An Evaluation of the Stabilization Properties of Equalization in Canada

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Abstract

The Canadian system of equalization is designed to address differences in revenue-raising capacity across provinces, basing a province's entitlements on its actual tax bases. However, since it does so on a year-on-year basis, the standard against which a given province's equalization entitlements are calculated fluctuates from year to year with all provinces' tax bases and tax rates. The consequence is that, while the redistribution function is fulfilled annually, the stability of provincial revenues suffers. The evidence we present indicates that, at least for the three revenue categories we examine, 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, stabilization, interregional redistribution

JEL Classification: H77

1 Introduction

In Canada, as in most federations, uneven fiscal capacities of provincial governments are partially offset by the system of federal-provincial equalization transfers. The size of these transfers is determined through a formula that artificially links provincial tax bases and thereby allows provincial governments to share fluctuations 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. Specifically, entitlement to equalization is based on the differences between each of a province's per capita tax bases and the average per capita tax base of five 'standard' provinces (Quebec, Ontario, Manitoba, Saskatchewan, and British Columbia). The differences are calculated for 33 revenue categories, multiplied by the average tax rates in all provinces, and summed up to yield the overall entitlement. The per capita entitlement for province k in year t, e_{kt}, is then given by:

$$e_{kt} = \max\left\{0,\ \sum_j \tau_t^j \cdot \left(b_{St}^j - b_{kt}^j\right)\right\} \tag{1}$$

where τ_t^j is the national average provincial tax rate for tax base j in year t, b_{St}^j is the per capita tax base j among the five standard provinces in year t, and b_{kt}^j is the per capita tax base j in province k in year t. Equalization entitlements are calculated annually and are financed out of federal general revenues raised throughout the country.

As is evident from the formula, the equalization system is designed as a *redistribution* scheme by compensating for differences in provincial per capita tax bases to equalize tax capacities comprehensively for the have-not provinces. As a by-product of this intermediation, short-run fluctuations in a province's tax bases are also shared by other provinces. As noted in Boothe (2002), it has generally been perceived that the equalization program contributes to enhanced stability of provincial revenues. However, unlike in some federations, equalization entitlements do not depend on *fixed* standards, but on the standards (τ^j and b_S^j) calculated from actual revenues and bases of individual provinces in a given year. If these variables were stable over time, changes in a recipient province's tax bases would be perfectly offset by those in its entitlements. But they do vary over time, and as a result recipient provinces are subject to shocks in their equalization transfers because of changes in policies and bases in other jurisdictions. It is then possible that equalization could actually be destabilizing, rather than stabilizing, from a recipient's perspective. The main purpose of this paper is to examine whether the equalization system is destabilizing, and if so, to identify the sources of the instability. By destabilizing we mean that equalization transfers increase the variability of a recipient province's revenue-raising capacity. This will be made more precise in what follows.

There is a growing empirical literature on the stabilizing and redistributive performance of fiscal transfers. Our approach contrasts with this literature as follows. 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, Mélitz and Zumer 2002, and Decressin 2002), 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 variables in the Canadian system are 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 stabilization 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 stabilization 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 the Canadian case. 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 regression equations theoretically derived from intertemporal consumption theory (Asdrubali et al. 1996), or ad hoc regression equations that relate pre- and post-transfer values of the targeted variables (Bayoumi and Masson 1995, von Hagen and Hepp 2000, Mélitz and Zumer 2002, and Decressin 2002). Our approach 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^j_S) and the own per capita base (b^j_k). This enables us to trace the source of changes in entitlements to these three components, and to evaluate the extent to which the system has, or has not been, stabilizing.

Our analysis focuses on three revenue sources in the equalization system — personal income, business income and sales — which together represent a substantial proportion of the transfers. To summarize our main results, we show that in attempting to achieve redistribution on a year-by-year basis, the system sacrifices its stabilization role. At least for these three revenue categories, 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 as well as changes in its own base. Especially the first of these exhibits large enough volatility to cause the system as a whole to be destabilizing.

The paper proceeds as follows. In the next section, we discuss our data source and take a preliminary look at the stabilization properties by examining correlation coefficients and variance ratios with the relevant data. We then decompose changes in equalization entitlements into the three components mentioned above and discuss the implications. Following that, we estimate the parts of tax base changes in each province that are due to different types of shocks and calculate how the equalization system responded to them. Finally, we offer some conclusions.

2 Preliminary Analysis

2.1 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 data include 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 n_{kt}.[1] These data are sufficient to compute for each revenue source, per capita tax bases b^j_{kt}, national average tax rates τ^j_t (the sum of provincial revenues divided by the sum of provincial tax bases), and the five-province standard per capita tax bases b^j_{St} (the sum of the tax bases in the five standard provinces divided by the sum of their populations).[2]

In using these data, three caveats should be born in mind. First, our analysis

[1] 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.

[2] It should be noted that the actual calculation of equalization entitlements for the personal income tax is somewhat more complicated than depicted in (1) above. In fact, the personal income category is effectively divided into several income classes with a separate national average tax rate applicable to each. The data provided by Finance Canada in the equalization tables include shares of provincial personal income, $n_{kt}b^j_{kt}/\sum_{i\in P} n_{it}b^j_{it}$, not their actual levels $n_{kt}b^j_{kt}$. And these are not disaggregated by income class. In our exercise, we treat the income tax as a single aggregate base. To obtain provincial bases, we simply multiply the provincial shares by the ten-province aggregate base. The latter — Basic Federal Tax to which provincial tax rates apply — was also obtained from Finance Canada.

is based on changes in entitlements for selected revenue categories, not those based on the entire 33 revenue categories. The categories we chose are 'personal income', 'business income' and 'sales'. This is because our analysis requires categories that apply throughout the period of analysis, and those three are among the few that meet this condition. The qualitative implications should not be that different from when all of the 33 tax bases are considered, since the entitlements based on those selected categories constitute a substantial portion of the total payments.[3] Moreover, these three bases span the range of those that might be expected to be relatively variable (business income taxes) to those that are more stable (sales taxes).

Second, the current formula is used to calculate the entitlements for the entire sample years. 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. The results for pre-1982 years are interpreted as counter-factual cases that show what the responses would have been if the current formula had been applied. One might object that this 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. However, we are interested in the evaluation of the current formula, not that of the past. Consistently using the current formula allows us to draw more meaningful comparisons than using different historical formulae over the same period.

Third, the data we use to calculate the entitlements 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 calculation 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 than the initial estimates. In any case, we expect that the differences between the two are not large enough to change our qualitative conclusions.

Our analysis is relevant only for transfer-receiving provinces since the equalization program is a gross scheme where revenues are kept intact for provinces with a negative overall entitlement. The group of recipient provinces is unchanged for the entire period of our analysis, namely, Newfoundland, Prince Edward Island, Nova Scotia, New Brunswick, Quebec, Manitoba and Saskatchewan. Excluding the remaining three provinces – Ontario, Alberta and British Columbia – from our analysis allows us to dispense with the original formula (1) and instead to express the per capita entitlement for recipient province k in period t as

$$e_{kt} = \sum_j e_{kt}^j \tag{2}$$

where e_{kt}^j is the per capita entitlement calculated for category j:

$$e_{kt}^j = \tau_t^j \cdot \left(b_{St}^j - b_{kt}^j\right). \tag{3}$$

[3] In 1998-99, the three bases account for about 60% of the total entitlement for the receiving provinces.

Recall that for our purposes, j indexes the three revenue categories of personal income, business income and sales. The average tax rates τ_t^j and the five-province per capita bases b_{St}^j are given as

$$\tau_t^j \equiv \frac{\sum_{i \in P} n_{it} r_{it}^j}{\sum_{i \in P} n_{it} b_{it}^j} \quad \text{and } b_{St}^j \equiv \frac{\sum_{i \in S} b_{it}^j}{\sum_{i \in S} n_{it}}$$

where r_{kt}^j is per capita revenues, P denotes the set of all ten provinces and S refers to the set of the five standard provinces. The annual change in the entitlement is then given as

$$\Delta e_{kt} = \sum_j \Delta e_{kt}^j \tag{4}$$

where $\Delta e_{kt}^j = e_{kt}^j - e_{kt-1}^j$. Note that, since we do not explicitly consider price changes, we net out changes in prices by dividing the per capita tax bases and revenues by the 1992 GDP deflator.

2.2 Correlations

To take a preliminary look at the possibility that the equalization system is destabilizing, let us first examine how annual changes in each province's per capita equalization entitlements respond to changes in its per capita revenues and bases, simply by looking at correlation coefficients between the relevant variables for the seven provinces during 1968–98. The coefficients are calculated both for changes in the total entitlements given by (2) and for changes in each of the three category-specific entitlements (3). To the extent that equalization is intended to compensate for a loss in provincial tax revenues or bases, we would expect these coefficients to be negative.

