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Education costs and institutional structure

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Abstract

An empirical comparison is made of the impact on disaggregated education costs of three types of education spending control regimes — state-level control of education spending; local school board control of spending with non-overlapping jurisdictions; and local school board control with overlapping jurisdictions. A model is specified which describes the determination of teacher wages, the teacher–student ratio, administrative costs, and other operating costs under each regime. The model is estimated using Canadian provincial-level data and the entire estimated structure of behaviour is allowed to vary across the three regimes. The estimates imply that education costs are regime dependent and that a single proxy variable is unlikely to reflect the differences between regimes. Simulations indicate that centralized state or provincial control of spending leads to the lowest teacher costs. The local control regime with non-overlapping jurisdictions is the most successful at controlling administrative and other operating costs.

Keywords: Costs; Resource allocation; Teacher salaries

1. Introduction

Spending on education is one of the areas of government spending which has grown most rapidly over the past several decades. Real per student expenditures on public elementary and secondary education grew by 72% in the US between 1970 and 1990, an annual growth rate of 2.8%, while real GDP per capita grew by only 1.1% per annum (Statistical Abstract of the United States, 1993). As noted by Flyer and Rosen (1994), from 1960 to 1990 average per student expenditure on elementary and secondary schools rose from 18.4 to 29.5% of median family income.

Given the rapid growth and large magnitude of education spending, governments have been increasingly interested in methods of controlling education costs. One possible strategy is to modify the institutional structure of education decision making in order to facilitate cost control. This can be done, for example, by shifting the control of education spending from one level of government to another. In order to determine whether this type of strategy is likely to be successful, this paper empirically examines whether the magnitudes of different types of education costs depend on the degree of centralization of spending control. In the most centralized of the three regimes compared, spending is controlled at the state (or provincial) level. The two other regimes examined are both characterized by local school board control of spending, but one allows school board jurisdictions to overlap geographically while the other does not.

The education systems of most industrialized countries are characterized by one or more of the three institutional structures of education spending control described above. For example, centralized state-level education spending control is the norm in Australia, France and the United Kingdom, while a system of local boards without overlapping jurisdictions characterizes most of the lower 48 US states. In Canada, education spending is directly controlled by provincial governments in some provinces and by local school boards in others. For some of the provinces in which local boards control spending, school board jurisdictions may overlap.[1] Given the use of all three institutional structures in Canada, Canadian data

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are particularly useful for a comparison of the impact of these different spending control regimes on education costs and, thus, are employed in the empirical analysis below.

The level of government which controls the size of education spending may have an impact on total education costs for several reasons.[2] First, the ability of voters to compare their taxes and services with those in neighbouring jurisdictions (Ladd, 1992; Besley & Case, 1995), as well as the mobility of taxpayers between jurisdictions, may put pressure on governments to restrain spending and control costs.[3] Both the competition for taxpayers and voter "yardstick" comparisons of governments are likely to be more important for local governments than for provincial governments (since voters are generally more mobile locally and local comparisons of taxes and services are likely to be easier). In addition, these effects are likely to be most significant for local school boards with overlapping jurisdictions since taxpayers in these boards may be able to compare school board performance more easily and can redirect their taxes between boards without relocating. Local spending control, and the focus of local school boards on the provision of one service (education) rather than many services, may also allow for more effective monitoring of school boards and administrators by voters.[4]

The centralized control of education spending may, on the other hand, yield lower education costs by facilitating the exploitation of economies of scale and eliminating duplication in the provision of education services.[5] In addition, as noted by Glennerster (1991), higher level governments may have more bargaining power and so may be more successful at resisting teacher demands for higher wages and benefits than smaller jurisdictions. However, as Silva and Sonstelie (1995) note, the median voter at the provincial level has a lower income than the average income of the median voters of local school boards. Depending on the size of the income and substitution effects, this could lead to greater or lower spending in provinces with centralized control than in those provinces in which spending is set at the level of individual boards.

1.1. Related literature

The comparison of government behaviour under regimes with different degrees of centralization and interjurisdictional competition has been the subject of a number of empirical studies. Oates (1985) found no evidence to suggest that greater state-level, rather than local-level, responsibility for taxes and expenditures leads to larger government spending. However, Nelson (1987), in an extension of Oates, found that greater decentralization, as measured by the number of jurisdictions per capita, does lead to lower spending by general-purpose governments, but not by single-purpose governments. In a related analysis, Zax (1988) found that county-level expenditures fall with an increase in the number of jurisdictions in the county (increased competition), but rise with the number of jurisdictions per capita (lost economies of scale). Similarly, Zax (1989) found that single-purpose governments which serve fewer voters have significantly higher spending than larger jurisdictions due to their failure to realize economies of scale.

The relationship between the degree of decentralization and the level of education spending has been analysed in several papers.[6] Wagner and Weber (1975) com-

[1] The existence of religious-based "separate" school boards is the primary reason for more than one school board to exist in a particular geographic region of Canada. However, there are generally few or no restrictions on which students can attend the schools of different boards and taxes can, in general, easily be directed by taxpayers to the board of their choice. Both "separate" and "public" school boards are public in the sense of being financed almost exclusively from tax revenues. A referendum is not required under locally controlled systems for boards to change the level of spending on education or the tax rate to finance this spending except in certain special cases. The only real control of taxpayers over the level of spending by school boards in Canada is the re-election or defeat of school board members.

[2] General arguments for and against the decentralization of government spending can be found in Oates (1985), Rubinfeld (1987), Wallis and Oates (1988), Zax (1988).

[3] Competition of this type is in the spirit of Tiebout (1956). Greater competition between boards generally implies greater local control, but does not necessarily lead to a reduction in education spending. With greater local control of education spending, voters may perceive spending to be more responsive to their needs, or that funds are being used more responsibly, and so may actually prefer higher education spending. Despite this possibility, the literature generally assumes that more competition leads to lower spending.

[4] The ease of monitoring in a more decentralized system has been noted by Friedman (1993).

[5] Deller and Rudnicki (1992) find that there are few economies of scale to be exploited by the consolidation of school districts. Their results indicate that local inefficiencies are not due to lost economies of scale, but to managerial inefficiency. Thus, a further argument in favour of centralization is that larger jurisdictions may be able to attract more experienced and efficient managers.

[6] There is a large literature that examines education spending without examining the decentralization–centralization issue. A summary empirical analysis of this literature can be found in Denzau and Grier (1984). In addition to not examining the impact of the institutional structure of spending control, as is done here, the studies reviewed in Denzau and Grier do not disaggregate spending into its different cost components. Chambers (1978) examines the determinants of local school spending, teacher and administrator salaries, and the demand for teacher

pared spending by school districts that were part of a general government with those that were independent and found that the independent school districts tended to spend less. Bell (1988) found that the number of school districts per square mile reduces education spending, a result which implies that competition between districts may be important. Hoxby (1994) and Kenny and Schmidt (1994) also find evidence that diminished competition leads to higher education expenditures. Hoxby (1994) uses a Herfindahl index of concentration to reflect both the presence of more school districts in a metropolitan area as well as a more even population distribution across districts (both of which she assumes lead to more competition between districts). She finds that areas with a lower concentration ratio and, therefore, greater opportunities for choice have lower per-pupil spending. Finally, Burnell (1991), taking an approach which is very similar to that of Bell (1988), adds the number of school boards in a county as an explanatory variable in a county-level education spending equation. Her results indicate that this variable (a proxy for the degree of competition between boards) is not associated with lower school spending. This contrasts with the evidence in the other papers cited above, all of which tend to support the hypothesis that greater decentralization reduces total education spending.

The analysis below differs from the existing literature in two principal respects. First, in contrast to the literature cited above, which addresses the determination of education spending in *aggregate*, the present analysis examines *disaggregated* education costs. In addition to avoiding the usual problem of aggregation bias, an analysis using disaggregated cost data may be able to signal the level of government that can best control each particular type of cost. This may be important since there is no reason to assume a priori that spending control by a single level of government will minimize all types of costs. By employing a disaggregated cost approach, it may also be possible to infer whether different regimes, with similar total education costs, are associated with different allocations of spending across the sub-components of total cost — teacher salaries, teacher–pupil ratios, administration costs, etc. Finally, by indicating the level of government best able to control each type of education cost, an analysis of disaggregated costs may be able to clarify why education spending differs across regimes with different institutional structures and may improve our understanding of the factors determining overall education spending.

