, that the vertical external effect becomes internalized. If, on the other hand, the regional government is acting Stackelberg leader, it is not possible to reach the socially optimal resource allocation by using the intergovernmental transfer system alone; the latter must be combined with another policy instrument in order to both internalize the vertical external effect and offset the effects of Stackelberg behavior.

It is not necessary to make a distinction between Nash competition and the Stackelberg game here, since we are analyzing the decision problem of the local governments conditional on the income tax rate and the expenditures decided upon by the regional governments. Denoting the socially optimal allocation of the regional public good by r^* (which the central government can determine by solving the underlying hypothetical social optimization

problem), the following subsidy rule will be part of a policy that implements the socially optimal resource allocation⁴;

$$S_l = (\tau - \tau_l)wl(w(1 - \tau_l - \tau_r)) - r^*/n \quad (9)$$

where $\tau = \tau_l + \tau_r$. By using equation (9), the budget constraint of the local government can be written

$$(\tau_l + \tau_r)wl(w(1 - \tau_l - \tau_r)) - r^*/n - x = 0 \quad (10)$$

meaning that each local government will behave as if it faces the budget constraint for the region as a whole. The first order condition for the local income tax rate changes to read

$$-v_\omega w + \phi_x [wl - (\tau_l + \tau_r)w^2 l_\omega] = 0 \quad (11)$$

Since equation (9) defines S_l as a function of τ_l , τ_r , w and r^*/n , we can write the best response function as $\tau_l = f(\tau_r, w, r^*/n, r)$. Differentiating equation (11) with respect to τ_l and τ_r , we obtain the response in the local income tax rate, following from a change in the regional income tax rate, when the vertical externality has become internalized;

$$\frac{\partial \tau_l}{\partial \tau_r} = -1 \quad (12)$$

A comparison between equations (8) and (12) implies that $\partial b(\cdot)/\partial \tau_r > \partial f(\cdot)/\partial \tau_r = -1$. By estimating the slope of the best response function, it is possible to test the null hypothesis, $H_0 : \partial \tau_l / \partial \tau_r = -1$, against the alternative hypothesis, $H_1 : \partial \tau_l / \partial \tau_r > -1$.

The reader should note that the null hypothesis is not dependent upon the particular intergovernmental tax or transfer system in use. Any system

⁴See Aronsson and Wikström (2001).

that internalizes the vertical fiscal externality must obey $\partial\tau_l/\partial\tau_r = -1$. The reason is that, in an efficient tax transfer system, a local government will behave as if it takes into consideration that an increase in its own tax rate crowds out tax revenue for the regional level of government.⁵

2.2 Extending the model to include migration

Allowing the individuals to move between the localities creates a ground for horizontal externalities. In this subsection, we shall extend the model to include horizontal interaction from mobility and allow this interaction to affect the test for vertical external effects. To make the extension empirically manageable, we simplify the analysis by assuming that the parameter representing the attachment to the home locality is uniformly distributed with support $\underline{\theta}$ and $\bar{\theta}$, respectively, and distribution function $F(\theta_j^i)$ for all i and j . We shall also require that the residents in any locality treat all other localities as equivalent with respect to attainable utility. Then, without loss of generality, we can restrict the attention to the simplified situation, where there are only two localities.

The point we wish to make in this subsection is that the test for the vertical external effect is dependent upon the possibility to distinguish between interregional and intraregional migration. To be able to make this point without introducing too much burdensome notation, let $v^i = v(w^i(1 - \tau_l^i - \tau_r)) + \phi(x^i, r)$ be the utility attainable in locality i as a result of its package

⁵For instance, instead of using the intergovernmental transfer system, the central government may use Pigouvian taxation to internalize the vertical external effect. Let δ be a Pigouvian tax on the local public good, where the Pigouvian tax is defined conditional on the regional income tax rate (since τ_l is defined conditional on τ_r in the model), in which case the best response function takes the form $\tau_l = g(\tau_r, w, S_l, r, \delta)$. One can show that this function has the property $\partial g(\cdot)/\partial\tau_r + \partial g(\cdot)/\partial\delta \cdot \partial\delta/\partial\tau_r = -1$ at the social optimum.

of policy instruments. Similarly, let $v^a = v(w^a(1 - \tau_l^a - \hat{\tau}_r)) + \phi(x^a, \hat{r})$ be the utility attainable in locality a as a result of its package of policy instruments.

