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Government Revenue Volatility: The Case of Alberta, an Energy Dependent Economy

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Abstract

The Alberta government is heavily exposed to energy price volatility as it relies to a great extent on revenue derived from the production of oil and natural gas. Energy prices change substantially and unpredictably, causing large and uncertain movements in revenues. Adjusting to these movements typically involves economic, social and political costs. Alberta government revenues are considerably more volatile than the revenues of other provinces, but Alberta's own-source revenues less royalty payments are of similar size and volatility as those of other provinces. Several methods to reduce the volatility of revenues are assessed. An often-suggested method, tax base diversification (for example, use of a retail sales tax), is shown to have a minor effect on overall revenue volatility since Alberta's royalty revenues are such a large share of total own-source revenues. Revenue smoothing using futures and options markets can be expensive, is associated with significant political risks, and cannot eliminate all revenue volatility. The Canadian dollar tends to appreciate (depreciate) when energy prices rise (fall), so exchange rate movements have smoothed Alberta government revenues, although not by a large amount. A simulation using Alberta data shows that a revenue savings fund could significantly reduce revenue volatility. This type of fund leads to greater revenue stability because the revenue it contributes to the budget in any particular year is based on revenues *averaged* over prior years. Revenue uncertainty is also reduced with a savings fund since future revenue depends on known past contributions.

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1. Introduction

Oil and natural gas prices often change rapidly, substantially and unpredictably. The Alberta government is heavily exposed to energy price volatility as it relies to a large extent on revenue derived from the production of oil and natural gas. For Alberta, as with the governments of other oil producing jurisdictions, dealing with large revenue movements typically involves economic, social and political costs. Rapid declines in energy revenues may lead to cuts in expenditures that are difficult to accomplish quickly and efficiently. Revenue volatility that drives government expenditures can also cause fiscal policy to be pro-cyclical, thus magnifying movements in economic activity.

This paper provides an analysis of the volatility of Alberta government revenues and, in so doing, considers the following questions. Is revenue volatility a problem? Are Alberta government revenues more volatile than the revenues of other provinces? What are the principal causes of Alberta government revenue volatility? Can revenue volatility be reduced through tax base diversification or hedging in futures and options markets? What impact do exchange rate movements have on revenue volatility? Could a revenue savings fund reduce volatility? These questions are addressed both in general terms and with explicit reference to the case of Alberta.[1]

Data indicate that Alberta government revenues are considerably more volatile than the revenues of other provinces, but own-source revenues less royalty payments are of similar size and volatility as those of other provinces. One method proposed to reduce the volatility of revenues, tax base diversification (for example, use of a retail sales tax), is shown to have a relatively minor effect on overall revenue volatility since Alberta's royalty revenues are such a large share of own-source revenues. Revenue smoothing using futures and options markets can be expensive, is associated with significant political risks, and cannot eliminate all revenue volatility. The Canadian dollar tends to appreciate (depreciate) when energy prices rise (fall), so exchange rate movements have smoothed Alberta government revenues, although not by a large amount. A simulation using Alberta data shows that a revenue savings fund could significantly reduce revenue volatility. This type of fund leads to greater revenue stability because the revenue it contributes to the budget in any particular year is based on revenues *averaged* over prior years and because a large proportion of the most volatile revenues, royalties, are deposited in the fund. Revenue uncertainty is also reduced with a savings fund since future revenue depends on known past contributions.

2. Is revenue volatility a problem?

Government revenue volatility may have important negative consequences. For example, revenue volatility increases uncertainty for both the public and private sectors. A government may wish to provide infrastructure and social services that reflect the long run permanent component of income, but it is difficult to set the correct level of spending when it is not clear what part of volatile revenue changes is permanent and what part is temporary. The volatility of revenues also creates uncertainty for the private sector since it is more difficult to predict future government tax and spending policies, both of which may have important consequences for private sector profits and investment decisions. Using data for a wide variety of countries, government revenue and

[1] Given the emphasis on revenue volatility, the important issues of expenditure volatility and intergenerational equity and fiscal sustainability are only addressed to the extent that they relate to revenue volatility.

expenditure volatility has been shown to lead to slower economic growth (Barnett and Ossowski, 2002; Afonso and Furceri, 2008; Sturm et al, 2009).

Another major consequence of revenue volatility is that, in many jurisdictions, volatile revenues induce volatile movements in government expenditures. When revenues expand during a boom, expenditures tend to grow rapidly and, when revenues fall, expenditures are cut (although often more slowly than expenditures initially rose). That is, revenue volatility may cause governments to pursue stop-go pro-cyclical fiscal policies (Sturm et al., 2009). These pro-cyclical policies accentuate the business cycle so that, rather than acting to reduce volatility, the government becomes a driving force magnifying economic fluctuations. The volatility of economic activity and the volatile provision of government services will reduce individual welfare if consumers are risk averse and, thereby, prefer less volatile income and consumption.[2] Further, given that there are real costs of moving resources between expanding and contracting sectors, it is especially important for government policy to help stabilize the economy, rather than to aggravate economic volatility.[3]

Government spending increases during revenue booms may increase the costs of goods purchased by the government. There is some indication that increases in government revenues are correlated with upward pressure on prices. In Alberta, the prices of current goods and services purchased by government rose at an average annual rate of 4.1 percent between 2002 and 2008, while they rose by only 2.6 percent in British Columbia and 3.3 percent in Ontario. During this same period, real per capita revenues were rising more than twice as fast in Alberta than in either Ontario or British Columbia.[4] Further, during booms, pro-cyclical government spending competes with private sector spending, which can raise wages and other input costs, thereby increasing private-sector costs.

Large increases in government revenues during booms may lead governments to spend on services and investment projects that have relatively low returns. The rapid expansion of programs and capital spending during revenue booms may also stretch the capacity of the government to provide services and monitor spending, leading to waste, inefficiency and the unproductive use of government funds (Barnett and Ossowski, 2002). Further, during a revenue collapse, it is difficult to cut spending efficiently; that is, to first cut projects and services with the lowest return. Large spending cuts precipitated by a fall in revenues may also damage the morale and capacity of the public sector, leading to the more inefficient provision of public services.

To the extent that it is easier politically to raise government spending than to reduce spending, there may be a greater tendency to expand spending in revenue booms than to contract spending in busts. Thus, revenue volatility may result in an expansion of the size of government and, potentially, the implementation of an unsustainable fiscal plan that will necessitate even greater expenditure cuts in the future.

[2] The magnitude of the welfare loss associated with consumption volatility is the subject of much debate. For example, Borensztein et al (2009) suggests that the magnitude of the loss from this type of volatility may not be that large, while Morduch (1995) argues that it can be quite large.

[3] These costs may explain why countries with highly volatile terms of trade, and, in particular, oil producers, tend to have slower growth rates (Blattman, Hwang and Williamson, 2007; van der Ploeg and Poelhekke, 2009; Frankel, 2010).

[4] Using data for 1981 to 2007, the log of real per capita own-source revenues is found to be a significant determinant of the ratio of the government current expenditure price index to the CPI for both Alberta and British Columbia (although not for Saskatchewan or Ontario). This is another indication that revenue growth may increase the prices of government purchased goods.

3. How volatile are Alberta government revenues?[5]

Alberta government own-source revenues are quite volatile relative to the revenues of the other provinces, as can be seen in Figures 1 and 2, where own-source revenue is total revenue less transfers from other levels of government.[6] Over the period 1982-2007, the year-to-year change in the real per capita own-source revenues of Alberta exceeded 10 percent nine times (that is, in 35 percent of the years). In comparison, this magnitude of a revenue change occurred on only six occasions in Saskatchewan, only once in British Columbia and not at all in Ontario.

Another method of comparing the relative volatility of revenues is to examine the extent to which revenues deviate from trend. These deviations can be measured using the coefficient of variation – the normalized standard deviation.[7] This measure can be interpreted as the percentage of the average value of a variable, government revenues in this case, represented by one standard deviation of the differences of the variable from trend.[8] For 1981 to 2007, the coefficient of variation for Alberta government real per capita own-source revenues is 15.4. In other words, if the deviations of revenues from trend have a normal distribution, there is a 68 percent probability that revenues fall in a band around the average value of own-source revenues that is equivalent in magnitude to 30.8 percent of the average (while the probability that they fall outside this band is 32 percent). The coefficients of variation associated with the real per capita own-source revenues of British Columbia, Saskatchewan and Ontario are 7.8, 6.5 and 6.2 respectively (Table 1).[9] Thus, Alberta's own-source revenues are more than twice as variable, relative to their average, as the revenues of the other three provinces.[10]

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[5] Sources and definitions for the data used in the text, figures and tables are given in the *Data Appendix*.