The second difference between the current paper and the existing literature is that the education cost equations estimated below use data from three well-defined institutional regimes and the entire structure of behaviour is allowed to vary across these regimes. The existing empirical literature examines the relationship between institutional structure and spending by adding to an education spending equation one or more variables as proxies for the degree of decentralization or interjurisdictional competition. The problem with this approach is that the choice of proxy variable may critically affect the results. In addition, if behaviour differs sufficiently across regimes, a single proxy variable may not adequately reflect behavioural differences. By employing data from all three regimes, the necessity of using a decentralization proxy can be avoided.[7]

The paper is organized as follows. Section 2 provides an overview of the derivation of the estimating equations as well as a description of the data and the empirical methodology. In Section 3, the coefficient estimates are discussed while, in Section 4, disaggregated education costs are simulated for each regime, and these simulations are compared and analysed. Concluding comments are provided in Section 5.

2. Empirical methodology

2.1. Derivation of the estimating equations

In order to analyse empirically the impact of institutional structure on education costs, it is first necessary to specify estimating equations which describe the determination of disaggregated education costs under each of the three spending control regimes being examined — the two regimes with local school board control of spending and the regime with provincial spending control. For the two regimes with local school board control, education spending depends on the behaviour of governments at both the local and provincial levels since provincial governments generally provide grants to local school boards which may alter school board spending and, in addition, provinces undertake some (relatively minor) direct education spending. Under the provincial control regime, spending is determined by the provincial government. Since local school boards have no effective impact on the level of education spending under this

characteristics using a sample of California school districts for 1970–71. He models the decision-making process of school boards, but does not address the decentralization–centralization question. Easton (1988) examines the impact of the legalisation of collective bargaining for teachers on education spending, teachers' wages and the student–teacher ratio using data from Oregon school districts for 4 years during the 1969 to 1982 period. While he attempts to determine the impact of a change in institutional structure on disaggregated education costs, his analysis does not address the centralization–decentralization issue.

[7] Landon (1998) also uses data for these three regimes. However, he analyses education spending in aggregate rather than examining disaggregated education costs as is done here.

regime, it is only necessary to model provincial government decision-making behaviour in this case. To keep the discussion brief, only an overview of the basic assumptions and modelling strategy underlying the derivation of the estimating equations for each of the three regimes is provided here. Details are given in Appendix A.

The model of education expenditure determination used here closely follows the analysis in Hettich and Winer (1984, 1988); Winer and Hettich (1991, 1992); Holtz-Eakin (1992) and assumes vote maximizing behaviour on the part of governments.[8] More precisely, whether education spending is under the control of local school boards or a provincial government, the governing body making spending decisions is assumed to choose taxes and spending, subject to its budget constraint, to maximize the preference function:

$$\Phi = \Phi(ES,\mathbf{Z}), \quad \Phi_{ES}(\cdot) > 0, \quad \Phi_{\mathbf{Z}}(\cdot) > 0, \tag{1}$$

where *ES* represents expected electoral support and **Z** is a vector of other factors which may be of direct interest to the government (such as spending on administration, buildings, etc.).[9] The expected support of voters depends on the level of education spending, disposable income (and, thus, taxes), and a vector of exogenous factors which may alter the tendency of voters to support the school board or provincial government. These may include variables which reflect the dependence of voter support for a particular school board on voter perceptions of the actions of neighbouring boards (as in Ladd, 1992; Besley & Case, 1995) or, in the regime with overlapping jurisdictions, voter perceptions of the actions of the other boards in the same geographic region.[10]

The level of teachers' salaries and the teacher–student ratio are determined within a bargaining framework in which bargaining between the school board (or provincial government) and the teachers' association maximizes the function:[11]

$$\Pi = \Omega^{\theta}\Phi^{1-\theta}, \tag{2}$$

where Ω is the teachers' objective function, Φ is determined by Eq. (1), and θ represents the relative bargaining strength of teachers and the government. Teachers are assumed to prefer higher salaries, a higher teacher–student ratio, and, potentially, more spending on other education inputs (since these may make their jobs easier). The government prefers higher teacher–student ratios because they may improve the perceived quality of education, but also realizes that lower teacher–student ratios and lower teacher wages are necessary to keep school taxes low (and voter support high).

Under the two local control regimes, voters know that local spending on education depends on the size of the provincial grant and so allocate some of the responsibility for education spending to the provincial government. The provincial government chooses the magnitude of its grant to local school boards in order to maximize its own electoral support taking into account the dependence of the behaviour of local boards on the size of the grant. Unlike the single-purpose local school boards, provincial governments have a wide range of spending and tax policies which may affect their voter support and which they must trade off against larger grants to local boards.

2.2. The estimating equations

Given the model outlined above, for all three spending control regimes it is possible to derive reduced-form equations (see Appendix A for details) which describe the major components of education costs: the average teacher wage (*TW*), the teacher–student ratio (*TS*), per student spending by both local boards and the province on education administration (*ADMIN*), per student provincial government services provided to school boards (*GSSB*), and per student school board operating expenditures other than teacher salaries and administration (*OE*).[12] As shown in Appendix A, the explanatory variables included in the reduced-form education cost equations are the same for all five types of costs and do not depend on the type of education spending control regime. However, since behaviour may vary across the three regimes, the estimated coefficients associated with each explanatory variable in each equation may be regime dependent. The estimation methodology used below allows for this.

The explanatory variables that appear in the reduced form equations for *TW*, *TS*, *ADMIN*, *GSSB* and *OE* can be divided into three groups: those variables that determine the bargaining power of teachers; exogenous characteristics of the school system; and income and

[8] While there are various assumptions with respect to voter and school board behaviour that could be used as the basis for the derivation of the estimating equations, these are likely to yield similar reduced-form estimating equations.

[9] The **Z** vector may also reflect the impact of bureaucratic interests on government behaviour. This type of effect has been the subject of a large literature, much of which is cited in Mehay and Gonzalez (1986).

[10] For the case with provincial government control, either the **Z** vector or the electoral support variable could also depend on a variable that represents the distribution of spending across districts in order to incorporate equity concerns.

[11] See Manning (1987) for a discussion of this bargaining framework and its relation to other possible frameworks.

[12] *GSSB* involves services such as administering exams and various other specialist and monitoring activities. Examples of costs included in *OE* are instructional supplies, conveyance and physical plant operation.

price variables. Given the absence of suitable alternatives, the bargaining power of teachers is represented by a one-zero dummy variable (*STRIKE*) that indicates whether teachers have the right to strike.[13]

Exogenous characteristics of the school system which may affect spending include the ratio of the number of students to the total population (*S/N*) since this may have an impact on the demand for education, and also represents the per capita cost of an extra dollar per student of education spending. The number of students per school (*S/SCHOOL*) may reflect the degree to which economies of scale in education are being exploited,[14] but may also affect the quality of education and the demand for education services.[15] Finally, the number of students per school board (*S/BOARD*) may have several effects on costs. Smaller boards may suffer from higher costs per student (since they cannot exploit economies of scale in administration) and may be more easily pressured by teachers to spend more and to award higher wages. In contrast, larger boards (those with more students) may be more difficult for voters to monitor and, consequently, may spend more on administration or teacher salaries.[16]

For each regime, the five education cost equations also include three variables that reflect income and relative price effects — real per capita income (*Y*), real per capita federal transfers to each province less provincial debt service payments ($F_P - I_P$), and the relative price of government-provided goods to the price of the numeraire consumption good (P_G/P_C). In addition, the constant term in each cost equation is allowed to be regime dependent.

As shown in Appendix A, the signs of the coefficients associated with each of the explanatory variables listed above will depend on the behaviour of decision makers and the institutional structure that characterizes each regime.[17] Without making restrictive assumptions with respect to the model's form and structure, the signs of these coefficients cannot be predicted ex ante. As a consequence, under each of the three regimes, the signs of the coefficients in each of the five cost equations is an empirical question.