It follows that individual j stays in locality i if $\theta_j^i \geq \tilde{\theta}^i$, where $\tilde{\theta}^i$ is defined by

$$v^i + \tilde{\theta}^i = v^a,$$

and the 'number of stayers' in locality i is given by $1 - F(\tilde{\theta}^i)$. In a similar way, the residents of locality a whose attachment to home parameter takes a value smaller than $\tilde{\theta}^a$, where

$$v^a + \tilde{\theta}^a = v^i$$

defines $\tilde{\theta}^a$, will move to locality i . The 'number of movers' to locality i is given by $F(\tilde{\theta}^a)$.

Let us assume that the central government has internalized the vertical fiscal externality by using the intergovernmental transfer scheme discussed in the previous subsection. The budget constraint of local government i is given by

$$\tau w l (w(1 - \tau)) [1 - F(\tilde{\theta}) + F(\tilde{\theta}^a)] - x - r^*/n = 0 \quad (13)$$

where $\tau = \tau_l + \tau_r$ and the superindex i has been suppressed for notational convenience. The local government maximizes the utility for those who decide to stay in the locality, $v(w(1 - \tau_l - \tau_r)) + \phi(x, r)$, subject to the budget constraint. The first order condition can be written

$$-v_\omega w + \phi_x \frac{\partial x}{\partial \tau_l} = 0 \quad (14)$$

where $\partial x / \partial \tau_l = [w l - \tau w^2 l_\omega] [1 - F(\tilde{\theta}) + F(\tilde{\theta}^a)] - \tau w l 2 F_\theta \tilde{\theta}_{\tau_l}$ and $F_\theta = \partial F(\cdot) / \partial \theta$ is a constant density function, the forms of which originate from the assumption that the attachment to home parameters follow the same uniform distribution.

To simplify the analysis, let us add the assumption that the equilibrium is symmetric in the sense that the wage rates and the public policy are identical in the two localities. Note also that the assumption of symmetry does not imply an equilibrium without migration, since the attachment to home parameter needs not be nonnegative for all individuals.

Let us now derive the relationship between τ_l and τ_r implied by the null hypothesis that the vertical external effect has become internalized. It is important to distinguish between the situation where the localities belong to the same region, and the situation where they do not belong to the same region. We derive the null hypothesis corresponding to each such case in the Appendix. If the two localities do not belong to the same region, meaning that the migration is interregional, it is easy to show that the null hypothesis derived in the previous subsection is still valid;

$$\frac{\partial \tau_l}{\partial \tau_r} = -1 \quad (15)$$

If, on the other hand, the localities belong to the same region, in which case the migration is intraregional, the null hypothesis implies the following relationship between τ_l and τ_r ;

$$\frac{\partial \tau_l}{\partial \tau_r} = -1 + \frac{\phi_x \tilde{\theta}_{\tau_l} 4F_{\theta} [\tau w^2 l_{\omega} - wl] - \phi_{xx} x_{\tau_l} \tau w l 2F_{\theta} \tilde{\theta}_{\tau_l}}{v_{\omega\omega} w^2 + \phi_{xx} (x_{\tau_l})^2 + \phi_x (\partial^2 x / \partial \tau_l^2)} \quad (16)$$

where the second term on the right hand side can be either positive or negative. The intuition behind these results is that, in case the two localities do not belong to the same region, the local and regional tax rates affect the mobility in the same way and their influences will, therefore, cancel out. This means, in turn, that the relationship between τ_l and τ_r implied by the null hypothesis takes the same form as when the population is immobile. However, in case the localities belong to the same region, the regional tax rate has no influence on mobility, which means that the influence of the local

tax rate on migration will affect the relationship between τ_l and τ_r .

In the empirical analysis, we will interpret these results to mean that, having conditioned on the interaction between the intraregional migration and the regional tax rate, the remaining influence of the regional tax rate must capture the first term on the right hand side of equation (16). In other words, conditional on this interaction, we will test the null hypothesis that the remaining effect satisfies $H_0 : \partial\tau_l/\partial\tau_r = -1$ against the alternative hypothesis that the remaining effect satisfies $H_1 : \partial\tau_l/\partial\tau_r \neq -1$. Note also that the parameter space corresponding to the alternative hypothesis is not restricted to the interval $(-1, 0)$.