[6] Revenue volatility depends on both movements in tax *bases* and changes in tax *rates*. Due to difficulties with obtaining data on different tax rates through time, for the most part, the analysis focuses on revenue volatility and does not distinguish whether this volatility is due to tax base or tax rate volatility.

[7] To measure the volatility of revenues, the coefficient of variation is calculated using the following procedure. The natural log of revenues is regressed on a trend; the predicted values in levels are found by taking the exponential of the predicted values from this regression; a series of residuals is calculated by subtracting the predicted values in levels from the corresponding observation in the revenues data; and the coefficient of variation is calculated as the ratio (multiplied by 100) of the standard deviation of these residuals to the average value of revenues. This method is similar to that used in Carroll (2009).

[8] This means that the standard deviation is measured in the same units as revenues. For example, if the coefficient of variation is 10, and the average value of revenues is $1000, the coefficient of variation implies that a one standard deviation band around the average ranges from $900 to $1100. One shortcoming of this method is that two variables with the same coefficient of variation can represent one standard deviation bands that differ significantly in dollar terms if their mean values differ. Boresztein et al (2009) use an alternative measure of volatility – the standard deviation of the residuals from a regression of the natural log of revenues on a trend. This is easier to compute and easier to compare across variables of different magnitudes because the average level and units of measurement are irrelevant. However, since this measure is the standard deviation of a log, it is difficult to relate to the units (dollars) in which revenues are measured. Nevertheless, the two methods generate the same conclusions and relative comparisons.

[9] Total real per capita revenues include transfers from other levels of government. Since the coefficients of variation are smaller for total revenues, relative to those for own-source revenues, federal transfers have, on average over the 1981-2007 period, reduced the volatility of revenues (although this has not been the case in every sub-period).

[10] In real per capita dollar terms, the difference in volatility is even larger since Alberta's own-source revenues are at least 20 percent higher on average than the revenues of the other provinces. For example, the dollar equivalent of the one standard deviation band around average real per capita own-source revenues for Alberta is $2188, while it is only $906 for British Columbia.

4. What are the causes of Alberta revenue volatility?

The greater variability of Alberta government revenues is driven principally by the highly volatile energy sector royalty component of revenues as well as, to a much smaller extent, by the volatility of corporate profits (Figure 3 and Table 2). Volatility in these revenue sources, in turn, is driven mainly by movements in energy prices.

4.1 The magnitude and volatility of royalty revenues in Alberta

As shown in Table 3, for Alberta, the simple correlation between the *growth rate* (percentage change) of real per capita total own-source revenues and the *growth rate* of royalty revenues is .90 over the period from 1982 to 2007. The growth rate of corporate tax revenues had the next highest correlation with own-source revenues (.71). In contrast, for personal income taxes, the second largest tax source in Alberta, the correlation coefficient with own-source revenues is only .42. In the other provinces, own-source revenues are less correlated with royalties and, in general, more correlated with personal income tax revenues.

The large impact of royalty volatility on own-source revenue volatility arises both because royalty revenues are volatile and because royalty revenues are the largest single component of own-source revenues. On average, from 1981-2007, royalty revenues accounted for 31 percent of real per capita own-source revenues. The next largest revenue type, direct taxes on persons, accounted for only 20.5 percent. The share of royalty revenues in own-source revenues is large relative to other provinces (Table 4). Royalties made up only 14.6 percent of Saskatchewan government own-source revenues over the 1981 to 2007 period and were Saskatchewan's third largest revenue source (after direct taxes on persons and the retail sales tax). In British Columbia, royalties comprised only 10.3 percent of revenues (and were the fourth largest revenue type) while, in Ontario, royalties made up an insignificant component of revenues.

Not only are royalties by far the largest component of government revenues in Alberta, they are also the most variable. The coefficient of variation associated with royalty revenues in Alberta over the period 1981-2007 is 43.6 (Table 2).[11] A one standard deviation band around the average value of real per capita royalty revenues ranges from $1245 to $3169. The magnitude of this band, $1924, is equivalent to 27 percent of average own-source revenues. In comparison, direct taxes on corporations, the second most variable component of revenues, with a coefficient of variation of 24.2, has a one standard deviation band of only $284.

The volatility of royalty revenues is due primarily to variation in energy prices, particularly the price of natural gas as natural gas accounted for 45 percent of total royalty payments from 1981-2009 and 54 percent over the past five years (Table 5). Over the 1982-2007 period, the simple correlation coefficient between the growth rate of real per capita royalty revenues and the growth rates of the real Canadian dollar prices of natural gas and West Texas Intermediate (WTI) petroleum were .87 and .70, respectively (Table 6). Given the large share of royalties in revenues, changes in these prices drive changes in total real per capita own-source revenues – the correlations between the growth rates of real per capita own-source revenues and real Canadian dollar natural gas and petroleum prices are .68 and .72. In comparison, the correlations between changes in real per capita

[11] This level of variability is not unique to Alberta. Borensztein et al (2009) find that the standard deviation of de-trended commodity exports for 21 major petroleum exporters is .34, implying export revenue volatility of similar magnitude to the variability of Alberta's royalty revenues.

own-source revenues less royalty revenues and changes in real natural gas and petroleum prices are only .13 and .53, respectively.

As another indication of the importance of energy price variation to royalty revenue variation, the growth rate of real per capita royalties was regressed on the change in the real natural gas price, lagged royalties and the lagged natural gas price. This regression explains 78 percent of the variation in the growth rate of royalties and all the coefficients in the regression are statistically significant. In contrast, a comparable regression explains only 17 percent of the variation in own-source revenues *less royalties*, and the two natural gas price variables in this regression are not statistically significant.

Given the close relationship between royalty revenues and energy prices, it is not surprising that royalty revenues are quite volatile since energy prices are also volatile (Table 2). The coefficients of variation over the period 1981 to 2007 of the real Canadian dollar prices of natural gas and WTI petroleum are 42.0 and 39.4, respectively. That is, the difference between the upper and lower bounds of a one standard deviation band around the averages of these prices is equivalent in magnitude to approximately 80 percent of the average price. These coefficients of variation are of similar magnitude to those of royalty revenues. The coefficients of variation of other tax bases tend to be much smaller. For example, the coefficient of variation of personal income, the tax base for the personal income tax, is just 4.8 (Table 2).

4.2 The volatility of non-royalty revenues

After royalties, corporate tax revenues are the most volatile revenue type in Alberta (Table 2). The coefficient of variation of real per capita Alberta corporate tax revenues for the period 1981 to 2007 is 24.2, which is similar to the volatility of corporate tax revenues in both Saskatchewan and Ontario. Although volatile, corporate tax revenues are not expected to be a large driver of overall revenue volatility because these revenues accounted for only 8.3 percent of own-source revenues during 1981-2007, one quarter of the share of the more volatile royalty component of revenues. In fact, the real per capita dollar value of the one standard deviation band around average corporate tax revenues was almost identical to that for the much less volatile revenues from direct taxes on persons because personal income taxes contributed a much larger share of total revenues on average (20.5 percent of own-source revenues). Nevertheless, both royalty revenues and corporate tax revenues are more highly correlated with energy prices than are personal income tax revenues and, thus, movements in energy prices may cause synchronized movements in both types of tax revenues, accentuating the volatility of total revenues (Table 6).

A comparison of the volatility of *non-royalty* own-source revenues in Alberta with the non-royalty own-source revenues in other provinces illustrates the importance of the role played by the volatility of royalty payments in generating Alberta government revenue volatility. While the coefficient of variation of Alberta's real per capita own-source revenues for the period 1981 to 2007 is 15.4, the coefficient of variation of own-source revenues less royalties is only 6.7 (Table 1). This is only slightly higher than the corresponding coefficient of variation for Ontario (6.2) and lower than the coefficients of variation for British Columbia (8.1) and Saskatchewan (9.2). As can be seen from Figure 4, the pattern of the differences of own-source revenues minus royalties from trend for Alberta is also similar to the pattern for the other three provinces.