– Table 1 –

Table 1 shows the correlation coefficients between annual changes in per capita equalization entitlements and those in per capita revenues for the seven equalization receiving provinces, along with P values (in parentheses) which indicate two-tailed? marginal statistical significance. The coefficients are calculated for the aggregate as well as each of all three revenue sources. Contrary to what might initially be expected, all correlation coefficients take on positive values for the aggregate measures, and are statistically significant at the .10 level for all provinces except Newfoundland and Quebec. The results for each of the three revenue sources corroborate those obtained in the aggregate, albeit with some differences among the three. The coefficients are found to be positive in almost all the cases, though several are not significant, especially in the category of sales. The few negatives ones (Saskatchewan for personal income, and Quebec and Saskatchewan for sales) are small in value and not significant at the .10 level. This tendency for a positive correlation, which mirrors that found by

Boothe (2002), may come as a surprise. It would imply that, contrary to its intent, the equalization system is actually destabilizing, at least with respect to revenue sources.

This finding is, however, premature. 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 a province's revenue-raising capacity. Following the procedure used in the equalization system itself, we employ the per capita tax base evaluated at the national average tax rate as a province's *tax capacity* from a given base. Although this measure might still be influenced by provincial tax policies, it presumably more closely reflects revenue-raising potential than do actual tax revenues.

– Table 2 –

Table 2 then shows the correlation coefficients between annual changes in per capita equalization entitlements and those in the per capita tax capacities $\sum_j \bar{\tau}_t^j \Delta b_{kt}^j$ where $\bar{\tau}_t^j \equiv (\tau_t^j + \tau_{t-1}^j)/2$.[4] Given (1), we would expect this correlation to be negative, more so than for the per capita tax revenues. The results, however, are mixed. For the three revenue sources taken in aggregate, negative correlations apply for three provinces — New Brunswick, Manitoba and Saskatchewan — but only the last is statistically significant at the .10 level. The correlations are positive for Newfoundland, Prince Edward Island, Nova Scotia, and Quebec, and significantly so for Newfoundland and Nova Scotia.

The destabilizing tendency also varies over the three revenue sources as the last three columns of Table 2 indicate. For personal income, five provinces (Newfoundland, Prince Edward Island, Nova Scotia, New Brunswick and Quebec) exhibit positive correlations, two of which are significant at the .10 level (Nova Scotia and New Brunswick). The remaining two (Manitoba and Saskatchewan) have negative correlations that are also statistically significant. For business income, Newfoundland and Manitoba exhibit positive signs but are not significant. Among the other five with negative correlations, three are statistically significant (Prince Edward Island, New Brunswick and Saskatchewan). For sales, the correlations are negative for all cases, significantly so for Nova Scotia, New Brunswick and Saskatchewan. The implication seems to be that equalization with respect to sales is somewhat more stabilizing than with respect to the income tax bases, especially personal income.

[4] The tax rates for the changes from $t-1$ to t are given as the average values of them in $t-1$ and t. This average values ($\bar{\tau}_t^j \equiv (\tau_t^j + \tau_{t-1}^j)/2$) will also be used in Section 3.

2.3 Response Patterns

While the correlation coefficient is a useful indicator of the extent to which changes in the entitlements and those in the actual or potential revenues in the same direction, it is of limited value for indicating the extent to which equalization entitlements are actually destabilizing. That is because the correlation coefficient only shows the tendency for two variables to move in tandem, not the relative magnitudes of their changes. For example, let ρ be the correlation coefficient between changes in the entitlements d_e and those in the actual or potential revenues d_r, and hypothetically assume that the following linear relation holds: $d_e = \alpha \cdot d_r$ so the variables are perfectly correlated — negatively or positively as $\alpha \lessgtr 0$. Then, it can be shown that $\rho = \alpha/|\alpha|$. If coefficient α is negative, we obtain $\rho = -1$, regardless of the magnitude of α. Yet, clearly the magnitude of α is relevant: a very small value of α would imply that even if $\alpha > 0$, so that the system is destabilizing, it would not be of great concern. By the same token, even if $\alpha < 0$, so entitlements offset changes in tax capacity, equalization could be destabilizing if the absolute size of α is large enough. Specifically, it can be considered to be destabilizing if the absolute value of the post-equalized revenue change is *larger* than that of the pre-equalized change, which will be the case if $\alpha < -2$.

– Figure 1 –

Such possibilities are revealed in Figure 1, where panels (a) and (b) respectively illustrate annual changes in pre- and post-equalized per capita tax capacities (i.e., $\sum_j \bar{\tau}_t^j \Delta b_{kt}^j$ and $\sum_j \bar{\tau}_t^j \Delta b_{kt}^j + \Delta e_{kt}$) for the seven receiving provinces. Noting that the two panels are presented in the same scale, the post-equalized changes indeed seem to be volatile than their the pre-equalized counterparts. To investigate this more closely, we then examine annual patterns of relative magnitudes of Δe_{kt} and $\sum_j \bar{\tau}_t^j \Delta b_{kt}^j$ for every period under consideration. We classify the following four patterns:

(a) *under-offsetting*: equalization entitlements offset changes in aggregate tax capacity incompletely: $\Delta e_{kt} \cdot \sum_j \bar{\tau}_t^j \Delta b_{kt}^j < 0$ and $|\Delta e_{kt}| < \left|\sum_j \bar{\tau}_t^j \Delta b_{kt}^j\right|$.

(b) *over-offsetting*: the offset more than compensates for changes in aggregate tax capacity, but is not destabilizing: $\Delta e_{kt} \cdot \sum_j \bar{\tau}_t^j \Delta b_{kt}^j < 0$, $|\Delta e_{kt}| > \left|\sum_j \bar{\tau}_t^j \Delta b_{kt}^j\right|$ and $\left|\sum_j \bar{\tau}_t^j \Delta b_{kt}^j\right| > \left|\sum_j \bar{\tau}_t^j \Delta b_{kt}^j + \Delta e_{kt}\right|$.

(c) *hyper-offsetting*: the offset more than compensates for changes in aggregate tax capacity and is destabilizing: $\Delta e_{kt} \cdot \sum_j \bar{\tau}_t^j \Delta b_{kt}^j < 0$, $|\Delta e_{kt}| > \left|\sum_j \bar{\tau}_t^j \Delta b_{kt}^j\right|$ and $\left|\sum_j \bar{\tau}_t^j \Delta b_{kt}^j\right| < \left|\sum_j \bar{\tau}_t^j \Delta b_{kt}^j + \Delta e_{kt}\right|$.

(d) *co-movement*: the entitlement and the aggregate tax capacity move in the same direction: $\Delta e_{kt} \cdot \sum_j \bar{\tau}_t^j \Delta b_{kt}^j > 0$.

We also examine the four patterns (a)–(d) for each of the three revenue sources individually by comparing changes in entitlements Δe^j_{kt} and in tax capacity $\bar{\tau}^j_t \Delta b^j_{kt}$. Note that patterns (a) and (b) are stabilizing, while (c) and (d) are destabilizing.

– Table 3 –

Table 3 breaks down the 31 annual changes according to the number that fall into each of the four patterns. The results in the table point dramatically to the destabilizing properties of the equalization system. For aggregate equalization entitlements in the top part of the table, cases of (d) — where equalization entitlements *increase* when a province's standardized tax revenues increase — account for more than half of the cases for Quebec and Saskatchewan, almost a half in New Brunswick, and almost a third of the cases for Prince Edward Island, Nova Scotia and Manitoba. Furthermore, most of the cases are destabilizing ones — cases (c)+(d) — with the lowest frequency of 13/31 for Newfoundland.

Overall, the same patterns apply to all three categories. Specifically, the case of co-movement (d) tends to have the highest frequencies for almost all categories and provinces. Furthermore, most of the cases are destabilizing ones (c)+(d), with the lowest frequency being 13/31 for Quebec's business income. Surprisingly, the frequency of destabilizing case in business income are *not* larger than those in the other two categories. On the contrary, the category of sales tends to exhibit the highest frequencies of (c) and (c)+(d).

2.4 Variance Ratios

The above results suggest that the equalization system does not contribute to stabilizing provincial revenues over time, and may even destabilize them for some provinces. We may pursue this line of argument in a more straightforward manner. The stabilization properties of a federal-provincial transfer system can be evaluated in terms of the degree to which annual changes in revenues are smoothed in the presence of the system. Such a smoothing effect may be characterized by comparing the variances of changes in pre- and post-equalized revenue quantities. If equalization smoothes (i.e., stabilizes) changes in provincial revenues, we then expect the variances of annual changes in post-equalized quantities to be smaller than those of annual changes in pre-equalized counterparts. If not, we expect the former to be larger than the latter. Here, we compare post- and pre-equalization variances for both actual revenues and standardized revenues (tax capacities).[5]

– Table 4 –

[5] This strategy was taken by Boothe (2002). However, he uses the pre- and post equalized values for actual aggregate provincial revenues only.

