Cost-sharing versus block-funding in a federal system: a demand systems approach

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Abstract. This paper employs a maximizing framework, consistent with the axioms of consumer preference, to analyse local government's choice of spending on different social services. Within this framework it is possible to include both block-funding and cost-sharing intergovernmental transfer schemes. Canada's movement to block-funding from the cost-sharing method of financing provincial expenditures on hospitals, medical care, and post-secondary education is analysed. The results indicate that the provincial governments' actions are generally consistent with a standard maximizing model of consumer behaviour and that the change to block-funding had a significant impact on real provincial funding of some previously cost-shared social services.

Partage des coûts versus financement forfaitaire dans un système fédéral: une approche en termes de systèmes de demandes. Ce mémoire utilise un cadre d'analyse de maximisation, compatible avec les axiomes de préférences des consommateurs, pour analyser les choix d'un gouvernement local entre différents services sociaux. Dans ce cadre d'analyse, il est possible d'inclure des transferts inter-gouvernementaux forfaitaires ou des transferts dans le cadre de programmes de partage de coûts. Les auteurs analysent le glissement de la méthode de financement des dépenses provinciales pour les hôpitaux, les soins, et l'éducation post-secondaire depuis des programmes de partage de coûts vers la méthode de paiements forfaitaires. Les résulats montrent que les choix des gouvernements provinciaux sont en général compatibles avec le modèle standard de maximisation du comportement du consommateur et que le passage à un financement forfaitaire a eu un impact significatif sur les sommes réelles contribuées par les provinces à des services sociaux antérieurement financés via un partage des coûts.

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I. INTRODUCTION

Cost-sharing (conditional grants) and block-funding (unconditional grants) are two methods used by federal governments to determine the size of their transfer to local governments (states or provinces). Under cost-sharing the grant from the federal to the local government is conditional on the level of spending by the local government on certain services. With block-funding the federal grant is determined in a manner that is independent of the pattern of local spending. A shift from cost-sharing to block-funding would alter the relative price of different services to local governments (since under cost-sharing the local government pays only a fraction of the actual cost) as well as the relative price between private expenditure and cost-shared publicly provided goods. It follows that a change in regime of this type could lead to a significantly different composition of real public spending.

Between 1971 and 1976 cost-shared expenditures on hospital care, medical care, and post-secondary education represented approximately 35 per cent of total provincial government expenditures in Canada. The cost-sharing of these expenditures created a significant wedge between the actual and the effective cost of these services. For every one dollar Ontario spent on hospital care, medical care, and post-secondary education, it received \$0.34, \$0.18, and \$0.50, respectively, in transfers from the federal government. This wedge was eliminated in 1977 when the federal government moved to the block-funding of transfers to the provinces.

The purpose of this paper is to establish a framework in which to analyse the relative impact on real local spending of cost-sharing and block-funding. As an example, Canada's shift to block-funding from the cost-sharing method of financing provincial expenditures on hospitals, medical care, and post-secondary education is analysed. The framework developed describes a provincial government's spending allocation decision and incorporates both block-funding and cost-sharing. Based on the maximization of a provincial government's objective function subject to its budget constraint, this framework yields a system of demand functions which are consistent with the axioms of consumer theory. The restrictions implied by the theory are tested and a measure of the real impact of the regime change is derived. It is found that for some types of social service spending the impact of the move to block-funding was significantly negative.

Studies that have explicitly examined the relationship between cost-sharing and block-funding, and the impact of this regime change on the provision of social services in Canada, generally conclude that the change in regime had little real effect and was, therefore, a fiscal non-event (see Brown (1980 and 1984) Soderstrom (1981) and Kapsalis (1982)).[1] The present study augments this literature by specifying and testing a model of provincial behaviour which determines the allocation of

1 Brown (1980) and Soderstrom (1981) examine the movement in the share of gross provincial spending on each of the three cost-shared services, while Kapsalis (1982) looks at the movement in real expenditure per capita. Brown (1984) calculates the ratio of each province's expenditure on all cost-shared programs to the federal contributions received by the province for the cost-shared programs and then regresses this ratio on a time trend. Although Brown's results indicate a decline in this ratio since the replacement of cost-sharing with block-funding, the implications

expenditure among different publicly provided services, the calculation of relative price and income effects, and the provision of a statistical test of the hypothesis that the regime change had no significant impact on real provincial expenditures.

The paper is organized as follows. Section II describes a maximizing framework, encompassing both cost-sharing and block-funding, in which the optimal provision of services by provincial governments is determined. Section III discusses the characteristics of the Canadian transfer system, the choice of the functional form to be estimated, and related empirical issues. Estimation results are given in section IV, and concluding comments are provided in section V.

II. THE MODEL

The model assumes that provinces choose taxation (the level of resources available for private consumption) and spending on government supplied goods to maximize:

$$V = V(Z_i, X; D), \qquad i = 1, \dots, n, \tag{1}$$

where the Z_i are the real per capita quantities of the n government supplied goods, X represents per capita consumption of private goods, and D is a vector of demographic variables.[2] This objective function represents an ordering of the provincial government's preferences over Z_i and X given D, which is consistent with the standard preference axioms.[3]

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of this result are unclear. His estimating equation is not based on any apparent theoretical model and, in particular, does not include any price or income effects. Other studies that examine the impact of intergovernmental transfers on the provision of social services in Canada are Hardy (1974, 1976), Auld (1976), Slack (1980), and Lindsay and Zycher (1984). The last two employ a demand systems methodology, but their approach is less general than that used below.

2 Contrary to many previous studies (e.g., Borcherding and Deacon 1972; Deacon 1978), it is not assumed that this objective function is separable in private and publicly provided goods. Our treatment of publicly provided goods also contrasts with the traditional method by not treating the public goods arguments of the province's objective function as a proportion of the total supply of public goods. With N representing population, the factor proportionality is usually written as $N^{-\gamma}$, where γ is the Samuelsonian index of publicness (Borcherding and Deacon 1972; Bergstrom and Goodman 1973; Gramlich and Rubinfeld 1982). If γ is unity, the good is purely private; if zero, purely public. Since the estimation of this index in a disaggregated demand system is beyond the scope of this paper, it is restricted to equal one. This approximation seems reasonable, since we are interested primarily in hospital care, medical care, and post-secondary education, all of which are likely to have a large private good component.