Not only do Alberta non-royalty own-source revenues have a similar degree of volatility as those of Saskatchewan, British Columbia and Ontario, they are also of a similar size in real per capita terms, as shown in Figure 5. Alberta's non-royalty real per capita own-source revenues averaged $4899 over the 1981 to 2007 period, while the non-royalty own-source revenues of Saskatchewan, British Columbia and Ontario averaged $4817, $5211 and $4684, respectively (Table 1). Hence, Alberta's *non-royalty* own-source revenues are, on average, similar in terms of volatility and magnitude to the revenues of the other provinces.[12]

4.3 Alberta revenue volatility and the persistence of revenue changes

Alberta revenues have been volatile, and much of this volatility has been driven by persistent movements away from trend. As Figure 2 shows, real per capita own-source revenues were above trend from 1981-85, below trend from 1986 through 1999, above trend in 2000 and 2001, below in 2002, and above trend from 2003 through 2007. The longer term movements in revenues away from trend are driven by movements in royalties, as own-source revenues minus royalties move above and below trend twice as often as total own-source revenues (Figure 4). The persistence of revenue movements above and below trend are important because they imply that downturns in revenues may not be short lived, while upturns may seem permanent and, thereby, may induce too great an increase in spending.

Given the dependence of royalties on energy prices, the long movements in own-source revenues away from trend can be attributed to persistent movements in energy prices. Considerable evidence suggests that oil prices follow a process similar to a random walk (Hamilton, 2008).[13] This has two important implications for the volatility of revenues. First, movements in revenues away from trend can be quite persistent as there are no forces causing oil prices to return to some constant equilibrium value. Second, if oil prices follow a random walk, the best forecast of the oil price in any future period is the current oil price. Nevertheless, this forecast is likely to be a very poor forecast since it has a very high standard error due to the high variance of oil prices.[14] This means that royalty revenues, the component of revenues that is both most closely related to oil prices and the driver of the volatility in total revenues, will be extremely difficult to forecast and will have no tendency to converge quickly to some stable average value.

5. What can be done to reduce revenue volatility?

Alberta government revenue volatility is primarily driven by royalty revenue volatility and this, in turn, is driven by energy price volatility. Energy prices are determined in world or North American markets and are effectively out of the control of the Alberta government. To reduce revenue volatility it is necessary to reduce the share of royalty revenues in overall revenues, say by tax base "diversification," or to reduce the volatility of royalty revenues, say by hedging or by smoothing royalty revenues through time.

[12] This comparison does not account for the different approaches used to levy education taxes in the four provinces.
[13] The data used in this study are consistent with real oil and natural gas prices following a random walk. A regression of the log of the real Canadian dollar WTI petroleum price on its lag using data for 1982-2008 yields a coefficient of .8, while a similar regression for the real Canadian dollar natural gas price yields a coefficient on the lag of .91. Both coefficients are not significantly different from one, so a random walk with drift cannot be rejected.
[14] Hamilton (2008) estimates that, with an oil price in 2008Q1 of US$115, the 95% confidence interval for 2008Q2 was $85-$156. However, as noted by Hamilton (2008): "To predict the price of oil one quarter, one year, or one decade ahead, it is not at all naive to offer as a forecast whatever the price currently happens to be." Engel and Valdes (2000) test a large number of models of oil price forecasts and find that a simple random walk, where the forecast of the future price is the current price, performs best.

5.1 Tax base diversification

5.1.1 Methods to reduce the share of revenues from the energy sector

One method to reduce revenue volatility is to decrease the dependence of revenues on the more volatile energy-related tax bases through tax base diversification. Tax base diversification is one motivation for suggestions that the government implement policies to diversify the economy away from energy-related activity. This method of tax base diversification has three significant shortcomings. First, this approach may take a long time to yield results and, second, is likely to be inefficient since it runs counter to Alberta's comparative advantage – the extraction of energy resources.[15] The third major shortcoming is that government-encouraged economic diversification relies on the government's ability to pick successful non-energy related industries, but there is little evidence that governments can do this more effectively than the private sector.

Another way to reduce the dependence of total revenues on the energy sector is to collect less revenue from the more volatile energy-related tax bases – energy sector production (royalties) and corporate profits. For example, the Alberta government could have set royalty rates and corporate tax rates at levels that would have collected 25 percent less revenue than was actually collected from these sources over the 1981 to 2007 period. Assuming no change in other tax revenues, the lower tax rates would have caused own-source revenue volatility to be just 14 percent smaller – the coefficient of variation would decline from 15.4 to 13.2. On the other hand, average own-source revenues would fall by just under 10 percent. Thus, even with a significant revenue sacrifice, revenue volatility would remain high because royalties would continue to comprise a large proportion of total own-source revenues. More importantly, it may be undesirable to reduce royalties on the grounds of economic efficiency since, to the extent that royalties are taxes on rents, they are likely to be less distortionary than taxes on other tax bases. In addition, a cut in royalty rates would reduce the return to the owners of the resource, the residents of Alberta.

5.1.2 A sales tax

Another often-mentioned method of reducing revenue volatility through tax diversification is to place greater emphasis on the retail sales tax since this tax base has been relatively under-exploited in Alberta (Table 4).[16] Including taxes on alcohol and tobacco, Saskatchewan collected \$900 per capita in retail sales taxes on average from 1981-2007 (in constant 2002 dollars), Ontario collected \$1063 and British Columbia collected \$1043. In contrast, Alberta collected \$141.[17] Thus, there seems ample opportunity for Alberta to significantly raise revenues through the imposition of a retail sales tax. Further, since the sales tax base tends to be relatively stable, greater reliance on a sales tax would reduce revenue volatility. For the 1981 to 2007 period, the coefficients of variation of two possible definitions of the retail sales tax base – real per capita expenditure on consumer goods and real per capita final demand – were just 2.7 and 8.3, respectively. As shown in Table 2, these tax bases are much less volatile than energy prices. Sales tax revenues have also proved to be

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[15] These first two points are made by Arrau and Claessens (1992) in their study of methods of revenue stabilization for commodity exporters.

[16] In a recent *Globe & Mail* column, DeCloet (2010) states that a provincial sales tax in Alberta would be "an economically-sensible idea".

[17] US states also rely on the sales tax to a much greater extent than does Alberta. Median state sales tax revenue accounts for about 30 percent of total state revenues (Felix, 2008).

quite stable in other provinces. The coefficient of variation of real per capita sales tax revenue is only 5 for British Columbia, and approximately 9 for both Saskatchewan and Ontario (Table 7).

A simple example illustrates the potential impact on Alberta revenue volatility of greater reliance on a sales tax. In this example, the change in revenue volatility is calculated when a volatile tax source – Alberta's corporate tax – is replaced with a more stable revenue source of almost equal magnitude – the real per capita retail sales tax revenues of British Columbia – for each year from 1981 to 2007.[18] Holding everything else constant, the adoption of a sales tax yielding per capita revenues identical to those collected by British Columbia, along with the elimination of the volatile corporate profits tax, causes the coefficient of variation of Alberta own-source revenues to fall by only 11.5 percent (from 15.4 to 13.6). Thus, even the complete replacement of volatile corporate tax revenues with much more stable sales tax revenues, yields a relatively small drop in the volatility of own-source revenues. The reason for this small change in volatility is that sales tax revenues are fairly small compared to royalties and, thus, the volatility of revenues would continue to be driven by royalties.

5.1.3 Other sources of revenue

Tax revenues could also be diversified by exploiting revenue sources other than the sales tax. Personal income tax revenues tend to be relatively stable and are only weakly correlated with royalties and energy prices (Tables 2 and 6).[19] On the other hand, in 2007, real per capita direct taxes on persons were already higher in Alberta than in British Columbia and Saskatchewan, although lower than in Ontario (and a similar comparison holds, on average, for the whole 1981-2007 period as shown in Figure 3). Thus, there may be little room to increase revenue from this source, particularly without significantly increasing the level of tax-induced distortions.

Income from interest and other investment income was, on average over the 1981-2007 period, the third largest component of Alberta own-source revenue. However, the real per capita contribution of this revenue source to total revenues has been falling over time, so these revenues are now a much less important component of total revenues than in the 1980s.[20] Further, given the current low level of real returns, it seems likely that this source of government income will continue to make a relatively small contribution to revenue. A significant advantage of revenue from interest and other investment income is that it is negatively correlated with both the level and growth rate of corporate tax revenue and is much less strongly correlated with royalties than is corporate tax revenue (Table 6). These revenues are also less volatile than either royalty revenues or corporate tax revenues (Table 2). Nevertheless, the potential for placing more emphasis on this type of revenue in the short run is limited because investment income depends on the level of past government saving.

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[18] To make the level of revenues similar in the two cases, British Columbia's actual real per capita retail sales tax revenues were used to replace Alberta's small real per capita retail sales tax revenues as well as its corporate tax revenues. Alberta's real per capita own-source revenues averaged $7419 over the 1981-2007 period for the case incorporating the BC sales tax revenues as opposed to the actual value of $7105.