Table 4 uses annual changes in actual per capita revenues, and lists the ratios of the variances of the post-equalized quantities to those of their pre-equalized counterparts. The values for these ratios are calculated for aggregate revenues — $\text{var}\left(\sum_j \Delta r_{kt}^j + \Delta e_{kt}\right) / \text{var}\left(\sum_j \Delta r_{kt}^j\right)$ — and for each of the three revenue categories — $\text{var}\left(\Delta r_{kt}^j + \Delta e_{kt}^j\right) / \text{var}\left(\Delta r_{kt}^j\right)$. As descriptive statistics, these ratios indeed indicate that post-equalized revenues are more volatile, with all values of the ratios being more than unity. When the sub-categories are compared, the ratios are largest for business income and smallest for sales in most cases. The table also shows P values for the null hypothesis that the variances are equal before and after equalization. At the .10 level, we reject the hypothesis in a majority of the cases. Especially notable is the the fact that the hypothesis of equal volatilities is rejected for all the Maritime provinces except with respect to sales. On the other hand, non-rejections are observed only with Quebec, Manitoba and Saskatchewan for personal income and with the latter two for business income, and all except Prince Edward Island for sales. Note that, while the case of non-rejection does not imply a destabilizing effect, it does not imply a stabilizing effect either, since the null hypothesis is that of equal volatilities.

– Table 5 –

Table 5 reports the same ratios of variances by using the standardized measure or tax capacities ($\bar{\tau}_t^j \Delta b_{kt}^j$ for each category and $\sum_j \bar{\tau}_t^j \Delta b_{kt}^j$ for the aggregate) in place of the actual per capita revenues. The ratios again indicate that annual changes in revenues are more volatile after equalization for all except Saskatchewan for personal income and New Brunswick for business income. The inferential results are quite similar to those with the actual revenues. Although not definite in every case — and two *stabilizing* cases are detected (personal income in Saskatchewan and business income in Quebec)[6] — these results in Tables 4 and 5 suggest that the equalization program tends to destabilize the revenue streams of the recipient provinces, especially for the two income tax categories.

2.5 Summary

The evidence seems to indicate that for the three revenue sources under consideration, the equalization system tends to be destabilizing. We find no firm evidence that annual changes in equalization payments are negatively correlated with those of tax capacities or pre-equalized revenues. And instances of destabilizing changes in equalization payments are more frequent than those of stabilizing changes. As well,

[6] For these two cases, the analysis in Section 2.3 indicates frequent occurrence of the destabilizing case. Recall that that analysis is based on the response patterns in a *single period*. On the other hand, the variances use the sum of squared values of deviations from the mean for the *whole period* of analysis. It is then possible to obtain at the same time a result that shows a frequent occurrence of the destabilizing case and a relatively low value of the variance ratio.

post-equalization variables are more volatile than their pre-equalization counterparts. In the next two sections, we attempt to identify the sources of the destabilizing effects. We first attribute changes in equalization entitlements to three components — those due to own base changes, those due to changes in the bases of the five representative provinces, and those due to changes in the national average tax rates. After having established that much of the volatility comes from changes in the bases of all provinces, we then in the subsequent section statistically decompose these into various types of shocks.

3 Decomposing Changes in Equalization Entitlements

3.1 Decomposition of annual changes

The previous section indicates that provincial entitlements e_{kt} might behave rather perversely with respect to changes in the province's tax capacities $\tau_t^j b_{kt}^j$. Since e_{kt} and $\tau_t^j b_{kt}^j$ are negatively related in the formula for entitlements, this implies that the perverse outcomes must be due to the influence of the other component of the formula, $\tau_t^j b_{St}^j$. Our next task is to quantify these influences. To do so, we decompose annual changes in e_{kt} into changes in its three component variables, namely, τ_t^j, b_{St}^j and b_{kt}^j for each revenue source. Given the multiplicative nature of the entitlement formula $e_{kt} = \sum_j \tau_t^j \cdot (b_{St}^j - b_{kt}^j)$, an exact decomposition of $\Delta e_{kt} \equiv e_{kt} - e_{t-1}$ can be obtained as follows:

$$\Delta e_{kt} = \sum_j \beta_{kt}^j \Delta\tau_t^j + \sum_j \bar{\tau}_t^j \Delta b_{St}^j - \sum_j \bar{\tau}_t^j \Delta b_{kt}^j \equiv x_{kt} + y_t + z_{kt} \tag{5}$$

where[7]

$$\begin{aligned} \beta_{kt}^j &\equiv [(b_{St}^j - b_{kt}^j) + (b_{St-1}^j - b_{kt-1}^j)]/2,\ \bar{\tau}_t^j \equiv (\tau_t^j + \tau_{t-1}^j)/2, \\ \Delta\tau_t^j &\equiv \tau_t^j - \tau_{t-1}^j,\ \Delta b_{St}^j \equiv b_{St}^j - b_{St-1}^j \text{ and } \Delta b_{kt}^j \equiv b_{kt}^j - b_{kt-1}^j. \end{aligned}$$

[7] To see that this is an exact decomposition, we can first totally differentiate $e_{kt} = \sum_j \tau_t^j (b_{St}^j - b_{kt}^j)$ to obtain an exact measure for differential changes, $de_{kt} = \sum_j [(b_{St}^j - b_{kt}^j) d\tau_t^j + \tau_t^j db_{St}^j - \tau_t^j db_{kt}^j]$. For discrete changes, we can use a Taylor approximation to obtain the relevant discrete analogue. Given the multiplicative form of the expression for e_k, a second-order Taylor expression will be exact since all third derivatives vanish. Equivalently, note that by definition for a single category, we have: $\Delta e_{kt}^j \equiv \tau_t^j (b_{St}^j - b_{kt}^j) - \tau_{t-1}^j (b_{St-1}^j - b_{kt-1}^j)$. By straightforward alternative rearrangements of this expression, we obtain: $\Delta e_{kt}^j = \sum_j [(b_{St}^j - b_{kt}^j)\Delta\tau_t^j + \tau_{t-1}^j \Delta b_{St}^j - \tau_{t-1}^j \Delta b_{kt}^j]$ and $\Delta e_{kt}^j = \sum_j [(b_{St-1}^j - b_{kt-1}^j)\Delta\tau_t^j + \tau_t^j \Delta b_{St}^j - \tau_t^j \Delta b_{kt}^j]$ where $\Delta\tau_t^j \equiv \tau_t^j - \tau_{t-1}^j$, $\Delta b_{St}^j \equiv b_{St}^j - b_{St-1}^j$ and $\Delta b_{kt}^j \equiv b_{kt}^j - b_{kt-1}^j$. The coefficients will differ slightly because of the different time periods used to value them. Our decomposition in (5) combines these two expressions, and evaluates the change in e_{kt} at the average value of the coefficients over the time periods involved (t and $t-1$).

Thus, $x_{kt} \equiv \sum_j \beta_{kt}^j \Delta\tau_t^j$ captures the effect of changes in national average tax rates on equalization entitlements from the three revenue sources; $y_t \equiv \sum_j \bar{\tau}_t^j \Delta b_{St}^j$ captures the effect of changes in the five-province standard per capita tax bases; and $z_{kt} \equiv -\sum_j \bar{\tau}_t^j \Delta b_{kt}^j$ captures the effect of changes in own per capita tax bases. As for the three sub-categories, the decomposition is also done such that $\Delta e_{kt}^j = \beta_{kt}^j \Delta\tau_t^j + \bar{\tau}_t^j \Delta b_{St}^j - \bar{\tau}_t^j \Delta b_{kt}^j \equiv x_{kt}^j + y_t^j + z_{kt}^j$.

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^j is constructed using the tax bases of the provinces, so we are ignoring whatever interdependency this causes. 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 tax rates are proportional.[8] In addition, changes in own base for the recipients that belong to the five standard provinces (i.e., Quebec, Manitoba and Saskatchewan) will to some extent affect changes in the five province standard Δb_{St}^j. However, such effects are found to be quantitatively negligible.[9] Our decomposition, therefore, seems like a good first approximation.

– Figure 2 –

Panels (a)–(g) in Figure 2 depict graphically the results of the decompositions calculated using (5) for the seven recipient provinces.[10] The solid diamonds show the values for Δe_{kt} during each of the fiscal years. As these indicate, there is considerable variability from one year to the next in per capita entitlements from these three revenue sources. The vertical bars consist of three segments that show the values for x_{kt}, y_t and z_{kt}. Those components with positive values appear above the horizontal

[8] 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 small tax base shares, the effects 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).

[9] To account for the effect of own bases on the five province standards, we rewrite the formula for a single category as $e_{kt} = \tau_t [b_{St}^{-k} - (1 - w_{kt})\, b_{kt}]$ where w_{it} is a population share and $b_{St}^{-k} \equiv b_{St} - w_{kt} b_{kt}$. The first-order approximation will then be: $\Delta e_{kt} \approx \alpha_{kt} \Delta\tau_t + \beta_{kt} \Delta b_{St}^{-k} + \gamma_{kt}^S \Delta b_{kt} + \phi_{kt} \Delta w_{kt}$ where $\Delta b_{St}^{-k} \equiv b_{St}^{-k} - b_{St-1}^{-k}$, $\gamma_{kt}^S \equiv -[(1 - w_{kt})\tau_t + (1 - w_{kt-1})\tau_{t-1}]/2$, $\Delta w_{kt} \equiv w_{kt} - w_{kt-1}$ and $\phi_{kt} \equiv (w_{kt} b_{kt} + w_{kt-1} b_{kt-1})/2$. However, these results are found to be similar to those in the case in the text where we ignore the effects of own base on the five-province standard.