2.3. *Data*[18]

Equations describing the five different types of education costs are estimated using annual provincial-level data covering the 10 provinces of Canada for the period from 1972/73 to 1988/89 (170 observations, 17 observations per province). Data prior to 1972/73 are excluded from the analysis because data for some variables are not available and because the provision of education services during the 1960s and early 1970s was disrupted by both the reorganization of education services in most provinces and the unprecedented growth in student numbers.[19]

The 170 available observations span the three different education expenditure control regimes: local school board control of spending with non-overlapping school boards (to be denoted local-non-overlapping control); local school board control of spending with overlapping jurisdictions (local-overlapping control); and provincial government control of spending (provincial control). The provinces with a local-non-overlapping system of education spending control were Nova Scotia and Manitoba for the entire sample period and British Columbia from 1972/73 to 1981/82 and from 1987/88 to 1988/89. Newfoundland, Ontario, Saskatchewan and Alberta had a system of local-overlapping expenditure control for the entire sample period while Quebec used this system from 1972/73 to 1979/80. Education spending was under direct provincial control in Prince Edward Island and New Brunswick for the entire sample period, in Quebec from 1980/81 to 1988/89 and in British Columbia from 1982/83 to 1986/87. Of the 170 observations in the sample, 76 are associated with the local-overlapping regime,

[13] Using US data, Delaney (1983) found that the right to strike increased teacher salaries by about 10%.

[14] The number of schools is assumed to be exogenous to school boards in a particular year (the time frame of decisions in this analysis). Wales (1973) found significant economies of scale related to school size.

[15] While smaller schools may provide a more intimate learning environment and give parents more of a feeling of participating in the education process, they may not be able to provide the same range of programmes as larger schools.

[16] Easton (1988) notes that there is a tendency reflected in the empirical literature (for example, Chambers, 1978) for larger districts to pay higher salaries. Romer, Rosenthal and Munley (1992) provide evidence that suggests that larger districts spend more per student than smaller districts.

[17] For example, the impact of an increase in the student/population ratio on the choice of education quality (and, thus, costs) will depend on the relative marginal effects of education quality and taxes on electoral support, the relative impacts of the student/population ratio and education quality on taxes through the budget constraint, and the relative impacts of the student/population ratio and the school board choice variables on the marginal benefit to the school board of changes in each of the school board's choice variables.

[18] Variable definitions and data sources are provided in Appendix B. Descriptive statistics for the data are given in Appendix C.

[19] One indicator of the changes during this period is the decline in the number of school boards in Canada. These fell from 15 990 in 1960/61 to 4245 in 1967/68 and then to 1037 in 1972/73. While consolidation has continued subsequently, there remained 868 boards in 1988/89. Data only up to 1988/89 were available due to long delays in the publication of school board financial data.

Table 1
Teacher wage equation — coefficient estimates for each regime

Variable	Local-non-overlapping	Local-overlapping	Provincial
S/N	−86 583 ***	−142 950 ***	−104 520 ***
	(2.48)	(5.85)	(4.48)
Y	0.3008	0.1808	0.3398**
	(1.21)	(1.44)	(1.68)
$F_P - I_P$	−2.116*	1.012	−0.3564
	(1.62)	(0.92)	(0.33)
P_G/P_C	18 926 ***	26 991 ***	11 162 *
	(2.42)	(5.02)	(1.62)
STRIKE	4101.5***	606.50	−1737.8
	(3.44)	(0.57)	(1.22)
S/SCHOOL	−34.70*	1.872	21.257***
	(1.57)	(0.40)	(3.86)
S/BOARD	0.4182***	0.3916***	−1.775***
	(2.16)	(2.77)	(2.86)
Constant	41 216 ***	38 460 ***	47 211 ***
	(2.63)	(3.40)	(4.26)
Test that all the parameters except the constant do not differ from the local non-overlapping regime (*F*-test)		1.34	2.99[b]
Test that all the parameters except the constant do not differ from the provincial regime (*F*-test)	3.00[b]	3.13[b]	
Buse R^2	0.899		
RESET test (*t*-statistic)	0.28		

Notes: The number in brackets below each coefficient estimate is the absolute value of the *t*-statistic associated with that coefficient.
***Significant at 95%.
**Significant at 90%.
*Significant at 85%.
[a]Rejects the null hypothesis at 5% but not at 1%.
[b]Rejects the null hypothesis at 5% and at 1%.

46 with the local-non-overlapping regime and 48 with the provincial control regime.[20]

Canadian education data not only span all three spending control regimes, but are also highly variable across provinces and time. From 1972 to 1988, real provincial GDP per capita grew by an average of 63% and the proportion of students in the population fell by 28%. During the same period, real spending per student on total education operating costs rose by 102%, average real teacher salaries and benefits (*TW*) rose by 57%, the teacher–student ratio (*TS*) rose by 24%, real per student spending on administration (*ADMIN*) rose by 170%, real operating costs per student exclusive of teachers' salaries and administration (*OE*) rose by 100%, and real per student services provided by the provinces to school boards (*GSSB*) rose by 187%.

In 1988/89, real (in 1986 constant dollars) operating expenditures per student varied from $3154 in Newfoundland to $4832 in Quebec, average teacher salaries and fringe benefits varied from $40 145 in Newfoundland to $48 627 in Alberta, the number of teachers per thousand students varied from 54.5 in British Columbia to 62.7 in Manitoba, real per student administration costs

[20] The distribution of the data across the three regimes was made on the basis of information in Council of Ministers of Education (1985, 1988); Lawton (1987); Sale (1992) as well as various issues of the Canadian Tax Foundation's *Provincial and Municipal Finances* (Canadian Tax Foundation, various issues). Newfoundland is often asserted to have a provincially controlled education system rather than the local-overlapping system assumed here. Although the provincial government provides the bulk of education finances, "There is no direct government control over school board expenditures. Accountability is encouraged at the school district level by the participation of the general public in funding education through local taxation" (Council of Ministers of Education, 1988, p. 93). In Nova Scotia, all funds used by school boards come from the province or municipal governments. School boards have no powers of taxation. While the province sets minimum education contribution levels for municipalities, municipal governments can provide funds in addition to this basic contribution and so Nova Scotia was assumed to have a locally controlled education system. School boards in parts of rural Alberta were also not independent of municipal governments.

Table 2
Teachers per 1000 students — coefficient estimates for each regime

Variable	Local-non-overlapping	Local-overlapping	Provincial
S/N	−128.65***	−145.41***	−138.82***
	(4.40)	(6.72)	(3.42)
Y	−0.0002	−0.0001	−0.00006
	(1.00)	(1.43)	(0.21)
$F_P - I_P$	0.0003	0.0030***	−0.0020
	(0.22)	(3.40)	(1.02)
P_G/P_C	12.35**	13.373***	−21.15***
	(1.94)	(3.02)	(2.20)
STRIKE	3.331***	−0.1000	−1.443
	(3.36)	(0.10)	(0.65)
S/SCHOOL	−0.0920***	0.0021	0.0021
	(3.76)	(0.39)	(0.22)
S/BOARD	−0.00003	−0.00001	−0.0008
	(0.34)	(0.06)	(0.77)
Constant	101.89***	74.044***	110.97***
	(9.37)	(7.96)	(6.64)
Test that all the parameters except the constant do not differ from the local non-overlapping regime (*F*-test)		5.45[b]	5.59[b]
Test that all the parameters except the constant do not differ from the provincial regime (*F*-test)	5.59[b]	3.86[b]	
Buse R^2	0.900		
RESET test (*t*-statistic)	0.13		

See notes to Table 1.

varied from $209 in Nova Scotia to $505 in Quebec, and real operating costs per student exclusive of spending on the salaries of teachers and administration varied from $555 in Newfoundland to $1451 in Quebec. The teacher wage bill, a function of the average salary and benefits of teachers (*TW*) and the teacher–student ratio (*TS*), is the largest component of education costs. On average, total teachers' salaries and fringe benefits were equal to 68% of education operating costs during the sample period. However, they varied from 75% of total operating costs in Newfoundland to only 62% of education costs in Quebec.

3. Estimation results

3.1. Estimates of the cost equations

Equations describing average teacher salaries and fringe benefits (*TW*), the teacher–student ratio (*TS*), education administration expenditures of school boards and the province (*ADMIN*), provincial government services to school boards (*GSSB*) and school board operating expenditures other than teacher wages and administration (*OE*) were estimated separately using a pooled cross-section estimation technique (since the sample consists of a pooled cross-section time series of provincial data) that accounts for the non-constancy across provinces of the variance of the error term and corrects for serial correlation in the errors (White, 1993).[21] In addition, since behaviour may be regime dependent, interaction of all the explanatory variables with regime dummy variables allows all the estimated coefficients in each of the five cost equations to differ across the three regimes.