[19] If we regress the growth rate of real per capita wages and salaries and other labour income on the growth rate of the real Canadian dollar price of natural gas as well as the natural logs of the lagged values of wages and the natural gas price, the two natural gas price variables are insignificant and the R^2 is only .16. A similar result is found for real per capita personal income. In contrast, if a comparable equation is estimated with real per capita corporate profits as the dependent variable, the natural gas price variables are both significant and the R^2 is .51.

[20] In 1981-1985, revenues from interest and other investment income accounted for 22.4 percent of own-source revenues, but this share had fallen to only 9.8 percent, on average, during 2003-2007.

Some of the smaller provincial tax bases are quite stable. For example, gasoline taxes have a coefficient of variation of only 3.2 over the 1994-2007 period, while the coefficient of variation for gambling revenues is 6.3. Payroll taxes have been a stable source of revenues in Ontario (with a coefficient of variation of only 2.1 over the 1992-2007 period)[21] and health care premiums were a stable source of revenues for Alberta. Nevertheless, greater use of these taxes to reduce overall revenue volatility is likely to have only a minor impact and, in some cases, greater use of these taxes would have serious shortcomings. First, Alberta already exploits gambling revenues to a greater extent than the other provinces, so it is unclear whether there is much opportunity for further diversification into this tax base (particularly with competition from internet gambling).[22] There may also be little room for further expansion of alcohol and tobacco taxes and greater reliance on property tax revenues could crowd out local government tax revenues. Second, while the gasoline tax base has been exploited less in Alberta than in other provinces – per capita real gasoline tax revenues in 2007 were $185 in Alberta, but were $350 in Saskatchewan, $215 in Ontario, and $250 in BC – the relatively small size of this revenue source in other provinces suggests that expansion is likely to be limited. Third, the introduction of a payroll tax (as used by Ontario) would raise the cost of labour and, potentially, have a negative impact on employment and other tax revenues. Finally, given the large share of royalty revenues in total revenues, and the magnitude of royalty volatility, none of the prospective tax bases are large enough and have enough room for further expansion to have an appreciable effect on overall revenue *volatility*. This is not to suggest that greater use of these tax bases would not have an impact on the *level* of revenues collected, just not on the *volatility* of revenues.

In summary, tax base diversification is likely to have a relatively minor effect on Alberta revenue volatility because royalty revenues are large and volatile relative to the alternatives. Tax base diversification can only reduce revenue volatility if the revenues collected from the unstable energy and corporate tax bases are significantly reduced as a proportion of total revenues. This would entail a significant increase in taxes from other sources and, thus, in the overall tax burden, or a significant decrease in the revenues collected from royalties and corporate taxes.

5.2 Revenue volatility and stabilization from exchange rate movements

Government expenditures (the wages of provincial government workers, for example) are mostly denominated in Canadian dollars, so the volatility of revenues in Canadian dollars is what matters to the government. The volatility of energy-related revenues in Canadian dollars depends on both the volatility of US dollar denominated energy prices and the volatility of the exchange rate. Given this link between exchange rate movements and revenue volatility, in order to understand revenue volatility, it is necessary to determine how exchange rate volatility affects the volatility of government revenues.

One way to assess the impact of the exchange rate on government revenues is to note that, since energy prices are denominated in US dollars, the Alberta government's royalty stream is similar to the returns from an investment in a US dollar denominated asset. For an investor in a foreign currency denominated asset, Campbell, Medeiros and Viceira (2010) show that optimal investment risk management depends on the extent to which the exchange rate and the value of the

[21] Ontario collects approximately $300 per capita in payroll taxes (in 2002 constant dollars).
[22] During 2007, in real per capita terms, Alberta collected $434 in gaming profits (in 2002 constant dollars) while British Columbia, Saskatchewan and Ontario collected $223, $280 and $105, respectively.

foreign asset are correlated. As an example, they observe that the Canadian dollar tends to appreciate relative to the US dollar when the US stock market rises in value. This movement in the Canadian dollar when US equity prices change acts to smooth Canadian dollar denominated returns from US equity investments. Thus, there is less need for a Canadian investor holding US assets to hedge against currency risk. Indeed, full currency hedging would *increase* a Canadian investor's portfolio risk by eliminating the smoothing function of the exchange rate.

As in the US equity example of Campbell, Medeiros and Viceira (2010), if the Canadian dollar rises (falls) in value with increases (decreases) in the US dollar price of oil, movements in the exchange rate would stabilize the Canadian dollar value of oil revenues. Evidence suggests that there exists this type of positive relationship between the Canadian dollar and energy prices, so the exchange rate works as a natural hedge with respect to oil price movements (Frankel, 2010).[23] Bayoumi and Mühleisen (2006) find that the value of the Canadian dollar rises with energy prices and, commensurately, Taylor (2008) and Lipsky (2008) note that the value of the US dollar is negatively correlated with the oil price. Chen and Rogoff (2003) find positive co-variation between the exchange rate and the price of export commodities, such as oil, using data for Canada, Australia and New Zealand, as do Chen, Rogoff, and Rossi (2008) who consider the same three countries plus Chile and South Africa. Further, evidence of such "commodity currencies" is presented by Cashin, Céspedes, Sahay (2004) using a sample of 58 countries, including five industrial countries (Australia, Canada, Iceland, Norway and New Zealand.)

Another reason to expect the Canadian dollar to appreciate following a rise in the price of oil is the Bank of Canada's inflation targeting policy. Ragan (2005) argues that inflation targeting means that the Bank will tighten monetary policy following a rise in commodity prices, causing an appreciation of the Canadian dollar. As Ragan notes, in this way inflation targeting will tend to accentuate the positive oil price-Canadian dollar correlation, thus increasing the smoothing effect of exchange rate movements on Canadian dollar denominated energy revenues[24]

The simple correlation coefficients reported in Table 6, which imply that a rise in energy prices leads to an appreciation of the Canadian dollar (a fall in the Canadian dollar price of a US dollar), are consistent with the evidence presented in the studies cited above. Therefore, movements in the Canadian dollar act to smooth movements in Canadian dollar denominated energy revenues. This is confirmed by the coefficients of variation presented in Table 2. These show that the real Canadian dollar prices of oil and natural gas are less variable than the US dollar prices (the coefficients of variation in Canadian dollars are smaller than those for the US dollar prices). This difference is greater for the price of oil, where the coefficient of variation for the real price of oil in US dollars is 46.9, while it is only 39.4 for the Canadian dollar price, a 16 percent difference.[25]

Although the coefficients of variation given in Table 2 indicate that exchange rate movements have reduced Canadian dollar oil and gas price volatility, the volatility of both prices in Canadian dollars is still quite high. Thus, the role of exchange rate movements in reducing revenue volatility is relatively small. Since the exchange rate moves for many reasons other than changes in energy prices, movements in the exchange rate only partly offset movements in US dollar

[23] The existence of this type of relationship seems reasonable since a rise in world demand for a major commodity export raises demand for the currency of the exporting country, causing the currency to appreciate in value.
[24] An alternative monetary policy strategy, proposed by Jeffrey Frankel (2005), is for oil exporters to target the export price index (rather than CPI inflation). This policy would also cause a currency appreciation following an oil price rise.
[25] The coefficient of variation for natural gas falls by only 9 percent. This smaller effect is not unexpected as the correlation between the Canadian dollar and natural gas prices tends to be smaller than that between the dollar and oil prices.

denominated energy prices. This is confirmed by the estimates in Bayoumi and Mühleisen (2006), obtained using quarterly data for the period from 1972-2005, which indicate that a 1 percent increase in energy prices leads only to a contemporaneous .37 percent increase in the value of the Canadian dollar relative to the US dollar. In other words, the exchange rate does not move by enough to completely counteract the effect of US dollar denominated energy price movements on Canadian dollar denominated prices. This suggests that other methods of hedging may be necessary if revenue volatility is to be reduced.[26]

5.3 Smoothing with futures and options

Many different types of financial market instruments exist to reduce revenue uncertainty and volatility. Of these, the two most commonly used involve pre-selling commodities in futures markets and the purchase of put options – assets which give the option, but not the obligation, to sell a commodity at a stated price during a fixed period of time.[27] For example, in late 1990 and early 1991, the Mexican government purchased put options with a strike price of US$17 per barrel in order to protect its oil-related revenues from a price decline (Larson and Varangis, 1996). Similarly, Texas set up a hedging program that operated on a regular basis from 1992-2000 to ensure that declines in oil prices did not lead to an overall budget deficit for the two-year duration of each budget period (Swidler, Buttimer and Shaw, 1999).