[10] Using $\Delta e_{kt}^j = \beta_{kt}^j \Delta\tau_t^j + \bar{\tau}_t^j \Delta b_{St}^j - \bar{\tau}_t^j \Delta b_{kt}^j = x_{kt}^j + y_{kt}^j + z_{kt}^j$, analogous figures can be made for each of the three subcategories, which are omitted due to space limitation.

axis, while those with negative values appear below. Naturally, all three add up to Δe_{kt}. 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 standards (y_t) are relatively large, usually exceeding the impacts of own tax bases (z_{kt}). The average tax rates (x_{kt}) is the least influential among the three, but it still exerts substantial impacts in some cases.

Note that the negative of the impacts of own tax bases z_{kt} coincides with changes in the standardized pre-equalized revenue, $\sum_j \bar{\tau}_t^j \Delta b_{kt}^j$, that we utilized in the previous section. Since $\Delta e_{kt} = x_{kt} + y_t + z_{kt}$, it then follows that the combined effects of the five-province standards and the average tax rates turn out to be changes in the post-equalized standardized revenue $x_{kt} + y_t = \sum_j \bar{\tau}_t^j \Delta b_{kt}^j + \Delta e_{kt}$. Therefore, we have in fact discussed the specific patterns of relative magnitudes between $x_{kt} + y_t$ and $-z_{kt}$ in Section 2.3, and shall not repeat them here.

3.2 Variance decompositions

We may further characterize the relative influence of these three components of entitlement changes by applying a variance decomposition to $\Delta e_{kt} = x_{kt} + y_t + z_{kt}$:

$$\begin{aligned} \text{var}\left(\Delta e_{kt}\right) &= \text{var}\left(x_{kt}\right) + \text{var}\left(y_t\right) + \text{var}\left(z_{kt}\right) \\ &\quad +2 \cdot \text{cov}\left(x_{kt}, y_t\right) + 2 \cdot \text{cov}\left(x_{kt}, z_{kt}\right) + 2 \cdot \text{cov}\left(y_t, z_{kt}\right). \end{aligned} \tag{6}$$

An analogous expression also applies for each of the single revenue categories, given that $\Delta e_{kt}^j = x_{kt}^j + y_t^j + z_{kt}^j$. Table 6 list the variance-covariance components for the aggregate and for each of the revenue categories individually. In each case, the components are normalized by the variance of the changes in entitlements — $\text{var}(\Delta e_{kt})$ or $\text{var}(\Delta e_{kt}^j)$ — so that they add up to unity.[11]

– Table 6 –

A number of observations follow from Table 6. First, the results show that *changes due to the five-province standard base y_t fluctuate considerably more than those due to own per capita tax bases z_{kt}*. And, in turn, variations in both of those two components are significantly larger than those in the national average tax rate x_t. At the same time, the large fluctuations of the former two do not materialize fully 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. We observe analogous results for each of the individual revenue sources. In each case, changes due to the five-province standard fluctuate more than those due to the own per capita tax base.

[11] Note that Table 6 is not suitable for cross-revenue comparison since the figures are normalized by the variance of changes in the corresponding single revenue category.

Second, post-equalized revenues are frequently more volatile than their pre-equalized counterparts. Recall that $-z_{kt} = \sum_j \bar{\tau}_t^j \Delta b_{kt}^j$ and that $x_{kt} + y_t = \sum_j \bar{\tau}_t^j \Delta b_{kt}^j + \Delta e_{kt}$. Then, the variance of the post-equalized tax capacities, $\sum_j \bar{\tau}_t^j \Delta b_{kt}^j + \Delta e_{kt}$, is

$$\text{var}(x_{kt} + y_t) = \text{var}(x_{kt}) + \text{var}(y_t) + 2 \cdot \text{cov}(x_{kt}, y_t)$$

and the variance of the pre-equalized counterparts, $\sum_j \bar{\tau}_t^j \Delta b_{kt}^j$, is $\text{var}(z_{kt})$. The normalized values of these variances and covariances in Table 6 can then be used to yield the variance ratios $[\text{var}(x_{kt})+\text{var}(y_t) + 2\cdot\text{cov}(x_{kt}, y_t)]/\text{var}(z_{kt})$. Given that $\bar{\tau}_t^j \Delta b_{kt}^j + \Delta e_{kt}^j = x_{kt}^j + y_t^j$ and $\text{var}(x_{kt}^j + y_t^j)$ $=\text{var}(x_{kt}^j)+\text{var}(y_t^j) + 2\cdot\text{cov}(x_{kt}^j, y_t^j)$ for each of the revenue sources, we obtain analogous results for the single category. These ratios are of course identical to those listed in Table 5. There, we saw that the equalization system results in the variance ratios being more than unity in every case with two exceptions, but the ratios are smaller for the category of sales.

Third, we find that the covariance between y_t and z_{kt} is uniformly negative ($\text{cov}(y, z) < 0$). Given that the negative of z_{kt} is identical to changes in the pre-equalized tax capacities, this implies that changes in the five-province standards ($\sum_j \bar{\tau}_t^j \Delta b_{St}^j$) and those in the tax capacities tend to move in the same direction. 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 (a decrease) in e_{kt} to offset revenue losses (gains) from own tax base changes. This then suggests the possibility that revenue losses from own tax base reductions may not be compensated by a change in equalization payments. The results for the three sub-categories are once again analogous to those for the aggregates.

4 Responses to Different Shocks

The analysis of the previous section indicated that the main source of variability in equalization entitlements comes from changes in tax bases. The possibility of entitlement changes being destabilizing was attributed mainly to movements in the five-province standard base. These often overwhelmed the stabilizing influence of the system in response to a province's own base changes. The fact that the changes in the five-province base are destabilizing suggests that there may be some common patterns underlying movements in individual provincial tax bases. If provincial tax base changes reflected province-specific economic shocks that were independent of one another, these shocks would be diversifiable so that the equalization system would act as a risk-pooling device over a period of time. That is, equalization should smooth provincial tax capacities inclusive of equalization. The fact that this does not seem to occur suggests that there is some common element to the changes in provincial tax bases which by their nature cannot be pooled. If shocks to per capita tax bases were common (perfectly correlated), the five-province standards would change in tandem with each recipient province's tax base so equalization would not be stabilizing

at all. More generally, the five-province standard might change in an erratic way relative to the per capita tax base of a recipient province giving rise to the possibility of destabilization. This section investigates the source of the destabilizing features of the tax system by decomposing changes in provincial tax bases into elements corresponding with different forms of shocks. To do so, we abstract from changes in tax rates due to policy decisions and focus entirely on the effects of changes in individual tax bases over the period.

To give some first indication of patterns of shocks to provincial tax bases, panels (a)–(c) in Figure 3 illustrate annual changes in per capita tax bases as well as the five-province standards respectively for personal income, business income and sales, with bold lines indicating those for the five-province standards. These figures suggest that common patterns exist in these annual changes. In addition, they seem to indicate some autoregressive patterns. Following this suggestion, the analysis that follows assumes that shocks to provincial tax bases can be of three forms — common with other provinces, uncorrelated and autocorrelated. We decompose annual changes in per capita tax bases into the parts that are attributable to these different types of shocks, and see how the equalization entitlements respond to each of them.

– Figure 3 –

More specifically, let us assume that annual changes in per capita tax bases consist of province-specific individual components and nationwide common shocks. The province-specific components are further decomposed into serially correlated individual changes (s_k^j) and serially independent individual shocks (ϵ_{kt}). Letting c_t stand for the common shocks, we can then express annual changes in the per capita tax base j in province k as

$$\Delta b_{kt}^j = s_{kt}^j + c_t^j + \epsilon_{kt}^j. \tag{7}$$

Our task is to identify the impacts that each of the three types of components in (7) have had on the observed changes in equalization entitlements. We proceed in three steps.