3 The specification of the government objective function in this form follows Dunne and Smith (1983) and Dunne, Pashardes, and Smith (1984). A similar objective function forms the basis for the empirical analysis in Deacon (1978) and McMillan and Amoako-Tuffour (1988). The existence and form of a government objective function that is consistent with the standard preference axioms as the outcome of a collective decision-making process in a representative democracy is still controversial. It has been shown that if certain severe restrictions hold, the government objective function will conform with the preferences of the median voter (see Rubinfeld 1987). However, the use of the median voter's preferences has been criticized (see Hinich 1977; Aranson and Ordeshook 1981). Shapiro (1978), following Hinich (1977), derives conditions under which the government objective function represents mean preferences, as opposed to median preferences, and the restrictions on individual preferences necessary for the existence of this function. Rubinfeld (1987) provides a second example in which government preferences should reflect the mean

The provincial government faces the budget constraint:

$$(G+Y)/N = \sum_{i=1}^{n} P_i Z_i + P_x X, \tag{2}$$

where G is the total value of federal grants to the provincial government, Y is total nominal provincial income net of federal taxes and transfers to individuals, N is the population of the province, P_i is the actual per unit price of the ith publicly provided good, and P_x is the per unit price of the private good.

Total grants from the federal to the provincial government consist of an unconditional component, G^u, and a conditional component that is a function of spending on the cost-shared programs in the province, spending on these programs in other provinces, and the relative size of the province. Thus, the per capita federal grant to a province is given by

$$G/N = G^u(\delta, \theta_i(\delta))/N + \sum_{i=1}^{n} [\lambda_i(\delta, \theta_i(\delta)) \cdot \bar{P}_i \cdot \bar{Z}_i + \theta_i(\delta) P_i \cdot Z_i], \tag{3}$$

where δ is the share of the national population in the province, $\bar{P}_i \cdot \bar{Z}_i$ is per capita spending on the ith publicly provided good in all other provinces, $\lambda_i(\delta, 0)$ equals zero, $G^u_\theta(\cdot)$ is negative, and $\theta_i(\delta)$ determines the extent to which expenditures on good i are cost shared. If $\theta_i(\delta)$ is equal to zero, equation (3) would represent a purely unconditional grant. If $\theta_i(\delta)$ is non-zero the grant determination formula incorporates cost-sharing.

Substitution of (3) into (2) yields the provincial budget constraint:

$$(G^u(\delta, \theta_i(\delta)) + Y)/N + \sum_{i=1}^{n} \lambda_i(\delta, \theta_i(\delta)) \cdot \bar{P}_i \cdot \bar{Z}_i$$

$$= \sum_{i=1}^{n} [1 - \theta_i(\delta)] \cdot P_i \cdot Z_i + P_x \cdot X = \sum_{i=1}^{n} \tilde{P}_i \cdot Z_i + P_x \cdot X, \tag{4}$$

where $\tilde{P}_i$ is the effective unit price to the province of the ith publicly provided good.[4] By altering the size of $\theta_i(\delta)$, this budget constraint can be made consistent with both cost-sharing and block-funding.

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rather than the median. Given the stringent conditions necessary for any voting model to lead to a consistent preference ordering, our methodology follows Deacon (1978) in taking an essentially empirical view of government expenditure decisions. That is, we examine whether the data can support the hypothesis that public sector expenditure decisions are analogous to consumer choices in the sense that they could be generated by maximizing a utility function subject to a budget constraint. A similar view is maintained in most empirical demand studies that use aggregate data to estimate demand functions based on individual maximization decisions. As noted by Deacon (1978, 185), 'the question of whether or not aggregated responses can be described by individualistic models is essentially empirical in both cases.'

4 This budget constraint treats unconditional grants and other types of provincial income identically. It abstracts from the 'flypaper effect,' which suggests that unconditional grants stimulate provincial government spending by more than a corresponding increase in other types of provincial income (Gramlich 1977; Courant, Gramlich, and Rubinfeld 1979; Winer 1983; and Logan 1986), and assumes there is no 'fiscal illusion' on the part of the provincial governments (see Oates 1985). Testing these hypotheses within a demand system is an area for future research.

The provincial government chooses the optimal levels of Z_i and X to maximize (1) subject to the budget constraint (4).[5] In doing this it takes its total income, B (the left-hand side of (4)), and all prices as given.[6] This optimization procedure yields first-order conditions that can implicitly be solved for a system of $n + 1$ demand functions each of which depend upon B, the $\tilde{P}_i$ (and thus the extent of cost-sharing) and P_x and satisfy the properties of homogeneity, symmetry, negativity, and adding-up.

III. THE EMPIRICAL SPECIFICATION

Prior to 1977 the size of federal transfers to the provinces in Canada were a function of the level of provincial spending on several social services. In particular, federal per capita transfers to a province for hospital care, medical care, and post-secondary education were determined as follows:

$$0.25[P_H \cdot H + (P_H \cdot H \cdot N + \bar{P}_H \cdot \bar{H} \cdot \bar{N})/(N + \bar{N})],^7 \qquad (5)$$

$$0.5[(P_M \cdot M \cdot N + \bar{P}_M \cdot \bar{M} \cdot \bar{N})/(N + \bar{N})],^8 \qquad (6)$$

5 By restricting the province's budget constraint and expenditure decision to one period, the model abstracts form the intertemporal choice problem provinces face when determining their expenditure and level of debt. This is consistent with much of the existing literature on the determination of public expenditure as well as the literature on the determination of consumer expenditure within a demand system. A related issue is the assumption that real provincial expenditure adjusts to its desired level within one period. Several studies have attempted to move away from static models of this type by using partial adjustment or autocorrelation specifications (Anderson and Blundell 1983, 1984; Dunne et al. 1984). However, given the short time span of our data (eleven years), the estimation of adjustment coefficients seems unrealistic (Dunne and Smith 1983 faced a similar problem). One simple test of the static restriction is undertaken in section IV.

