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An Evaluation of the Risk-Sharing Function of Equalization in Canada

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Abstract

The Canadian system of equalization is designed to address di¤erences in revenue-raising capacity across provinces, basing entitlements on actual provincial tax rates and bases. However, since it does so on a year-on-year basis, the standard against which a given province's equalization entitlements are calculated ‡uctuates from year to year as all provinces' tax bases and tax rates do. The consequence is that, while the redistribution function is ful…lled annually, the risk-sharing function su¤ers. The evidence we present indicates that, at least for the business income tax, the equalization system can actually be destabilizing, thereby imposing on provinces variability in their potential revenue streams that exceeds what would exist in the absence of equalization.

Key words: intergovernmental transfers, equalization, risksharing, interregional redistribution

JEL Classi…cation: H77

1 Introduction

In Canada, as in most federations, uneven …scal capacities of provincial governments are partially o¤set by the system of federal-provincial equalization transfers. The size of these transfers is determined through a mechanical formula, which arti…cially links provincial tax bases and thereby allows provincial governments to share ‡uctuations in each of their individual tax bases. Equalization payments in Canada are unconditional grants from the federal government to those provinces — the so-called 'have-not' provinces — whose tax capacities are below a national norm. Speci…cally, entitlement to equalization is based on the di¤erences between each of a province's per capita tax bases and the average per capita tax base of …ve 'standard' provinces (Quebec, Ontario, Manitoba, Saskatchewan, and British Columbia). The di¤erences are calculated for 33 revenue categories, multiplied by the average tax rates

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in all provinces, and summed up to yield the overall entitlement. The per capita entitlement for province k, e_k, is then given by:

$$e_k = \max\left\{0, \sum_j \tau^j \cdot \left(b_S^j - b_k^j\right)\right\}$$

where τ^j is national average provincial tax rate for tax base j, b_S^j is per capita tax base j among the five standard provinces, and b_k^j is per capita tax base j in province k. Equalization entitlements are calculated annually and are financed out of federal general revenues raised throughout the country.

We can identify three types of effects the equalization system has on the budget of a given province. First, idiosyncratic fluctuations in a province's tax bases are shared by other provinces through the intermediation of the transfer system. This is characterized in the literature as the risk-sharing function of inter-regional transfers, the presumption being that the federal government can pool these risks across provinces through its access to nationwide tax bases (e.g., Bayoumi and Masson 1995, von Hagen and Hepp 2000, Konrad and Seitz 2001). Second, the equalization system serves a redistribution function by compensating for persistent differences in provincial per capita tax bases (Bayoumi and Masson 1995, von Hagen and Hepp 2000, Hobson 1998). Third, and somewhat contradictory to the first two, provinces might be subject to shocks in their equalization transfers as a result of changes in policies and bases in other jurisdictions. This is because equalization entitlements are based on actual provincial tax bases and tax rates rather than on some federally imposed standard as in some federations. From this point of view, equalization could actually be destabilizing from a recipient's perspective, a prospect recently documented by Boothe (2001) for Saskatchewan.

The main purpose of this paper is to examine the extent to which the equalization system is in fact destabilizing, and to identify the sources of the instability. We follow the literature in characterizing the risk-sharing effect in terms of fiscal flows intended to offset adverse changes in a targeted variable like tax bases or revenues (Bayoumi and Masson 1995, von Hagen and Hepp 2000). Given this standard definition, the effect of the transfers is destabilizing when the fiscal flows co-move with the tax bases or revenues. The key feature is that changes over time in recipient province k's entitlement from a given tax source e_k^j hinge not only on changes in its own tax base b_k^j but also on changes in both the national average tax rate τ^j the per capita tax base of the five standard provinces b_S^j. For example, even when province k has a negative shock on b_k^j, which is to be compensated if the risk-sharing function is in effect, a simultaneous, and possibly independent, negative change in b_S^j may result in a reduction in e_k^j.

There is a growing empirical literature on the risk-sharing and redistributive performance of fiscal transfers. Our approach contrasts with this literature in three main ways. First, while the literature discusses the issues in terms of per capita regional income (Bayoumi and Masson 1995, Asdrubali et al. 1996, von Hagen and Hepp 2000), we focus on provincial tax collections. That is because the equalization system is emphatically not meant to be one that addresses differences in individual incomes. Its purpose is to equalize the ability of provinces to provide comparable levels of public services. Put differently, it is intended to address issues of horizontal equity, not vertical equity (Boadway and Hobson 1993, 1998). As such, the targeted variable in the Canadian system is the revenues of the provinces, not the incomes of individual citizens within a province. The redistributive function involves equalizing revenue-raising capacities across provinces, and the risk-sharing function involves providing provinces with more stable and predictable flows of revenues than those generated from their own sources.

Second, we set aside the redistribution function and concentrate mainly on the risk-sharing/stabilizing features of equalization. The former has been a major issue in the literature, but evaluating the redistribution performance of equalization is of limited concern in Canada. That is because the design of the equalization system itself (along with other components of the fiscal transfer system) is based on a formula that ensures that tax capacities are comprehensively equalized for the have-not provinces. Thus, the adequacy of the equalization system in addressing the redistribution function is not in question, although there may well be debates about the normative case for such a function, and the extent to which it should be pursued (Usher 1995). There is as well a conceptual problem with taking the standard approach to estimating the redistributive impact of equalization on personal incomes. One would have to take account both of the equalization transfers paid by the federal government, and the source of general revenues used to finance the scheme. By focusing on provincial government revenues, this kind of individual income accounting is not necessary.

Third, while previous studies analyze aggregate intergovernmental transfers and regional income levels, we directly examine the behaviour of components of the equalization formula itself. The typical approach in the literature is to employ indirect methods by examining the value of key coefficients from either i) regression equations theoretically derived from intertemporal consumption theory (Asdrubali et al. 1996), or ii) ad hoc regression equations that relate several variations of pre- and post-transfer values of per capita regional income (Bayoumi and Masson 1995, von Hagen and Hepp 2000).

Our task is twofold. One is to decompose annual changes in per capita equalization entitlement into those due to annual changes in the three components in the formula, namely the average tax rate (τ^j), the five-province standard (b_S^j) and the own per capita base (b_k^j). This enables us to trace the source of actual changes in entitlements to these three components, and to evaluate the extent to which the system has, or has not been, stabilizing. The other is to evaluate the risk-related aspect of the equalization scheme by examining how equalization payments have responded to asymmetric contemporaneous shocks to the ten provinces. To do so, we statistically decompose variations in annual per capita tax base changes in each province into a shock, or idiosyncratic, element and a structural element. The former are used to determine the response of the equalization transfers to the shocks. In particular, we analyze whether the response to these idiosyncratic shocks taken together are stabilizing or destabilizing with respect to have-not province equalization entitlements.

Our analysis is relevant only for those provinces that actually received transfers, which over the entire period of our analysis included Newfoundland, Prince Edward Island, Nova Scotia, New Brunswick, Quebec, Manitoba and Saskatchewan. These provinces had a positive overall entitlement for equalization, $\sum_j \tau^j \cdot (b^j_S - b^j_k) > 0$. For the remaining three provinces — Ontario, Alberta and British Columbia — $\sum_j \tau^j \cdot (b^j_S - b^j_k) < 0$ for all periods. These provinces are not insured against idiosyncratic shocks, nor are they subject to shocks arising elsewhere in the country. In addition, we limit our analysis to a single tax base, business income, which is one for which idiosyncratic shocks are likely to be relatively more prevalent. Our analysis is not based on equalization payments to the provinces that are aggregated over all 33 revenue categories, but on changes in entitlement that originates in that single revenue category. As such, implications for risk sharing and exposure to exogenous shocks may be different for the actual equalization mechanism where shocks to the 33 tax bases are aggregated.

The Canadian equalization system is designed primarily with the restribution function in mind. Our results show that in attempting to achieve redistribution on a year-by-year basis, the system sacrifices its risk-sharing role. At least for the busniess tax, equalization transfers are actually destabilizing, and that is due to fact that a recipient province's entitlement depends on changes in the five-province standard base and the national average tax rate, both of which exhibit instability. Although we focus only on the busniess tax base, the present study should provide an exemplary method for analyzing the risk-related aspects of the interprovincial fiscal equalization mechanism more generally. Our analysis, in principle, can be extended to include other important tax bases that are considered in the equalization formula.

The paper proceeds as follows. In the next section, we discuss our data source and take a preliminary look at the relevant statistical correlations in the data. Then, we decompose changes in business tax entitlements into the three components mentioned above and discuss the implications. Following that, we estimate the part of tax base changes in each province that are due to idiosyncratic shocks and calculate how the equalization system responded to them. Finally, we offer some conclusions.