First, we obtain plausible estimates for the three types of changes. For this purpose, we assume that (7) is generated by the following stochastic process:

$$\Delta b_{kt}^j = \rho_{k0}^j + \rho_k^j \Delta b_{kt-1}^j + \sum_{h \neq j} \rho_k^h \Delta b_{kt-1}^h + c_t^j + \epsilon_{kt}^j \tag{8}$$

where $s_{kt}^j \equiv \rho_{k0}^j + \rho_k^j \Delta b_{kt-1}^j + \sum_{h \neq j} \rho_k^h \Delta b_{kt-1}^h$ and ρ^j's are coefficients. We perform OLS estimation on (8) using annual changes in per capita tax bases in the ten provinces during 1969–98. The panel structure of our data allows us to obtain estimates for the common shocks (c_t^j) as time-specific fixed effects (i.e., coefficients on time dummies). Note that the slope coefficients (ρ_k^j) as well as fixed effects (ρ_{k0}^j) are allowed to take on province-specific values with the use of provincial dummies. From these estimates, we

obtain the residuals $\hat{\epsilon}_{it}^{j}$ and the time effects $\hat{c}_{t}^{j}$ for each of the three revenue sources. These can then be used to give us estimates for the three components of (7): (i) serially correlated individual changes $\hat{\mathbf{s}}_{t}^{j} = \{\hat{s}_{it}^{j}\}_{i} = \{\Delta b_{kt}^{j} - \hat{c}_{t}^{j} - \hat{\epsilon}_{it}^{j}\}_{i}$, (ii) serially uncorrelated individual shocks $\hat{\boldsymbol{\epsilon}}_{t}^{j} = \{\hat{\epsilon}_{it}^{j}\}_{i}$[12] and (iii) common shocks $\hat{\mathbf{c}}_{t}^{j} = \{\hat{c}_{t}^{j}\}_{t}$ for $t = 1969 - 98$.[13]

Second, we calculate the portions of $\Delta\tau_{t}^{j}$, Δb_{St}^{j} and Δb_{t}^{j} that are caused by each of the three different changes in provincial per capita tax bases. Let $\hat{\mathbf{u}}_{t}^{j} = \{\hat{u}_{it}^{j}\}_{i=1}^{10}$ be a generic expression for one of the three components ($\hat{s}_{kt}^{j}$, $\hat{c}_{t}^{j}$, $\hat{\epsilon}_{kt}^{j}$). Then, such portions are given as

$$\begin{aligned}
\Delta\tau_{t}^{j} &: \Delta\tau\left(\hat{\mathbf{u}}_{t}^{j}\right) \equiv \frac{\sum_{i\in P} n_{it-1}\tau_{it-1}^{j}\cdot\left(b_{it-1}^{j}+\hat{u}_{it}^{j}\right)}{\sum_{i\in P} n_{it-1}\cdot\left(b_{it-1}^{j}+\hat{u}_{it}^{j}\right)} - \tau_{t-1}^{j} \\
\Delta b_{St}^{j} &: \Delta b_{S}\left(\hat{\mathbf{u}}_{t}^{j}\right) \equiv \frac{\sum_{i\in S} n_{it-1}\cdot\left(b_{it-1}^{j}+\hat{u}_{it}^{j}\right)}{\sum_{i\in S} n_{it-1}} - b_{St-1}^{j} = \frac{\sum_{i\in S} n_{it-1}\hat{u}_{it}^{j}}{\sum_{i\in S} n_{it-1}} \qquad (9) \\
\Delta b_{t}^{j} &: \Delta b\left(\hat{\mathbf{u}}_{t}^{j}\right) \equiv \hat{u}_{it}^{j}.
\end{aligned}$$

Third, by taking advantage of decomposition formula (5), we may obtain the change in the entitlements attributable to $\hat{\mathbf{u}}_{t}^{j}$ as

$$\Delta e_{kt}\left(\hat{\mathbf{u}}_{t}^{j}\right) = \sum_{j}\beta_{kt}^{j}\Delta\tau\left(\hat{\mathbf{u}}_{t}^{j}\right) + \sum_{j}\bar{\tau}_{t}^{j}\Delta b_{S}\left(\hat{\mathbf{u}}_{t}^{j}\right) - \sum_{j}\bar{\tau}_{t}^{j}\hat{u}_{kt}^{j}. \qquad (10)$$

A standardized measure for the change in revenue-raising ability caused by a shock to its own tax bases is defined analogously as before:

$$\sum_{j}\bar{\tau}_{t}^{j}\cdot\hat{u}_{kt}^{j}.$$

This constitutes the pre-equalized revenue change. The post-equalized counterpart is also defined as before:

$$\sum_{j}\bar{\tau}_{t}^{j}\cdot\hat{u}_{kt}^{j} + \Delta\hat{e}_{kt}.$$

To characterize the impacts of different shocks $\hat{u}_{kt}^{j} = \hat{s}_{kt}^{j}$, $\hat{c}_{t}^{j}$ and $\hat{\epsilon}_{kt}^{j}$, we simply conduct analogous analyses to those in earlier sections. As in Section 2, we calculate (i) $\rho(\Delta\hat{e}_{kt}, \sum_{j}\bar{\tau}_{t}^{j}\cdot\hat{u}_{kt}^{j})$ — the correlation coefficient between changes in tax capacities due to shocks and corresponding responses of equalization entitlements, and (ii)

[12] Note that the values for $\hat{\epsilon}_{it}^{j}$ are calculated so as to add up to zero both cross-sectionally and serially ($\sum_{i\in P}\hat{\epsilon}_{it} = 0$ and $\sum_{t}\hat{\epsilon}_{it} = 0$).

[13] Of course, the estimators for the two fixed effects (ρ_{k0}^{j} and c_{t}^{j}) are not consistent. In this sense, the three estimates for the components of (7) are not preferable in the statistical sense. However, this should not be a problem here, since we regard this exercise as a numerical simulation based upon some given set plausible values. We therefore do not list the details of the estimation results, although they can be obtained from the authors upon request.

$\text{var}(\sum_j \bar{\tau}_t^j \cdot \hat{u}_{kt}^j + \Delta\hat{e}_{kt})/\text{var}(\sum_j \bar{\tau}_t^j \cdot \hat{u}_{kt}^j)$ — the ratio of the variance of post-equalized revenue changes to that of pre-equalized revenue changes. Also, as in Section 3, we examine frequencies of specific patterns of entitlement changes for 1969–98. We list the correlation coefficients and the variance ratios in Table 7, and the patterns of per capita entitlement responses in Table 8, respectively for serially correlated individual changes, serially uncorrelated individual shocks, and common shocks.

– Tables 7 and 8 –

The correlation coefficients for the serially correlated individual changes ($\hat{s}_{kt}^j$) are all negative and statistically significant, which implies an offsetting relation. On the other hand, the destabilizing properties seem to be retained. Except for Prince Edward Island, all the variance ratios are more than one, although only those for Newfoundland and Quebec are statistically significant at the .10 level. The response pattern confirms the destabilizing tendency since about two-third of the cases are destabilizing for every receiving province. By construction, the serially correlated individual changes retain the dynamic properties, since they are actual tax base changes net of the serially uncorrelated and common shocks. We may then argue that the destabilization properties demonstrated in the previous sections are partly due to these dynamic properties of the tax bases. However, the significantly negative correlations somewhat contradict what we find in Table 2 for most of the provinces. This should be related to the present calculation procedures given in (9). Note that the changes in the entitlements are calculated with population and provincial average tax rates that are *fixed* at their previous year's values. As such, we expect them to be less volatile than otherwise.

The responses to the serially uncorrelated individual shocks ($\hat{\epsilon}_{kt}^j$) are different except that the correlations are again all negative and significant. The variance ratios are all below unity except for Nova Scotia. In addition, the reduced variances are significant for New Brunswick, Manitoba and Saskatchewan. Furthermore, the frequencies of the destabilizing cases are reduced to about one half of the cases for all recipients. Notably, compared with the case for the serially correlated changes, the frequencies of co-movement are almost halved in all but Nova Scotia. Notice, however, that statistically significant reductions in the variances are only found for New Brunswick, Manitoba and Saskatchewan. For the others, we do not reject the hypothesis of no changes in volatility. This, along with the fact that there are still substantive cases of destabilization, indicates that the scheme cannot pool the serially uncorrelated individual shocks as well as we may have expected, although it does better than the case with the serially correlated counterparts. This result may be due to the facts that the shocks are defined on per capita basis and that the standard base is based upon the subset of the federation members. While the estimated per capita shocks add up to zero cross-sectionally ($\sum_{i\in P} \hat{\epsilon}_{it} = 0$), population-weighted counterparts do not ($\sum_{i\in P} n_{it-1}\hat{\epsilon}_{it}^j \neq 0$), which implies that aggregated shocks are not symmetric. In addition, the equalization standards do not fully account for the

aggregated shocks, since their changes only reflect those in *the five standard provinces* $\sum_{i\in S} n_{it-1}\hat{\epsilon}^j_{it}$, not all of the ten provinces $\sum_{i\in P} n_{it-1}\hat{\epsilon}^j_{it}$. Still, our simulation shows that $\Delta e_{kt}\left(\hat{\boldsymbol{\epsilon}}^j_t\right)$ and $\hat{\epsilon}^j_{kt}$ are offsetting on average since the correlations are negative. This implies that, even though $\Delta b_S\left(\hat{\boldsymbol{\epsilon}}^j_t\right) = 0$ does not hold, its value does not frequently co-move with that of $\hat{\epsilon}^j_{kt}$, which may still have something to do with the fact that, albeit in per capita term, the shocks are estimated such that $\sum_{i\in P}\hat{\epsilon}_{it} = 0$. Morever, we hardly expect full risk-pooling to apply in practice since the law of large number will not operate in a federation of only ten provinces.

