Equalization and stabilization*

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Abstract
The federal Equalization transfer program makes fiscal resources of “have-not” provinces depend on fiscal conditions in “have” provinces, which tends to destabilize provincial finances: the data show that equalized revenues of receiving provinces are more volatile than own-source revenues. But this reflects the revenue risks facing the aggregate of all provinces, which an equalization program cannot insure. Controlling for aggregate risk, I find that the program has a significant stabilizing effect on provincial finances. Nevertheless, some improvements in revenue sharing through the program might be contemplated. For example, a return to national-average capacity standard, from the five-province standard that has been in place since 1982, would increase insurance for idiosyncratic shocks by about one-third.

1 Introduction
Equalization is sometimes called the “glue” that holds the Canadian federation together. Perhaps, but those bonds have been loosening in recent years. The program has been subject to an unparalleled degree of scrutiny (and indeed criticism) in the media, and the political tug-of-war over the program has intensified since its last renewal. According to its critics, Equalization is unnecessarily complex and non-transparent, and most importantly it creates perverse incentives for provincial governments, changing the way they tax economic activity and foster economic development, to the detriment of all Canadians.1

More recently, critics in provincial governments and academic circles have also argued that Equalization payments are unnecessarily volatile, inhibiting stabilization of revenues and making fiscal planning more difficult for provincial governments (Boothe, 2002). This objection has gained additional currency in the fiscal environment facing the provinces in recent months. According to government projections in early 2004, Equalization are projected to fall by $1.3 billion in the next fiscal year, due largely the sharp deterioration in the Ontario government’s finances and the resulting decrease in provincial revenues subject to Equalization.2 Naturally, such changes appear capricious to officials in the receiving provinces. They also raise broader issues of the design of the Equalization formula and its implications for risk sharing among governments in Canada.

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1See Smart (2002) inter alia for a recent commentary on these issues.

In this paper, I offer a quantitative description of the impact of Equalization on the stability of provincial finances, as well as an assessment of the system on the basis of economic theory. Using data for the 1982-98 period, I find that Equalization entitlements are indeed highly volatile. More importantly, and logically distinct, Equalization has had a destabilizing effect on the total fiscal resources of receiving provinces. In this respect, my results echo Boothe (2002) and Boadway and Hayashi (2004), who also document the effects of the program on revenue volatility.\(^3\)

But could a different scheme do better? Any equalization arrangement that is defined on the basis of provincial revenues and tax bases has the potential to “insure” governments against idiosyncratic risks of shortfalls in their own revenues, but it can do nothing to eliminate the risk of changes in the aggregate of revenues for all provinces. Applying the theory of optimal risk sharing, I argue (with some qualifications) that the best such schemes should expose all provinces to the aggregate risks in exactly the same measure. I then show how the current Equalization scheme differs from this benchmark of “efficient revenue sharing”.

This perspective leads to a rather different assessment of the current system. Controlling for aggregate risks, I find that Equalization insured receiving provinces for about 58 per cent of the idiosyncratic shocks to tax capacity that they faced in the 1982-98 period. (This is consistent with the variance decompositions in Boadway and Hayashi (2004), who find that much of the volatility in equalized revenue can be attributed to the volatility of standard tax capacity.) Changes to the formula could however enhance the stabilization effect. For example, I find that broadening the definition of tax capacity to include all ten provinces, in place of the current Representative Five-Province Standard, would increase the insurance of idiosyncratic shocks considerably.

2 Equalization: How it works

2.1 The formula

The RTS system is designed to allow provinces to obtain the same fiscal resources (“comparable” is the Constitutional term) when they levy the same tax rates, despite differences in the sizes of their tax bases. It pays provinces an amount in respect of each measured tax base equal to the deficiency, relative to the standard level, in the revenues it could collect from each measured base, if it levied the average of all provinces’ tax rates.

The mechanics of the basic formula are most easily understood by judicious use of algebra: Consider a single tax base, for which each province \(i = 1, \ldots, n\) has a measured per capita tax base \(X_i\) and collects per capita revenues subject to equalization \(R_i = t_iX_i\). Let \(N_i\) be the population of each province, and \(N = \sum_j N_j\) be national population. The national average per capita revenues and tax bases are then

\[
\bar{R} = \frac{\sum_i N_i t_i X_i}{N} \\
\bar{X} = \frac{\sum_i N_i X_i}{N}
\]

while \(\bar{t} = \bar{R}/\bar{X}\) is the corresponding national average tax rate.