2 A Preliminary Look at the Data

The data we use are obtained from Finance Canada. They include the raw data used to calculate annual equalization entitlements for all provinces and revenue sources from 1967-98. These include revenue bases and revenues obtained from all 33 revenue sources used in the representative tax system and for all ten provinces, as well as provincial populations. These data are sufficient to compute national average tax rates (the sum of provincial revenues divided by the sum of provincial tax bases for each revenue source) and the five-province standard per capita tax base (the sum of the tax bases in the five standard provinces divided by the sum of their populations). Note that, while the provincial revenues are those actually collected in each provinces, the tax bases do not reflect those used by the provinces. Instead, a standardized definition of the tax base is used so that meaningful differences between provinces can be used as the basis for entitlements.

In using these data, three caveats should be borne in mind in what follows. First, we deflate all our variables (per capita tax base b_k^j, per capita tax collection r_k^j from the base, and the five-province standard per capita tax base b_S^j) by the 1992 implicit price deflator so as to net out the effects of price changes over time. Second, the entitlements for all 31 years are calculated using the current formula. Prior to 1982, the equalization formula was somewhat different. For example, a ten-province standard was in effect rather than the present five-province one. This allows us to draw comparisons over the whole period using a consistent equalization system. One might object that this procedures causes problems to the extent that the tax bases and tax rates might themselves have been different had a different equalization formula been in effect. Third, the entitlements data we use are final figures, while the annual volumes of the transfers initially paid are based upon preliminary estimates. The difference between the preliminary and final figures are adjusted, but the calcuation of the final figures takes a few years to complete. As such, our analysis is applied to the due amounts that the equalization formula is supposed to deliver. It is not clear in principle whether these final figures are more or less volatile that the initial estimates. In any case, we expect that the differences between the two is not large enough to significantly effect our qualitative results.

The average tax rate τ^j and the five-province standard base b_S^j are calculated with the quantities of revenues and bases of individual provinces in a given year. As such, they fluctuate from year to year. More important, by the very way those two values are calculated, they constitute routes through which changes in tax policies and bases in one province influence the payments the have-not provinces are entitled to receive. This interdependency makes it relevant to consider the prospect of the destabilizing effect of equalization payments.

To take a preliminary look, let us examine how each province's per capita equalization entitlements respond to variations in its per capita revenues, simply by looking at correlation coefficients between the relevant variables. Since we focus on a single revenue source — business income — we can from now on drop the superscript j that indexes the tax base. Instead, we add a time subscript t since we are examining changes over time. We can then express the per capita entitlement accruing to province k in year t as:

$$e_{kt} = \tau_t \cdot (b_{St} - b_{kt}). \qquad (1)$$

From the data, we can indeed discern a destabilizing, rather than stabilizing, effect of the equalization system. Table 1 shows three sets of correlation coefficients for the seven equalization receiving provinces, along with P values (in parentheses) which indicate two-tail marginal statistical significance. The first column shows the correlation between per capita equalization entitlements and per capita revenues for the seven provinces. To the extent that equalization is intended to compensate for a loss in provincial tax revenues, we would expect these coefficients to be negative. In fact, all correlation coefficients exhibit positive values for business income revenues. More specifically, the correlations for the five provinces other than Quebec and Manitoba are statistically significant at the $.025$ level, while entitlements and revenues are statistically uncorrelated for these two provinces. Such a finding, which mirrors that found by Boothe (2001) for the aggregate of all revenues sources in the case of Saskatchewan, may come as a surprise. It would imply that, contrary to its intent, the equalization system is actually destabilizing, at least with respect to business tax revenues.

This finding is, however, premature. Business tax revenues are to some extent affected by the tax policies of the provincial governments, so the correlation could reflect the effect of policy changes. The equalization system is intended to compensate for changes in the potential to raise revenues rather than the actual revenues themselves. A more relevant correlation might be that between equalization entitlements and provincial tax bases. Although the latter might still be influenced by provincial tax policies, they presumably more closely reflect revenue-raising potential than do actual tax revenues. Alternatively, another correlation worth considering would be between the entitlements and some standarized revenue-raising capacities. Here, we can employ per capita tax base evaluated at the national average tax rate, $\tau_t b_{kt}$. Differences in these are, after all, what the equalization system attempts to compensate for.

The second column of Table 1 then shows the correlation coefficients between per capita equalization entitlements and per capita business income tax bases for each of the have-not provinces. Given (1), we would expect that the negative correlation holds, more so than for the per capita tax revenues. The results, however, are rather mixed. For four provinces (New Brunswick, Quebec, Manitoba and Saskatchewan) the correlations are negative as expected, but they are positive for the remaining three provinces (Newfoundland, Prince Edward Island and Nova Scotia). At the $.05$ level, the negative correlations for Quebec and Saskatchewan and the positive correlations for Newfoundland and Nova Scotia are statistically significant. The two variables for the other three provinces — Prince Edward Island, New Brunswick and Manitoba — are judged to be statistically uncorrelated.

The third column of Table 1 lists the correlation coefficients between the entitlements and the standarized revenue capacities, per capita tax base evaluated at the national average tax rate, $\tau_t b_{kt}$. Rewriting (1) as $e_{kt} = \tau_t b_{St} - \tau_t b_{kt}$, we would again expect that the negative correlation holds, even more so than for the two variables above. The results, however, are again mixed. Now the negative correlations are seen only for two provinces – Quebec and Saskatchewan, and only the former is statistically significant at the standard levels. The correlations are positive for the remaining five provinces (Newfoundland, Prince Edward Island, Nova Scotia, New Brunswick and Manitoba). The correlations for New Brunswick and Manitoba are insignificant at the $.05$ level, and only the latter is so at the 0.10 level.

The results of Table 1 suggest that the equalization system may destabilize, rather than stabilize, provincial revenues over time. To obtain a rough indication of its destabilizing effect, we calculate the standard deviations and the average values of pre-equalized per capita revenue r_{kt} and those of post-equalized per capita revenue $r_{kt} + e_{kt}$ for the seven provinces in Table 2. The descriptive statistics indeed indicate that post-equalized revenues are more volatile than pre-equalized revenues, with substantive increases in the standard deviations for most of the provinces. Of course, since those provinces are recipients, the mean values are larger after the equalization. We also calculate the analogous descriptive statistics of the pre-equalized standarized per capita revenue $\tau_t b_{kt}$ and those of post-equalized per capita revenue $\tau_t b_{kt} + e_{kt} = \tau_t b_{kt} + (\tau_t b_{St} - \tau_t b_{kt}) = \tau_t b_{St}$. Notice that the latter variable and the statistics calculated for it are common for all the recipient provinces. The results again indicate that, except for Quebec, post-equalized potential revenues are more volatile than pre-equalized potential revenues, with increases in the standard deviations resulting from the equalization system.

3 Decomposing Changes in Equalization Entitlements

The results of the previous section indicated that provincial entitlements e_t might behave rather perversely with respect to changes in a province's own tax base b_{kt}. Since these two factors are negatively related in the formula for entitlements, this implies that the perverse outcomes must be due to the influence of the other two components of the formula, changes in the average tax rate τ_t and in the five-province standard b_{St}. Our next task is to quantify these influences. To do so, we decompose annual changes in e_t into annual changes in the three components, namely, τ_t, b_{St} and b_{kt}. It turns out that, given the multiplicative nature of the entitlement formula — $e_k(\tau; b_S; b_k) \equiv \tau \cdot (b_S - b_k)$ — an exact decomposition can be done. To interpret this decomposition in terms of the influence of each of the three components, we assume that we can treat each of them as independent in the equalization formula. In fact, the national average tax rate τ is constructed using the tax bases of the provinces, so we are ignoring whatever interdependency this gives rise to. This will be legitimate to the extent that the determination of the national average tax rate is based on provincial tax rates rather than their bases, which will be the case when provincial business income tax rates are proportional. This seems like a good first approximation.[1]

For differential changes, we obtain the total derivative $de_k(\tau; b_S; b_k) = (b_S - b_k)d\tau + \tau db_S - \tau db_k$. For the discrete annual changes that we are dealing with, we can use a Taylor approximation to obtain the relevant discrete analogue. Given the multiplicative form of the expression for $e_k(\tau; b_S; b_k)$, a second-order Taylor expression will be exact since all third derivatives vanish.

[1] Recall that the ten-province average tax rate (τ) is given as $\tau \equiv \sum_k n_k r_k / \sum n_k b_k = \sum_k n_k \tau_k b_k / \sum n_k b_k = \sum_k s_k \tau_k$ where n_k is population, r_k is per capita revenue, τ_k is individual average tax rate, and $s_k \equiv n_k b_k / \sum n_k b_k$ is tax base share, all for province k. The last expression illustrates that the tax rate of a province has an influence on the national average tax rate to the extent of its tax base share. As such, for most have-not provinces with smaller tax base share, the effect of their own tax rate changes on the national average are not likely to be significant. The per capita tax base may well influence the individual average tax rates as well. However, if provincial taxes are proportional, then τ_k is constant and independent of changes in individual per capita tax bases, which may not be an unreasonable assumption. If this assumption is maintained, we could, in principle, decompose changes in $\tau = \sum_k s_k \tau_k$ into that due to the own province's tax rate changes and that due to tax base changes (via changes in s_k).