The estimated coefficients of the *TW*, *TS*, *ADMIN*, *GSSB* and *OE* equations are presented in Tables 1–5, respectively. The R^2 statistics for four of the five equations are fairly high (ranging from 0.675 to 0.900), although the R^2 statistic for the government services to school boards (*GSSB*) equation is only 0.212. The estimates of the teacher–wage equation and the teacher–student ratio equation are not rejected by a RESET specification test.[22] However, a RESET test does reject the estimates of the administrative cost, the *GSSB*, and the other operating expenditures (*OE*) equations and, thus,

[21] The income variables and the education spending variables were all converted into real per capita terms and real per student terms, respectively. Each equation was estimated in levels. Preliminary estimates using logs were generally rejected by a RESET test.

[22] The RESET test is described in Ramsey (1969).

Table 3
Administration costs per student — coefficient estimates for each regime

Variable	Local-non-overlapping	Local-overlapping	Provincial
S/N	−1913.7***	−2589.1***	−3969.4***
	(2.48)	(6.95)	(5.77)
Y	0.0122***	−0.0030***	−0.0013
	(2.09)	(2.07)	(0.24)
$F_P - I_P$	0.0102	0.0442***	0.0141
	(0.36)	(2.62)	(0.44)
P_G/P_C	−735.37***	75.83	−817.20***
	(4.83)	(0.86)	(4.61)
STRIKE	4.727	40.594**	64.305**
	(0.19)	(1.72)	(1.78)
S/SCHOOL	−2.592***	0.1783**	0.1960
	(4.71)	(1.76)	(1.17)
S/BOARD	−0.011***	0.0084***	0.0302**
	(3.43)	(3.07)	(1.66)
Constant	2010.6***	630.55***	1608.7***
	(6.17)	(3.64)	(5.42)
Test that all the parameters except the constant do not differ from the local non-overlapping regime (*F*-test)		17.54[b]	7.85[b]
Test that all the parameters except the constant do not differ from the provincial regime (*F*-test)	7.86[b]	6.00[b]	
Buse R^2	0.675		
RESET test (*t*-statistic)	2.98[b]		

See notes to Table 1.

the results associated with these equations should be treated with more caution.

As is evident from an examination of the results in Tables 1–5, the coefficient estimates differ quite significantly across the three regimes in terms of which variables are significant as well as with respect to the magnitude of the estimated coefficients. Since the institutional structure of expenditure determination is quite different under each of the three regimes, these large differences in the coefficient estimates are not surprising. The hypothesis that all the coefficients (except those associated with the regime-dependent constant) are the same across all three regimes is rejected in every case. This result implies that the behaviour determining education costs differs significantly under the three regimes and suggests that the extent of these differences in behaviour is unlikely to be adequately represented by a single proxy variable.

While the large number of estimated coefficients implies that a detailed discussion of the estimates is impractical, several general conclusions can be drawn. Fourteen of the 15 estimated parameters associated with the variable representing the proportion of students in the population (*S/N*) are significant. This variable generally has a negative effect on the level of resources allocated to each type of cost which is consistent with its role as the per capita price of an extra dollar of spending per student. The other price variable, the price of government services relative to the price of the consumption good (P_G/P_C), is significant in a majority of cases, and is generally positive, indicating that as the price of government services increases, the quantity of resources devoted to education rises.

The two income variables, provincial GDP per capita (*Y*) and Federal transfers to the provinces less provincial interest payments ($F_P - I_P$), have only a weak impact on the five cost variables. Only for administration costs (*ADMIN*) and provincial government services to school boards (*GSSB*) does there seem to be a significant positive relationship between the income variables and spending, although even in these two cases this relationship is not clear cut. The general insignificance of the two income variables may not, in fact, be unexpected. Since local school boards rely on property taxes (which are not generally deductible from income in Canada) to finance their spending, and receive no direct benefit from Federal transfers to the provinces, the link between the two income variables and local school board revenues may be quite weak. While the link between provincial government revenues and the two income variables should be stronger, the relationship between income and provincial education spending is complicated by the multi-purpose role of provincial government spending.

The right to strike dummy variable (*STRIKE*) is posi-

Table 4
Government services to school boards — coefficient estimates for each regime

Variable	Local-non-overlapping	Local-overlapping	Provincial
S/N	−1029.1**	293.453	4704.5***
	(1.88)	(0.83)	(1.97)
Y	−0.0063*	0.0022**	0.0247
	(1.51)	(1.78)	(1.37)
$F_P - I_P$	−0.0047	0.0433***	0.1100
	(0.23)	(2.45)	(0.99)
P_G/P_C	7.660	279.33***	2195.9***
	(0.08)	(3.44)	(3.79)
STRIKE	−12.92	−6.328	39.529
	(0.75)	(0.72)	(0.30)
S/SCHOOL	−0.1803	0.0493	−2.651***
	(0.41)	(0.44)	(5.02)
S/BOARD	−0.0014	−0.0059***	−0.1718***
	(0.82)	(2.36)	(2.76)
Constant	464.10***	−290.33**	−1515.6*
	(2.32)	(1.79)	(1.49)
Test that all the parameters except the constant do not differ from the local non-overlapping regime (*F*-test)		2.86[b]	25.96[b]
Test that all the parameters except the constant do not differ from the provincial regime (*F*-test)	25.96[b]	22.09[b]	
Buse R^2	0.212		
RESET test (*t*-statistic)	8.02[b]		

See notes to Table 1.

tive in a majority of cases, significant and positive in four cases, and is never negative and significant. This provides some evidence that the ability of teachers to strike raises education costs.

The number of students per school (*S/SCHOOL*) has a generally positive effect on the teacher wage (*TW*) and the number of teachers per student (*TS*) under both the local-overlapping and provincial regimes, but has a negative effect, possibly indicating the presence of economies of scale, under the local-non-overlapping regime. While *S/SCHOOL* also has a negative effect on the other three types of costs under the local-non-overlapping regime, under the provincial regime it only has a negative effect on provincial government services to school boards (*GSSB*), while it has a positive effect on administration costs (*ADMIN*) under the local-overlapping regime.

The number of students per school board (*S/BOARD*) generally has a negative effect on education costs under the provincial regime (except for the case of administrative costs) and the local-non-overlapping regime (except for the case of teachers' wages). Under the local-overlapping regime, the impact on costs of *S/BOARD* is less clear — three of the estimated coefficients are negative, but only one of these is significant, while the two positive coefficients are both significant. Overall, however, the results give some support to the hypothesis that larger boards cause some types of education costs to be lower.

4. A comparison of the magnitude of education costs under the three regimes

The principal purpose of this study is to compare the levels of the five different types of education costs under three different regimes of education spending control — the local-non-overlapping, local-overlapping and provincial regimes. Since the estimation methodology allows the whole pattern of behaviour to vary across regimes (and the coefficient estimates indicate that behaviour does in fact differ significantly between regimes), there does not exist a single estimated coefficient that can indicate whether one regime leads to higher costs than another.[23] As a result, the levels of the five education cost variables (*TW*, *TS*, *ADMIN*, *GSSB* and *OE*) under each of the three regimes can only be compared using simulations.

Simulation of the five education cost variables under

[23] For example, the significant positive constant term associated with the provincial regime in the teacher wage equation (Table 1) does not imply that teacher wages are necessarily higher under this regime than under the other two regimes since the other estimated coefficients differ across the three regions and these differences must be taken into account when comparing cost levels under the three regimes.