3 Empirical analysis

3.1 Data

The data are obtained from Statistics Sweden and refer to the local and regional public sectors. The estimation period is 1981-1990, the choice of which is motivated by the temporary restrictions on the local and regional power to tax introduced by the central government in the early 1990s. Since the national income tax and expenditure policies are the same for all localities and regions, and do not vary much from one year to the next, they are not included in the analysis. There are 24 counties, and the number of municipalities varies between 279 in 1981 and 284 in 1990. The municipalities are mainly responsible for pre-university education, child care and social care, while the main responsibility of the counties is health care. However, there is no strict and unanimous division of responsibilities between the two levels of government. In the cities of Göteborg and Malmö, as well as the island of Gotland, the local public sector is unified in the sense that the municipalities are responsible for health care in addition to the other services

provided by municipalities. We will, therefore, exclude the municipalities of Göteborg, Malmö and Gotland from the analysis. This leaves us with an unbalanced panel containing between 276 and 281 municipalities and 23 counties.

Let us discuss the variables to be used in the analysis. The municipal and county income tax rates (τ_l and τ_r , respectively) are defined as the tax payment per 100 SEK. We shall use the average private income (y) in the municipality as a proxy for the hourly gross wage rate. This variable is measured as the average gross income for the population aged 20 and above. The services provided by the county level of government (r) are measured as the real operating cost per capita of the regional government.

Recall from section 2 that the best response function is defined conditional on the part of the grants from the central government to the municipality that is treated as exogenous by the municipality. It is important not to condition on the part of the grant that depends on the tax and expenditure policies chosen by the municipality. This part of the grant will, instead, influence the slope of the best response function in $\tau_l - \tau_r$ space, which is what we intend to capture in the empirical analysis. We define the part of the grant that is exogenous to the municipality by subtracting the part of the grant-in-aid that depends on the tax and/or expenditure policy of the municipality from the total grant. The resulting lump-sum grant, \bar{S} , can be either positive or negative, as it may reflect different combinations of transfers from and fees to the central government. In the context of the theoretical model set out above, which abstracts from other central government objectives than internalization of the vertical external effect, $\bar{S} = -r^*/n$. Finally, a comparison between equations (15) and (16) suggests that the slope of the best response function in $\tau_l - \tau_r$ space, which arises when the vertical external effect has become internalized, depends on whether the mi-

gration to/from the municipality is interregional or intraregional. We have constructed a variable (INTRA) measuring the share of the net migration from the municipality that is intraregional, which is calculated as an average share over the estimation period for each municipality. How to use this variable in the estimation will be described below.

Following the literature on the determinants of the local public expenditures, we shall also condition on municipal characteristics as represented by the population density, the age structure of the population as well as political preferences and fragmentation of the local parliament. The population density (DENS) is measured by the number of inhabitants per square kilometer. The age structure is characterized by the share of inhabitants aged 15 or below (YOUNG), and the share of inhabitants older than 65 (OLD). It is often found that localities where a large share of the seats in the local parliament is occupied by the left wing parties are more likely to choose larger expenditures than localities where the left wing parties have fewer seats in the local parliament. To control for political preferences, we include the share of the seats in the municipal parliament occupied by members of the Social Democratic Party and the Left Party (SOC). Political strength is represented by a Herfindale index (HERF). Descriptive statistics for the variables used are presented in Table A1 in the Appendix.