\(^3\)However, I conduct this analysis for a larger set of provinces than Boothe (indeed, all of them), and for more tax bases than Boadway and Hayashi.
The RTS equalization system calculates the difference between each province’s tax base \( X_i \) and a “standard” per capita level, say \( X_s \), and pays the province a transfer (positive or negative) equal to that deficiency, multiplied by the national average tax rate \( \bar{t} \). In Canada at present, the standard is not the national average tax base \( \bar{X} \), but rather the average for a subset of five of the provinces. This is known as the Representative Five Province Standard (RFPS).\(^4\) Formally, let \( j \in S \) if province \( j \) is part of the standard, and define \( N_s = \sum_{j \in S} N_j \) as standard population and

\[
X_s = \frac{\sum_{j \in S} N_j X_j}{N_s}
\]
as the per capita standard tax base. Then the equalization entitlement of each province \( i \) (again, positive or negative) under RFPS is \( \bar{t}(X_s - X_i) \). More importantly for my analysis, the province’s equalized revenues under RFPS (the sum of own-source revenues and equalization entitlements) is

\[
G_i = t_i X_i + \bar{t}(X_s - X_i) = (t_i - \bar{t}) X_i + \frac{X_s}{\bar{X}} \bar{R} \tag{1}
\]

where I have used the definition of \( \bar{t} \) to express equalized revenues in terms of national average revenues \( \bar{R} \).

This defines equalized revenues in respect of a single tax base. In the Canadian system, this calculation is done for 33 separate revenue sources, and equalization entitlements are then summed across all categories. Actual transfers are then determined on a “gross” rather than “net” basis: Provinces with a positive aggregate entitlement receive a payment from the federal treasury, while provinces with negative entitlements are not required to contribute to the program.

But even this extended summary of the system hides important complexities in the determinants of actual transfers. For a small number of bases, only a fraction of capacity deficiencies are included in the formula (the so-called “generic solution”). Further, actual transfers have differed from aggregate entitlements because of “ceiling” and “floor” provisions that are intended to smooth changes in payouts for both federal and provincial governments.\(^5\) In what follows, however, I largely ignore these considerations, in order to concentrate under the basic RFPS entitlement formula and its risk-sharing characteristics.

Note from equation (1) that, when all provinces levy the same tax rates, and the average bases in standard provinces equal the average bases in the nation, then the formula reduces to \( G_i = \bar{R} \), or complete equalization of provincial own-source revenues. When there are differences in tax rates, or in the bases of standard and non-standard provinces, however, the formula no longer guarantees “reasonably comparable levels of spending at reasonably comparable levels of taxation”. As we will see, these differences are also central to understanding the stabilization effects of the formula.

2.2 Risk sharing and redistribution in Equalization

Setting aside such considerations for now, it is apparent from the formula that the program has the potential to completely equalize revenue capacities of the seven “have-not” provinces that

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\(^4\)The standard excludes the four Atlantic provinces and Alberta.

\(^5\)The ceiling provision was lifted in 2003.
have historically received transfers. This is the “redistributive function” of Equalization, which is its core mandate. In practice, the level of redistribution achieved on average by the formula depends on the effects of the ceiling and floor provisions, the generic solution and, more fundamentally, on the definitions of tax bases used to calculate entitlements. The efficacy of redistribution has been studied in detail elsewhere (see, e.g., Boadway and Hobson 1993, and Smart 2002) and will not be pursued here. On balance, however, the formula has been extremely effective as a redistributive mechanism.

But Equalization may also play a role in stabilization of provincial own-source revenues. Since Equalization compensates provinces for tax base deficiencies, it has the potential to “insure” recipient governments against cyclical, adverse fiscal conditions affecting them on a short-term basis. An idealized system of equalization would in fact operate like a system of mutual insurance: provinces exposed to adverse revenue shocks in the short run would receive compensating transfers, at the expense of other provinces facing better fiscal conditions. This is a desirable property of intergovernmental transfers, since having stable net revenues aids governments in fiscal planning exercises and reduces the costs (whether economic or political) of short-run deficit finance. In this sense, the stabilization function creates gains for all provinces, in contrast to the redistributive function, which creates predictable “winners” and “losers” among provinces over time.

In contrast to this view, critics in provincial governments and academic circles have also argued that Equalization payments are unnecessarily volatile and in fact have destabilizing effects on net provincial revenues. As we will see, there is some support for both views.

To gain some sense of the actual effects of the program, I first provide a descriptive analysis of actual Equalization transfers and revenues for the Canadian provinces in the 1982-98 period. Throughout the following analysis, I employ data on Equalization entitlements and provincial populations, derived from the actual federal worksheets used by program administrators. Note that the data are entitlements rather than payments—that is, ceiling and floor provisions are ignored—and are based on final calculations, rather than the various interim estimates. In all cases, nominal variables are deflated using the national implicit price index for GDP at market prices and expressed in 1999 dollars.