Applying a second-order Taylor expansion to the time-dependent expression for equalization entitlements $e_k(\tau_t, b_{St}, b_{kt})$ yields two alternative expressions:

$$\begin{aligned} \Delta e_{kt} &= (b_{St} - b_{kt}) \cdot \Delta\tau_t + \tau_{t-1} \cdot \Delta b_{St} - \tau_{t-1} \cdot \Delta b_{kt} \\ \Delta e_{kt} &= (b_{St-1} - b_{kt-1}) \cdot \Delta\tau_t + \tau_t \cdot \Delta b_{St} - \tau_t \cdot \Delta b_{kt}. \end{aligned}$$

where $\Delta e_{kt} \equiv e_{kt} - e_{kt-1}$, $\Delta\tau_t \equiv \tau_t - \tau_{t-1}$, $\Delta b_{St} \equiv b_{St} - b_{St-1}$ and $\Delta b_{kt} \equiv b_{kt} - b_{kt-1}$.[2] They represent two alternative ways of decomposing changes in entitlements into those due to the three components. The coefficients will differ slightly because of the different time periods used to construct them. In fact, combining these two expressions, the change in e_{kt} can be evaluated at the average value of the coefficients over the time periods involved (t and $t-1$):

$$\Delta e_{kt} = \alpha_{kt} \Delta\tau_t + \beta_{kt} \Delta b_{St} - \gamma_{kt} \Delta b_{kt}. \qquad (2)$$

where $\alpha_{kt} \equiv [(b_{St} - b_{kt}) + (b_{St-1} - b_{kt-1})]/2$, $\beta_{kt} \equiv (\tau_t + \tau_{t-1})/2$ and $\gamma_{kt} \equiv (\tau_t + \tau_{t-1})/2$. This is what we use for our decomposition.[3]

Panels a–g in Figure 1 depict graphically the results of the decompositions calculated using (2) for the seven recipients. The solid squares show the values for Δe_{kt} during each of the calendar years. As these indicate, there is considerable variability from one year to the next in per capita entitlements from this revenue source. The vertical bars consist of three segments that show the values for $\alpha_{kt}\Delta\tau_t$, $\beta_{kt}\Delta b_{St}$ and $-\gamma_{kt}\Delta b_{kt}$. Those components with positive values appear above the horizontal axis, while those with negative values appear below. Naturally, all three add up to Δe_{kt}.

Figure 1

As can be seen, in most years, there are both negative and positive components regardless of the sign of Δe_{kt}. For all seven provinces, the impacts of the five-province standard (b_{St}) are relatively large, usually exceeding the impacts of own tax bases (b_{kt}). The average tax rates (τ_t) is the least influential among the three, but it still

[2] The second-order Taylor expansion results in: $e_k(\tau_{t-1} + \Delta\tau_t, b_{St-1} + \Delta b_{St}, b_{kt-1} + \Delta b_{kt}) = e_k(\tau_{t-1}, b_{St-1}, b_{kt-1}) + (b_{St-1} - b_{kt-1})\Delta\tau_t + \tau_{t-1}\Delta b_{St} - \tau_{t-1}\Delta b_{kt} + \Delta\tau_t \Delta b_{St} - \Delta\tau_t \Delta b_{kt}$. Noting $e_{kt} = e_k(\tau_{t-1} + \Delta\tau_t, b_{St-1} + \Delta b_{St}, b_{kt-1} + \Delta b_{kt})$ and collecting terms, the above expression yields the two expression in the text. Actually, since the second-order expansion is exact, we do not really need a Taylor expansion to obtain these decompositions. Noting that by definition $\Delta e_{kt} \equiv \tau_t \cdot (b_{St} - b_{kt}) - \tau_{t-1} \cdot (b_{St-1} - b_{kt-1})$, we see that straightforward rearrangement of this expression results in either of the two decompositions.

[3] For have-not provinces that are part of the five-province standard (i.e., Quebec, Manitoba and Saskatchewan), their own base will also to some extent affect the five province standard. To account for such an effect, we may rewrite the formula as $e_{kt} = \tau_t \cdot \left[b^{ik}_{St} - (1 - w_{kt}) b_{kt} \right]$ where w_{it} is a population share and $b^{ik}_{St} \equiv b_{St} - w_{kt} b_{kt}$. The first-order approximation analogous to Eq. (2) will then be: $\Delta e_{kt} \approx \alpha_{kt} \Delta\tau_t + \beta_{kt} \Delta b^{ik}_{St} + \gamma^S_{kt} \Delta b_{kt} + \psi_{kt} \Delta w_{kt}$ where $\Delta b^{ik}_{St} \equiv b^{ik}_{St} - b^{ik}_{St-1}$, $\gamma^S_{kt} \equiv -[(1 - w_{kt})\tau_t + (1 - w_{kt-1})\tau_{t-1}]/2$, $\Delta w_{kt} \equiv w_{kt} - w_{kt-1}$ and $\psi_{kt} \equiv (w_{kt} b_{kt} + w_{kt-1} b_{kt-1})/2$. While this decomposition does not yield an exact approximation given a third-order term (i.e., $\tau_t w_{kt} b_{kt}$) in the formula, its performance is almost accurate with the largest error of 1.5% (and most of the errors are less than .1%). The general results, however, are not so different from the case in the text. The details are provided by the authors upon requiest.

exerts substantial impacts. We can summarize these variations taking advantage of the variance decomposition of (2), namely:

$$
\begin{aligned}
\mathrm{Var}(\Delta e_{kt}) = {} & \mathrm{Var}(\alpha_{kt} \Delta \tau_t) + \mathrm{Var}(\beta_{kt} \Delta b_{St}) + \mathrm{Var}(-\gamma_{kt} \Delta b_{kt}) \\
& + 2 \cdot \mathrm{Cov}(\alpha_{kt} \Delta \tau_t, \beta_{kt} \Delta b_{St}) + 2 \cdot \mathrm{Cov}(\alpha_{kt} \Delta \tau_t, -\gamma_{kt} \Delta b_{kt}) \\
& + 2 \cdot \mathrm{Cov}(\beta_{kt} \Delta b_{St}, -\gamma_{kt} \Delta b_{kt}) .
\end{aligned}
$$

Table 3 lists the variance-covariance components normalized by $\mathrm{Var}(\Delta e_{kt})$. It shows that changes due to the five-province standard ($\beta_{kt} \Delta b_{St}$) fluctuate more than those due to own per capita tax bases ($-\gamma_{kt} \Delta b_{kt}$), except for New Brunswick. The variations in both of those two components are significantly larger than those in the national average tax rate $\alpha_{kt} \Delta \tau_t$. However, the large fluctuation of the former two do not materialize into changes in the equalization entitlements, since the two components are inversely correlated to a sizable extent, as indicated by the far right column in the table.

To the extent that the equalization system is intended to insure against changes in each province's own tax capacity, we would expect an increase in e_{kt} to compensate for revenue losses from own tax base reductions. While an exact offset ($\Delta e_{kt} = -\gamma_{kt} \Delta b_{kt}$) is not expected since the average tax rate and the five-province standard fluctuate over time ($\Delta \tau_t \neq 0$ and $\Delta b_{St} \neq 0$), we might expect at least some degree of compensation to a base change. If so, the majority of the cases would involve $\Delta e_t \cdot \Delta b_{kt} > 0$ with either (a) 'under-compensation' where equalization payments offset less than a change in the base necessitates (i.e., $\mathrm{abs}(\Delta e_t) < \mathrm{abs}(-\gamma_{kt} \Delta b_{kt})$), or (b) 'over-compensation' where the offset is more than necessary (i.e., $\mathrm{abs}(\Delta e_t) > \mathrm{abs}(-\gamma_{kt} \Delta b_{kt})$). However, this is not the case if we eyeball the fluctuations in Figure 1.

Table 4 summarizes the results for the seven province for the 31 periods. The majority of the cases are identified as adverse ones where where the entitlements and the tax bases move in the same direction. More specifically, there are 'depriving' cases, denoted (c1), where a loss in own tax base is accompanied by a decrease in transfer payments ($\Delta b_{kt} < 0$ and $\alpha_{kt} \Delta \tau_t + \beta_{kt} \Delta b_{St} < \gamma_{kt} \Delta b_{kt}$), and 'unnecessary compensation'cases, denoted (c2), where a province obtains an increase in entitlements when there is an increase in its own tax base ($\Delta b_{kt} > 0$ and $\alpha_{kt} \Delta \tau_t + \beta_{kt} \Delta b_{St} > \gamma_{kt} \Delta b_{kt}$). These adverse cases are mainly explained by the influence of the five-province standard tax base b_{St} (and to lesser extent the average tax rates τ_t). Recall that the primary purpose of the scheme is to 'equalize' tax capacities of receiving provinces to the standard in a single period, not to insure against revenue losses over periods. As per capita tax bases change in the five standard provinces, the five-province standard changes over time, and can do so in an erratic way relative to the per capita tax base of a recipient province. This may also explain why unnecessary compensation occupies the majority of the period for all seven provinces. When the standard grows faster than tax base of a recipient, an equalizing scheme may compensate even if the latter grows. Such compensation may be unnecessary as an insurance device, but it does sevre as an equalizing device satisfying the redistribution function.