6 The specification of the budget constraint follows the existing demand systems approach to public goods provision by assuming that relative prices are independent of the tax financing of government expenditures (Deacon 1978; Dunne and Smith 1983). By fully specifying the provincial government and federal government financing constraints as well as modelling their tax-setting behaviour, it may be possible to explicitly include the tax financing of both provincial expenditures and federal transfers to the provinces in the model. Montmarquette (1983) shows how this can be done with a single publicly provided good in a median voter model. The empirical extension of this to a multi-good, bilevel government model would complicate the analysis considerably and, to our knowledge, has not been developed in a theoretical framework.

7 Federal cost-sharing of hospital care expenditures is applied only to hospital operating and maintenance costs, and diagnostic services. The federal per capita transfer to a province for hospital care was 25 per cent of the province's per capita expenditure on the relevant hospital services plus 25 per cent of the national per capita cost of these services.

8 The federal per capita transfer to a province for medical care (physician services and some related services rendered by other health care professionals) was 50 per cent of the national per capita cost of the cost-shared medical services. The federal funding formula for medical care was open ended until 1976 at which time, owing to the rapid rise in transfers, a 13 per cent ceiling was placed on the annual increase in per capita transfers to the provinces. In the empirical analysis undertaken below we have ignored this ceiling for two reasons. First, the change was not given assent until 16 July 1976 and thus may not have been in the provinces' planning horizon when they determined their 1976 expenditure allocations (the last under cost-sharing). Second, the actual impact was a relatively insignificant $0.20 decline in the average per capita transfer for 1976, only 0.8 per cent of the 1975 average per capita transfer to the provinces (Health and Welfare Canada 1977; Statistics Canada 1976).

$$\max\ [0.5 \cdot P_E \cdot E, l],^{9} \tag{7}$$

where *H, M,* and *E* are, respectively, the real per capita quantities of hospital care, medical care, and post-secondary education provided by a province; *l* is the alternative per capita federal transfer for post-secondary education; and a variable with a bar over it represents the value of that variable in the other provinces. Following the form of equation (4) above, equations (5), (6), and (7) can be combined to yield a province's budget constraints for the cost-sharing case:[10]

$$(G^u + Y)/N + 0.25(1-\delta)\bar{P}_H \cdot \bar{H} + 0.5(1-\delta)\bar{P}_M \cdot \bar{M} = \tilde{P}_H \cdot H + \tilde{P}_M \cdot M + \tilde{P}_E \cdot E + P_X \cdot X, \tag{8a}$$

when $0.5P_E \cdot E > l$, and:

$$(G^u + Y)/N + 0.25(1-\delta)\bar{P}_H \cdot \bar{H} + 0.5(1-\delta)\bar{P}_M \cdot \bar{M} + l = \tilde{P}_H \cdot H + P_M \cdot M + \tilde{P}_E \cdot E + P_X \cdot X, \tag{8b}$$

when $0.5P_E \cdot E < l$, where:

$$\tilde{P}_H = [1 - 0.25(1+\delta)]P_H,$$

$$\tilde{P}_M = [1 - 0.5\delta)]P_M,$$

$$\tilde{P}_E = 0.5P_E.$$

The 1977 Fiscal Arrangements Act replaced the conditional grants for hospital care, medical care, and post-secondary education with unconditional federal transfers to the provinces. With the connection broken between federal transfers and

9 Transfers for post-secondary education from the federal government to the provincial governments were equal to 50 per cent of the operating costs of post-secondary education institutions within a province or \$15.00 per capita (escalated annually by the rate of increase in national post-secondary operating costs) whichever was greater. (Only three provinces elected to receive the per capita payment: Newfoundland, Prince Edward Island, and New Brunswick.) In 1972 the federal government restricted the annual growth rate in its transfer to each province for post-secondary education to 15 per cent. In a number of cases this ceiling became binding, and the province in question bore the full marginal cost of any additional spending. That is, the price faced by the province at the margin was P_E even though they participated in the cost-sharing program. (Moffit 1984 discusses problems associated with the empirical analysis of closed-end grants. He develops a method to deal with these in a one-good model, but it does not appear to be tractable in a system of equations.) More complete descriptions of the cost-sharing scheme for post-secondary education, as well as for health care, can be found in Boadway (1980), Brown (1980), and Soderstrom (1978).

10 Because we are principally interested in the demand for *H, M,* and *E,* and because there does not exist good proxy for the price of other provincial government purchases that is distinct from that of the price of *X,* we have included all provincial spending other than that on *H, M,* and *E* in *X.* Note that the variable *X* includes all goods provided by levels of government other than the provinces. This might cause a problem if these included spending on the three social services of interest. However, the level of spending by other levels of government on hospital care, medical care, and post-secondary education is extremely small and relatively constant as can be ascertained by a comparison of expenditure data in the annual Statistics Canada publications *Consolidated Government Finance* and *Provincial Government Finance.*

provincial spending on health care and post-secondary education, each province now bore the full marginal cost of its expenditures on these services. As a result, the per capita budget constraint of a province became

$$(G^{u'} + Y')/N = P_H \cdot H + P_M \cdot M + P_E \cdot E + P_X \cdot X, \tag{9}$$

where the primes on $G^{u'}$ and Y' indicate that cost-sharing was replaced with larger unconditional grants and tax-point transfers to the province (i.e., lower federal net revenues).[11]

The explicit budget constraints for the pre- and post-1977 periods, in conjunction with an objective function corresponding to equation (1), imply a system of provincial demand equations for *H, M, E,* and *X*. Each of these is a function of the total per capita provincial budget (the left-hand side of equations (8a), (8b) or (9)), and the prices $\tilde{P}_H, \tilde{P}_M, \tilde{P}_E$, or P_E, and P_X for the pre-1977 period and P_H, P_M, P_E, and P_X for 1977 and thereafter.

For the purposes of estimation, it is necessary to specify a explicit functional form for these demand equations. A large segment of the empirical literature has approached this problem by restricting their analysis to the demand for specific categories of government services within a single equation framework (Borcherding 1972; Bergstrom and Goodman 1973; Perkins 1977; Pommerehne 1978; Pommerehne and Frey 1976; McMillan et al. 1981; Moffit 1984). Rather than follow this route, since the model described above yields a system of demand equations, the present study treats these equations as a system for the purpose of estimation. This makes the interpretation of the estimated coefficients more obvious, allows for cross-price effects, uses information implied by the cross-equation restrictions, and makes it possible to test the restrictions implied by consumer theory.