As a first step to gauging the stabilization function of Equalization, I plot one-year changes in equalized revenue $G_{it} - G_{i,t-1}$ against one-year changes in own-source revenue $R_{it} - R_{i,t-1}$. (The notation used here and throughout the remainder of the paper corresponds to that of Section 2.1, with years of data represented by the subscript $t$.) If Equalization provides insurance against high-frequency revenue variations, then the scatterplot of these two variables should form something like a horizontal line: ideally, changes in equalized revenues should not reflect changes in own-source revenue at all. This is a traditional approach to measuring the stabilization effects of government transfers, which forms the basis for recent research by von Hagen and Hepp (2000), Mélicit and Zumer (2002), and Boadway and Hayashi (2004), among others.

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6I exclude British Columbia from this enumeration, since it did not receive equalization payments in the 1982-98 period covered by the data discussed below.

7This argument simplifies matters by ignoring the federal government, which pays Equalization transfers to recipients in Canada's "gross" system of equalization, rather than non-recipients, as in a "net" system. The difference is not central to the argument, however. Even in a gross scheme, uncorrelated shocks to fiscal positions of the receiving provinces will tend to average out, so that the federal government can provide insurance at a relatively stable total cost. The degree of insurance would however be greater in a net scheme.
The data are plotted together with the line of best fit for the sample\(^8\) in Figure 1. Clearly, the data show very little stabilization. In fact, the slope of the line of best fit is 1.25, indicating that Equalization appears to magnify the effect of short-term variations in revenue.\(^9\)

The result is startling, and it demonstrates just how far Equalization is from a true revenue stabilization program. To place the result in perspective, it is useful to compare the stabilizing effects of other transfer systems. Using a very similar approach, von Hagen and Hepp (2000) examine Germany’s *Finanzausgleich* (FA), which pays federal transfers to states with per capita revenue below the national average. They estimate that the program compensates states for 88 per cent of annual per capita revenue changes. This is perhaps unsurprising, since FA is a revenue pooling program, calculating transfers on the basis of actual state revenues, rather than indirectly on the basis of fiscal capacity as in Canada, but the difference is larger than might have been expected.

A look at summary statistics on Equalization confirms the story told in Figure 1. Again using inflation-adjusted per capita data for the 1982-98 period, I measure volatility by the standard deviation of one-year changes in revenues and transfers. To give a sense of the scale of these measures, in the first two columns of Table 1, I present the average level of own-source revenues and equalization entitlements for each province. In the remaining three columns of the table, I present the volatility of own-source revenues, equalization entitlements, and equalized

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\(^8\)The line of best fit is in fact the regression line for the model

\[
G_{it} - G_{it-1} = \alpha + \beta(R_{it} - R_{it-1}) + \epsilon_{it}
\]

For a good general discussion of the methodology, and for a broader look at redistribution and stabilization through tax and transfer policies in a number of countries, see Mélices and Zumer (2002).

\(^9\)The standard error of the estimate is 0.05, so that the estimated coefficient is different from zero at the one per cent significance level.
revenues. The figures in the columns 3 and 5 of the table confirm the analysis derived from Figure 1. In all provinces, the volatility of equalized revenues is in fact greater than the volatility of own-source revenues. For the seven receiving provinces taken together, the standard deviation of per capita equalized revenue changes is 241.1, about 28 per cent higher than the 187.8 standard deviation of own-source revenue changes. But the effect is especially pronounced in the Atlantic provinces, where volatility of equalized revenue changes exceeds that of own-source revenue by about 50 per cent. On this basis, then, one may conclude that Equalization has a destabilizing effect on provincial finances.

A look at the various components of average volatility in Table 1 is also instructive. In particular, assessing the program on the basis of volatility in equalization entitlements alone gives a misleading picture of the situation. Referring to column 4, for example, the volatility of entitlements (either absolutely or relative to its mean) is lowest in Quebec, reflecting the comparatively small role of volatile business tax bases in Quebec’s entitlement. But, because the covariance of revenue and equalization changes is above-average for Quebec, the destabilizing effect of Equalization is closer to that of the other provinces: the ratio of column 5 to column 3 is 1.22, compared to 1.28 for all provinces. Likewise, the relatively high volatility of entitlements in Saskatchewan, relative to mean payments, does not translate into a significantly higher destabilizing effect on equalized revenues. This is because Saskatchewan’s entitlements, while more volatile than other provinces, also covary more negatively with own-source revenue than other provinces’.