3.2 Specification of the empirical model

Equations (15) and (16) represent the null hypothesis in two special cases; equation (15) is based on the assumption that all migration is interregional, whereas equation (16) is derived on the basis of the assumption that all migration is intraregional. Even if these two special cases may not, themselves, be empirically relevant, they are important in the sense of highlighting the role of intraregional migration for the design of the test. Since the mobility

pattern that we observe contains both interregional and intraregional parts, the empirical model should be formulated to represent a combination of the two special cases. This suggests to us that we should control for the possibility that the intraregional part of the net migration influences the best response function in $\tau_l - \tau_r$ space. The estimating equation is given by

$$\begin{aligned} \tau_{l,t}^{i,k} = & \alpha^i + \gamma_t + \beta_1 \tau_{r,t}^k + \beta_2 \tau_{r,t}^k \times (INTRA)^{i,k} + \beta_3 r_t^k \\ & + \beta_4 y_t^{i,k} + \beta_5 \bar{S}_t^{i,k} + z_t^{i,k} + \varepsilon_t^{i,k} \end{aligned} \quad (17)$$

where indices k and t denote, respectively, region and time, y is the private income, z represents the influence of municipal characteristics and ε is an error term. The model is estimated with municipality specific intercepts (the $\alpha : s$) as well as period specific effects (the $\gamma : s$). The reader should also note that several of the right-hand side variables are decision variables on part of the regional governments, the central government, and individuals. Therefore, as a first step, we use information lagged once to estimate models for the regional tax rate (τ_r), the regional per capita expenditure (r), the intergovernmental grant (\bar{S}), and income (y). These regressions are performed by the method of ordinary least squares. The explained part of these regressions are then used to estimate equation (17). Some of the municipal characteristics may also be endogenous. Therefore, the variables DENS, YOUNG and OLD are lagged once in the estimation of equation (17).

3.3 Results

The first two columns of Table 1 refer to the results from the benchmark model, where the residents are immobile. In the final two columns, we relax the assumption of interjurisdictional immobility.

Table 1 HERE

The demographic variables appear to have some important implications for the determination of tax rates in the municipalities. The municipalities have the main responsibility for providing schooling and day-care services both of which represent a large proportion of the budget and are mainly financed by income taxation. As a consequence, we find that the higher the share of young people in the municipality, *ceteris paribus*, the higher will be the municipal income tax rate. The share of elderly in the municipality has no significant effect on the municipal income tax rate. A possible explanation is that a large part of the programs directed towards the elderly was organized by the county councils during the estimation period. The municipal income tax rate decreases with the population density, which is either interpreted to mean economies of scale with respect to the population or diseconomies with respect to geographical size. The political preferences and the fragmentation of the local parliament have significant effects on the local income tax rate. In accordance with common beliefs, the results suggest that a municipal parliament represented by a large share of socialist parties has a tendency to choose a higher income tax rate than other municipalities. Political strength implies the opposite: the less fragmented the municipal parliament (i.e. the higher the value of the Herfindale indicator), *ceteris paribus*, the lower the municipal income tax rate.

Turning to the results on vertical interaction, we find a negative and statistically significant relationship between the county and municipal tax rates. The interpretation is that an increase in the county tax rate causes the municipalities to respond by decreasing their tax rates. This result is in accordance with the findings by Goodspeed (2000a, 2000b). By comparing columns A and B, this result does not seem to depend on whether or not we include the lump-sum transfers directed towards municipalities (\bar{S}).

Relaxing the assumption of interjurisdictional immobility of tax payers introduces the possibility of horizontal externalities. However, note that we are not able to explicitly test for horizontal fiscal externalities. At the very best, we can only hope to control for their influence on the test for the vertical external effect. The results imply that the interaction term is not significantly different from zero, meaning that there is no statistical evidence that municipalities with a high share of intraregional mobility are more or less sensitive to the regional government's choice of tax rate than those with a low share of intraregional migration.

As we mentioned above, the null hypothesis is that the parameter associated with the regional income tax rate, β_1 , is equal to -1 , which can be tested by using a t-statistic. The test statistics corresponding to columns B and D are 46.6 and 19.0, respectively, meaning that the null is heavily rejected for both specifications. This means that an increase in the income tax rate of the county leads to a reaction by the municipalities that is likely to be suboptimal from society's point of view. In other words, the central government has not been able to fully internalize the vertical fiscal externality between the regional and local governments.

One possible objection to the test conducted above is that the government policy may not have remained the same during the 1980s. To test for structural shifts, we split the sample into two subperiods, 1982 to 1986 and 1987 to 1990. The reason for choosing subperiods in this way is that the national government in 1987 introduced a fee to be paid by the municipalities to help finance the grant-in-aid system, which is a major change of the grant system. The model corresponding to column B of Table 1 is estimated for the two subperiods, and a Wald statistic used to test whether the estimate of the parameter β_1 is the same for both subperiods. The test statistic is 1.78 ($\chi^2_{0.95}(1) = 3.84$), indicating that there is no significant difference. An

interpretation is that the change in the grant-in-aid system does not seem to have had any effect on the ability of the central government to internalize the vertical external effects.