4 Responses to Asymmetric Shocks

While the results of the previous section may well be indicative of the destabilizing properties of equalization payments, they do not have direct implications for its risk-sharing function. The risk-sharing function of a transfer scheme is typically characterized in the literature in terms of its response to unpredictable asymmetric shocks. For example, Bayoumi and Masson (1995) identify the risk-sharing role with the degree of response to temporary deviations from the growth path of fiscal capacities. In addition, von Hagen and Hammond (1998) argue that the case for insurance is based on the existence of temporary and asymmetric shocks. Fiscal transfers as a risk-sharing mechanism should be paid in response to shocks that are both asymmetric and serially uncorrelated. In the previous section, we considered the response of equalization payments to annual changes in the three components of the transfer scheme, namely, the recipient province's per capita tax base, the national average tax rate and the five-province standard tax base. However, changes in the per capita tax bases are not generally asymmetric and serially uncorrelated. They include persistent changes that arise because of changes in the level and distribution of provincial tax bases. The redistribution function of equalization is imeant to deal with these. To evaluate the extent to which the equalization system acts purely as a risk-sharing device, we need to focus on those changes in per capita tax bases that represent asymmetric and serially uncorrelated — that is, idiosyncratic — shocks.

Our first task is to identify the set of such idiosyncratic shocks or 'innovations' to the per capita tax bases. To obtain some plausible estimates, we take a time-series approach and model annual changes in the per capita business tax base in province i (Δb_{it}) as the following AR(p) process:

$$\Delta b_{it} = c_t + \rho_{i0} + \sum_{s=1}^{p} \rho_{is} \Delta b_{it-s} + \varepsilon_{it}. \tag{3}$$

where the ρ_{is}'s ($s = 1, \ldots, p$) are coefficients, ε_{it} is an independently distributed shock and c_t is the common component that identically affects all provinces. We use a set of residuals $\hat{\varepsilon}_t' \equiv [\hat{\varepsilon}_{1t}\ \hat{\varepsilon}_{2t}\ \hat{\varepsilon}_{3t}\ \hat{\varepsilon}_{4t}\ \hat{\varepsilon}_{5t}\ \hat{\varepsilon}_{6t}\ \hat{\varepsilon}_{7t}\ \hat{\varepsilon}_{8t}\ \hat{\varepsilon}_{9t}\ \hat{\varepsilon}_{10t}]$ from the regression as the 'historical' shocks on which our characterization will be based. Note that for the residuals to be asymmetric, we require $\sum_{i \in P} \hat{\varepsilon}_{it} = 0$ for a given t.

To estimate (3), we use our panel of per capita business income bases for the 10 provinces over the period 1969–98. Notice that the common component c_t may include both deterministic and stochastic factors. The deterministic factor may consist of a common trend as well as some common structural changes, while the stochastic factor may include a nation-wide contemporaneous shock that affects the ten provinces identically at the same time. These factors are captured all together by the inclusion of time dummies for individual years. Coefficients on such dummies are considered to be the estimates for c_t.

We also allow individual coefficients ρ_{is}'s to take different values over the provinces ($i = 1, \ldots, 10$). Therefore, our panel estimation is in effect identical to the estimation of a system of ten different regression equations that are restricted by the common factor (c_t). When estimated with our pooled data, the model utilizes regional dummies to yield provincial fixed effects (ρ_{i0}) as well as the individual slope coefficients (ρ_{is}). Note that the fixed effects (ρ_{i0}) are meant to capture persistent province-specific effects that are reflected in annual changes in equalization entitlement. Of course, one of the dummies must be excluded to avoid the singularity problem (or perfect collinearity). We chose to exclude the provincial dummy for British Columbia. As such, all of the common time effects (coefficients on the time dummies) should be interpreted to include the regional effect for British Columbia.

Given the short length of the time series (30 annual observations), we began with small values for the time lag p. We first tested the model with $p = 1$ against the model with $p = 2$, and could not reject the former with a large P value of .9836. We therefore opted for the model with $p = 1$. Furthermore, we tested the model without either of the two sets of fixed effects, given $p = 1$. We statistically rejected the case without the time dummies with a P value of .0000. This suggests that there is a nation-wide common factor that partly explains annual changes in the per capita tax bases. On the other hand, we cannot reject the model that excludes the province dummies with a P value of .9965. This may suggest dispensing with provincial dummies, but we chose not to do so. This is because we are more concerned with creating residuals ε_t than with obtaining the parameter estimates. Including provincial dummies makes the set of residuals asymmetric in the sense that $\sum_i \varepsilon_{it} = 0$ holds for any t. In addition, this makes it easier to interpret the results of our exercise. Therefore, we use the results from the model with $p = 1$ with both the time and provincial dummies included. The estimates are listed in Table 5.

Table 5

We interpret the residuals $\varepsilon \equiv \{\varepsilon_t\}_{t=1969}^{1998}$ obtained from the regression of (3) with $p = 1$ as the random-shock portion of Δb_{it}. These shocks to the tax base induce changes both in the revenue-raising capability of the provinces and in their equalization entitlements. The question of concern to us is the extent to which the latter offsets the former for equalization-receiving provinces. We can calculate the corresponding variations in equalization entitlements Δe_{kt} induced by these random shocks, denoted $\Delta e_{kt}(\varepsilon_t)$, as:[4]

$$\begin{aligned}\Delta e_{kt}(\varepsilon_t) \;=\; & \frac{\sum_{i\in P} n_{it-1}\tau_{it-1}\cdot(b_{it-1}+\varepsilon_{it})}{\sum_{i\in P} n_{it-1}\cdot(b_{it-1}+\varepsilon_{it})} \\ & \times\left(\frac{\sum_{i\in S} n_{it-1}\cdot(b_{it-1}+\varepsilon_{it})}{\sum_{i\in S} n_{it-1}} - (b_{kt-1}+\varepsilon_{kt})\right) \\ & - e_{kt-1}. \end{aligned} \tag{4}$$

A standardized measure for the change in revenue-raising ability caused by a shock to its own tax base may be expressed as $\tau_{t-1}\varepsilon_{kt}$ where

$$\tau_{t-1} \equiv \frac{\sum_{i\in P} n_{it-1}\tau_{it-1}b_{it-1}}{\sum_{i\in P} n_{it-1}b_{it-1}}$$

[4] Recall that we ignore plausible correlation between τ and b for the reason stated before.

This is simply the change in revenue that would be raised using national average tax rates.

Define the difference between the standardized measure for the revenue change and the change in entitlement due to shocks as:

$$d_{kt} \equiv \tau_{t-1}\varepsilon_{kt} - \Delta e_{kt}(\varepsilon_t)$$

and the ratio between them as

$$\lambda_{kt} \equiv \frac{\Delta e_{kt}(\varepsilon_t)}{\tau_{t-1}\varepsilon_{kt}}.$$

For the equalization formula to perfectly offset the shocks, we require $d_{kt} = 0$ or $\lambda_{kt} = -1$. This will be the case when the average tax rate τ and the five-province standard b_S are fixed at some values, say, at τ^0 and b_S^0.[5] However, the perfect offsetting is not generally the case since τ and b_S are not fixed but fluctuate with the shocks that occur to the other provinces as well. In other words, all of the elements in ε_t propagate throughout the equalization system via τ and b_S so that unexpected changes may occur to e_{kt} in relation to ε_{kt}.

We have calculated $\tau_{t-1}\varepsilon_{kt}$, $\Delta e_{it}(\varepsilon_t)$, d_{kt} and λ_{kt} for the ten provinces for the period from 1969–1998, where, as earlier, the formula in place since 1982 is used to calculate entitlements. The results for pre-1982 fiscal years are interpreted as counter-factual cases that show what the responses would have been if the current formula had been applied. We list the results for λ_{kt} in Table 6.[6] The ratios in the table would take on values of -1 if the shocks were perfectly offset, and will be closer to -1 to the extent the offsetting works appropriately. A rough look at the tables, however, implies that the equalization system has performed far from perfectly as a risk-sharing device. There are relatively few cases where the ratio is close to -1. For example, there are only eleven cases out of 210 (seven provinces $\times$ 30 fiscal years) where the ratio is such that $-1.1 \le \lambda_{kt} \le -.9$ (Newfoundland 1988, 89; PEI 1988, 89, 98; Nova Scotia 1988, 89; New Brunswick 1988; Quebec 1989; Manitoba 1988; Saskatchewan 1989). In addition, there are 49 cases (almost a quarter of the total number) with positive values which implies that changes in the entitlements and the innovations moved in the same direction.