Controlling for tax rate changes. An important objection to the analysis of volatility derived from Table 1 is that it is based on the actual revenues of receiving provinces. Hence changes in own-source revenues reflect not only changes in tax capacities, but also changes in the effective tax rates levied on bases. Tax rate changes are at least in principle under the control of provincial governments, and the Equalization program was never designed to compensate for them. Furthermore, the effective tax rates of all provinces are likely to covary positively for a
variety of reasons (macroeconomic conditions, political climate, and so on), leading to positive covariation in actual own-source revenues as well. Since Equalization transfers are defined as a function of national average provincial revenues, as indicated by equation (1), entitlements and own-source revenues tend to move together, because of the latent effect of effective tax rates on both variables. This may go some way to explaining the positive covariation of entitlements and revenues indicated by Figure 1.

Whether this is a desirable feature of RTS equalization or not, it is useful to isolate the effect of variation in tax capacities, rather than tax rates, on the stabilization function. To do so, I next calculate simulated values for entitlements and own-source revenues for the 1982-99 period, based on the counterfactual assumption that all (receiving and non-receiving) provinces had maintained effective tax rates at their (province-specific) average levels throughout the sample period. Doing so is complicated by the fact that the definition of many tax bases used in Equalization calculations changed during the period, and capacity and tax rate figures are not comparable across all years. To avoid comparing apples to oranges, I restrict the calculation to a subset of six major bases that appear to be measured consistently for all years. 10 Table 2 presents the same volatility measures for the fixed-rate counterfactual data.

To interpret the results, first note that both average revenues and equalization entitlements of receiving provinces are much lower for the simulated data than for the actual data; on average, revenues in Table 2 are 67 per cent, and entitlements are 75 per cent, of those in Table 1. This reflects the share of the subset of consistently measured bases in the total, as well as the effect of trends in actual effective tax rates and per capita bases in the rising tax environment of the 1980s and 1990s. Second, notice that the discrepancy in average entitlements is greatest for the Atlantic provinces (less than 70 per cent coverage) and is in fact negative for Saskatchewan. This is largely because Table 2 excludes resource bases, in which the Atlantic provinces were highly deficient, while Saskatchewan’s capacity exceeded the standard. This omission is unfortunate, 10

Table 2: Mean transfers and volatility, Fixed tax rates, 1982-98

<table>
<thead>
<tr>
<th>Province</th>
<th>Own-source revenues</th>
<th>Equalization</th>
<th>Own-source revenues</th>
<th>Equalization</th>
<th>Equalized revenues</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>Newfoundland</td>
<td>2316.45</td>
<td>1192.78</td>
<td>82.97</td>
<td>88.92</td>
<td>141.73</td>
</tr>
<tr>
<td>Prince Edward Island</td>
<td>2131.19</td>
<td>1068.26</td>
<td>96.78</td>
<td>99.40</td>
<td>133.74</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>2275.11</td>
<td>731.03</td>
<td>74.06</td>
<td>85.87</td>
<td>119.66</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>2320.25</td>
<td>894.82</td>
<td>116.44</td>
<td>106.39</td>
<td>132.12</td>
</tr>
<tr>
<td>Quebec</td>
<td>3478.11</td>
<td>388.72</td>
<td>76.94</td>
<td>58.11</td>
<td>112.32</td>
</tr>
<tr>
<td>Manitoba</td>
<td>2784.78</td>
<td>628.80</td>
<td>101.58</td>
<td>93.88</td>
<td>115.20</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>3001.80</td>
<td>645.74</td>
<td>122.51</td>
<td>114.84</td>
<td>121.92</td>
</tr>
<tr>
<td>All provinces</td>
<td>2615.38</td>
<td>792.88</td>
<td>96.04</td>
<td>92.08</td>
<td>123.39</td>
</tr>
</tbody>
</table>

- 1999 dollars per capita -

10 These are personal income taxes, business income and capital taxes, sales taxes, property taxes, and miscellaneous revenues. Together, they comprise 61.1 per cent of all provincial revenues in the data set.
since resource revenues are also likely the most volatile component of provincial revenues and equalization entitlements, but it is an inevitable consequence of the data used.

Turning to the volatility measures, however, the story that emerges is in fact quite similar to that derived from the actual data of Table 1. In all provinces, the volatility of equalized revenues is higher than that of own-source revenues. Thus Equalization again appears to have a destabilizing effect on provincial finances. The greatest difference between the tables is for Saskatchewan and Manitoba, where equalized revenues are much less volatile in Table 2. This again reflects the dependence of equalization entitlements there on resource bases excluded from Table 2.