The results for common shocks (c^j_t) are quite similar across the seven provinces. This is due to the fact that, if $\hat{u}_{it} = \hat{c}_t$, the changes in the entitlement is given as $\Delta e_{kt}\left(\hat{\mathbf{c}}_t\right) = \sum_j \beta^j_{kt}\Delta\tau\left(\hat{\mathbf{c}}_t\right)$. That is, changes in the entitlements are entirely induced by those in the average tax rates. While we expect the magnitude of these changes to be relatively small based upon the analysis in the previous section, we do not exclude the possibility of a destabilizing outcome. In fact, destabilizing patterns are actually observed in one-third of the cases. But reflecting presumably smaller changes of $\sum_j \beta^j_{kt}\Delta\tau\left(\hat{\mathbf{c}}_t\right)$, the frequencies of destabilizing cases are less than those with the other two types of shocks, and all of the destabilizing cases are those of co-movement: none are hyper-offsetting cases. Otherwise, the common shocks seems to be well accounted for. The correlation coefficients are all negative and significant. Likewise, the variance ratios are also all less than unity and significant. This may seem to be odd at first glance since one might expect that a system of cross-region transfers can only pool region-specific shocks. But, since the equalization program is a 'gross' scheme rather than a 'net' one, this result should not be a surprise. That is, the scheme can pool common shocks affecting recipient provinces at the expense of changes in the federal budget.

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.[14] 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 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 stabilization function suffers. The evidence we have presented in this paper indicates that, at least for the three major revenue categories we study, the equalization system can actually be destabilizing, thereby imposing on equalization-receiving 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 stabilization 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.

[14] 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.

References

Asdrubali, P., Sorensen, B.E., Yosha, O., 1996. Channels of interstate risksharing: United States 1963–1990. *Quarterly Journal of Economics* 111(4), 1081–1110.

Boadway, R., Flatters, F., 1979. Efficiency and equalization payments in a federal system of government: A synthesis and extension of recent results. *Canadian Journal of Economics* 15, 613-633.

Boadway, R., Hobson, P., 1993. *Intergovernmental Fiscal Relations in Canada* (Canadian Tax Foundation, Toronto).

Boadway, R., Hobson, P., Eds. 1998. *Equalization: Its Contribution to Canada's Economic and Fiscal Progress* (Policy Forum Series 36, John Deutsch Institute for the Study of Economic Policy, Queen's University, Kingston).

Bayoumi, T., Masson, P.R., 1995. Fiscal flows in the United States and Canada: Lessons for monetary union in Europe. *European Economic Review* 39, 253-74.

Boothe, P., 2002. The stabilization properties of Canada's equalization program. Paper presetnted at the 58th Congress of the International Institute of Public Finance (Helsinki, Finland, August 2002).

Buchanan, J.M., 1950. Federalism and fiscal equity. *American Economic Review* 40, 583-599.

Buchanan, J.M., 1952. Federal grants and resource allocation. *Journal of Political Economy* 60, 208-217.

Decressin, J., 2002. Regional income redistribution and risk sharing: how does Italy compare in Europe? *Journal of Public Economics* 86(2), 287-306.

Graham, J.F., 1964. Fiscal adjustment in a federal country. in *Intergovernmental Fiscal Arragnement* (Canadian Tax Foundation, Toronto).

Hobson, P., 1998. Is there too much revenue redistribution through Canada's fiscal equalization program? in: Boadway and Hobson (1998).

Konrad, K., Seitz, H., 2001. Fiscal federalism and risksharing in Germany: The role of size difference. Paper presented at Public Finances and Public Policy in the New Millennium: A Conference on the Occation of Richard Musgrave's 90th and CES's 10th Birthday, University of Munich, 12–13 January 2001.

Mélitz, J., Zumur, F., 2002. Regional redistribution and stabilization by the center in Canada, France, the UK and the US: A reassessment and new tests. *Journal of Public Economics* 86(2), 263-286.

Usher, D., 1995. *The Uneasy Case for Equalization Payments* (The Fraser Institute, Vancouver).

von Hagen, J., Hammond, G.W., 1998. Regional insurance against asymmetric shocks: An empirical study for the European Community. *Manchester School* 66(3), 331-53.

von Hagen, J.V., Hepp, R., 2000. Regional risksharing and redistribution in the German Federation. ZEI, University of Bonn. Unpublished paper.

	Aggregate		Personal		Business		Sales	
Nfld.	.179	(.328)	.240	(.181)	.441*	(.006)	.336*	(.050)
P.E.I.	.563*	(.000)	.450*	(.005)	.632*	(.000)	.174	(.345)
N.S.	.392*	(.018)	.389*	(.020)	.644*	(.000)	.129	(.485)
N.B.	.358*	(.035)	.444*	(.006)	.552*	(.000)	.200	(.271)
Que.	.206	(.257)	.115	(.534)	.498*	(.001)	−.009	(.964)
Man.	.294*	(.093)	.426*	(.009)	.200	(.272)	.290*	(.099)
Sask.	.296*	(.091)	−.112	(.546)	.208	(.251)	−.182	(.318)

Table 1: Correlation coefficients with per capita revenues
Note: '*' indicates statistical significance at the .10 level: *P*-values are in parentheses.

	Aggregate		Personal		Business		Sales	
Nfld.	.417*	(.011)	.086	(.644)	.192	(.293)	−.268	(.130)
P.E.I.	.130	(.481)	.269	(.128)	−.309*	(.076)	−.236	(.188)
N.S.	.402*	(.015)	.371*	(.028)	−.089	(.632)	−.300*	(.086)
N.B.	−.201	(.268)	.380*	(.023)	−.736*	(.000)	−.322*	(.062)
Que.	.246	(.168)	.263	(.139)	−.089	(.634)	−.170	(.352)
Man.	−.014	(.938)	−.343*	(.045)	.124	(.501)	−.040	(.831)
Sask.	−.442*	(.006)	−.539*	(.000)	−.381*	(.023)	−.398*	(.016)

Table 2: Correlation coefficients with per capita tax capacities
Note: '*' indicates statistical significance at the .10 level: *P*-values are in parentheses.

		offset			*co-move*	*destabilizing*
		(a)under	*(b)over*	*(c)hyper*	*(d)*	*(c)+(d)*
Aggregate	Nfld.	11/31	7/31	7/31	6/31	13/31
	P.E.I.	9/31	3/31	9/31	10/31	19/31
	N.S.	9/31	5/31	5/31	12/31	17/31
	N.B.	8/31	6/31	2/31	15/31	17/31
	Que.	12/31	1/31	2/31	16/31	18/31
	Man.	14/31	2/31	2/31	13/31	15/31
	Sask.	2/31	3/31	3/31	23/31	26/31
Personal	Nfld.	8/31	1/31	7/31	15/31	22/31
	P.E.I.	5/31	3/31	5/31	18/31	23/31
	N.S.	10/31	5/31	3/31	13/31	16/31
	N.B.	6/31	7/31	4/31	14/31	18/31
	Que.	15/31	3/31	0/31	13/31	13/31
	Man.	9/31	4/31	2/31	16/31	18/31
	Sask.	4/31	0/31	3/31	24/31	27/31
Business	Nfld.	5/31	8/31	5/31	13/31	18/31
	P.E.I.	2/31	4/31	8/31	17/31	25/31
	N.S.	6/31	6/31	8/31	11/31	19/31
	N.B.	9/31	2/31	4/31	16/31	20/31
	Que.	12/31	4/31	4/31	11/31	15/31
	Man.	14/31	3/31	2/31	12/31	14/31
	Sask.	10/31	2/31	1/31	18/31	19/31
Sales	Nfld.	7/31	1/31	4/31	19/31	23/31
	P.E.I.	5/31	3/31	5/31	18/31	23/31
	N.S.	8/31	1/31	2/31	20/31	22/31
	N.B.	5/31	1/31	3/31	22/31	25/31
	Que.	10/31	0/31	0/31	21/31	21/31
	Man.	8/31	1/31	4/31	18/31	22/31
	Sask.	5/31	2/31	2/31	22/31	24/31

Table 3: Patterns of responses
Note: The values refer to the number of occurrences out of 31 periods.

	Aggregate		Personal		Business		Sales	
Nfld.	1.67*	(.083)	1.73*	(.070)	2.87*	(.003)	1.47	(.150)
P.E.I.	3.00*	(.002)	2.13*	(.021)	3.66*	(.000)	1.72*	(.073)
N.S.	2.09*	(.024)	1.66*	(.087)	2.40*	(.010)	1.34	(.213)
N.B.	1.85*	(.048)	1.75*	(.066)	2.50*	(.007)	1.38	(.193)
Que.	1.26	(.263)	1.13	(.369)	1.63*	(.093)	1.06	(.440)
Man.	1.60	(.103)	1.52	(.128)	1.50	(.135)	1.38	(.193)
Sask.	1.46	(.152)	1.26	(.266)	1.10	(.395)	1.09	(.403)

Table 4: Ratios of variances of post- to pre-equalized revenues
Note: '*' indicates statistical significance at the .10 level: *P*-values are in parentheses.