Table 6

Table 7 summarizes more detailed results, classifying the cases into the following eight categories by the directions and volumes of $\tau_{t-1}\varepsilon_{it}$, $\Delta e_{kt}(\varepsilon_t)$ and d_{kt}. Figure 2 is a graphical representation of these eight patterns.

Case a: A decrease in revenue-raising ($\tau_{t-1}\varepsilon_{it} < 0$) with an under-offsetting transfer ($\Delta e_{kt}(\varepsilon_t) > 0$, $d_{kt} < 0$), which is stabilizing ($\mathrm{abs}(d_{kt}) < \mathrm{abs}(\tau_{t-1}\varepsilon_{it})$)

[5] Then, using (4), we obtain $\Delta e_{kt}(\varepsilon_t) = \tau^0\Delta(b_S^0 - (b_{kt-1} + \varepsilon_{kt})) - \tau^0\Delta(b_S^0 - b_{kt-1}^0) = -\tau^0\Delta\varepsilon_{kt}$.

[6] The results for $\tau_{t-1}\varepsilon_{kt}$, $\Delta e_{it}(\varepsilon_t)$ and d_{kt} are provided by the authors upon request.

Case b: A decrease in revenue-raising ($\tau_{t-1}\epsilon_{it} < 0$) with a transfer that is over-offsetting ($\Delta e_{kt}(\epsilon_t) > 0$, $d_{kt} > 0$) but stabilizing ($abs(d_{kt}) < abs(\tau_{t-1}\epsilon_{it})$)

Case c: A decrease in revenue-raising ($\tau_{t-1}\epsilon_{it} < 0$) with a transfer that is over-offsetting ($\Delta e_{kt}(\epsilon_t) > 0$, $d_{kt} > 0$) and destabilizing ($abs(d_{kt}) > abs(\tau_{t-1}\epsilon_{it})$)

Case d: A decreases in revenue-raising with a reduced transfer ($\tau_{t-1}\epsilon_{it} < 0$, $\Delta e_{kt}(\epsilon_t) < 0$), which is destabilizing ($abs(d_{kt}) > abs(\tau_{t-1}\epsilon_{it})$)

Case e: An increase in revenuie-raising ($\tau_{t-1}\epsilon_{it} > 0$) with an under-offsetting transfer ($\Delta e_{kt}(\epsilon_t) < 0$, $d_{kt} > 0$), which is stabilizing ($abs(d_{kt}) < abs(\tau_{t-1}\epsilon_{it})$)

Case f: An increase in revenuie-raising ($\tau_{t-1}\epsilon_{it} > 0$) with a transfer that is over-offsetting ($\Delta e_{kt}(\epsilon_t) < 0$, $d_{kt} < 0$) but stabilizing ($abs(d_{kt}) < abs(\tau_{t-1}\epsilon_{it})$)

Case g: An increase in tax base ($\tau_{t-1}\epsilon_{it} > 0$) with a transfer that is over-offsetting ($\Delta e_{kt}(\epsilon_t) < 0$, $d_{kt} < 0$) and destabilizing ($abs(d_{kt}) > abs(\tau_{t-1}\epsilon_{it})$)

Case h: An increase in revenue-raising ($\tau_{t-1}\epsilon_{it} > 0$) with an increased transfer ($\Delta e_{kt}(\epsilon_t) > 0$), which is destabilizing ($abs(d_{kt}) > abs(\tau_{t-1}\epsilon_{it})$)

The 'destabilizing' cases refers to the cases where a change in the standardized revenue ($\tau_{t-1}\epsilon_{it}$) is larger than a concurrent change in the standardized post-equalized revenue (d_{kt}), both measured in absolute value. In these cases, changes in post-equalized provincial revenues will be more volatile than in pre-equalized revenues. Cases c, d, g and h are the destabilizing cases, and, among them, Case d and Case h parallel respectively with 'depriving case' and 'unnecessary compensation' that were explained in the previous section.

Table 7 & Figure 2

Table 7 marks the destabilizing cases with darker shades (lighter shades indicate non-recipient provinces). As shown, the seven equalization receiving provinces experience destabilizing effects more often than not during the period we examine (111 out of the total of 210 cases). Out of the 30 years, there were 17 destabilizing years for Newfoundland (57%), 11 for PEI (37%), 18 for Nova Scotia (60%), 13 for New Brunswick (43%), 21 for Quebec (70%), 18 for Manitoba (60%) and 13 for Saskatchewan (43%). The two perverse cases of d (depriving) and h (unnecessary compensation) occurred quite often in Quebec and Manitoba, with Case h the most frequent and Case d the second most frequent.

Recall that these are the responses to asymmetric shocks that are constructed to sum up to zero across provinces in each year. In other words, those shocks should cancel each out other if a proper transfer arrangement is in effect. The frequency of the non-perfect offsetting in Table 6 and the destabilizing cases in Table 7 imply a weak risk-sharing function of the equalization scheme.

As mentioned, the main reasons for this poor performance is that the average rate and the standard base are also influenced by the shocks. Although it is difficult to obtain analytically the pattern of changes in τ_{it} and b_{St} caused by ϵ_t, we may numerically obtain such changes as

$$\Delta\overline{\tau}_t = \frac{\sum_{i\in P} n_{it-1}\tau_{it-1}\cdot(b_{it-1}+\epsilon_{it})}{\sum_{i\in P} n_{it-1}\cdot(b_{it-1}+\epsilon_{it})} - \tau_{t-1}$$

for the national average tax rate and

$$\Delta\overline{b}_{St} = \frac{\sum_{i\in S} n_{it-1}\cdot(b_{it-1}+\epsilon_{it})}{\sum_{i\in S} n_{it-1}} - b_{St-1}$$

for the five-province standard. Calculating the changes due to non-innovation sources as $\Delta\tau_t - \Delta\overline{\tau}_t$ and $\Delta b_{St} - \Delta\overline{b}_{St}$, Figures 3 and 4 decompose annual changes in the average tax rate and the five-province standard into changes due to ϵ_t and those due to the other sources. In both cases, the tables clearly show that in most of the times the asymmetric shock elements account for those annual changes more than the other sources of the changes.

Figures 3–4

5 Concluding Remarks

The Canadian constitution commits the federal government to the 'principle of making equalization payments to ensure that provincial governments have sufficient revenues to provide reasonably comparable levels of public services at reasonably comparable levels of taxation'. This admonition is consistent with the economic arguments for equalization that originated in the classic contributions by Buchanan (1950, 1952), and that were developed with the Canadian case in mind by Graham (1964) and Boadway and Flatters (1982). The core argument is that in a decentralized federation, comparable citizens residing in different provinces would receive different 'net fiscal benefits' (NFBs) from their respective provincial governments. These differences in NFBs would provide an incentive for inefficient fiscally induced migration between provinces, and would also result in a violation of horizontal equity across provinces. The remedy calls for equalization payments among provinces to offset these differences in NFBs. In certain stylized circumstances (e.g., provincial tax rates on residents are roughly proportional to incomes, while benefits of provincial public services are independent of income), full equalization of revenue-raising capacity is optimal.[7] The Canadian system of equalization is designed to address differences in revenue-raising capacity across provinces. That is, it focuses entirely on the redistributive function of equalization.

Consistent with that objective of erasing NFB differentials, the equalization system bases entitlements on actual provincial tax rates and bases. But, because it does

[7] Moreover, to the extent that provincial public services are targetted to particular types of persons (the elderly, the ill, the young, etc.), equalization ought to compensate for differences across provinces in the proportions of persons of these different types, referred to as differences in need. The Canadian equalization system, unlike that in many other federations, is based solely on revenue equalization.

so on a year-on-year basis, the standard against which a given province's equalization entitlements are calculated fluctuates from year to year as all provinces' tax bases and tax rates do. The consequence is that, while the redistribution function is fulfilled annually, the risk-sharing function suffers. The evidence we have presented in this paper indicates that, at least for the business income tax, the equalization system can actually be destabilizing, thereby imposing on provinces variability in their revenue streams that exceeds what would exist in the absence of equalization.

To restore the stabilization function of equalization, there must be some persistence in the standard used to calculate each province's entitlement. If the standard is stable, the system should succeed in sharing the risks arising from independent asymmetric shocks to the province's own base. There are two ways that the standard could be made less variable. One is for the federal government to use something other than an aggregate of actual provincial outcomes to set the standard. This might be unsatisfactory for two reasons. First, it would imply that equalization entitlements did not reflect actual differences in NFBs, which is the purpose of the equalization system in principle. Second, if the federal government is given discretion for setting the equalization standard, it opens the possibility that standard becomes part of the annual budgetary policy of the federal government, which itself can lead to unpredictability and uncertainty on the part of the provinces. An alternative approach might be to retain the use of actual provincial tax rates and bases to determine the standard, but to smooth out fluctuations in entitlements by some method of averaging over time. Thus, payments might be based not on currently calculated national standards, but on some moving average of past national standards. Such a procedure could retain the important redistributive function of equalization while at the same time allowing it to fulfil a risk-sharing role. An interesting topic for future research might be to examine if this is the case by following the methodology in this paper with a specific formula that incorporates such a moving average in place of the current formula.