4 Concluding remarks

Most modern economic federations contain more than one level of government sharing the same tax base for distortionary income taxation. In this paper we study vertical interaction between the local (municipal) and regional (county) public sectors in Sweden. Such vertical interaction is likely to take place, although it does not necessarily imply the presence of vertical externalities. Allowing the central government to intervene, it is possible to construct an intergovernmental transfer system such that the vertical external effect becomes internalized. The purpose of this paper is to design a test of whether the central government has been able to internalize the vertical external effect via the intergovernmental transfer system. The test is implemented using data for the Swedish local and regional public sectors.

We find that there is a negative relationship between the tax rates chosen by the two levels of government. In addition, this conclusion does not depend on whether or not we control for intraregional migration. The null hypothesis, which means that the central government internalizes the vertical external effect via intergovernmental transfers, is heavily rejected. Therefore, the choices of income tax rates by the local governments are not likely to be optimal from society's point of view.

Appendix

Table A1 Variables

Variable	Description
τ_l	Municipal income tax rate, tax payment per SEK100
τ_r	County income tax rate, tax payment per SEK100
INTRA	Share of net intraregional migration
y	Average gross private income, thousands of SEK for the population aged 20 and above
r	Real operating cost per capita for regional government, thousands of SEK per capita
\bar{S}	Exogenous grant to municipality, thousands of SEK per capita
DENS	Population density, inhabitants per square kilometer
YOUNG	Share of inhabitants aged 15 or below
OLD	Share of inhabitants older than 65
SOC	Share of Social Democrats and Left Party members in municipal government
HERF	Herfindahl index of political strength

Note: y , r and \bar{S} are deflated by CPI (1980=100).

Table A2 Summary statistics

Variable	1982	1985	1990	1981-1990
τ_l	16.13 (1.108)	16.29 (1.132)	16.49 (1.074)	16.27 (1.103)
τ_r	12.77 (0.692)	13.06 (0.685)	13.88 (0.433)	13.17 (0.741)
r	7.16 (1.374)	7.80 (1.462)	6.79 (1.261)	7.21 (1.452)
\bar{S}	-0.02 (0.054)	-0.02 (0.046)	-0.19 (0.162)	-0.04 (0.133)
y	49.76 (6.083)	50.77 (5.849)	60.73 (7.252)	53.55 (7.652)
INTRA				0.46 (0.162)
DENS($t-1$)	104.90 (344.186)	104.07 (345.131)	108.60 (368.527)	105.67 (351.622)
YOUNG($t-1$)	0.22 (0.028)	0.20 (0.025)	0.20 (0.019)	0.20 (0.024)
OLD($t-1$)	0.17 (0.043)	0.18 (0.043)	0.19 (0.042)	0.18 (0.043)
SOC	0.48 (0.118)	0.51 (0.122)	0.48 (0.115)	0.49 (0.118)
HERF	0.31 (0.053)	0.32 (0.061)	0.28 (0.053)	0.31 (0.058)

Note: standard deviations in parentheses.

Derivation of equations (15) and (16)

Differentiating equation (14) with respect to τ_l and τ_r gives

$$\frac{\partial \tau_l}{\partial \tau_r} = -1 + \frac{\phi_x \left(\frac{\partial^2 x}{\partial \tau_l^2} - \frac{\partial^2 x}{\partial \tau_l \partial \tau_r} \right) + \phi_{xx} \frac{\partial x}{\partial \tau_l} \left(\frac{\partial x}{\partial \tau_l} - \frac{\partial x}{\partial \tau_r} \right)}{A} \quad (\text{A1})$$

where

$$A = \frac{\partial^2 V}{\partial \tau_l^2} = v_{\omega\omega} w^2 + \phi_x \frac{\partial^2 x}{\partial \tau_l^2} + \phi_{xx} \left(\frac{\partial x}{\partial \tau_l} \right)^2 < 0$$