5.3.1 Futures markets

5.3.1.1 Selling in-kind oil royalty payments in futures markets

In Alberta, conventional crude oil royalties are paid in-kind.[28] By contracting to sell this oil at a fixed price on the date in the future when the in-kind royalty will be paid, it is possible to eliminate uncertainty with respect to the revenues that will be received from these royalty payments. For example, the revenues from the in-kind royalty payments to be received during a fiscal year could be made certain by selling twelve futures contracts at the beginning of the fiscal year equal to the quantities of oil that are expected to be delivered in each month of the year.

While futures markets can reduce revenue uncertainty, these markets have several shortcomings. The majority of transactions in futures markets involve relatively short-term contracts (one or two months), but to have a significant impact on uncertainty and the volatility of revenues, the government would need to enter into futures contracts that cover at least the current budget year. Futures markets may not be very liquid at longer maturities, which may make the sale of these contracts more difficult and more costly (Larson, Varangis and Yabuki, 1998; Domanski and Heath, 2007; Borensztein et al, 2009). Further, the price locked in by futures contracts will

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[26] The role of the exchange rate as a natural hedge appears to be misunderstood. Governments often point out that an appreciation of the Canadian dollar reduces Canadian dollar revenues, but rarely acknowledge the positive contribution to the smoothing of Canadian dollar denominated revenues from a depreciation of the currency when energy prices fall.

[27] There are many other types of hedging contracts and hedging methods. One strategy is to invest in assets that have returns that are negatively correlated with energy prices. Caballero and Cowan (2007) suggest using options and futures markets to do this by shorting instruments such as the VIX or other assets whose returns are correlated with the demand for oil.

[28] Alberta "accepts delivery of the Crown's royalty share of crude oil and sells it at current market value. Unlike other energy commodities, conventional crude oil royalties are paid with 'in-kind' product" (Alberta, Department of Energy, *Annual Report 2007-08*, p 7).

vary from year to year since the contracts are sold in different years. Thus, while futures contracts can make revenues more certain over short periods, they cannot *eliminate* the volatility of revenues over the long term. Nevertheless, the use of futures contracts may still *reduce* the level of volatility since futures prices appear to be less volatile than spot prices.[29]

Exchange traded oil futures contracts are denominated in US dollars, so the sale of a futures contract would fix revenues in US dollars. To eliminate the uncertainty associated with the Canadian dollar value of these contracts, it would be necessary to enter a second contract to sell US dollars forward, thereby adding to hedging costs.

Futures contracts involve standardized commodities, such as WTI petroleum, but Alberta's oil is heavier and generally sells for less, with the differential between the WTI price and the price of Alberta oil varying over time.[30] This means that there is risk that the spread between the price of the WTI oil specified in the contract and the price of the oil produced in Alberta and delivered in-kind will change during the life of the contract, causing revenues to be different than expected.

A major shortcoming of the use of futures contracts to reduce Alberta government revenue volatility is that the sale of futures contracts is only practical for royalties that are received in-kind, a small part of total royalty revenues (Table 5).[31] The elimination of all variability in royalties from conventional oil would have little impact on overall royalty variability since conventional oil accounted for only 12.8 percent of total non-renewable resource revenues in 2005-09, about 4 percent of total own-source revenues (Table 5).

5.3.1.2 The cost of transactions in futures markets

The direct transactions cost associated with selling futures contracts is relatively small — Alaska (2002) estimates these costs to be about US$.10 per barrel. On the other hand, it may be costly to allocate funds to the upfront margin payments required by the futures exchange. Daniel (2001) estimates that the required margins associated with futures sales are 5-10 percent of the value of the contract, so the cost in terms of the assets that must be committed to these margin payments could be substantial. Further, these payments can change significantly at short notice. Alaska (2002) estimates that a $5 per barrel rise in the oil price would have required it to increase its margin payment by US$950 million. Use of futures contracts by the Alberta government to reduce revenue volatility would require the government to commit a quantity of assets to margin payments and to have sufficient liquid assets available to cover changes in the margin requirement.

[29] Using data for 1990-2001, Daniel (2001) compares a strategy that would involve selling oil each month at the 12-month ahead futures price to a strategy that involves selling the same oil at the spot price when it is received in 12 months. He finds that the futures price is much less volatile than the spot price, but would also have resulted in a slightly lower average price over the sample. Domanski and Heath (2007) also find that futures energy prices may be less volatile than spot prices, at least for futures contracts that are far enough in the future, generally at least 12 months.

[30] From 2004-2008, Alberta non-heavy oil sold in a range of 86 to 100 percent of the WTI price, while the range for heavy oil was 38 to 83 percent (www.energy.alberta.ca/1524.asp).

[31] It is possible to hedge royalty payments, other than those paid in-kind, using futures contracts since movements in the price of oil and total royalty revenues are highly correlated. However, selling a quantity of futures contracts greater than the quantity of in-kind royalties would expose the province to a potentially large liability. For example, suppose the province sold a greater number of petroleum futures contracts than the quantity of its in-kind royalty payments and the price of petroleum rose relative to the price stipulated in the futures contracts. The province would then be responsible for making up the difference between the spot price and the contracted futures price without necessarily having a counterbalancing rise in its own revenues since energy prices and royalty revenues, although highly correlated, do not necessarily move one-for-one.

5.3.2 Options markets

Another shortcoming of futures markets as a method to smooth revenues is that, while futures contracts remove downside price risk, they also eliminate the potential benefit of an energy price increase. Considerable public dissatisfaction is likely to ensue if revenues do not rise when energy prices rise. For this reason, a jurisdiction may prefer to purchase put option contracts – contracts which provide insurance against price declines by essentially giving the holder of the contract the *option*, but not the *obligation*, to sell a commodity at a stated price if the price falls below this "strike price." With this type of option, a government obtains the benefit of a price rise, if commodity prices rise rather than fall, but is protected against a price fall. Using data for 1990-2000, Daniel (2001) simulated a put option strategy and found that it raised the mean return (by eliminating two large price falls) and reduced volatility.

One of the benefits of options is that they do not restrict hedging to in-kind commodities only. For example, given the very high correlation between royalty revenues and energy prices, the Alberta government could insure itself against a royalty decline by purchasing an option to sell oil at a fixed price (the strike price) for a fixed period of time. If the price of oil fell, causing royalty payments to fall, the government would be able to counterbalance the fall in royalty revenues with the profits it would make by exercising the option (as long as the oil price fell below the strike price). The purchase of the put options would insure the government against a fall in its royalty revenues to the extent that oil prices and royalty revenues are correlated.

A number of oil exporting jurisdictions – Ecuador, Mexico and Texas, for example – have used option contracts. In 2008, with the price of oil over US$100, Mexico hedged all of its oil sales for 2009 through the purchase of put options with a strike price of US$70 (Blas, 2009). In December 2009, Mexico announced that it had hedged 230 million barrels of oil, a large proportion of its 2010 oil production, at a strike price of $57.[32] Despite the potential benefits of hedging, it is not common for energy exporting countries to hedge (Blas, 2009; Borensztein et al, 2009). Texas implemented a hedging program from 1992 to 2000, but other states – Alaska, New Mexico, Oklahoma and Louisiana – have examined the costs and benefits of hedging and decided not to proceed in this direction.

5.3.2.1 Problems associated with the use of options markets

One reason jurisdictions have hesitated to use options markets to reduce the volatility of revenues may be political. Frankel (2010), Caballero and Cowan (2007) and Daniel (2001) note that the political costs of hedging can outweigh the benefits. In the case of a fall in the spot price, any financial gains from a hedging program may be seen as speculative returns. Further, if a government had not hedged, it would be easy to blame the international oil market for any budgetary problems. On the other hand, if the spot price remains above the strike price for the duration of the contract, the jurisdiction that purchased the put option would not reap an explicit benefit, but would still bear the cost of purchasing the option. While this is a characteristic of every insurance contract, it may be difficult to explain to the public why the government committed significant resources to the purchase of options contracts that were worthless *ex post* (Caballero and

[32] Mexico only appears to hedge periodically. For example, it did not hedge in 1998 when prices also fell.

Cowan, 2007).[33] In Ecuador, this situation led to allegations of "corruption" (Daniel, 2001). The asymmetric nature of the political risk associated with the purchase of options may be one reason why politicians have been very hesitant to commit resources to options programs.