Table 5
Other education operating expenditures — coefficient estimates for each regime

Variable	Local-non-overlapping	Local-overlapping	Provincial
S/N	−4532.9***	−6328.8***	−6419.9***
	(5.22)	(7.31)	(3.89)
Y	0.0086	−0.0095***	0.0048
	(1.19)	(3.04)	(0.39)
$F_P - I_P$	0.0058	−0.1673***	−0.0442
	(0.14)	(4.51)	(0.59)
P_G/P_C	431.10*	297.79*	−668.45**
	(1.47)	(1.57)	(1.76)
STRIKE	−3.913	17.561	78.381
	(0.14)	(0.47)	(0.90)
S/SCHOOL	−1.030	0.0144	0.6724**
	(1.19)	(0.06)	(1.74)
S/BOARD	−0.0067***	−0.0103	−0.0129
	(1.97)	(0.97)	(0.31)
Constant	1489.0***	2231.9***	2522.7***
	(3.19)	(6.02)	(3.78)
Test that all the parameters except the constant do not differ from the local non-overlapping regime (*F*-test)		2.34[a]	2.28[a]
Test that all the parameters except the constant do not differ from the provincial regime (*F*-test)	2.29[a]	2.72[a]	
Buse R^2	0.890		
RESET test (*t*-statistic)	8.88[b]		

See notes to Table 1.

each of the three regimes was carried out using the following procedure. The estimated coefficients from Tables 1–5, in conjunction with *all* the observations on the explanatory variables, were used to predict the five dependent variables under each of the three regimes for each province during each year from 1972/73 to 1988/89. Since the same data is used to predict costs under each of the three regimes, predicted costs vary across the regimes only as a result of differences in the estimated coefficients for the three regimes. The values reported for each of the five cost variables in Table 6 are the means of the simulated values for the 10 provincial observations that correspond to the last year of the data set (1988/89). To provide some evidence of the robustness of the predictions, the average simulated values under each regime for the entire sample are provided in Table 7.

Using either the predicted values averaged over the last year of the sample (Table 6) or the predicted values averaged over the entire sample (Table 7), the provincial regime has both the lowest teacher salaries, the lowest teacher–student ratio and, thus, the lowest overall teacher costs. In contrast, the local-overlapping regime is characterized by the highest teacher salaries, the highest teacher–student ratio and, thus, the highest teacher-related costs. This evidence suggests that provincial governments are better at containing teacher salary costs, perhaps due to their stronger bargaining power vis-à-vis teacher associations, than the smaller and more decentralized local school boards.

Administration costs are also lowest under the provincial regime, in which major decisions are made centrally, than under the two local control regimes, in which each school board must operate an administrative structure. Once again, the costs associated with the local-overlapping regime are the highest in both Tables 6 and 7.

As might be expected, the provinces must provide much larger government services to school boards (*GSSB*) when the education system is run from the centre (the provincial regime) than when there is local control and, as a result, the simulated value of *GSSB* is highest under the provincial regime. If administration costs (*ADMIN*) and provincial government services to school boards (*GSSB*) are combined, these combined costs are almost twice as large under the provincial regime as under the two local-control regimes. This result suggests that, while the two local-control regimes are not better at controlling teacher costs than the provincial regime, they may be more successful at restraining administrative spending, perhaps due to the greater inter-jurisdictional competition that characterizes these regimes. In contrast, the predicted level of other operating expenditures (*OE*) is highest under the local-overlapping regime and lowest under the local-non-overlapping regime.

Table 6
Predicted education costs under each regime for 1988/89

Type of cost	Institutional structure		
(Mean of the actual 1988/89 data)	Local-non-overlapping	Local-overlapping	Provincial
Average teacher salary (*TW*)	42 165[b]	45 341[a]	41 105
(43 915)	(2.6)	(10.3)	
Teachers per 1000 students (*TS*)	58.96[b]	59.77[a]	56.18
(58.113)	(4.9)	(6.4)	
Administration costs (*ADMIN*)	289.43[b]	311.65[a]	279.51
(298.42)	(3.5)	(11.5)	
Government services to school	79.11	97.23[b]	448.13[a]
boards (*GSSB*)		(22.9)	(466.5)
(170.99)			
Operating expenditures	668.25	810.28[a]	729.90[b]
(other than teacher salaries		(21.3)	(9.2)
and administration) (*OE*)			
(987.77)			
Total teacher costs per student	2486.05[b]	2710.03[a]	2309.27
(2552.03)	(7.7)	(17.4)	
Total non-teacher costs per student	1036.79	1219.16[b]	1457.54[a]
(*ADMIN* + *GSSB* + *OE*) (1457.18)		(17.6)	(40.6)
Total cost per student	3522.84	3929.12[a]	3766.81[b]
(4009.21)		(11.5)	(6.9)

Notes: Each value in this table is the mean of the predicted values for the 10 observations (one for each province) for 1988/89 using the coefficient estimates associated with each institutional structure from Tables 1–5. All values are in 1986 constant dollars.
The number in brackets under each predicted value is the percentage difference between that predicted value and the predicted value of the lowest cost regime for that type of expenditure.

[a]The highest cost regime for each type of expenditure.

[b]The second highest cost regime for each type of expenditure.

While teacher costs are highest under the local-overlapping regime and lowest under the provincial regime, total non-teacher-related costs are highest under the provincial regime and lowest under the local-non-overlapping regime in both Tables 6 and 7.

If the predictions are averaged over only the last year of the sample, the total cost per student is highest under the local-overlapping regime and lowest under the local-non-overlapping regime. However, if the cost predictions are averaged over the entire sample, while the local-non-overlapping regime continues to be the lowest cost regime, the provincial regime has the highest overall costs (although just barely relative to the local-overlapping regime).

The results in Tables 6 and 7 also indicate that the distribution of education costs across the five categories of spending is different for each of the three regimes. For example, in Table 6, approximately 69% of the costs of the local-overlapping regime are accounted for by teacher salaries. This compares to approximately 61% for the provincial regime and 71% for the local-non-overlapping regime. Under both local-control regimes the sum of administration costs and government services to school boards accounts for approximately 10% of education operating costs, while under the provincial regime these two types of costs account for just under 20% of costs.

In summary, the simulated values reported in Tables 6 and 7 imply that the local-overlapping regime is relatively poor at controlling both teacher costs, administrative costs and other operating costs. The provincial control regime is relatively good at controlling teacher costs, and administrative costs, but results in large spending on provincial government services to school boards. The local-non-overlapping regime has either the lowest or second lowest level of spending on all five categories of education costs and the lowest overall costs.[24]

[24] If teacher quality is not a choice variable of school boards in a particular year (that is, if teacher quality is predetermined), variables reflecting teacher quality should enter the five education cost equations as explanatory variables. Using the percentage of teachers with university degrees and the average age of teachers to proxy teacher quality, the cost equations were re-estimated and the cost simulations re-calculated. The inclusion of the teacher quality variables in the costs equations has little impact on the coefficient estimates and the comparison of the five types of costs under the three different regimes is essen-

Table 7
Predicted education costs under each regime averaged over the whole sample

Type of cost	Institutional structure		
(Mean of the actual data)	Local-non-overlapping	Local-overlapping	Provincial
Average teacher salary (*TW*) (37 063)	36 739[b] (0.3)	38 746[a] (5.9)	36 597
Teachers per 1000 students (*TS*) (53.283)	54.31[b] (1.1)	55.25[a] (2.9)	53.70
Administration costs (*ADMIN*) (222.84)	221.18[b] (3.2)	241.59[a] (12.8)	214.25
Government services to school boards (*GSSB*) (129.76)	68.29	84.84[b] (24.2)	374.18[a] (447.9)
Operating expenditures (other than teacher salaries and administration) (*OE*) (758.04)	668.25	810.28[a] (21.3)	729.90[b] (9.2)
Total teacher costs per student (1974.83)	1995.30[b] (1.5)	2140.72[a] (8.9)	1965.26
Total non-teacher costs per student (*ADMIN* + *GSSB* + *OE*) (1110.64)	957.72	1136.71[b] (18.7)	1318.33[a] (37.7)
Total cost per student (3085.47)	2953.02	3277.43[b] (11.0)	3283.59[a] (11.2)

Note: The predicted values in this table are calculated using all 170 observations in the data set. See the notes to Table 6.

5. Conclusion

The analysis above examines the impact of the institutional structure of spending control on different categories of education costs. Three regimes are compared — state-level (provincial-level) control of education spending; local school board control of spending without overlapping jurisdictions; and local school board control with overlapping jurisdictions. For each of these three regimes, a model is specified that describes average teacher wages (*TW*), the teacher–student ratio (*TS*), administrative costs (*ADMIN*, *GSSB*), and other operating costs (*OE*) as functions of variables reflecting the bargaining power of teachers; exogenous characteristics of the school system; income and prices.