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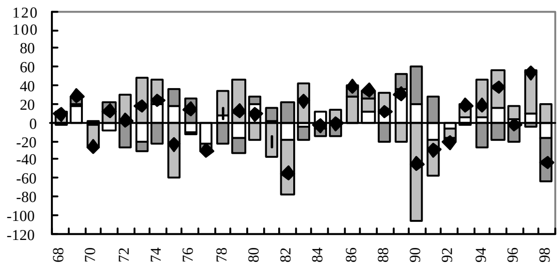
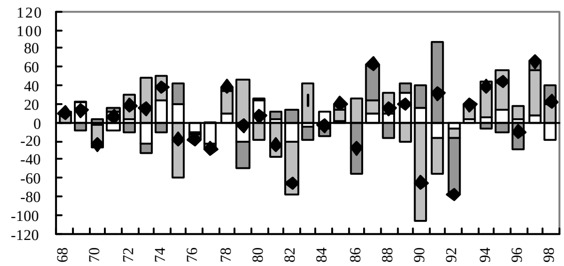
Figure 1. Decomposition of Entitlement Changes (Business Income Taxes)

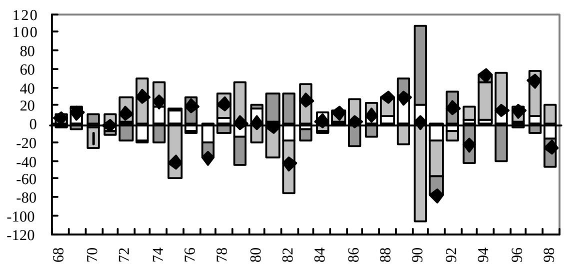
Panel a. Newfoundland



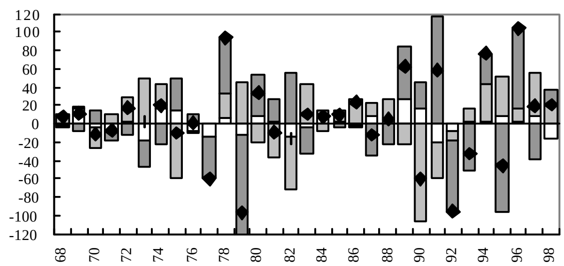
Panel b. Price Edward Island



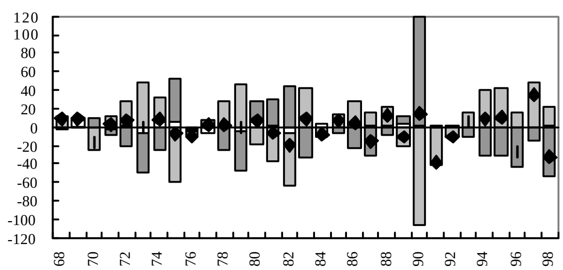
Panel c. Nova Scotia



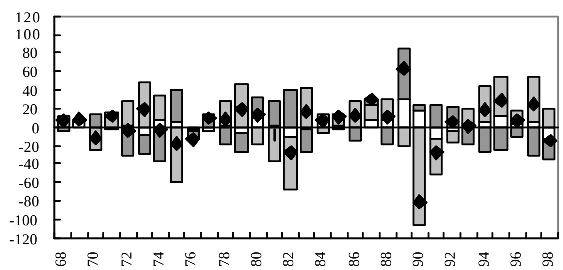
Panel d. New Brunswick



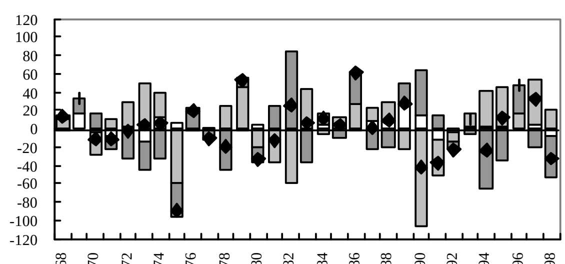
Panel e. Quebec



Panel f. Manitoba



Panel g. Saskatchewan

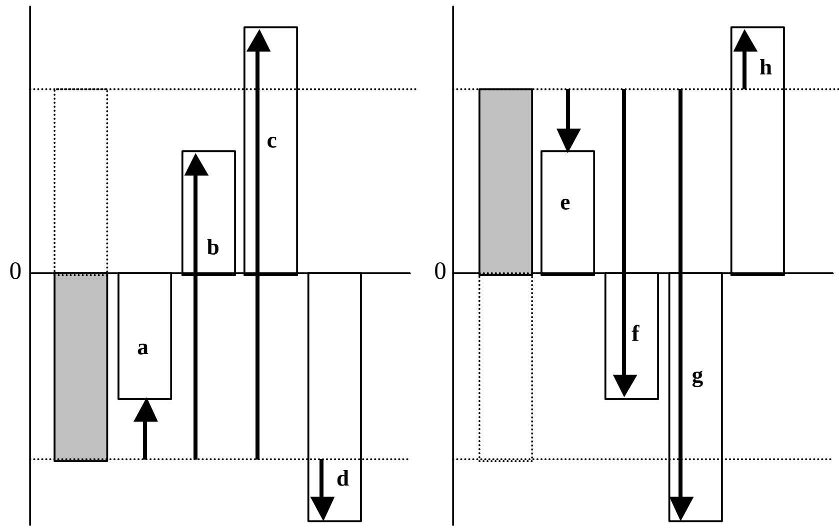


Notes:

- Changes due to those in the average tax rates
- Changes due to those in the standard tax base
- Changes due to those in the own tax base

*All figures are in per capita values in 1992 Canadian dollar

Figure 2. Response Patterns



Notes:

1) The shaded box (below or above the zero horizontal line) shows the initial change in the tax base.
2) The distance from the zero horizontal line to the dotted lines is identical to the absolute value of the tax base change.
3) The length and direction of the arrow corresponds to the volume and the direction of equalization transfers.

Figure 3. Decomposition of Changes in the National Average Tax Rate

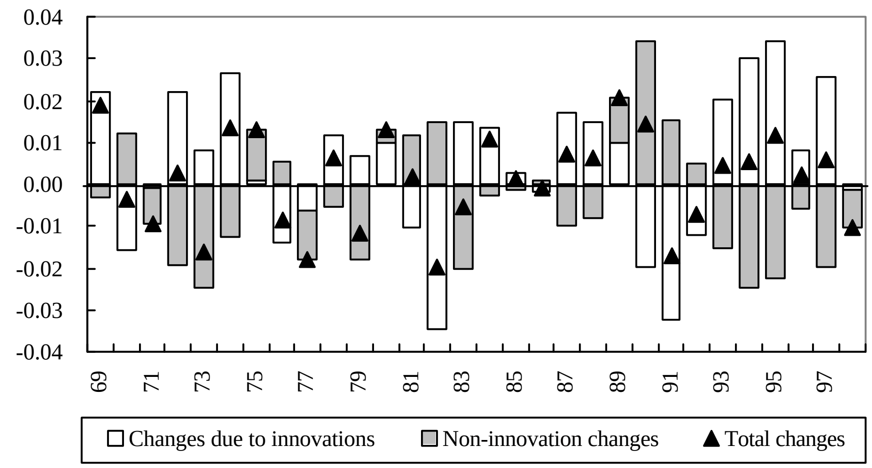
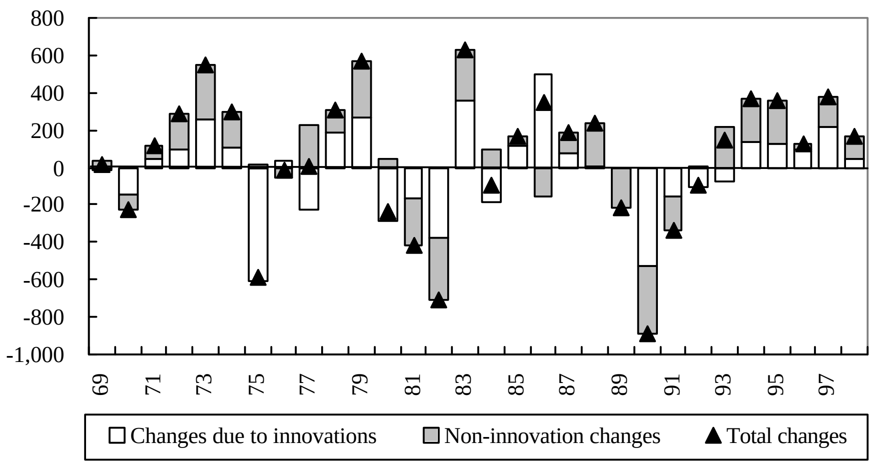


Figure 4. Decomposition of Changes in the Five-Province Standard



Notes: Figures are per capita values in 1992 Canadian dollar.