Another major consideration with the use of put options to insure against a revenue fall is that these options are generally expensive. Using data for 2 March 2010, when the WTI spot price was US$80.53, a put option that expired in March 2011 with a strike price of US$80.5 would have cost $8.48 per barrel, making the cost of insuring $1 billion of oil approximately $105 million.[34] Given this price, the purchaser of the option would not receive any net benefit unless the spot price fell below US$72.02. Hedging with natural gas put options is even more expensive (most likely because the market is thinner). The cost of insuring $1 billion of gas for a year, with an at-the-money strike price was approximately US$165 million. If the price of the commodity remains above the strike price, the premium would be lost and government expenditures would have increased by the cost of the option. Swidler, Buttimer and Shaw (1999) show, using simulations, that the purchase of put options leads to more frequent deficits than without hedging because the cost of the options increases expenditures. On the other hand, while deficits are more frequent, they are not as large as those that occur without hedging.

To hedge all its oil sales in 2009, Mexico paid $1.5 billion for put options with a strike price of $70 when the spot price was over $100 (Blas, 2009).[35] In the end, Mexico netted $5 billion from this strategy (McCallion, 2009), but if prices had not fallen below $70, the Mexican government would have spent an extra $1.5 billion without an explicit payoff. Simulations for the case of Texas in Swidler, Buttimer and Shaw (1999) show that the ex post *net* insurance premium paid by Texas was equal, on average, to about 2.6% of oil revenues.[36] Alaska (2002) estimates that a 3-year put option with a strike price $1 below the 3-year futures price would have cost US$3 per barrel, or 11 percent of the spot price at the time (US$26). Mexico's 2010 hedge of 230 million barrels cost US$1.2 billion, a little over US$5 per barrel. When the hedge was announced in late 2009, the strike price of $57 was approximately $20 less than spot and futures prices.[37] In other words, Mexico paid US$5 per barrel to hedge for a relatively short period – a year – with a strike price far out-of-the-money. Given these costs, there may be a tendency to use hedging strategies only if spot prices appear to be far out of line. However, it is difficult to determine when prices are out of line and how long they will remain so, making this strategy speculative.

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[33] A report by Alaska's revenue department warned: "If a program succeeded, it is unlikely the policymakers who took the initiative to create the program would be rewarded with public congratulations . . . . On the other hand, if the state lost significant sums ... the conventional wisdom is that public criticism would be harsh" (quoted in Blas, 2009).

[34] The purchase of the same quantity of contracts with a strike price of $78.50, $2 below the spot price, would have cost US$95 million. These calculations are based on NYMEX prior settlement prices as there were no actual trades.

[35] The strike price of $70 was far below the spot price at the time, which was over $100. A minimum estimate of the per barrel cost of this hedge is $1.60. This estimate assumes Mexico was producing 2.5 million barrels per day, and that the options covered Mexico's entire production for the year.

[36] Lower spot prices appear to be associated with much lower put option prices. Verleger (1993) gives the cost of Mexico's 1990-91 purchase of put options with a strike price of $17 as approximately $.40 per barrel when spot prices were approximately $30. Lu and Neftci (2008) provide lower cost estimates for hedging using simulations (rather than actual market prices). They find that the cost of an at-the-money put option on oil was 4.1 percent for a 1-year contract and 4.8 percent for three years. A 20 percent out of the money option on oil would cost .3 percent for 1-year and 1 percent for 3-years. That is, buying a three-year 20 percent out-of-the-money option for insuring an underlying portfolio of $US 500 million of oil would cost $5 million.

[37] This strike price is not that far below the US$61.69 WTI average price for 2009. It may have been less speculative to sell futures contracts for US$77, the reigning futures price in December 2009, but this would have eliminated the up-side potential.

The cost of a put option depends on the time to expiration of the contract (shorter are cheaper), the extent to which the option is out-of-the-money (more out-of-the-money are cheaper) and the volatility of the price of the underlying commodity (less volatile are cheaper). One way to reduce the cost of the hedge is to purchase a shorter maturity option or one with a lower strike price. A three month at-the-money put option is about half the price of a one-year option, while a one year option that is 2.5 percent out-of-the-money is about 10 percent cheaper than an at-the-money option.[38] Of course, the level of insurance provided by the option would then be lower.

Another method of reducing the upfront cost of hedging is to *sell* an option to *buy* oil at a specific price (a call option) at the same time as the option to *sell* (the put option) is *purchased* (creating a no cost collar). The premium received for the option to buy would offset the premium paid for the option to sell. The problem with this procedure is that it puts an upper bound on the earnings from a price increase, and so eliminates some of the upside potential. Further, while it is costly, but riskless, to purchase any quantity of options to sell oil, selling call options (options to buy) in quantities that are greater than the quantity of in-kind oil royalty payments is risky. If the price of oil rises above the strike price, the government would be liable for a payment to the holders of the call options equal to the difference between the spot price and the strike price. If royalty payments have not also risen one-for-one with the price of oil, the obligation associated with the call option would exceed the royalty revenue increase, implying a net cost. Finally, unlike the purchase of a put option, the sale of a call would require the commitment of government resources to a margin payment.

There are several other shortcomings with the use of options as a method of smoothing revenues, most of which are similar to the shortcomings of futures contracts. Put options will only insure against a fall in prices during the length of the contract. Contract lengths are not indefinite, so full insurance cannot be obtained. Nevertheless, hedging may provide the government with time during which to plan adjustment. The purchase of longer contracts is likely to be more expensive as most of the liquidity in the options market is at very short horizons. Borensztein et al (2009) note that on NYMEX most hedging is for maturities of less than three months and the risk premium becomes very large for longer maturities.[39] It is possible to buy longer term options in the over-the-counter market, but these contracts are illiquid and involve greater counterparty risk than options traded on an exchange. If a government follows a hedging program, particularly one using over-the-counter instruments, the government must possess sufficient expertise to run the hedging program, understand the risks and monitor the activities of the hedging unit.[40] Hedging operations are often quite complex and Daniel (2001) argues that, without adequate institutional capacity, the use of these contracts can lead to less transparency and foster poor governance.

[38] These comparisons use NYMEX data from 2 March 2010.

[39] It has been suggested that short term contracts can simply be rolled over to facilitate longer maturity hedging (Verleger, 1993; Borensztein et al, 2009), but there is some debate about the risk associated with this procedure (Powell, 1989; Larson and Varangis, 1996).

[40] As noted by Larson and Varangis (1996), the "cases of Codelco (a copper producer in Chile), MG Corp. (a unit of Germany's Metallgesellschaft AG), Procter and Gamble Co., Orange County in California, Sumitomo, and Barings Bank have shown that the lack of internal controls and systems to monitor the exposure from using derivative markets can result in very serious losses."

5.4 Revenue Volatility with a Savings Fund

The analysis above has made clear that revenue volatility in Alberta is driven by royalty volatility. On average, over the period 1981 to 2007, the volatility of real per capita own-source revenues *excluding royalties* has been similar in Alberta, Saskatchewan, British Columbia and Ontario. Therefore, stabilization of revenue from royalties is a key element of stabilizing Alberta government revenues.

The most effective method to achieve revenue stabilization is through a royalty revenue savings fund. While Alberta has the Alberta Heritage Savings Trust Fund (AHSTF), the objective of this fund is not the reduction of revenue volatility *per se*, and there has been considerable discretion involved in the allocation of revenue into and out of the AHSTF and other funds operated by the Alberta government (Busby, 2008). In a report commissioned by the Alberta Minister of Finance, Tuer (2002) proposed that the AHSTF be redesigned to stabilize the impact of volatile resource revenues on the province's budget, but the province has not acted on this recommendation.

5.4.1 Key features of a savings fund

The two key design elements of the savings fund proposed here are the commitment of a fixed percentage of volatile current revenues to the fund, and the withdrawal — the transfer to current government revenues — of *long term* real earnings and a fixed percentage of the *total* assets in the fund. A fund with these characteristics reduces volatility in three ways. First, a proportion of the most volatile component of revenues, royalties, are deposited in the fund and, therefore, are excluded from current government revenues. This leaves only the more stable components of revenues, plus withdrawals from the fund, to finance current spending. The ability of a savings fund to reduce volatility is greater the larger is the share of royalties deposited in the fund.

Second, fund withdrawals are based on a long-term *average* real interest rate. An average reduces the volatility of this component of transfers to government revenues, since returns vary considerably from year-to-year. In general, the longer the averaging period, the smaller is the volatility of real returns.