Equations describing the determination of each of these five different types of education costs are estimated using Canadian provincial-level data. These data, by spanning all three spending control regimes, allow the entire structure of behaviour to vary across the regimes. The coefficient estimates indicate that the determinants of costs under the three regimes differ significantly and that these differences cannot be represented by a regime-dependent constant. This result casts doubt on the likelihood of successfully representing institutional differences with a single proxy variable (as has been attempted in much of the literature).

Simulations using the estimated coefficients indicate that, while the provincial regime is effective at controlling teacher related costs, this regime is associated with large provincial government spending on services to school boards and the second highest expenditures on other operating costs (*OE*). In contrast, the local-control regime *without* overlapping jurisdictions has either the lowest or second lowest level of all five types of costs, and the lowest overall costs.

The local-control regime *with* overlapping jurisdictions has the highest level of spending on four of the five different costs. This regime may not be characterized by large enough jurisdictions to bargain successfully against teacher associations, while the benefits of inter-jurisdictional competition may not be large enough to counter the increased administrative and other costs associated with operating parallel school systems.

If the control of education costs is a policy goal, the results above indicate that the lowest level of education costs can be achieved through local-control *without* overlapping jurisdictions. While the provincial regime successfully restrains teacher costs, and may be best at equalizing spending per student across school districts, it is not the best regime for controlling other education costs and, in addition, it provides little local input into edu-

tially the same as that given in Tables 6 and 7. The estimates which include the two teacher quality variables are available from the author on request.

cation spending decisions. As an alternative, provincial authorities could take responsibility for bargaining with teachers over salaries and student–teacher ratios while allowing decisions about the level of expenditures on other education inputs to be made at the local level. This division of responsibility could produce the lowest level of overall education costs, particularly if a local-control regime *without* overlapping jurisdictions is employed, while increasing the level of local control over education spending decisions.

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Appendix A

Derivation of the estimating equations

The derivation of the estimating equations is treated separately for the two principal institutional structures being examined — the case in which local school boards have control of education spending and the case in which spending control resides with the provincial government. For the two regimes with local school board control, education spending typically depends on the behaviour of governments at both the local and the provincial levels since provincial governments generally provide grants to local school boards. In addition, provinces undertake some (relatively minor) direct education spending of their own. Thus, for the two local control regimes, it is necessary to model the behaviour of both levels of government in order to model the determination of spending on particular types of education costs. In contrast, under the provincial control regime, it is only necessary to model the behaviour of the provincial government since, in this case, local school boards have no effective impact on the level of education spending.

A model of education cost determination with local school board control of spending

Since only aggregate provincial-level school board (and other) data are available on a consistent basis, a representative school board is used to model the behaviour of school boards in each province. This school board determines the level of local school taxes and the level of education spending, and negotiates salaries and some aspects of working conditions with teachers. When determining the level of spending, and in their bargaining with teachers, the board takes grants from the higher level of government as given. Since there exist many school boards in each province, an individual board is unlikely to act as if it can alter the provincial government's grant determination formula. (In Canada, provincial grants are based on exogenous factors rather than on the actual expenditures of boards (Council of Ministers of Education, 1985, 1988).

Following the vote-maximizing models of Hettich and Winer (1984, 1988), Winer and Hettich (1991, 1992) and Holtz-Eakin (1992), school boards choose the level of school taxes and spending to maximize their own welfare. Specifically, school boards make choices in order to maximize the preference function:

$$\Phi = \Phi(ES,\mathbf{Z}), \quad \Phi_{ES}(\cdot) > 0, \quad \Phi_{\mathbf{Z}}(\cdot) > 0, \tag{3}$$

where ES is the expected voter support for the board, and $\mathbf{Z}$ is a vector of factors which may directly affect the school board's welfare. These might include spending on buildings, salaries, support staff, etc. (See Mehay and Gonzalez (1986) for a discussion of these types of factors and why they might enter the objective function of public sector managers.)

The expected support of voters depends on the level of education services provided by the board, voter income less education taxes, and a vector of exogenous factors which may alter the tendency of voters to support the school board:

$$ES = ES(E,Y - T,\mathbf{X}), \quad ES_E(\cdot) > 0, \quad ES_{Y-T}(\cdot) > 0, \tag{4}$$

where E is a per student index of the perceived quality and quantity of education services provided by the board, Y is the real income of the representative voter measured in terms of the consumption good, T are real school board taxes measured in terms of the consumption good, and $\mathbf{X}$ is a vector of exogenous factors which may alter the tendency of the representative voter to support the board.

In part, the support of voters for a particular school board may depend on voters' perceptions of the actions of neighbouring boards or, in the regime with overlapping jurisdictions, their perception of the actions of the other board in the same geographic region. (Ladd (1992); Besley & Case (1995) analyse models in which voters compare the actions of their government to those of governments in neighbouring jurisdictions.) Therefore, the form of the $ES(\cdot)$ function may depend on whether school board jurisdictions are overlapping or non-overlapping. (An alternative approach is to introduce neighbouring and/or overlapping school board taxes and spending explicitly into the $ES(\cdot)$ function. This would not change the reduced-form estimating equations since, in the process of determining aggregate provincial-level spending, the spending of individual boards which represent these "neighbourhood effects" must be factored out. Since there exist many school boards in each prov-

ince, individual boards take the actions of other boards as exogenous to their own actions.)

The education index, E, is described by the transformation function:

$$E = E(TS,\mathbf{TQ},\mathbf{EQ}_C,\mathbf{EQ}_{NC}) \tag{5}$$

$$E_{TS}(\cdot) > 0, \quad E_{\mathbf{TQ}}(\cdot) > 0, \quad E_{EQ}(\cdot) > 0,$$

where TS is the teacher–student ratio, $\mathbf{TQ}$ is a vector of variables reflecting teacher quality that can be chosen by the board, and $\mathbf{EQ_C}$ is a vector of non-teacher variables reflecting education quality that can be chosen by the board. This could include expenditures on non-teacher education services or facilities. $\mathbf{EQ_{NC}}$ is a vector of non-teacher variables reflecting education quality that are not chosen by the board (at least in the short run) such as the size of schools.

Elements of $\mathbf{EQ_C}$ (and even $\mathbf{EQ_{NC}}$) could be arguments in $\mathbf{Z}$ as well.

The budget constraint of the representative school board is:

$$S{\cdot}P_E{\cdot}E = S{\cdot}P_C{\cdot}G + N{\cdot}P_C{\cdot}T, \tag{6}$$

where S is the number of students, P_E is the price of education services, P_C is the price of the numeraire consumption good, G is real per student grants to the school board from the provincial government, and N is the population of the jurisdiction.

Each school board chooses its taxes and spending on education once the level of teachers' salaries and the teacher–student ratio have been determined. (This does not imply that teacher salaries and the teacher–student ratio are exogenous to the school board. Rather, as discussed below, the levels of these two teacher cost variables are the result of a bargaining process, the outcome of which depends on the school board's preferences and budget constraint.) In making this choice, the school board takes as exogenous to its own choices the size of the grant it will receive from the province, the actions of other boards, as well as certain characteristics of the school system (for example, the number of students, the number of schools).

The ratio of the price of education services to the price of the consumption good can be represented by the function:

$$P_E/P_C = P(TW,TS,\mathbf{Z}), \tag{7}$$

$$P_{TW}(\cdot) > 0,\ P_{TS}(\cdot) > 0,\ P_{\mathbf{Z}}(\cdot) > 0,$$

where TW is the average real wage of teachers in terms of the consumption good.