Table 1. Correlation coefficients

	e_{kt} and r_{kt}	e_{kt} and b_{kt}	e_{kt} and $t_t b_{kt}$
Newfoundland	0.5076 (0.0008)	0.4715 (0.0024)	0.7977 (0.0000)
Prince Edward Island	0.4133 (0.0105)	0.1988 (0.2660)	0.4577 (0.0035)
Nova Scotia	0.5581 (0.0001)	0.3452 (0.0400)	0.7299 (0.0000)
New Brunswick	0.5507 (0.0002)	-0.1783 (0.3213)	0.1199 (0.5103)
Quebec	0.0257 (0.8891)	-0.4059 (0.0124)	-0.5527 (0.0001)
Manitoba	0.1275 (0.4833)	-0.1064 (0.5599)	0.2941 (0.0881)
Saskatchewan	0.3842 (0.0195)	-0.4581 (0.0034)	-0.2074 (0.2446)

Table 2. Means and standard deviations

	r_{kt}		$r_{kt}+e_{kt}$	
	St.Dev.	*Mean*	*St.Dev.*	*Mean*
Newfoundland	34.43	118.24	62.29	238.53
Prince Edward Island	43.38	107.38	71.09	228.97
Nova Scotia	35.54	105.65	64.99	216.38
New Brunswick	59.92	119.85	90.21	217.64
Quebec	48.39	144.82	53.19	164.15
Manitoba	41.01	160.75	63.66	231.66
Saskatchewan	183.77	275.51	202.88	333.99
	$t_t b_{kt}$		$t_t b_{kt}+e_{kt}=t_t b_{St}$	
	St.Dev.	*Mean*	*St.Dev.*	*Mean*
Newfoundland	33.03	95.40	66.69	215.69
Prince Edward Island	36.89	94.10	66.69	215.69
Nova Scotia	33.60	104.96	66.69	215.69
New Brunswick	46.94	117.91	66.69	215.69
Quebec	75.91	196.36	66.69	215.69
Manitoba	39.09	144.79	66.69	215.69
Saskatchewan	61.97	157.21	66.69	215.69

Table 3. Variance decomposition: 1968-1998

	$Var(aDt)/Var(De)$	$Var(bDb_S)/Var(De)$	$Var(-gDb)/Var(De)$	
Newfoundland	0.29	1.75	0.53	
Prince Edward Island	0.18	1.07	0.57	
Nova Scotia	0.23	1.68	0.88	
New Brunswick	0.06	0.59	1.23	
Quebec	0.06	5.71	4.90	
Manitoba	0.14	2.25	0.95	
Saskatchewan	0.07	1.35	1.07	
	$2\times Cov(aDt,bDb_S)/Var(De))$	$2\times Cov(aDt,-gDb)/Var(De))$	$2\times Cov(bDb_S,-gDb)/Var(De)$	$Var(De)/Var(De)$
Newfoundland	-0.22	0.08	-1.42	1.00
Prince Edward Island	-0.15	0.00	-0.67	1.00
Nova Scotia	-0.20	0.14	-1.73	1.00
New Brunswick	-0.06	0.05	-0.87	1.00
Quebec	-0.26	0.21	-9.63	1.00
Manitoba	-0.19	0.11	-2.27	1.00
Saskatchewan	-0.14	0.07	-1.42	1.00

Table 4. The summary of the decomposition

	Nfld	PEI	NS	NB	Que	Man	Sask
1968	**c2**	**c2**	**c2**	**c2**	**c2**	**c2**	**b**
1969	**b**	**c2**	**c2**	**c2**	**c2**	**b**	**b**
1970	**c1**	**c1**	**c1**	**c1**	**c1**	**c1**	**c1**
1971	**b**	**b**	**a**	**a**	**c2**	**b**	**a**
1972	**c2**	**c2**	**c2**	**c2**	**c2**	**a**	**a**
1973	**c2**	**c2**	**c2**	**c2**	**a**	**c2**	**c2**
1974	**c2**	**c2**	**c2**	**c2**	**c2**	**a**	**c2**
1975	**c1**	**c1**	**c1**	**c1**	**c1**	**c1**	**b**
1976	**a**	**b**	**a**	**a**	**b**	**b**	**a**
1977	**b**	**b**	**b**	**b**	**a**	**a**	**b**
1978	**c2**	**b**	**c2**	**b**	**c2**	**c2**	**a**
1979	**c2**	**a**	**c2**	**a**	**a**	**c2**	**b**
1980	**b**	**b**	**a**	**a**	**a**	**a**	**b**
1981	**c1**	**c1**	**c1**	**c1**	**c1**	**c1**	**c1**
1982	**c1**	**c1**	**c1**	**c1**	**c1**	**c1**	**a**
1983	**c2**	**c2**	**c2**	**c2**	**c2**	**c2**	**c2**
1984	**a**	**a**	**c2**	**b**	**b**	**b**	**a**
1985	**a**	**b**	**c2**	**c2**	**c2**	**c2**	**c2**
1986	**b**	**a**	**c2**	**c2**	**c2**	**c2**	**b**
1987	**b**	**b**	**c2**	**a**	**a**	**b**	**c2**
1988	**c2**	**c2**	**c2**	**c2**	**c2**	**c2**	**c2**
1989	**b**	**b**	**b**	**b**	**c1**	**b**	**b**
1990	**c1**	**c1**	**a**	**c1**	**a**	**c1**	**c1**
1991	**c1**	**a**	**b**	**a**	**c1**	**c1**	**c1**
1992	**b**	**b**	**a**	**b**	**b**	**a**	**b**
1993	**c2**	**b**	**a**	**a**	**c2**	**c2**	**c2**
1994	**c2**	**c2**	**b**	**b**	**c2**	**c2**	**a**
1995	**c2**	**c2**	**c2**	**a**	**c2**	**c2**	**c2**
1996	**a**	**a**	**c2**	**b**	**a**	**c2**	**b**
1997	**c2**	**b**	**c2**	**c2**	**c2**	**c2**	**c2**
1998	**a**	**b**	**a**	**b**	**a**	**a**	**a**
	The number of occurrence during 1968-98 (31 years)						
a. Under-offset	5	5	7	8	8	6	8
b. Over-offset	8	12	4	8	3	6	10
c. Adverse	18	14	20	15	20	19	13
c1. Depriving	6	5	4	5	6	6	4
c2. Unnecessary	12	9	16	10	14	13	9

Table 5. Estimation results: Panel of annual data from 1969 to 1998 for the ten provinces