Various functional forms for demand systems have been used to model the provision of public services.[12] Following Dunne and Smith (1983) and Dunne et al. (1984), the present study uses the AIDS model of Deaton and Muellbauer (1980). This model is straightforward to estimate, is a first-order approximation to any demand system, allows for the testing of homogeneity and symmetry, and is consistent with the inclusion of supplementary variables representing taste differentials.

Letting W_i be the budget share of good i, the demand equations of the AIDS model can be written in share form as[13]

$$W_i = \alpha_i + \sum_j \gamma_{ij} \log \tilde{P}_j + \beta_i \log(B/P), \qquad j = 1, \dots, m, \tag{10}$$

11 For details of the new funding arrangements see Boadway (1980), Courchene (1979), and the Parliamentary Task Force (1981).

12 Stone's (1954) rather restrictive Linear Expenditure System has been employed by Slack (1980). The Rotterdam Model, introduced by Theil (1965), was used by Deacon (1978). Grosskopf and Hayes (1983), Hayes and Grosskopf (1984), McMillan and Amoako-Tuffour (1988), and Slack (1980) employ the translog model of Christensen et al. (1975).

13 As discussed in Pollak and Wales (1969) and Mackinnon (1976), the estimation of demand equations in share form, rather than in quantities, reduces the likelihood of a non-constant covariance matrix.

where m is the number of equations in the system, B is the total per capita budget, $\tilde{P}_j$ is the effective unit price to the province of the jth good, and P is a price index defined by

$$\log P = \alpha_0 + \sum_k \alpha_k \log \tilde{P}_k + \frac{1}{2} \sum_j \sum_k \gamma_{kj} \log \tilde{P}_k \log \tilde{P}_k, \quad k, j = 1, \ldots, m.$$

Following Deaton and Muellbauer, a random error, ϵ_{it}, is added to each share equation and is assumed to have the following properties:

i) $E[\epsilon_{it}] = 0$,

ii) $E[\epsilon_{it}\epsilon_{jt'}] = 0$ for all i, j if $t \neq t'$,

$= \sigma_{ij}$ for $t = t'$.

The restrictions implied by consumer theory are

$$\sum_{i=1}^{m} \alpha_i = 1; \sum_{i=1}^{m} \gamma_{ij} = 0, \forall_j; \sum_{i=1}^{m} \beta_i = 0; \qquad \text{(additivity)},$$

$$\sum_{j=1}^{m} \gamma_{ij} = 0, \forall_i; \qquad \text{(homogeneity)},$$

$$\gamma_{ij} = \gamma_{ji}. \qquad \text{(symmetry)}.$$

While the homogeneity and symmetry restrictions can be both imposed and tested, additivity cannot be tested and negativity cannot be imposed. However, an indication of whether the latter property is supported by the data can be found by examining the eigenvalues of the Slutsky matrix.

Adding-up implies that the covariance matrix is singular, and thus only three of the four share equations can be estimated directly. As Barten (1969) shows, the estimated coefficients are invariant to the equation dropped. During estimation the X equation was excluded from the system and then adding-up was used to derive its coefficients and their standard errors.

The price index P causes some parameters to be difficult to identify, makes estimation highly non-linear, and leads the model to become extremely complex when constant dummies are used. Deaton and Muellbauer (1980 and 1982) suggest that log P is approximated by the price index:

$$\text{Log } P^* = W_H \log \tilde{P}_H + W_M \log \tilde{P}_M + W_E \log \tilde{P}_E + W_X \log P_X, \qquad (11)$$

where W_H, W_M, W_E, and W_X are the budget shares of H, M, E, and X, respectively. This approximation has been widely used in AIDS estimation and, when comparisons with estimates using the true price index are made (Deaton and Muellbauer (1980), Anderson and Blundell (1983)), it has proved to have little impact on the results. For these reason, all the results given in this paper were derived using equation (11) as an approximation to the true price index.

The data used to estimate the share equations for H, M, E, and X cover nine provinces of Canada for the years 1971 through 1981 (99 observations).[14] The data begin in 1971 because it was not until that year that all nine provinces were participating in the three cost-sharing programs of interest. It was necessary to terminate the data series in 1981 because the system of determining federal-provincial transfers was significantly changed in 1982 (see Brown 1984).

The pooling of provincial data is necessitated by the insufficient number of observations for any single province. In addition to specifying the model in share form, two adjustments are made to account for potential differences among the provinces. First, the constant term, α_i, in the share equations is allowed to differ across provinces. Second, as noted by Deaton and Muellbauer (1980), the AIDS model allows the introduction of variables which reflect taste differences across observations (D in equation (1)). (The coefficients on these variables must sum to zero for the share equations to satisfy adding-up.) Following Dunne et al. (1984), several variables reflecting the demographic characteristics of the provinces are used to proxy provincial taste differences. These are

- POP = log of provincial population,
- P2024 = log of the ratio of the number of people aged twenty to twenty-four years to the total population in the province,
- P65 = log of the ratio of the number of people aged sixty-five and over to the total population in the province.

The POP variable is introduced to account for different degrees of publicness, or alternatively, economies of scale in the provision of services. The two other variables are introduced to proxy differing tastes for post-secondary education and health care due to differing age distributions. The number of people aged twenty to twenty-four years was used for P2024 rather than for post-secondary enrolment, since the latter may depend upon post-secondary education expenditures.

To estimate the model described above it is necessary to obtain data for $\tilde{P}_H$, $\tilde{P}_M$, $\tilde{P}_E$, P_H, P_M, P_E, P_X, W_H, W_M, W_E, W_X, B, POP, P2024, and P65. These variables are defined in appendix A, and a detailed description of the sources and methods used to construct them is provided in appendix B.