Third, withdrawals each year are a *constant* fraction of the fund's stock of assets. This reduces revenue volatility because the revenue paid out by the fund in a particular year is based on contributions from all previous years. A withdrawal formula based on past contributions would also effectively eliminate the possibility of zero transfers from the fund during a year. This is in contrast to the experience of the AHSTF where no payments were made in 2002-03 and 2008-09 when the value of the fund declined.[41]

The savings fund described here is not a stabilization fund or a "rainy day" fund, as extra funds are not withdrawn when there is a negative disturbance to revenues.[42] It is a savings fund that can smooth revenues by weakening the link between current royalties and current budgetary revenues. A major advantage of a savings fund over a stabilization fund is that it does not require the government to identify the conditions under which contributions and withdrawals should be

[41] With the current design of the AHSTF, revenue payouts are highly variable since *all current income* from the fund is transferred to general revenues, less only an amount required for inflation proofing (*Annual Report for the AHSTF*, 2010, p5).

[42] Frankel (2010, 30-31) stresses the importance of a rule dictating a cap on spending out of a fund, "to insure that politicians will not raid the fund when it is flush."

made. In addition, a savings fund may facilitate a process whereby government takes a long-term view of budgeting. Finally, this type of fund is transparent and easy to design and understand. [43]

A related benefit of this type of fund is that it would reduce revenue *uncertainty* as current and future revenues would depend on past contributions and the long term earnings of the fund. Given that current and future fund disbursements depend on past contributions and returns, the government would have considerable information on the future path of transfers from the fund, and could use this information to plan expenditures.

5.4.2 An example of revenue stabilization with a savings fund

Using data on actual revenues over the past 30 years, a simple example shows the extent to which a savings fund can reduce revenue volatility.[44] In this simulation, 75 percent of Alberta's royalty revenues are committed to a savings fund each year. If all non-renewable resource revenues were added to the fund, as recommended by Tuer (2002, p51), there would be greater revenue stabilization.[45]

Each year the fund pays out to general revenues the average real earnings of the fund plus 5 percent of the total assets in the fund. Since real interest rates vary considerably, greater smoothing is achieved with the use of a long period average return, so the simulation employs the average medium term real Government of Canada bond yield over the previous 20 years. Five percent, or one twentieth, of total assets are withdrawn each year in order to smooth earnings over approximately 20 years. A long period is needed to provide adequate revenue smoothing as Alberta revenue downturns and upturns tend to be long-lived, often lasting 5-10 years, as illustrated in Figure 1. [46]

Under this scheme, average per capita own-source revenues available to the government, net of contributions to and withdrawals from the savings fund, would have been only 4.5 percent lower than actual average real per capita own-source revenues for the period 1981 to 2007.[47] Further, real per capita own-source revenues, net of contributions to and withdrawals from the savings fund, would have still been 25 percent higher than the average for Saskatchewan, British Columbia and Ontario. In addition, the total assets in the fund would have been close to $75 billion by 2007 and the volatility of own-source revenues, net of contributions and withdrawals from the fund, would have fallen from 15.4 to 5.9, a decline of over 60 percent. This level of volatility would have been lower than the revenue volatility of British Columbia, Saskatchewan and Ontario (Table 7).

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[43] One way to make the fund even more simple and easy to understand, without greatly reducing the fund's stabilizing feature, is to eliminate the withdrawal of real earnings, and raise the fixed percentage of total assets withdrawn each year by a small amount.

[44] This example is intended for the purposes of illustration and does not adjust for the savings that were actually undertaken by the Alberta government during the sample period, such as saving through the Alberta Heritage Trust Fund and other Alberta government funds.

[45] When the AHSTF was established in 1976 it received only 30% of non-renewable resource revenues. There have been no contributions to the AHSTF since 1987.

[46] Tuer, et al. (2002, p52) recommends that the amount withdrawn should be the *lesser* of the average of resource revenues for the previous *three* years or $3.5 billion (the 20-year average of resource revenues). Given the large and often long-lived swings in resource revenues, Tuer's proposed rule, as it is based on revenues from just the previous three years, is likely to lead to greater volatility than the five percent rule proposed here.

[47] This lower average level of revenues follows because, in the initial years, the government makes contributions to the fund, but the fund has few assets to disburse.

The principal concern with the creation of a savings fund of this type is that, as the fund grows in size, pressure may mount for taxes to be cut or the proportion of assets withdrawn from the fund to be increased, particularly in times when revenues from other sources have fallen. As a consequence, it may be difficult to maintain contributions to the fund and prevent *ad hoc* withdrawals.[48]

6. Conclusion

Volatile revenues may lead to the inefficient provision of government services, stop-go pro-cyclical fiscal policies and, potentially, slower growth. Alberta's revenues are volatile relative to those of other provinces. This volatility is associated principally with the volatility of energy sector royalties. Own-source revenues less royalties are no more volatile than the corresponding revenues of other provinces. Further, the magnitude of Alberta's non-royalty own-source revenues are of similar size to those of other provinces.

The principal problem with revenue volatility is that it usually leads to volatile government expenditures. Revenue volatility would be much less of a problem if governments could maintain stable spending during revenue booms and busts. However, it is difficult to forecast the extent to which revenues are permanent when they depend heavily on energy price movements, and this makes it difficult to choose the correct balanced path for expenditures. History also shows that, across numerous countries and time periods, it is politically very difficult to control spending during revenue expansions, even if these are likely to be temporary.

Given the large contribution of the volatile royalty component to total government revenues, there are few practical methods available to stabilize revenues. The hedging of royalty revenues using futures and options markets is costly, cannot remove all volatility or uncertainty and, given the experience of other jurisdictions, may have significant political risk.

On average, although not in every sub-period, movements in the exchange rate have tended to reduce the volatility of own-source revenues. While this smoothing effect has likely been increased by the Bank of Canada's policy of inflation targeting, exchange rate movements still act as only a partial hedge against energy price movements.

Tax base diversification, through the introduction of a sales tax for example, is likely to have only a minor effect on revenue volatility. This follows because the more stable alternative tax bases have already been fully exploited or the maximum revenues that could be obtained from these tax bases are not likely to be large enough to have an appreciable effect on overall revenue volatility. The only way tax base diversification could have a large impact on revenue volatility is if there is a significant relative increase in taxes on non-energy-related tax bases, but this would

[48] Another budgeting method that has been used to reduce the risk of a revenue shortfall and the need to cut expenditures is to underestimate revenues. Tying expenditures to a downward-biased revenue forecast would not change the degree of revenue volatility, but would provide a buffer against an unexpected fall in revenue. This type of policy could also be used as a backdoor method of creating a "rainy day" fund, if the "unexpected" surpluses are saved, but it is likely to be difficult to create a sizable fund in this way. A policy of this type also has two other shortcomings. First, the *ex post* budget surpluses that result on average can be easily identified and may induce demands for increased spending. For example, at the federal level, Robson (2006) argues "padding" the bottom line in budget projections has led to extra fiscal room and spending hikes. Second, this type of policy will quickly make budget forecasts non-credible and could lead to a political backlash and calls for tax reductions, which would defeat the purpose of the buffer.

imply a rise in the overall tax burden or a very large decrease in the revenues collected from royalties and corporate taxes.

The most promising approach to address revenue volatility is the creation of a savings fund into which the most volatile components of revenues are deposited. If withdrawals from the fund are a fixed proportion of the fund's total assets and are tied to the long-term earnings of the fund, there is a considerable reduction in the volatility of government budgetary revenues (net of contributions to and withdrawals from the fund). A fund of this type would also provide long term revenue predictability.

References

Afonso, Antonio and Davide Furceri, 2008, "Government size, composition, volatility and economic growth," ECB Working Paper 849, January.

Alaska (2002) "Hedging oil revenue summary," Alaska Department of Revenue, 21 October.

Arrau, Patricio and Stijm Claessens (1992) "Commodity stabilization funds," World Bank, International Economics Department Working Paper 835.

Ball, Laurence M. (2009) "Policy responses to exchange-rate movements," NBER WP 15173.

Barnett, Steven and Rolando Ossowski, 2002, "Operational aspects of fiscal policy in oil-producing countries" IMF Working Paper WP/02/177, October.

Bayoumi, Tamim and Martin Mühleisen (2006) "Energy, the exchange rate, and the economy: Macroeconomic benefits of Canada's oil sands production," IMF Working Paper WP/06/70.

Bems, Rudolfs and Irineu de Carvalho Filho (2009) "The current account and precautionary savings for exporters of exhaustible resources,"

Blas, Javier, 2009, "Mexico's big gamble pays off," Financial Times, FT.com, 7 September 2009.

Blattman, Christopher, Jason Hwang and Jeffrey G. Williamson (2007) "Winners and losers in the commodity lottery: The impact of terms of trade growth and volatility in the periphery 1870-1939," *Journal of Development Economics* 82, 156-179.