	Aggregate		Personal		Business		Sales	
Nfld.	3.72*	(.000)	2.84*	(.003)	3.41*	(.001)	1.49	(.140)
P.E.I.	3.18*	(.001)	3.92*	(.000)	1.94*	(.037)	1.87*	(.045)
N.S.	2.71*	(.004)	2.19*	(.018)	1.95*	(.036)	1.05	(.444)
N.B.	1.60	(.102)	3.01*	(.002)	0.49*[a]	(.026)	1.37	(.198)
Que.	1.43	(.165)	1.48	(.144)	1.12	(.376)	1.00	(.497)
Man.	1.63*	(.093)	1.09	(.411)	2.30*	(.013)	1.51	(.134)
Sask.	1.07	(.432)	0.81[a]	(.282)	1.20	(.313)	1.12	(.379)

Table 5: Ratios of variances of post- to pre-equalized tax capacities
Note: '*' indicates statistical significance at the .10 level: *P*-values are in parentheses. '*a*' refers to the case where the alternative hypothesis is that the equalization system is stabilizing.

		var(x)	var(y)	var(z)	2·cov(x, y)	2·cov(x, z)	2·cov(y, z)
Aggregate	Nfld.	.23	2.47	.61	−.45	.16	−2.03
	P.E.I.	.19	1.93	.55	−.38	.03	−1.31
	N.S.	.15	3.07	1.07	−.32	.21	−3.18
	N.B.	.11	1.73	1.00	−.25	.03	−1.63
	Que.	.07	7.41	4.81	−.59	.53	−11.23
	Man.	.07	2.62	1.53	−.19	.10	−3.12
	Sask.	.04	1.21	1.10	−.08	.11	−1.39
Personal	Nfld.	.64	2.10	.62	−.98	.32	−1.69
	P.E.I.	.73	2.24	.47	−1.13	.19	−1.49
	N.S.	.65	4.49	1.64	−1.56	.66	−4.89
	N.B.	.65	3.15	.85	−1.26	.49	−2.88
	Que.	.22	7.25	4.36	−1.01	.66	−10.48
	Man.	.13	1.97	1.58	−.39	.29	−2.59
	Sask.	.10	1.18	1.37	−.17	.22	−1.70
Business	Nfld.	.29	1.75	.53	−.22	.08	−1.42
	P.E.I.	.18	1.07	.57	−.15	.00	−.67
	N.S.	.23	1.68	.88	−.20	.14	−1.73
	N.B.	.06	0.59	1.23	−.06	.05	−.87
	Que.	.06	5.71	4.90	−.26	.20	−9.63
	Man.	.14	2.25	.95	−.19	.11	−2.27
	Sask.	.07	1.35	1.07	−.14	.07	−1.42
Sales	Nfld.	.14	1.68	.97	−.37	.15	−1.55
	P.E.I.	.14	1.46	.69	−.30	.00	−.99
	N.S.	.09	2.46	2.18	−.25	.18	−3.65
	N.B.	.05	1.52	.98	−.23	.18	−1.51
	Que.	.13	8.82	8.16	−.76	.65	−16.00
	Man.	.06	2.99	1.76	−.39	.11	−3.53
	Sask.	.02	1.43	1.17	−.07	.07	−1.54

Table 6: Variance-covariance decompositions

Note: (a) The values are normalized by the variance of annual changes in the entitlements for each revenue source. (b) x, y and z respectively refers to changes due to those in the average tax rates, the five-province per capita tax bases and own per capita tax bases.

		Correlation Coef.		*Variance Ratios*	
Serially correlated	Nfld.	$-.716^*$	(.000)	1.734^*	(.069)
individual changes	P.E.I.	$-.778^*$	(.000)	.964	(.540)
	N.S.	$-.816^*$	(.000)	1.157	(.346)
	N.B.	$-.763^*$	(.000)	1.047	(.451)
	Que.	$-.733^*$	(.000)	2.882^*	(.002)
	Man.	$-.650^*$	(.000)	1.604	(.101)
	Sask.	$-.745^*$	(.000)	1.399	(.181)
Serially uncorrelated	Nfld.	$-.804^*$	(.000)	.840	(.318)
individual shocks	P.E.I.	$-.811^*$	(.000)	.661	(.131)
	N.S.	$-.463^*$	(.004)	1.309	(.232)
	N.B.	$-.858^*$	(.000)	$.566^*$	(.062)
	Que.	$-.468^*$	(.004)	.877	(.364)
	Man.	$-.810^*$	(.000)	$.554^*$	(.055)
	Sask.	$-.881^*$	(.000)	$.425^*$	(.011)
Common shocks	Nfld.	$-.788^*$	(.000)	$.415^*$	(.009)
	P.E.I.	$-.787^*$	(.000)	$.416^*$	(.010)
	N.S.	$-.791^*$	(.000)	$.411^*$	(.009)
	N.B.	$-.789^*$	(.000)	$.413^*$	(.009)
	Que.	$-.795^*$	(.000)	$.402^*$	(.007)
	Man.	$-.793^*$	(.000)	$.407^*$	(.008)
	Sask.	$-.796^*$	(.000)	$.403^*$	(.008)

Table 7: Responses to different shocks: Correlation coefficients and variance ratios

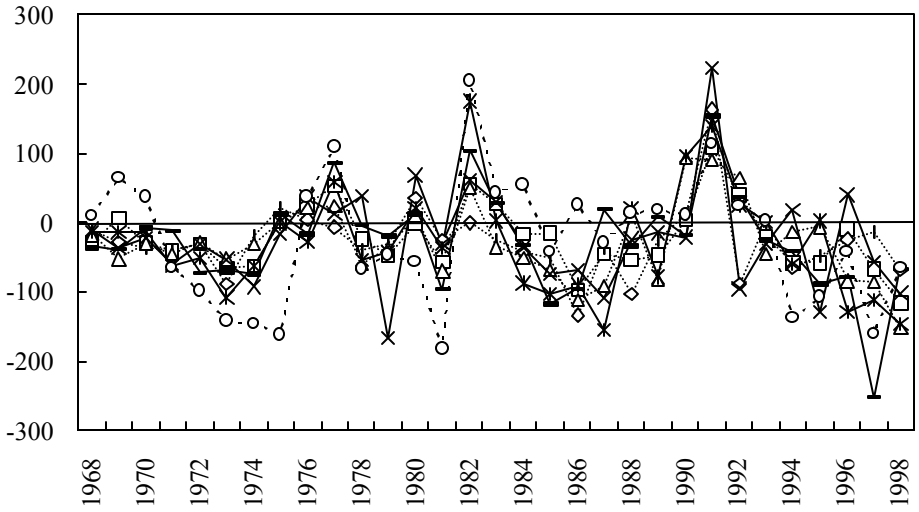
Note: (a) The variance ratios are given as the variances of post-equalized quantities divided by those of pre-equalized quantities. (b) '*' indicates statistical significance at the .10 level: *P*-values are in parentheses.

		offset			*co-move*	*destabilize*
		(a)	*(b)*	*(c)*	*(d)*	*(c)+(d)*
Serially correlated	Nfld.	5/30	6/30	10/30	9/30	19/30
individual changes	P.E.I.	5/30	9/30	7/30	9/30	16/30
	N.S.	4/30	8/30	5/30	13/30	18/30
	N.B.	4/30	8/30	6/30	12/30	18/30
	Que.	6/30	6/30	4/30	15/30	19/30
	Man.	6/30	6/30	8/30	10/30	18/30
	Sask.	3/30	7/30	11/30	9/30	20/30
Serially uncorrelated	Nfld.	5/30	12/30	8/30	5/30	13/30
individual shocks	P.E.I.	8/30	9/30	5/30	8/30	13/30
	N.S.	6/30	7/30	6/30	11/30	17/30
	N.B.	6/30	10/30	8/30	6/30	14/30
	Que.	11/30	5/30	5/30	9/30	14/30
	Man.	10/30	9/30	6/30	5/30	11/30
	Sask.	9/30	11/30	6/30	4/30	10/30
Common shocks	Nfld.	18/30	2/30	0/30	10/30	10/30
	P.E.I.	18/30	2/30	0/30	10/30	10/30
	N.S.	18/30	2/30	0/30	10/30	10/30
	N.B.	18/30	2/30	0/30	10/30	10/30
	Que.	18/30	2/30	0/30	10/30	10/30
	Man.	18/30	2/30	0/30	10/30	10/30
	Sask.	18/30	2/30	0/30	10/30	10/30

Table 8: Responses to different shocks: Response patterns
Note: (a)-(d) refer to the number of occurance out of 30 periods.