IV. ESTIMATION AND RESULTS

Initially the share equations for W_H, W_M, and W_E were jointly estimated over the entire sample without the symmetry or homogeneity restrictions imposed. A test

14 The province of Quebec was excluded from the data set because it opted out of cost-sharing arrangements prior to 1971 (see Boadway 1980). Given the potential for demand to vary significantly under block-funding and cost-sharing, it seems unreasonable to pool the Quebec data with that of the other nine provinces, all of whom were participating in cost-sharing.

for structural change, described in Anderson and Blundell (1984), was used to determine whether the introduction of the 1977 Fiscal Arrangements Act caused a significant change in the model's structure.[15] Splitting the sample at the end of 1976, the test statistic is 336.51. With a 1 per cent critical value of 227.06, the hypothesis that there was no structural change is rejected.[16]

There are two possible explanations for this result. First, the change in regime, even though it only altered relative prices and income, may have caused the provinces to behave differently by altering the policy decision framework. Second, the AIDS model is only a local approximation to any particular demand system. The change in regime may have been large enough to shift the system to a different local approximation.

Because the evidence suggests a structural change, the model was re-estimated with the data split at the end of 1976. For both samples a likelihood ratio test was used to test the inclusion of different constant terms for each province, and a second test was carried out to determine the significance of the three demographic variables. Both tests significantly rejected their implied restrictions. The test statistics associated with restricting the constant terms to be identical across provinces were 201.17 and 147.88 for the 1971–6 and 1977–81 samples, respectively. (The 1 per cent critical value is 42.98.) The test of zero coefficients on the demographic variables yielded test statistics for the two samples of 30.62 and 28.91, while the 1 per cent critical value is 21.67.

The model was estimated in a static form owing to the short time series available, six years in the first sample and five in the second. (Even the most simple dynamic specification would necessitate dropping a whole year (nine observations) of data from each sample.) In order to provide some indication of whether this static specification is appropriate, and LM test suggested by Harvey (1981) was used to test for first-order serial correlation of the residuals in each share equation. (This test compares the residual of a particular province in one period with its residual in the previous period.) As the results presented in tables 1 and 2 show, of the six tests carried out, five cannot reject the hypothesis that the residuals are not serially correlated at a 5 per cent confidence level and the sixth cannot reject this hypothesis at 1 per cent.

To give some idea of the appropriateness of the model's theoretical underpinnings, the homogeneity and symmetry restrictions were tested. A likelihood ratio test of the homogeneity of all three equations yielded test statistics of 7.31 and 3.77 for the 1971–6 and 1977–81 samples, respectively. Given the 5 per cent critical

15 The test statistic is $2[(T/T_1)L_1 + (T/2)\,(\text{Log}\,(T/T_1)) - L]$, and is distributed as a χ^2 statistic with $n(T - T_1)$ degrees of freedom, where
n = number of equations in the system
T = number of observation in the total sample
L = log of the likelihood using the whole sample
T_1 = number of observations in the restricted sample
L_1 = log of the likelihood using the restricted sample.

16 Altering the model to include a constant dummy at the time of the change as well as several dummies to accommodate the adjustment that took place after 1976 did not alter the conclusion of this test.

value for this test is 7.81, the homogeneity restriction cannot be rejected. The two test statistics for the symmetry restriction are 3.01 and 3.19, while the 5 per cent critical value is 7.81, and thus the symmetry restriction also cannot be rejected. A joint test of symmetry and homogeneity yields test statistics of 10.32 and 6.95 for the two sample periods, while the 5 per cent critical value is 12.59.

In addition to these tests of homogeneity and symmetry, negativity was examined by calculating the eigenvalues of the Slutsky matrix at each observation using both the actual and the predicted values of the budget shares. For all observations, of the three non-zero eigenvalues only two had the correct negative sign. Failure of all eigenvalues to be negative is characteristic of much of the demand systems literature. (See Deaton and Muellbauer 1980, and Anderson and Blundell 1983, for example.) It is not clear what this implies however, since an examination of the eigenvalues, while being a useful diagnostic, is not a formal statistical test.

The estimated coefficients, with both symmetry and homogeneity imposed, are presented in tables 1 and 2.[17] Of the twenty-eight key price and income coefficients, nineteen are significant at 5 per cent, and an additional four at 10 per cent. The negative sign on the income coefficients in the W_H, W_M, and W_E equations, and the positive sign in the W_X equation, indicate that the three cost-shared social services are necessities, while expenditure on other goods is a luxury. The compensated elasticities, calculated at the mean of each sample, are presented in table 3. Of the eight own-price elasticities, five have the negative sign predicted by the theory, and none of the remaining three is significantly different from zero.

The empirical results presented above give support to the proposed model of provincial government expenditure allocation. In addition, the tests for structural change indicate that the behaviour of the provincial governments differed significantly between the cost-sharing and block-funding regimes. This supports the contention that there was, in fact, a real impact on social service spending as a result of the change in the transfer determination mechanisms, but it does to indicate the magnitude or direction of this impact.

The effect of the change from cost-sharing to block-funding on the real quantity of hospital care, medical care, and post-secondary education provided by the provinces can be estimated by forecasting the real quantities of these services that would have been provided if cost-sharing had been maintained, and then comparing these forecasts with the actual real quantities. To carry out this exercise, the second-period cost-sharing prices were simulated using the formulas given in equations (8a) and (8b), that is, as if the cost-sharing system had continued through 1981 and all grants had remained open ended. Since the change in regime was supposed to be revenue neutral, the forecast budget for each province under cost-sharing

17 In an attempt to test the appropriateness of pooling all the provinces in one sample, each of our two samples was split in two (the four Atlantic provinces in one group and the other provinces in the other), and Anderson and Blundell's test statistic for structural change was calculated. For the 1971–6 and 1977–81 samples, the first test statistics are 182.40 and 79.13, respectively, while the 5 per cent critical values are 199.14 and 169.06. Thus, the hypothesis that these two groups of provinces act similarly cannot be rejected.