Following the substitution of Eqs. (4)–(7) into Eq. (3) for the variables ES, T, E and P_E/P_C, respectively, the school board preference function can be rewritten as:

$$\Phi = \hat{\Phi}(TS,\mathbf{TQ},TW,\mathbf{EQ}_C,\mathbf{EQ}_{NC},Y,S/N,G,\mathbf{X},\mathbf{Z}), \tag{8}$$

the partial derivatives of which are ambiguous except for $\hat{\Phi}_{TW}(\cdot) < 0$, $\hat{\Phi}_Y(\cdot) > 0$, and $\hat{\Phi}_G(\cdot) > 0$. The board maximizes Φ by choice of $\mathbf{TQ}$, $\mathbf{EQ_C}$ and $\mathbf{Z}$ taking all other variables as exogenous to its actions. This optimization procedure yields the following equations which describe the determination of $\mathbf{TQ}$, $\mathbf{EQ_C}$ and $\mathbf{Z}$:

$$\mathbf{TQ} = \mathbf{TQ}(TS,TW,\mathbf{EQ}_{NC},Y,S/N,G,\mathbf{X},), \tag{9}$$

$$\mathbf{EQ}_C = \mathbf{EQ}_C(TS,TW,\mathbf{EQ}_{NC},Y,S/N,G,\mathbf{X},), \tag{10}$$

$$\mathbf{Z} = \mathbf{Z}(TS,TW,\mathbf{EQ}_{NC},Y,S/N,G,\mathbf{X},), \tag{11}$$

where the partial derivatives of $\mathbf{TQ}(\cdot)$, $\mathbf{EQ_C}(\cdot)$ and $\mathbf{Z}(\cdot)$ are all ambiguous. Substituting for $\mathbf{TQ}$, $\mathbf{EQ_C}$ and $\mathbf{Z}$ in Eq. (8) yields:

$$\Phi^* = \hat{\Phi}^*(TS,TW,\mathbf{EQ}_{NC},Y,S/N,G,\mathbf{X}). \tag{12}$$

The teacher–student ratio (TS) and teacher wages (TW) are determined through bargaining with the teachers' association taking $\mathbf{EQ_{NC}}$, Y, S/N, G and $\mathbf{X}$ as given. The preferences of the teachers' association are represented by the function:

$$\Omega = \Omega(TS,TW,\mathbf{EQ}_C,\mathbf{EQ}_{NC}), \tag{13}$$

where all the partial derivatives of $\Omega(\cdot)$ are positive and $\mathbf{EQ_C}$ is determined by Eq. (10) above. Teachers are assumed to prefer higher salaries, a higher teacher–student ratio, and, potentially, more spending on other inputs associated with education quality (since these may make their jobs easier). Assuming an efficient Nash-cooperative bargaining framework, the teachers and the board choose TS and TW to maximize (Manning, 1987):

$$\Pi = \Omega^{\theta}\Phi^{*1-\theta},$$

where θ represents the relative bargaining strength of teachers and the board. The solution to this problem yields the optimal values of TS and TW:

$$TS^* = TS(\mathbf{EQ}_{NC},Y,S/N,G,\mathbf{X},\theta), \tag{14}$$

$$TW^* = TW(\mathbf{EQ}_{NC},Y,S/N,G,\mathbf{X},\theta). \tag{15}$$

Substitution of Eqs. (14) and (15) into Eqs. (10) and (11) gives:

$$\mathbf{EQ}_C^* = \mathbf{EQ}_C^*(\mathbf{EQ}_{NC},Y,S/N,G,\mathbf{X},\theta), \tag{16}$$

$$\mathbf{Z}^* = \mathbf{Z}(\mathbf{EQ}_{NC},Y,S/N,G,\mathbf{X},\theta). \tag{17}$$

In provinces with local school board control of education spending, there is some spending on education at the provincial level since provincial governments determine curricula and may also provide special services to local boards. In addition, the provincial government provides grants (G) to school boards. Under the two local control regimes, voters know that local spending on education depends on the size of the provincial grant and so

allocate some of the responsibility for education spending to the provincial government. The provincial government chooses the magnitude of its grant to local school boards in order to maximize its own electoral support taking into account the form of the dependence of the behaviour of local boards on the size of its grant. Unlike the single-purpose local school boards, provincial governments have a wide range of spending and tax policies which may affect their voter support and which they must trade off against larger grants to local boards. The province decides on the level of G and its own spending, taking as given the solution to the local spending decision as represented by Eqs. (9), (14)–(17), to maximize its expected electoral support function:

$$ES_P = ES_P(\mathbf{E}_P, E, GS_P, Y - T_P, D_P), \tag{18}$$

where $\mathbf{E_P}$ is a vector of different types of real (in terms of the consumption good) per student spending on education directly made by the province, GS_P is per capita real provincial spending on goods and services other than education, T_P is real per capita provincial taxes, and D_P is the real per capita provincial deficit.

The inclusion of school board spending on education (E) in the provincial government electoral support function reflects the assumption that voters attribute some of the responsibility for school board spending to the provincial government. The ES_P function could also include a variable representing the distribution of education spending across school districts in order to reflect equity concerns.

The budget constraint of the province in real per capita terms is:

$$T_P + F_P + D_P = \tag{19}$$
$$(P_G/P_C)\cdot GS_P + (S/N)\cdot G + I_P + (S/N)\cdot \mathbf{E}_P,$$

where F_P are real per capita federal transfers to the province, P_G is the price of goods and services purchased by the province, and I_P are real per capita interest payments on the provincial debt.

Maximization of ES_P subject to this budget constraint yields functions describing the optimal values of T_P, D_P, GS_P and, most importantly, G and $\mathbf{E_P}$:

$$G^* = G(E, Y, F_P - I_P, P_G/P_C, S/N), \tag{20}$$

$$E_P^* = \mathbf{E}_P(E, Y, F_P - I_P, P_G/P_C, S/N). \tag{21}$$

Using Eq. (20) to substitute out for G in Eqs. (14)–(17), and Eqs. (5), (9), (14) and (16) to substitute for E in Eq. (21) yields:

$$TS^* = TS(\mathbf{EQ}_{NC}, S/N, Y, F_P - I_P, P_G/P_C, \mathbf{X}, \theta). \tag{22}$$

$$TW^* = TW(\mathbf{EQ}_{NC}, S/N, Y, F_P - I_P, P_G/P_C, \mathbf{X}, \theta). \tag{23}$$

$$EQ_C^* = EQ_C(\mathbf{EQ}_{NC}, S/N, Y, F_P - I_P, P_G/P_C, \mathbf{X}, \theta). \tag{24}$$

$$\mathbf{Z}^* = \mathbf{Z}(\mathbf{EQ}_{NC}, S/N, Y, F_P - I_P, P_G/P_C, \mathbf{X}, \theta). \tag{25}$$

$$E_P^* = \mathbf{E}_P(\mathbf{EQ}_{NC}, S/N, Y, F_P - I_P, P_G/P_C, \mathbf{X}, \theta). \tag{26}$$

These five equations describe the major sub-categories of costs that, when aggregated, determine total education spending.

A model of education cost determination with provincial control of spending

The model with provincial spending control is very similar to that with local control except that all education spending is determined at the level of the provincial government and, thus, it is not necessary to model school board behaviour. In this case, the expected voter support function for the provincial government is:

$$ES_P = ES_P(\mathbf{E}_P, E, GS_P, Y - T_P, D_P, \mathbf{X}_P), \tag{27}$$

where $\mathbf{X_P}$ is a vector of other education factors which may alter a voter's preferences for the provincial party, and the goal of the provincial government is to maximize the preference function $\Phi_P = \Phi_P(ES_P, \mathbf{Z_P})$ in which ES_P and $\mathbf{Z_P}$ are analagous to ES and $\mathbf{Z}$. (Using Eq. (18) rather than this preference function for the province would not alter the basic form of the reduced form cost equations.) The budget constraint of the province in real per capita terms is now:

$$T_P + F_P + D_P = \tag{28}$$
$$(P_G/P_C)\cdot GS_P + I_P + (S/N)\cdot(P_E/P_C)\cdot E + (S/N)\cdot \mathbf{E}_P.$$

The solution method in this case is exactly the same as that under local school board control, except that there is no need to determine the level of the grant to the local board, and yields reduced form equations which are identical in form to Eqs. (22)–(26), above.

Transformation of the reduced form equations into estimable form

In order to estimate Eqs. (22)–(26), it is necessary to associate the dependent and independent variables in these equations with variables for which data are available. The dependent variables TS and TW have straightforward representations in the available data. The $\mathbf{EQ_C}$, $\mathbf{Z}$ and $\mathbf{E_P}$ variables are represented by the following three variables: administrative expenses of both school boards and the provincial government (*ADMIN*) — this could be the sum of certain elements of one or all of $\mathbf{EQ_C}$, $\mathbf{Z}$ and $\mathbf{E_P}$; expenditures by school boards on operating costs other than teachers' salaries and administration (*OE*) which could be the sum of elements in $\mathbf{EQ_C}$ and $\mathbf{Z}$; and provincial government services to school boards (*GSSB*) which could be an element in $\mathbf{E_P}$.