Figure 1. Annual changes in pre- and post-equalized tax capacities

(a) Annual changes in pre-equalized tax capacities



(b) Annual changes in post-equalized tax capacities

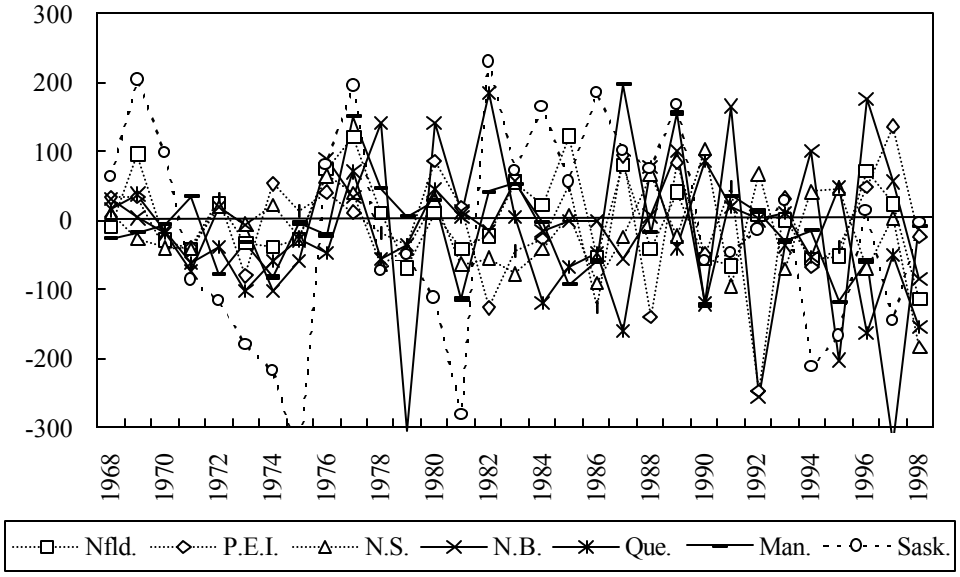
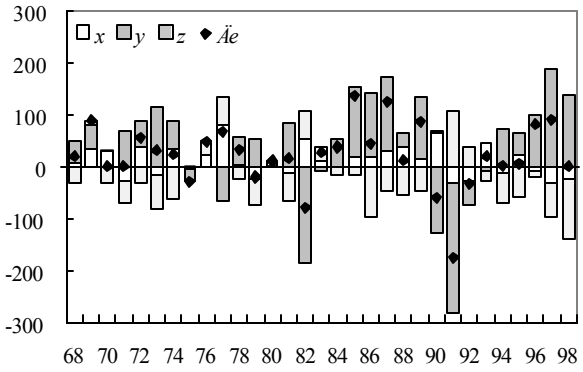
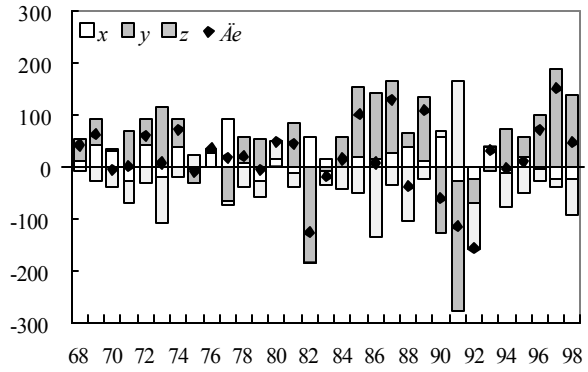


Figure 2. Decompositions

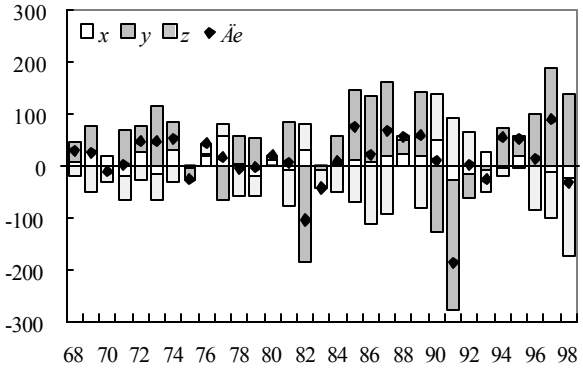
(a) Newfoundland



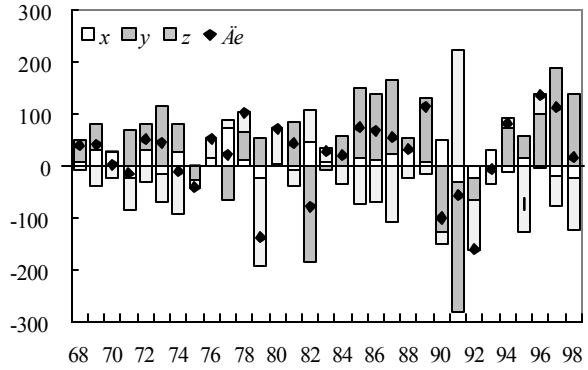
(b) Prince Edward Island



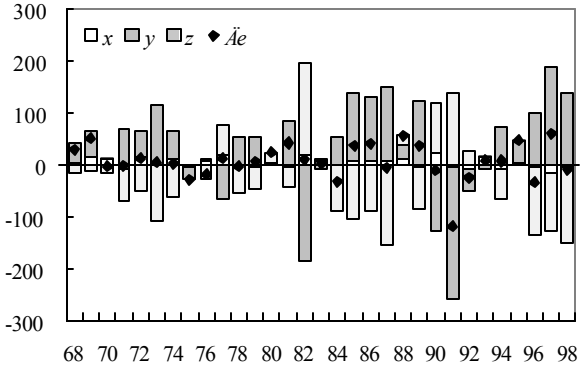
(c) Nova Scotia



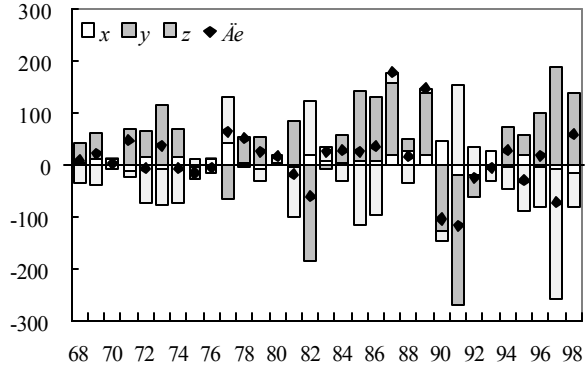
(d) New Brunswick



(e) Quebec



(f) Manitoba



(g) Saskatchewan

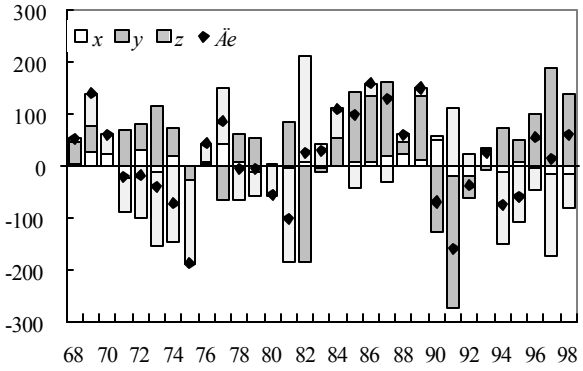
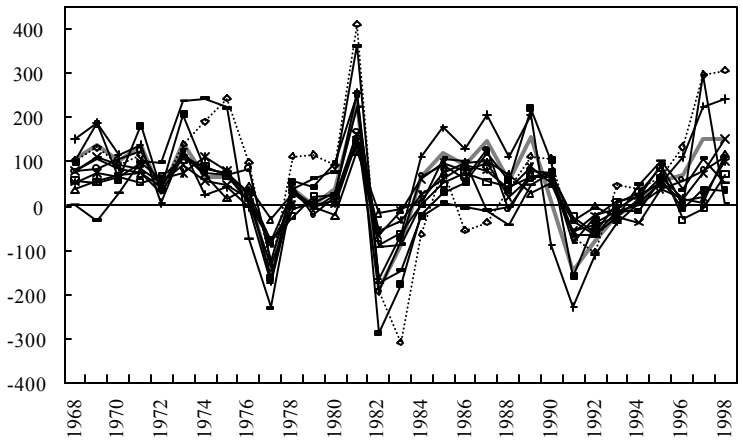
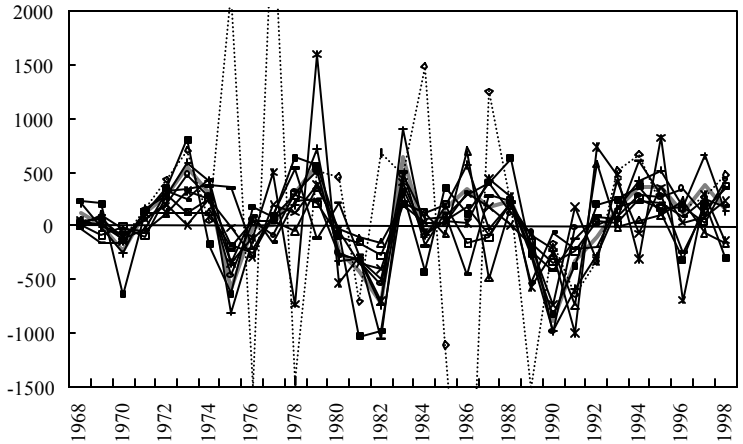


Figure 3. Changes in per capita tax bases

(a) Personal Income



(b) Business Income



(c) Sales