TABLE 1
Parameter estimates 1971–6

	W_H	W_M	W_E	W_X
Log ($\tilde{P}_H$)	0.01295			
	(4.33)			
Log ($\tilde{P}_M$)	0.00339	0.01752		
	(1.63)	(6.41)		
Log ($\tilde{P}_E$)	0.00054	−0.00100	0.01012	
	(1.17)	(2.04)	(23.88)	
Log (P_X)	−0.01688	−0.01991	−0.00966	0.04645
	(4.22)	(5.21)	(10.31)	(6.86)
Log (B/P^*)	−0.02395	−0.01066	−0.01258	0.04720
	(11.01)	(4.66)	(6.44)	(11.20)
DNF	0.16296	−0.00407	0.18440	0.65671
	(3.51)	(0.09)	(4.56)	(7.07)
DPEI	0.18083	0.03545	0.17271	0.61101
	(4.76)	(0.91)	(5.18)	(8.00)
DNS	0.13357	−0.02159	0.17778	0.71024
	(2.81)	(0.45)	(4.43)	(7.63)
DNB	0.14336	−0.01562	0.17684	0.69542
	(3.08)	(0.33)	(4.47)	(7.58)
DO	0.06778	−0.08088	0.18180	0.83130
	(1.12)	(1.36)	(3.68)	(7.19)
DM	0.12361	−0.02697	0.17603	0.72733
	(2.55)	(0.56)	(4.32)	(7.68)
DS	0.12188	−0.02705	0.17473	0.73044
	(2.54)	(0.56)	(4.35)	(7.82)
DA	0.12232	−0.03430	0.18522	0.72676
	(2.35)	(0.66)	(4.21)	(7.12)
DBC	0.09667	−0.04757	0.17763	0.77327
	(1.82)	(0.90)	(4.02)	(7.52)
P65	0.04892	0.01957	0.01966	−0.08815
	(5.74)	(2.33)	(2.60)	(5.27)
P2024	−0.00025	0.01183	0.00642	−0.01800
	(0.07)	(3.26)	(2.08)	(2.52)
POP	0.03112	0.02977	0.00035	−0.06124
	(4.47)	(4.70)	(0.06)	(4.97)
R^2	0.973	0.900	0.972	
LM test statistic for AR1 (unrestricted model)	6.33[b]	0.29[a]	0.43[a]	
LM test statistic for AR1 (restricted model)	5.69[b]	1.02[a]	0.19[a]	

a Cannot reject the hypothesis of no serial correlation at 5 per cent.
b Cannot reject the hypothesis of no serial correlation at 1 per cent.
NOTES: The number in brackets are asymptotic *t*-statistics.
The LM test statistic for AR1 is distributed as a χ^2 with one degree of freedom.

TABLE 2
Parameter estimates 1977–81

	W_H	W_M	W_E	W_X
Log ($\tilde{P}_H$)	0.02499			
	(1.85)			
Log ($\tilde{P}_M$)	0.00799	0.00768		
	(1.60)	(1.64)		
Log ($\tilde{P}_E$)	0.00309	0.00542	0.00305	
	(0.64)	(1.76)	(0.79)	
Log (P_X)	−0.03607	−0.02109	−0.01156	0.06872
	(2.36)	(3.83)	(1.95)	(3.30)
Log (B/P^*)	−0.03562	−0.01536	−0.01120	0.06218
	(5.55)	(6.96)	(4.76)	(7.46)
DNF	0.18438	0.00612	0.18200	0.62750
	(1.11)	(0.11)	(3.21)	(3.01)
DPEI	0.21135	0.03778	0.16509	0.58578
	(1.52)	(0.82)	(3.45)	(3.34)
DNS	0.15074	−0.00216	0.18426	0.66716
	(0.89)	(0.04)	(3.19)	(3.13)
DNB	0.15903	−0.00012	0.18099	0.66010
	(0.95)	(0.002)	(3.18)	(3.15)
DO	0.05906	−0.04939	0.20391	0.78642
	(0.28)	(0.72)	(2.87)	(2.99)
DM	0.13454	−0.00807	0.18470	0.68883
	(0.78)	(0.14)	(3.14)	(3.17)
DS	0.13316	−0.00780	0.18411	0.69053
	(0.78)	(0.14)	(3.17)	(3.22)
DA	0.13246	−0.01391	0.19297	0.68848
	(0.72)	(0.23)	(3.08)	(2.98)
DBC	0.09691	−0.02412	0.19205	0.73516
	(0.52)	(0.39)	(3.01)	(3.12)
P65	0.05424	0.01585	0.00296	−0.07305
	(5.29)	(4.48)	(0.84)	(5.59)
P2024	−0.01765	−0.01226	0.00671	0.02320
	(1.04)	(2.18)	(1.12)	(1.09)
POP	0.03977	0.02286	−0.00789	−0.05474
	(2.15)	(3.81)	(1.28)	(2.37)
R^2	0.967	0.973	0.936	
LM test statistic for AR1 (unrestricted model)	1.20[a]	0.43[a]	1.17[a]	
LM test statistic for AR1 (restricted model)	0.94[a]	0.11[a]	1.40[a]	

See notes to table 1.

TABLE 3
Compensated price elasticities

	$\tilde{P}_H$	$\tilde{P}_M$	$\tilde{P}_E$	P_X
		1971–6		
H	−0.40178	0.16463	0.03515	0.20199
	(3.02)	(1.79)	(1.71)	(1.14)
M	0.26583	0.27152	−0.06090	−0.47645
	(1.79)	(1.38)	(1.72)	(1.74)
E	0.07126	−0.07645	−0.07703	0.08222
	(1.71)	(1.72)	(2.02)	(0.97)
X	0.00477	−0.00697	0.00096	0.00124
	(1.14)	(1.74)	(0.97)	(0.17)
		1977–81		
H	−0.21718	0.25434	0.10554	−0.14270
	(0.54)	(1.70)	(0.73)	(0.31)
M	0.57794	−0.46171	0.38211	−0.49834
	(1.70)	(1.45)	(1.82)	(1.33)
E	0.27628	0.44021	−0.74804	0.03155
	(0.73)	(1.82)	(2.47)	(0.07)
X	−0.00507	−0.00779	0.00043	0.01242
	(0.31)	(1.33)	(0.07)	(0.56)

NOTE
Elasticities are evaluated at the mean of each sample.
The numbers in parentheses are asymptotically standard normal and test the hypothesis that the elasticity is zero (Livernois and Ryan 1989).

was calculated by determining the provincial income necessary, given the simulated cost-sharing prices, to purchase the real quantity of goods actually purchased. Finally, a forecast of the price index was constructed by substituting the simulated prices and the actual budget shares into equation (11). A comparison of the simulated and actual prices and budget is given in table 4 for each of the nine provinces.