For completeness, I note that the analysis of Figure 1 might also be conducted for the fixed-rate counterfactual; this is omitted to save space. Again, the picture that emerges is fairly similar. The slope of the line of best fit now falls to 0.93 from 1.25. At conventional significance measures, it is not possible to reject the hypothesis that the slope is unity. In either case, then, the data are consistent with there being no insurance effects on provincial revenues whatsoever.11

3 Efficient risk sharing in Equalization

3.1 A benchmark

While the analysis of Section 2 confirms earlier work about the destabilizing effect of Equalization, it begs the question of whether an alternative formula could do better. To answer this question, I first turn to the general theoretical question of what constitutes an efficient revenue sharing arrangement among governments facing fiscal risks. (In doing so, I adopt a thought experiment first suggested by Townsend (1994) in a somewhat different context.) The goal is to develop a benchmark for all desirable transfer schemes against which the current formula can fairly be compared.

Consider again the environment of Section 2.1, with a single aggregate per capita tax base \( X_i \) in each province. Tax rates \( t_i \) are fixed exogenously, but tax bases may vary from year to year in random ways. Specifically, let \( X = (X_1, \ldots, X_n) \) denote the vector of tax bases, which are jointly distributed according to some arbitrary probability density function \( f(X) \). Government spending \( G_i \) in each province is consumed by \( N_i \) citizens, each with utility function 12 \( U_i(G_i) \). The functions \( U_i \) are assumed to be strictly concave, which creates a demand for insurance against volatility in each province's tax bases, which can be provided through revenue sharing arrangements.

A revenue sharing arrangement is therefore a formula that specifies each province's equalized revenues \( G_i \) as a function of the vector of tax bases and tax rates in all provinces. Further, we require that the net transfers to each province sum to zero, so that the system be self-financing. (Thus I consider “net” rather than “gross” schemes, about which more below.) What such arrangements are Pareto efficient, in the sense that the expected utility of no representative citizen can be improved, without harming another? By definition, for any such arrangement, there exist positive welfare weights \( (\lambda_1, \ldots, \lambda_n) \) such that the weighted sum of expected utilities is max-

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11Interestingly, a plot of the fixed-rate data shows that the 1991 observations are outliers, in which equalization entitlements fell more than own-source revenues. Comparable to the present time, 1991 was a recession year that hit Ontario particularly hard. If the 1991 data are excluded, the slope of the line of best fit falls to 0.45, indicating a much higher degree of stabilization in “normal” years.

12Thus I ignore the direct effect of tax base variation on citizens’ welfare. This makes no difference, as long as private consumption and government spending enter into utility in an additively separable way.
mized. That is, an efficient arrangement solves

$$\max \sum \lambda_i N_i EU_i(G_i)$$

s.t. $$\sum N_i G_i = \sum N_i t_i X_i$$

The general characterization of all such arrangements is complicated. But in two plausible cases, a very simple rule emerges, given in the following results and proved in an appendix.

**Proposition 1**

1. Suppose that all citizens have constant (but possibly different) coefficients of absolute risk aversion: $$U_i(G_i) = -\exp(-G_i/a_i)$$ for some $$a_i > 0$$. Then, under all Pareto-efficient revenue sharing arrangements, equalized revenue in each province is a linear function of national average revenue:

$$G_i = a_i + \beta_i \bar{R} \quad (i = 1, \ldots, n)$$

2. Suppose that all citizens have identical (but arbitrary) risk preferences $$U(G_i)$$, and that all are assigned the same welfare weight $$\lambda$$. Then the unique optimal revenue sharing arrangement completely equalizes revenue in all provinces:

$$G_i = \bar{R} \quad (i = 1, \ldots, n)$$

The proposition states that, for two plausible cases at least, an equalization arrangement achieves efficient risk sharing if and only if it insures provinces against all idiosyncratic risk in their own tax bases, and exposes all provinces to the non-diversifiable risk in average provincial revenues in the same, linear way.

Put simply, the dependence of transfers on the measured tax bases of non-recipient standard provinces like Ontario is not only unavoidable, it is efficient. Variation in national average revenues represents non-diversifiable risk for the provinces, which should be shared by all. Of course, the conclusion emerges here most starkly because I examine a net scheme financed entirely from provincial revenues, rather than Canada’s gross scheme financed by the federal government. But federal tax bases are largely the same as provincial ones, and the revenue cost of federal equalization transfers are largely borne by taxpayers in the non-receiving provinces. Thus a formal analysis of a gross scheme financed from federal revenues would have roughly the same qualitative implications.