Expanding the two parentheses in equation (A1) yields

$$\left(\frac{\partial x}{\partial \tau_l} - \frac{\partial x}{\partial \tau_r} \right) = -\tau w l 2 F_\theta \left(\frac{\partial \tilde{\theta}}{\partial \tau_l} - \frac{\partial \tilde{\theta}}{\partial \tau_r} \right) \quad (\text{A2})$$

and

$$\begin{aligned} \left(\frac{\partial^2 x}{\partial \tau_l^2} - \frac{\partial^2 x}{\partial \tau_l \partial \tau_r} \right) &= \left(\frac{\partial \tilde{\theta}}{\partial \tau_l} - \frac{\partial \tilde{\theta}}{\partial \tau_r} \right) (\tau w^2 l_\omega - w l) 4 F_\theta A 3 \\ &\quad - \tau w l 2 F_\theta \left(\frac{\partial^2 \tilde{\theta}}{\partial \tau_l^2} - \frac{\partial^2 \tilde{\theta}}{\partial \tau_l \partial \tau_r} \right) \end{aligned} \quad (\text{A3})$$

Substituting equations (A2) and (A3) into equation (A1), and using

$$\frac{\partial \tilde{\theta}}{\partial \tau_l} = v_\omega w = \frac{\partial \tilde{\theta}}{\partial \tau_r} \text{ and } \frac{\partial^2 \tilde{\theta}}{\partial \tau_l^2} = -v_{\omega\omega} w^2 = \frac{\partial^2 \tilde{\theta}}{\partial \tau_l \partial \tau_r}$$

we obtain equation (15).

Equation (16) can be derived in a similar way. Substitute for equations (A2) and (A3) in equation (A1), and notice that

$$\frac{\partial \tilde{\theta}}{\partial \tau_l} = v_\omega w \text{ and } \frac{\partial \tilde{\theta}}{\partial \tau_r} = v_\omega w - v_\omega w = 0 \text{ (imposing symmetry)}$$

and

$$\frac{\partial^2 \tilde{\theta}}{\partial \tau_l^2} = -v_{\omega\omega} w^2 = \frac{\partial^2 \tilde{\theta}}{\partial \tau_l \partial \tau_r}$$

This gives the following relationship between local and regional income tax rates

$$\frac{\partial \tau_l}{\partial \tau_r} = -1 + \Psi$$

where $\Psi = \left[\phi_x \tilde{\theta}_{\tau_l} 4 F_\theta [\tau w^2 l_\omega - w l] - \phi_{xx} x_{\tau_l} \tau w l 2 F_\theta \tilde{\theta}_{\tau_l} \right] / A \geq 0$

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Table 1 Estimation results (estimation period 1982-1990)

	A	B	C	D
τ_r	-0.109 (-5.67)	-0.104 (-5.42)	-0.102 (-2.12)	-0.088 (-1.83)
INTRA $\times\tau_r$			-0.016 (-0.17)	-0.036 (-0.37)
y	0.009 (1.14)	-0.003 (-0.36)	0.009 (1.15)	-0.003 (-0.34)
r	0.020 (0.75)	0.035 (1.28)	0.020 (0.73)	0.034 (1.25)
\overline{S}		-0.512 (-4.98)		-0.513 (-4.99)
DENS($t-1$)	-0.001 (-2.25)	-0.001 (-2.37)	-0.001 (-2.24)	-0.001 (-2.35)
YOUNG($t-1$)	7.465 (5.66)	7.240 (5.51)	7.458 (5.65)	7.224 (5.50)
OLD($t-1$)	-1.386 (-0.80)	-2.048 (-1.19)	-1.388 (-0.81)	-2.055 (-1.19)
SOC	3.433 (7.28)	3.380 (7.20)	3.427 (7.25)	3.367 (7.16)
HERF	-1.748 (-3.44)	-1.766 (-3.49)	-1.736 (-3.38)	-1.740 (-3.41)
R ² (overall)	0.172	0.187	0.178	0.197
F	27.42	27.54	25.80	26.01
No. of obs	2524	2524	2524	2524
No. of groups	281	281	281	281

Note: t-values in parentheses. The variables τ_r , y , \overline{S} , and r have been instrumented by using lagged information.