The cost-sharing prices and budget simulated for 1981 were used, in conjunction with the coefficients estimated for the actual 1971–6 cost-sharing period, to forecast the budget shares that would have been committed to health care and post-secondary education in each of the nine provinces during 1981 if cost-sharing had continued.[18] (Data from 1981 was used, since it is the latest year in the sample.) Using these predicted shares and the simulated prices and budget, it is posssible to estimate the real quantity of hospital care, medical care, and post-secondary education that would have been provided by each province in 1981 had cost-sharing continued. The percentage differences between these quantities and the actual quantities provided in 1981 are given in table 5.

18 The use of the coefficients estimated under the actual cost-sharing regime to simulate the cost-sharing shares in 1981 recognizes the difference in behaviour under the two regimes. This is consistent with the argument in Lucas (1976).

TABLE 4
Simulated effect of a movement from cost-sharing to block-funding, 1981 (per cent)

	$\tilde{P}_H$	$\tilde{P}_M$	$\tilde{P}_E$	B
Newfoundland	34.4	1.2	0	1.4
Prince Edward Island	33.6	0.3	0	0.9
Nova Scotia	34.9	1.8	100.0	2.2
New Brunswick	34.6	1.5	0	1.1
Ontario	51.2	21.6	100.0	1.9
Manitoba	35.2	2.1	100.0	1.5
Saskatchewan	35.1	2.0	100.0	1.3
Alberta	37.6	4.8	100.0	1.3
British Columbia	38.6	6.0	100.0	1.6

NOTE

This table indicates, for example, that Nova Scotia's effective unit prices of hospital care, medical care, and post-secondary education were 34.9, 1.8 and 100.0 per cent higher, respectively, in 1981 under block-funding than they would have been under cost-sharing. Purchasing the real quantity of goods it actually did under block-funding in 1981 required provincial resources which were 2.2 per cent larger than would have been necessary under the lower cost-sharing prices.

TABLE 5
Simulations of the per cent change in real spending in 1981 due to the move from cost-sharing to block-funding

	H	M	E
Newfoundland	8.6	2.1	−12.3
	(1.61)	(0.18)	(1.45)
Prince Edward Island	−2.9	0.7	−18.2
	(0.59)	(0.13)	(3.05)
Nova Scotia	17.2	2.7	−15.8
	(3.59)	(0.39)	(1.46)
New Brunswick	−7.9	10.5	−11.8
	(1.76)	(1.15)	(1.56)
Ontario	−23.3	−8.6	−30.6
	(3.49)	(0.99)	(2.04)
Manitoba	−5.1	−0.2	−27.2
	(0.82)	(0.02)	(1.73)
Saskatchewan	−10.2	−5.9	7.1
	(1.62)	(0.84)	(0.54)
Alberta	−8.3	−46.5	17.8
	(0.77)	(5.49)	(0.55)
British Columbia	−11.5	−13.8	−4.3
	(1.62)	(2.12)	(0.21)

NOTE

The numbers in parentheses give the absolute value of the ratio of the difference in real quantities under the two regimes to the standard error of this difference (quasi-t-statistics).

Though there are some exceptions, table 5 indicates that the movement from cost-sharing to block-funding had a negative effect on real spending by the provinces on hospital care and post-secondary education. Fourteen of the eighteen provincial forecasts for these two services indicate that there was a negative effect on spending owing to the shift to block-funding, and of these ten are significant at a 15 per cent confidence level. Of the four forecasts with positive signs, only two are significant. The results for Ontario show a particularly large effect with spending on hospital care and post-secondary education less by over 23 and 30 per cent, respectively. In contrast, the results with respect to medical care generally indicate little real effect of the regime change. Of the nine medical care forecasts four are positive and five negative, with only two of these significant at 15 per cent (though both are large and negative). These rather inconclusive results with respect to medical care spending may be a consequence of the fairly small change in the effective price of medical care which most provinces experienced because of the regime change (see table 4).

V. CONCLUSION

This paper posits a maximizing model of provincial expenditure determination within which can be nested both block-funding and cost-sharing federal-provincial transfer schemes. This framework is used to analyze the shift in Canada from cost-sharing to block-funding of provincial expenditures on hospital care, medical care, and post-secondary education.

Tests indicate that the data are consistent with two key implications of the model specified, homogeneity and symmetry. A test for structural change confirms that the behaviour of the provinces differed significantly under the two regimes. Forecasts of the level of real expenditures on health care and post-secondary education under the assumption of a continuation of cost-sharing were compared with actual real spending on these services. This comparison generally indicates a significant decline in real spending on hospital care and post-secondary education owing to the move from cost-sharing to block-funding. These results cast doubt on the prevailing view that this regime change was a fiscal non-event.

APPENDIX A: VARIABLE DEFINITIONS

(all quantity variables are per capita)

$\tilde{P}_H$ = an index of the effective price paid by the provinces for hospital operating costs.
P_H = an index of the actual price of hospital operating costs.
$\tilde{P}_M$ = an index of the effective price paid by the provinces for medical care.
P_M = an index of the actual price of medical care.
$\tilde{P}_E$ = an index of the effective price paid by the provinces for post-secondary education operating costs.
P_E = an index of the actual price of post-secondary education operating costs.

P_X = an index of the actual price of all other goods.
H = an index of the per capita real quantity of medical care purchased by a province.
M = an index of the per capita real quantity of medical care purchased by a province.
E = an index of the per capita real quantity of post-secondary education operating costs purchased by a province.
X = an index of the per capita real quantity of all other goods available for consumption in the province.
B = the total per capita budget of a province.
P^* = price index of all goods purchased by a province.
DNF = constant dummy for Newfoundland.
DPEI = constant dummy for Prince Edward Island.
DNS = constant dummy for Nova Scotia.
DNB = constant dummy for New Brunswick.
DO = constant dummy for Ontario.
DM = constant dummy for Manitoba.
DS = constant dummy for Saskatchewan.
DA = constant dummy for Alberta.
DBC = constant dummy for British Columbia.
P65 = log of the ratio of the number of people aged sixty-five and over to the total population of the province
P2024 = log of the ratio of the number of people aged 20 to 24 years to the total population of the province
POP = log of provincial population.
W_H = share of provincial expenditure on hospital operating costs.
W_M = share of provincial expenditure on medical care.
W_E = share of provincial expenditure on post-secondary education operating costs.
W_X = share of provincial expenditure on all other goods.