How does the RFPS Equalization formula differ from the efficient formula? To answer this, let us suppose that risk tolerance is identical in all provinces (the simplest and perhaps most plausible case) so that equation (4) describes the optimal revenue sharing arrangement. We can calculate the difference between RFPS and efficient transfers using equation (1) as

$$G_i - \bar{R} = (t_i - \bar{t})X_i + (X_s - \bar{X})\bar{t}$$

A simple measure of the expected loss in potential risk-sharing is the variance of this difference, or

$$\text{Var}(G_i - \bar{R}) = (t_i - \bar{t})^2 \text{Var} X_i + \bar{t}^2 \text{Var}(X_s - \bar{X})$$

$$+ 2\bar{t}(t_i - \bar{t}) \text{cov}(X_i, X_s - \bar{X})$$

13The exception is resource bases, which are mainly under provincial control.
This decomposition illustrates the various sources of deficiency in the RFPS formula. In particular, the RFPS system creates excessive volatility when there are:

1. Differences in tax rates: To the extent that tax rates differ among provinces, $t_i \neq \bar{t}$, and the first term in (5) is positive. This effect is larger when the variance in a tax base is larger (whether because of idiosyncratic or aggregate risk). A province with effective tax rates that differ from the national average will not be fully compensated for idiosyncratic revenue shocks by an RTS equalization formula, which values changes in capacity at the standard tax rate. As differences in tax mix among provinces continue to grow in Canada (Boadway, 1998), this effect becomes of greater consequence. Of course, while a pure revenue sharing system (such as Germany's Finanzausgleich) would provide fuller insurance, it would likely have undesirable effects on provincial incentives in the Canadian context (Smart, 1998).

2. Differences between five-province standard and national average tax bases: Unless $X_s = \bar{X}$ a.e., the second term is positive. While exposure to non-diversifiable national risks is inevitable, the RFPS brings additional risks of changes in the standard capacity relative to the national average. Below, I provide an estimate of the potential insurance gains of a return to a national-average standard. This effect grows proportionately to the square of the national average tax rate $\bar{t}$: The cost of inefficient revenue sharing is greater in proportion to expected revenues when tax rates are higher on average.

3. Covariance effects: The third term in (5) indicates that, if a province's tax base covaries positively with the difference between the standard and national average bases, then the departure from efficient revenue sharing is greater if the province's tax rate is above the national average, but it is smaller if the province levies a lower-than-average rate.

This term is likely to be of smaller magnitude than the other two and, by definition, it must average to zero among all provinces. Nevertheless, it suggests that volatility may be quite different for recipient provinces, in particular Quebec, that are part of the standard (so that the covariance in (5) tends to be larger). This effect tends to increase volatility of equalized revenues for bases like the personal income tax, for which Quebec levies an effective rate above the national average, but tends to decrease volatility of equalized business income tax revenues, where Quebec has a below-average rate.

A full analysis would also consider the effects of covariances among different tax bases, both within a province and between them. Cross-base terms are absent from (5), since I examine a single base for analytical simplicity. In practice, most major bases seem to covary strongly from year to year, so that the focus on aggregates is not particularly misleading.

### 3.2 Assessment

The preceding results suggest that the traditional analysis of stabilization, such as that provided in Section 2, is limited, because it fails to consider the covariance of each province's tax bases with the national averages, and the resulting degree of non-diversifiable risk to which the provinces are inevitably exposed through revenue sharing. It also suggests a simple test of the efficiency of risk sharing under the Equalization program. If risk sharing is efficient, and the assumptions about risk preferences leading to Proposition 1 are correct, then, controlling for aggregate provincial revenue, each province's equalized revenue should be independent of its own-source revenue. In plainer language, Equalization if efficient should provide complete insurance of province-specific revenue changes.
To test this hypothesis, I estimate the regression model

\[ G_i = \alpha_i + \delta_i t + \beta \bar{R}_i + \gamma R_{it} + \epsilon_{it} \]  

If risk sharing through Equalization is efficient, then it should not be possible to reject the hypothesis that \( \gamma = 0 \). The strong version of Proposition 1, given in (4), additionally implies the hypothesis that \( \beta = 1 \). (Under these hypotheses, a one dollar fall in a province’s own-source revenue is on average fully compensated through Equalization, while a one dollar fall in national average revenues is passed through to all provinces in equal measure.) Note that the inclusion of province-specific linear trends \( \alpha_i + \delta_i t \) in (6) controls for long-run changes in each province’s equalized revenues that are unrelated to the higher-frequency stabilization effects that we are interested in exploring.\(^{14}\)

Estimates of the coefficients \( \beta \) and \( \gamma \) are presented in Table 3. For all regressions, I exclude observations on Saskatchewan in the four years (1982-86) when its net entitlement was negative and no payment was received; hence there are 115 observations on the seven provinces during the 17-year period. In the leftmost column of numbers, I use data on actual revenues and equalization entitlements, corresponding to the data summarized in Table 1. The estimated \( \gamma \) is 0.98, which is different from zero at the one per cent level of significance, indicating essentially no insurance of own-source revenues through Equalization. The estimate of \( \beta \) in turn is 0.42, which demonstrates relatively little dependence of equalized revenues on independent variation in the aggregate. The table also presents the test statistic for the hypothesis that \( \beta = 1 \): this can be rejected with extreme confidence.