A subset of the explanatory variables in Eqs. (22)–(26) — S/N, Y, $F_P - I_P$, P_G/P_C — all have relatively straightforward representations in the data. Variables which proxy non-choice aspects of education quality ($\mathbf{EQ_{NC}}$), exogenous factors which may alter voter support for the school board or the province ($\mathbf{X}$ and $\mathbf{X_P}$) and factors which reflect the relative bargaining strength of teachers' (the determinants of θ) are discussed in Section 2 of the text.

Appendix B

Variable definitions and data sources

ADMIN

Real per student expenditures on administration. This is the sum of school board expenditures on administration and departmental (provincial) expenditures on administration deflated by S and P_C. Source: 1972/73–1979/80: Statistics Canada, *A Decade of Education Finance, 1970–71 to 1979–80* (81–560): 1980/81–1983/84: Statistics Canada, *Financial Statistics of Education 1984–85* (81–208); 1984/85–1988/89: Statistics Canada, *Financial Statistics of Education 1988–89* (81–208).

BOARD

Number of school boards by province. Excludes special revenue school districts in Manitoba (because they have no revenue base), equals school units plus school districts not in units in Saskatchewan and only includes districts in Alberta which operate schools. Source: Canadian Tax Foundation, *Provincial and Municipal Finances*, various issues; Council of Ministers of Education (1988); Lawton (1987); Department of Education, Prince Edward Island, *Annual Report*, various issues; Department of Education, New Brunswick, *Statistics: Enrollment by School*, various issues; Department of Education, Quebec, *Education in Quebec*, various issues; Department of Education, Quebec, *L'education au Quebec*, various issues; Department of Education, Quebec, *Repertoire des organismes et des etablissements d'enseignement*, various issues; Department of Education, Quebec, *Statistique de l'education*, various issues; Ministry of Education, Ontario, *Directory of School Boards*, various issues; Department of Education, Manitoba, *Education in Manitoba Annual Report*, various issues; Saskatchewan Education, *Annual Report*, various issues; Alberta Education, *Annual Report*, various issues; Ministry of Education, Province of British Columbia, *Statistical Supplement to the Ministry of Education Annual Report*, various issues; Ministry of Education, Province of British Columbia, *Report on Education*, various issues.

$F_P - I_P$

Real per capita federal transfers to the province minus the real per capita interest payments of the province. Source: Statistics Canada, Cansim database series: D12842, D12862, D12882, D12902, D12922, D12942, D12962, D12982, D13002 and D12822 less D12851, D12871, D12891, D12911, D12931, D12951, D12971, D12991, D13011 and D12831 deflated by *POP* and P_C.

GSSB

Real per student provincial government services to school boards. Source: 1972/73–1979/80: Statistics Canada, *A Decade of Education Finance, 1970–71 to 1979–80* (81–560): 1980/81–1988/89: Statistics Canada, *Financial Statistics of Education* (81–208), various issues, deflated by S and P_C.

N

Population by province. Source: Statistics Canada, Cansim Database series: D892586, D892904, D893222, D893540, D893858, D894176, D894494, D894812, D895130 and D895448.

OE

Real per student operating expenditures of school boards less their spending on teachers' salaries and administration. Source: 1972/73–1979/80: Statistics Canada, *A Decade of Education Finance, 1979–71 to 1979–80* (81–560): 1980/81–1983/84: Statistics Canada, *Financial Statistics of Education 1983–84* (81–208); 1984/85–1987/88: Statistics Canada, *Financial Statistics of Education 1987–88* (81–208); 1988/89: Statistics Canada, *Financial Statistics of Education 1988–89* (81–208) deflated by S and P_C.

P_C

Price of the consumption good. Source: Implicit Price Index of Final Domestic Demand (1986 = 100), Statistics Canada, Cansim Database series: D44764, D44778, D44792, D44806, D44820, D44834, D44848, D44862, D44876 and D44890. These prices were adjusted for inter-provincial differences in living costs (Toronto is used as the base) using the relative living costs for homeowners given in J.G. Frank, *Provincial Differences: A Challenge to Compensation and Relocation Policies*, Conference Board of Canada, 1981, p. 30.

P_G

Price index for goods and services purchased by provincial governments. It equals 100 in 1986 for each of the 10 provinces. Source: Implicit Price Index of Final Domestic Demand: Government Current Expenditure on Goods and Services, Statistics Canada, Cansim Database series: D44770, D44784, D44798, D44812, D44826, D44840, D44854, D44868, D44882 and D44896.

P_G/P_C

The price of goods purchased by government divided by the price of the numeraire consumption good. Since this is a ratio of two price indices, neither index was adjusted for inter-provincial price level differences.

S

Number of students enrolled in primary and secondary public schools. Source: 1972/73–1979/80: Statistics Canada, *A Decade of Education Finance, 1970–71 to 1979–80* (81–560); 1980/81–1984/85: Statistics Canada, *Education in Canada: A Statistical Review for 1984–85* (81–229); 1985/86–1988/89: Statistics Canada, *Education in Canada: A Statistical Review for 1989–90* (81–229).

SCHOOL

The number of public elementary and secondary schools. Source: 1972/73–1979/80: Statistics Canada, *Education Statistics for the Seventies 1979* (81–569); 1982/83–1988/89: Statistics Canada, *Elementary–Secondary School Enrollment* (81–210), various issues; 1980/81–1981/82: Statistics Canada, *Education in Canada* (81–229), various issues. For 1980/81 and 1981/82 data were only available for all schools (including federal schools and private schools). The data for these two years were adjusted by taking the average difference between the data for the previous year and the following year for both definitions and subtracting this from the 1980/81 and 1981/82 data to give an estimate of the number of public elementary and secondary schools.

STRIKE

A right-to-strike dummy variable. It equals one if teachers have the right to strike and zero otherwise. (Source: Gayfer, 1974, 1978, 1984, 1991).

S/BOARD

The average number of students per school board.

S/N

Students in primary and secondary education as a fraction of the population.

S/SCHOOL

The average number of students per school.

TS

Teachers per 1000 students. This is the sum of the number of full-time teachers and the number of full-time equivalent part-time teachers divided by *S* and multiplied by 1000. Source: 1972/73–1979/80: Statistics Canada, *A Decade of Education Finance, 1970–71 to 1979–80* (81–560); 1980/81–1984/85: Statistics Canada, *Education in Canada: A Statistical Review for 1984–85* (81–229); 1985/86–1988/89: Statistics Canada, *Education in Canada: A Statistical Review for 1989–90* (81–229). The number of full-time equivalent part-time teachers was not available for 1980/81 to 1984/85 and so was approximated by a linear interpolation for each province of the data from immediately preceding and immediately following years.

TW

Average real salary and fringe benefits of teachers. Source: 1972/73–1979/80: Statistics Canada, *A Decade of Education Finance, 1970–71 to 1979–80* (81–560); 1980/81–1983/84: Statistics Canada, *Financial Statistics of Education 1983–84* (81–208); 1984/85–1987/88: Statistics Canada, *Financial Statistics of Education 1987–88* (81–208); 1988/89: Statistics Canada, *Financial Statistics of Education 1988–89* (81–208) deflated by P_C and the number of teachers (see *TS*).

Y

Real per capita GDP. Source: Statistics Canada, Cansim Database series: D31544, D31558, D31572, D31586, D31600, D31614, D31628, D31642, D31656 and D44000 deflated by P_C and *POP*.

Appendix C

Table 8
Descriptive statistics

Variable	Mean	Minimum	Maximum
TW	37 063	20 279	48 853
TS	53.283	40.875	64.504
ADMIN	222.84	47.49	505.46
GSSB	129.76	10.71	872.85
OE	758.04	314.85	1452.0
STRIKE	0.665	0	1
S/N	0.2204	0.15604	0.30717
S/SCHOOL	320.10	167.21	506.75
S/BOARD	4946.8	1733.3	10 737
Y	15 784	7480.1	29 393
$F_P - I_P$	727.95	−128.59	2059.1
P_G/P_C	0.93579	0.75749	1.0346

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