APPENDIX B: DATA METHODOLOGY AND SOURCES

P_X = The annual average of the consumer price indices for Canada by city. The price index for the largest city in a province was used as a proxy for the provincial price index except in Alberta and Saskatchewan where an average was used. For the years 1971 through 1974, the index for St Johns, Newfoundland was used as the Prince Edward Island index, since there is no index for Charlottetown prior to 1975. Sources for these price indices: 1971–5, Statistics Canada, *Historical Statistics of Canada*, Second edition; 1976–81, Statistics Canada, *Consumer Prices and Price Indexes*, October-December 1982.

P_H = The derivation of this index began with the hospital price index for Canada given in Barer and Evans (1983, table 11). This covered all the relevant years except 1972, 1978, and 1981. Since Barer and Evans (1983, 37) state that the main component of the index is wages, we used the percentage change in hospital wages (Barer and Evans 1983, tables 8 and 9) to fill in the gaps. To construct a provincial index we spread the Canadian index across provinces according to the ratio of average weekly wages and salaries in each province to the average for Canada as a whole (Statistics Canada, *Canadian Statistical Review*, various issues).

$\tilde{P}_H$ = P_H multiplied by the federal grant determination formula. This formula depends upon the percentage of the population in each province for the years 1971–6. Source: Statistics Canada, *Annual Estimates of Population for Canada and the Provinces as of June 1*, various issues.

P_M = A provincial medical care fee schedule price index, given in table D3 of Health and Welfare Canada (1986), based on physicians' benefit rates was used to construct this variable.

$\tilde{P}_M$ = P_M multiplied by the federal grant determination formula. This formula depends upon the percentage of the population in each province (see P_H for source).

P_E = Assumes post-secondary education operating costs depend primarily on salaries and thus uses an index of the average full-time university teacher's salary by province. The source is Statistics Canada, *Education in Canada*, 81–229, except for Nova Scotia (1978, 1979), New Brunswick (1977), Ontario (1979), and Saskatchewan (1977) for which no data was available. These missing values were proxied by using the average increase in salaries and wages for each province (see P_H for source) weighted so that the total increase is the same as between known university salaries.

$\tilde{P}_E$ = P_E multiplied by the federal grant determination formula. The grant formula is as given in the text except for the cases in which the closed-end grant was binding after 1972 (see Economic Council of Canada 1982, 160). For those provinces that reached the upper limit on the grant, the grant determination formula was set equal to one, since the marginal cost of an additional unit of education was its actual cost.

$P_H \cdot H$ = Total public hospital operating expenses per capita. Sources: 1971–5, Statistics Canada, *Hospital Statistics Vol. II*, 83–228, 1975; 1976–81, Statistics Canada, *Hospital Annual Statistics*, 83–232, various issues. Put in per capita terms by dividing by the total population of each province as given in Statistics Canada, *Annual Estimates of Population for Canada and Provinces as of June 1*, various issues.

$P_E \cdot E$ = Provincial government operating expenditures on post-secondary education per capita. Sources: 1971–9, Statistics Canada, *Decade of Education Finance, 1970–71 to 1979–80*, 81–560, 1983; 1980–1, Statistics Canada, *Financial Statistics of Eduction*, 81–208, various issues. Divided by the total population in each province to put in per capita terms (see $P_H \cdot H$ for source).

$P_M \cdot M$ = Per capita gross provincial expenditure on medical care. Statistics Canada, *Provincial Government Finances,* 68–207, various issues. This was put in per capita terms by dividing by total provincial population (see $P_H \cdot H$ for source).

$P_X \cdot X$ = Per capita spending on everything else is the sum of two key elements. The first is government provincial expenditure less debt service payments (both from Statistics Canada, *Provincial Government Finances*, 68–207, various issues), less $P_M \cdot M$, $P_E \cdot E$, and $P_H \cdot H$. The second part of the sum is provincial GDP less federal taxes, less provincial revenues, plus federal transfers to individuals in each province. The source for provincial GDP is Statistics Canada, *System of National Accounts: Provincial Economic Accounts Experimental Data* 13–213. Federal taxes per province were calculated by taking total federal government revenue (Statistics Canada, *Canadian Statistical Review*, 11-003, various issues) and allocating it to each province on the basis of the ratio of provincial GDP to total Canadian GDP. Total provincial revenues are given by total gross general revenue from own source, Statistics Canada, *Provincial Government Finances*, 68–207, various issues. Federal transfers to individuals are calculated as the sum of unemployment insurance payments, pension payments, the old age supplement, veterans benefits and family allowances. Unemployment insurance payments by province can be found in Statistics Canada, *Statistics Report on the Operation of the Unemployment Insurance Act*, October-December 1982, 73-001. Pension payments to individuals are calculated using Canada Pension Plan payments for Canada found in Statistics Canada, *Federal Government Finance*, 68-211, various issues. This is allocated among the provinces on the basis of population (assuming that no CPP payments were made to residents of Quebec). OAS, veterans allowance, and family allowances can also be found in 68-211. These were allocated among all the provinces (including Quebec) on the basis of population.

$B = \tilde{P}_H \cdot H + \tilde{P}_M \cdot M + \tilde{P}_E \cdot E + P_X \cdot X.$

$W_H = \tilde{P}_H \cdot H/B.$

$W_M = \tilde{P}_M \cdot M/B.$

$W_E = \tilde{P}_E \cdot E/B.$

$W_X = P_X \cdot X/B.$

POP = log of the total population by province from Statistics Canada, *Canadian Statistical Review*, 11-003, various issues.

P2024 = log of the ratio of the provincial population aged between twenty and twenty-four to the total provincial population (1971–5, Statistics Canada, 84-206; 1976–80, Statistics Canada, 91-202; 1981, Statistics Canada 63-224).

P65 = log of the ratio of the population over sixty-five years to the total population by province (source same as for P2024).

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