Once again, however, the use of actual revenues is suspect, since it includes the effects of tax rate variations, which likely covary positively among provinces. In the middle column of the table, I present the same coefficient estimates using the fixed-rate data summarized in Table 2. In this case, the estimated \( \gamma \) falls to 0.42 and \( \beta \) rises to 0.77. Nevertheless, \( \gamma \) remains different

\(^{14}\)An alternative model more consistent with (3), albeit with weaker power against the null, allows coefficients on national average revenues \( \beta_i \) that differ among provinces. The results from this specification are similar, but more cumbersome to present.

Table 3: Regression analysis of risk-sharing effects

<table>
<thead>
<tr>
<th></th>
<th>Actual revenues</th>
<th>Revenues at fixed tax rates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RFPS equalization</td>
<td>RFPS equalization</td>
</tr>
<tr>
<td>National average revenues</td>
<td>0.420** [6.90]</td>
<td>0.768** [6.10]</td>
</tr>
<tr>
<td>Own-source revenues</td>
<td>0.978** [19.56]</td>
<td>0.418** [2.98]</td>
</tr>
<tr>
<td>T-test: National average revenues=1</td>
<td>90.88** 3.40*</td>
<td>5.22</td>
</tr>
<tr>
<td>Observations</td>
<td>115</td>
<td>115</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.99</td>
<td>0.97</td>
</tr>
</tbody>
</table>

Robust t statistics in brackets. All regressions include province-specific linear trends, not reported.

** significant at 5% level; * significant at 10% level
from zero at the five per cent significance level, and $\beta$ remains different from one at the ten per cent level.

To give a more concrete interpretation of these results, suppose that a province's own standardized tax capacity fell by $100$ per capita, while the national average capacity remained constant. According to the above estimate, the affected province's equalization entitlement would on average increase by only $58$ per capita, leaving it with $42$ less in equalized revenues per capita. In contrast, if national average capacity increased by $100$, while the province's own fiscal situation remained unchanged, its equalization entitlements would on average rise by $77$ per capita. Thus the fixed-rate data are consistent with a reasonable degree of risk sharing through the current formula, once allowance for non-diversifiable risk is made. However, significant imperfections remain.

The final row of the table reports the $R^2$ for the regressions, the fraction of variation in equalized revenues that can be explained by variations in provincial and national own-source revenue and by the province-specific trend terms. Whether the actual or simulated data are used, $R^2$ is extremely close to one, indicating that Equalization introduces very little "noise" into provincial finances. Thus while Equalization is imperfect in sharing revenue risks, it does not at least create entirely spurious risks for the provinces.

Stabilization under the RNAS. The final column deals with a counterfactual question: How much better would risk sharing have been, had transfers been calculated on a Representative National Average Standard (RNAS) of all ten provinces, rather than the current RFPS? The discussion in the preceding section concluded that risk sharing under the RNAS would be better than under the RFPS, but could give no indication of the magnitude of the effect. To find out, I calculated the equalized revenues provinces would have had at fixed tax rates, had they received equalization entitlements calculated under the RNAS (also using fixed tax rates). When the regression model is estimated for the counterfactual data, the estimate of $\gamma$ falls again to 0.27 (still significant), and the estimate of $\beta$ rises to 0.83 (now insignificantly different from one). Comparing the two estimates of $\gamma$, I conclude that, in loose terms, RNAS equalization would have yielded about one-third more insurance of idiosyncratic risk than the RFPS formula affords. Of course, receiving provinces have lately appealed for a return to the RNAS would for a different reason (Provincial and Territorial Ministers of Finance, 2001): it would increase standard tax capacity by about three per cent and so result in larger payments. The potential stabilization gains for all might be seen to strengthen their case for the change.

This conclusion however applies only to the major non-resource tax bases that are included in my fixed-rate calculations of Equalization entitlements and revenues. In contrast, it is commonly thought that a return to the RNAS would create more volatility, since entitlements would once again depend on Alberta's unpredictable energy revenues. But the data suggest this concern is overstated: if Equalization entitlements had been calculated on the basis of RNAS in the 1982-98 period, the standard deviation of equalized revenue changes would have been 240.9 per capita. This is indistinguishable from the analogous figure, reported in Table 1, of 241.1 per capita under the RFPS. On either basis then, insurance arguments appear to favour the RNAS.