# of observations	300	Uncentered R^2	0.3954
DF	251	Centered R^2	0.3924
Durbin-Watson	2.0480	Adjusted R^2	0.2762

		Variable	Coeff.	Std. error	t-stat.	P values
Newfoundland	Regional effects	D_{Nfld}	40.6321	112.7389	0.3604	0.7188
	AR(1) coefs	$\Delta b_{Nfld, t-1}$	-0.4773	0.4661	-1.0240	0.3068
Prind Edward Island	Regional effects	D_{PEI}	40.7244	112.7537	0.3612	0.7183
	AR(1) coefs	$\Delta b_{PEI, t-1}$	-0.6945	0.3206	-2.1661	0.0312
Nova Scotia	Regional effects	D_{NS}	37.8368	112.6256	0.3360	0.7372
	AR(1) coefs	$\Delta b_{NS, t-1}$	-0.5971	0.3456	-1.7278	0.0853
New Brunswick	Regional effects	D_{NB}	38.2821	112.5388	0.3402	0.7340
	AR(1) coefs	$\Delta b_{NB, t-1}$	-0.5911	0.1604	-3.6854	0.0003
Quebec	Regional effects	D_{Que}	92.2446	113.3548	0.8138	0.4165
	AR(1) coefs	$\Delta b_{Que, t-1}$	-0.4153	0.2701	-1.5376	0.1254
Ontario	Regional effects	D_{Ont}	62.4384	112.8863	0.5531	0.5807
	AR(1) coefs	$\Delta b_{Ont, t-1}$	-0.1780	0.1911	-0.9314	0.3526
Manitoba	Regional effects	D_{Man}	30.4535	112.5608	0.2706	0.7870
	AR(1) coefs	$\Delta b_{Man, t-1}$	-0.6779	0.3498	-1.9379	0.0538
Saskatchewan	Regional effects	D_{Sask}	61.0104	112.7898	0.5409	0.5890
	AR(1) coefs	$\Delta b_{Sask, t-1}$	-0.2875	0.2494	-1.1527	0.2501
Alberta	Regional effects	D_{Alt}	117.5154	112.5967	1.0437	0.2976
	AR(1) coefs	$\Delta b_{Alt, t-1}$	-0.3428	0.0705	-4.8616	0.0000
British Columbia	Regional effects	$\Delta b_{BC, t-1}$	-0.1164	0.1822	-0.6390	0.5234
Common Effects (Time)	1969	D_{1969}	-10.4997	157.2093	-0.0668	0.9468
	1970	D_{1970}	-209.7274	157.2966	-1.3333	0.1836
	1971	D_{1971}	-40.6433	158.1828	-0.2569	0.7974
	1972	D_{1972}	230.8262	157.2392	1.4680	0.1434
	1973	D_{1973}	426.9598	159.6921	2.6736	0.0080
	1974	D_{1974}	298.0289	160.6690	1.8549	0.0648
	1975	D_{1975}	8.5967	159.9459	0.0538	0.9572
	1976	D_{1976}	-290.4284	162.2792	-1.7897	0.0747
	1977	D_{1977}	248.4696	158.7219	1.5654	0.1187
	1978	D_{1978}	97.2287	158.9748	0.6116	0.5414
	1979	D_{1979}	423.6346	160.4548	2.6402	0.0088
	1980	D_{1980}	71.7904	164.5700	0.4362	0.6630
	1981	D_{1981}	-496.3783	158.6752	-3.1283	0.0020
	1982	D_{1982}	-658.4063	162.0298	-4.0635	0.0001
	1983	D_{1983}	169.9729	169.8754	1.0006	0.3180
	1984	D_{1984}	197.8481	162.0848	1.2207	0.2234
	1985	D_{1985}	-17.1753	157.7146	-0.1089	0.9134
	1986	D_{1986}	-275.8983	157.8961	-1.7473	0.0818
	1987	D_{1987}	127.8481	162.6021	0.7863	0.4325
	1988	D_{1988}	238.1846	159.1479	1.4966	0.1357
	1989	D_{1989}	-357.1840	158.9820	-2.2467	0.0255
	1990	D_{1990}	-716.4259	160.8356	-4.4544	0.0000
	1991	D_{1991}	-610.1290	169.8591	-3.5920	0.0004
	1992	D_{1992}	-168.4409	162.6728	-1.0355	0.3015
	1993	D_{1993}	203.7636	159.2093	1.2799	0.2018
	1994	D_{1994}	291.3355	158.4060	1.8392	0.0671
	1995	D_{1995}	324.0233	159.6347	2.0298	0.0434
	1996	D_{1996}	76.0779	160.0900	0.4752	0.6350
	1997	D_{1997}	146.3305	158.1006	0.9256	0.3556
	1998	D_{1998}	172.4272	158.2620	1.0895	0.2770

Table 6. Ratio of changes in entitlements to those in per capita bases at the average tax rate

	Nfld	PEI	NS	NB	Que	Man	Sask
1969	-0.75	-1.40	-1.40	-1.39	-0.67	-2.62	-0.88
1970	-2.24	-1.74	-2.36	-3.17	-4.72	-3.66	1.80
1971	-1.48	-1.74	122.35	0.99	-2.66	-1.44	-0.36
1972	-3.83	-1.51	-2.90	-2.13	-2.17	1.15	0.14
1973	-2.21	-1.95	-1.72	-4.70	4.17	33.90	-5.35
1974	-5.90	-1.86	-2.19	-0.04	0.20	-0.61	-0.07
1975	3.84	2.21	-8.14	1.27	0.30	4.95	-2.55
1976	-1.49	-0.70	-1.92	-1.70	-0.27	-0.64	-0.67
1977	-0.19	0.28	0.00	-2.64	-0.43	-0.38	-0.17
1978	0.12	-2.44	0.93	-1.37	1.53	-59.06	-0.53
1979	-3.21	-2.99	-25.91	-0.61	1.10	-6.55	-1.61
1980	1.68	-4.10	-5.75	-1.95	0.41	0.36	-7.16
1981	-1.65	-1.52	-3.20	0.06	4.51	5.07	-1.75
1982	-2.45	-2.00	-55.59	0.49	2.33	3.67	-0.30
1983	-3.75	-4.16	-2.41	-2.71	-26.98	-2.83	-14.02
1984	13.12	-9.42	1.24	2.56	5.39	1.43	-0.33
1985	-0.43	-8.40	3.67	-17.06	3.14	-5.17	4.82
1986	2.43	-0.38	0.01	0.91	0.02	0.22	-3.75
1987	-1.11	-1.30	-0.73	-0.82	-0.76	-1.41	-2.21
1988	-1.02	-1.00	-1.02	-0.97	-1.17	-1.03	0.03
1989	-0.96	-0.97	-0.92	-1.09	-1.03	-1.17	-0.94
1990	-2.94	-2.25	1.85	-6.65	0.31	-2.89	-3.94
1991	-1.82	-0.60	-1.43	-0.79	-2.78	-1.44	-1.47
1992	-2.76	-1.45	-0.09	-1.30	-2.33	-0.56	-1.61
1993	-0.65	-1.49	1.40	-1.11	-0.63	-0.63	-0.59
1994	-3.28	-1.55	-1.99	-1.42	-2.98	3.11	-0.48
1995	-2.63	-1.58	-3.66	-0.53	-5.17	5.42	0.72
1996	-0.44	-0.57	-0.42	-1.25	-0.67	-0.36	-1.27
1997	-4.06	-3.21	-3.60	-1.74	18.37	0.84	-2.89
1998	-0.80	-1.07	-0.50	-1.20	-0.75	-0.72	-0.74
Average	-2.40	-0.27	44.64	-0.63	15.37	-1.84	-2.29

Table 7. Detailed responses

	Nfld	PEI	NS	NB	Que	Man	Sask
1969	**a**	**f**	**f**	**f**	**a**	**g**	**a**
1970	**g**	**f**	**g**	**g**	**g**	**g**	**d**
1971	**b**	**b**	**h**	**h**	**c**	**b**	**e**
1972	**c**	**b**	**c**	**c**	**c**	**h**	**h**
1973	**c**	**b**	**b**	**c**	**h**	**h**	**c**
1974	**c**	**b**	**c**	**e**	**h**	**e**	**e**
1975	**d**	**d**	**g**	**d**	**d**	**d**	**g**
1976	**b**	**e**	**b**	**b**	**e**	**e**	**e**
1977	**a**	**d**	**a**	**g**	**a**	**a**	**a**
1978	**h**	**c**	**h**	**b**	**h**	**c**	**e**
1979	**c**	**c**	**c**	**e**	**h**	**c**	**b**
1980	**d**	**g**	**g**	**f**	**d**	**d**	**g**
1981	**f**	**f**	**g**	**d**	**d**	**d**	**f**
1982	**g**	**g**	**g**	**d**	**d**	**d**	**a**
1983	**c**	**c**	**c**	**c**	**c**	**c**	**c**
1984	**d**	**g**	**d**	**d**	**d**	**d**	**a**
1985	**e**	**c**	**h**	**c**	**h**	**c**	**h**
1986	**h**	**e**	**h**	**h**	**h**	**h**	**c**
1987	**b**	**b**	**e**	**e**	**e**	**b**	**c**
1988	**b**	**b**	**b**	**e**	**b**	**b**	**h**
1989	**e**	**e**	**e**	**b**	**f**	**b**	**e**
1990	**g**	**g**	**d**	**g**	**d**	**g**	**g**
1991	**f**	**a**	**f**	**a**	**g**	**f**	**f**
1992	**g**	**f**	**a**	**f**	**g**	**a**	**f**
1993	**a**	**f**	**d**	**f**	**a**	**a**	**a**
1994	**c**	**b**	**b**	**b**	**c**	**h**	**e**
1995	**c**	**b**	**c**	**e**	**c**	**h**	**h**
1996	**e**	**e**	**e**	**b**	**e**	**e**	**b**
1997	**c**	**c**	**c**	**b**	**h**	**h**	**c**
1998	**e**	**b**	**e**	**b**	**e**	**e**	**e**
# Case a	3	1	2	1	3	3	5
# Case b	4	9	4	7	1	4	2
# Case c	8	5	6	4	5	4	5
# Case d	3	2	3	4	6	5	1
# Case e	4	4	4	5	4	4	7
# Case f	2	5	2	4	1	1	3
# Case g	4	4	5	3	3	3	3
# Case h	2	0	4	2	7	6	4
# of Destabilizing Case (c+d+g+h)	17	11	18	13	21	18	13
% of Destabilizing Case (c+d+g+h)	56.7%	36.7%	60.0%	43.3%	70.0%	60.0%	43.3%

a. Negative tax base change, under-offsetting, stabilizing
b. Negative tax base change, over-offsetting, stabilizing
c. Negative tax base change, over-offset, destabilizing
d. Negative tax base change, adverse effect, destabilizing
e. Positive tax base change, under-offsetting, stabilizing
f. Positive tax base change, over-offsetting, stabilizing
g. Positive tax base change, over-offsetting, destabilizing
h. Positive tax base change, unnecessary compensation, destabilizing