4 Conclusion

Critics have charged that Equalization induces volatility in the finances of receiving provinces, exposing them to needless and costly risks of revenue shortfalls and inhibiting long-range fis-
cal planning. By conventional measures, the critics are correct. Equalization entitlements vary considerably from year to year in most provinces, and in all provinces the standard deviation of changes in equalized revenue substantially exceeds that of own-source revenue.

But could a different system do better? The most appropriate benchmark for judging stabilization in a program that is, like Equalization, based on provincial revenues, is its ability to insure idiosyncratic rather than non-diversifiable risks. Compared to an efficient system, Canada’s current Equalization formula offers inadequate insurance to the extent that provinces levy different tax rates, and to the extent that the current Representative Five-Province Standard differs from national-average measures of tax capacity.

Nevertheless, the data exhibit a reasonable degree of revenue insurance through the current Equalization program, once allowance is made for the non-diversifiable component of provincial revenue risk. Equalization entitlements offset 58 per cent of idiosyncratic shocks to tax capacity in the 1982-98 period, for the major non-resource bases at least. If a Representative National Average Standard had been adopted, however, this figure would have risen to 73 per cent.

If further revenue insurance for the receiving provinces is deemed desirable, it would have to take the form of an explicit stabilization arrangement, that calculated transfers on the basis of something other than current-year measures of provincial tax bases and revenues. One possibility, proposed by Boadway and Hayashi (2004), is that entitlements be calculated relative to a multi-year moving average of standard levels, which might “smooth out” year-to-year volatility. In effect, any such program would give provinces access to borrowing to cover short-term deficits at terms other than what capital markets currently afford them. Given the large spreads in bond yields faced by some provinces, such a change might well be desirable. Nevertheless, it should be recognized that any such arrangement would merely shift fiscal risks from the provinces to the federal government, while doing nothing to allocate risk more efficiently than can be achieved by equalization transfers alone.

A Appendix: Proof of Proposition 1

Exchanging the order of summation and integration, the optimization problem in (2) can be written

\[
\max \int \sum \lambda_i N_i U_i(G_i) f(X) dX \\
\text{s.t. } \sum N_i G_i = \sum N_i t_i X_i
\]  

(7)

The solution to (7) is by pointwise maximization for each value of \((X_1, \ldots, X_n)\), with first-order conditions

\[\lambda_i N_i U_i'(G_i) = \mu N_i \quad (\text{all } i)\]

for some Lagrange multiplier \(\mu\). Let risk preferences be \(U_i(G) = -\exp\{-G/a_i\}\). Then the first-order conditions can be written

\[\log(\lambda_i/a_i) - a_i^{-1} G_i = \log \mu\]

or

\[G_i = \omega_i - a_i \log \mu\]

\[^{15}\text{Such an arrangement would also affect the volatility in payments resulting from the continual revision of interim estimates of entitlements, which appears to be particularly vexatious to the provinces. I thank a referee for pointing this out.}\]
where $\omega_j = a_i \log(\lambda_i / a_i)$. Summing gives

$$\sum N_i G_i = \sum N_j \omega_j - \log \mu \sum N_j a_j = N\bar{R} \equiv \sum N_j t_j X_j$$

after applying the budget constraint, so that

$$\log \mu = \frac{\sum N_j \omega_j - N\bar{R}}{\sum N_j a_j} \equiv \frac{\bar{\omega} - \bar{R}}{\bar{a}}$$

where $\bar{\omega} = \sum N_j \omega_j / N$ and $\bar{a} = \sum N_j a_j / N$. Substituting into the sharing rule gives

$$G_i = \omega_i - \frac{a_i}{\bar{a}} \bar{\omega} + \frac{a_i}{\bar{a}} \bar{R} \equiv \alpha_i + \beta_i \bar{R}$$

Alternatively, suppose that citizens have any identical risk preferences $U(G_i)$ in all provinces and all citizens get equal weight $\lambda_i = \lambda$. Then the first-order conditions become

$$\lambda N_i U'(G_i) = \mu N_i \quad \text{(all } i\text{)}$$

or $G_i = U^{-1}(\mu / \lambda)$. Now, summing gives $\sum N_i G_i = N\bar{R} = NU^{-1}(\mu / \lambda)$ or, substituting into the first-order conditions,

$$G_i = \bar{R} \quad \square$$
References