Borensztein, Eduardo, Olivier Jeanne and Damiano Sandri, 2009, "Macro-hedging for commodity exporters," NBER working paper 15452, October.

Busby, Colin (2008) "After the oil rush: A blueprint for Alberta's long-term happiness," *C.D. Howe Institute e-brief*.

Caballero, Ricardo J. and Kevin Cowan, 2007, "Financial integration without the volatility," Massachusetts Institute of Technology, Department of Economics, Working Paper 08-04.

Campbell, John Y., Karine Serfaty-de Medeiros and Luis M. Viceira (2010) "Global currency hedging," *Journal of Finance*, Volume 65, Issue 1, February 2010, pages 87-121.

Carroll, Deborah A., 2009, "Diversifying municipal government revenue structures: Fiscal illusion or instability?" *Public Budgeting & Finance*, Spring, 27-48.

Cashin, Paul, Luis F. Céspedes and Ratna Sahay (2004) "Commodity currencies and the real exchange rate," *Journal of Development Economics* 75, 239-268.

Chen, Yu-chin and Kenneth Rogoff (2003) "Commodity currencies," *Journal of International Economics* 60, 133-160.

Chen, Yu-Chin, Kenneth Rogoff and Barbara Rossi (2008) "Can exchange rates forecast commodity prices?" NBER Working Paper 13901, March.

Daniel, James A., 2001, "Hedging government oil price risk," IMF Working Paper WP/01/185, November.

DeCloet, Derek, 2010, "Truth, lies and Alberta's royalty backtrack," *Globe & Mail*, 13 March.

Devlin, Julia and Michael Lewin, 2004, "Managing oil booms and busts in developing countries." Draft chapter for *Managing Volatility and Crises: A Practitioner's Guide*, March, World Bank.

Domanski, Dietrich and Alexandra Heath, 2007, "Financial investors and commodity markets," BIS Quarterly Review, March, 53-67.

Engel, Eduardo and Rodrigo Valdes, 2000, "Optimal fiscal strategy for oil exporting countries," IMF Working Paper WP/00/118, June.

Felix, R. Alison, 2008, "The growth and volatility of state tax revenue sources in the Tenth District," Federal Reserve Bank of Kansas City Economic Review, Third Quarter, 63-88.

Frankel, Jeffrey, 2005, "Peg the export price index: A proposed monetary regime for small countries," *Journal of Policy Modeling* 27, 495-508.

Frankel, Jeffrey, 2010, "The natural resource curse: A survey," Kennedy School Faculty Research Working Paper 10-005, Harvard University, February.

Hamilton, James D., 2008, "Understanding crude oil prices," NBER Working Paper 14492, November.

Larson, Don and Panos Varangis, 1996, "Dealing with commodity price uncertainty," World Bank Policy Research Working Paper 1667, International Economics Department, Commodity Policy and Analysis Unit, October.

Larson, Don, Panos Varangis and Nanae Yabuki, 1998, "Commodity risk management and development," World Bank Policy Research Working Paper 1963, Development Research Group, August.

Lipsky, John P. (2008) "Commodity prices and global inflation." Remarks by John Lipsky, First Deputy Managing Director, International Monetary Fund at the Council on Foreign Relations, New York City, May 8.

Lu, Yinqin and Salih Neftci, 2008, "Financial instruments to hedge commodity price risk for developing countries," IMF working paper WP/08/6, January.

McCallion, Pauline, 2009, "Mexico hedges oil price at $57 in 2010," *Energy Risk*, 9 December.

Medas, Paulo and Daria Zakharova, 2009, "A primer on fiscal analysis in oil-producing countries," IMF Working Paper WP/09/56, March.

Powell, Andrew, 1989, "The management of risk in developing country finance," *Oxford Review of Economic Policy* 5:4, Winter, 69-87.

Ragan, Christopher (2005) "The exchange rate and Canadian inflation targeting," Bank of Canada Working Paper 2005-34.

Robson, William B.P. 2006. “Beating the Odds: A New Framework for Prudent Federal Budgeting,”C.D. Howe Institute Commentary No. 230, March.

Sturm, Michael, François Gurtner and Juan Gonzalez Alegre, 2009, “Fiscal policy challenges in oil-exporting countries: A review of key issues,” European Central Bank, Occasional paper series No. 104, June.

Swidler, Steve, Richard J. Buttimer, Jr., and Ron Shaw,1999, “Government hedging: Motivation, implementation, and evaluation,” *Public Budgeting & Finance*, Winter, 75-90.

Taylor, John B. (2008) “The way back to stability and growth in the global economy: The Mayekawa lecture.” Presented at the 2008 International Conference: Frontiers in Monetary Theory and Policy, The Institute for Monetary and Economic Studies, Bank of Japan, 28 May 2008.

Tuer, David. 2002. *Moving From Good To Great: Enhancing Alberta's Fiscal Framework,* Alberta Financial Management Commission, July.

van der Ploeg, Frederick and Steven Poelhekke (2009) “Volatility and the natural resource curse,” *Oxford Economic Papers*, 1-34.

Verleger, Philip K., 1993, *Adjusting to Volatile Energy Prices*, Institute of International Economics: Washington, D.C.

Data Appendix

All government revenue data are from the Statistics Canada Cansim database, tables 3840004, 3840007 and 3840008. These are based on Provincial Economic Accounts.[49]

Data are converted to per capita terms using Statistics Canada population estimates for Alberta (V469503), British Columbia (V469818), Saskatchewan (V469188) and Ontario (V468558).

Values are converted to real terms using Statistics Canada price indices for net government current expenditure on goods and services - Alberta (V3840832), British Columbia (V3840036), Saskatchewan (V3840803) and Ontario (V3840745).

Tax base data for Alberta are in current dollars and are from the Statistics Canada Cansim database:
- Wages and salaries and supplementary labour income (V687289),
- Corporation profits before taxes (V687290),
- Interest and miscellaneous investment income (V687291),
- Personal expenditures on consumer goods (V687648),
- Final domestic demand (V687680),
- Personal income (V691711).

Average annual exchange rate data (Canadian dollars per US dollar) are from the International Monetary Fund's International Financial Statistics database (identifier: 156..RF.ZF…).

The West Texas Intermediate (WTI) petroleum price in US dollars is the period average from the International Monetary Fund's International Financial Statistics database (identifier: 11176AAZZFM17).

The Alberta natural gas price data were downloaded from the website of the Canadian Association of Petroleum Producers on 10 February 2010 (http://www.capp.ca/LIBRARY/STATISTICS/Pages/default.aspx#4luXUn7UFh0k). These are annual averages in Canadian dollars.

Data on disaggregated natural resource revenues are from various issues of the *Annual Report* of the Alberta Government's Department of Energy.

[49] We chose to use *Provincial Economic Accounts* data, rather than Statistics Canada's FMS data because the *Provincial Economic Accounts* begin in 1981, rather than 1988, and disaggregate royalty revenues from interest and other investment income revenues, which the FMS data do not do.

Table 1: Average Real Per Capita Revenue and Volatility, 1981-2007

	Alberta	*Saskatchewan*	*British Columbia*	*Ontario*
Real per capita revenue:				
Total revenue	8063	7327	6772	5508
Own-source revenue	7105	5639	5810	4707
Percentage share of total revenue	*88.1*	*77.0*	*85.8*	*85.5*
Own-source revenue minus royalties	4899	4817	5211	4684
Percentage share of total revenue	*60.8*	*65.7*	*76.9*	*85.0*
Coefficients of variation:*				
Total revenue	13.4	6.5	6.3	5.0
Own-source revenue	15.4	6.5	7.8	6.2
Own-source revenue minus royalties	6.7	9.2	8.1	6.2

*The coefficient of variation is the ratio (multiplied by 100) of the standard deviation of the differences from an exponential trend to the average value of the series.

Source: Authors' calculations using Statistics Canada data. See the *Data Appendix* for more information.

Table 2: Volatility of Government Revenues and Selected Tax Bases in Alberta, 1981-2007

	*Coefficient of Variation**
Real Per Capita Government Revenues:	
Total revenues	13.4
Own-source revenues	15.4
Own-source revenues minus royalties	6.7
Royalties	43.6
Direct taxes corporations	24.2
Interest and other investment income	14.9
Direct taxes persons	10.2
Retail sales tax**	12.0
Gaming profits**	6.3
Gasoline tax**	3.2
Real Per Capita Tax Base Variables:	
Corporation profits before taxes	36.0
Interest and miscellaneous investment income	21.4
Final demand	8.3
Wages, salaries and supplementary labour income	8.2
Personal income	4.8
Expenditure on consumer goods	2.7
Real Energy Prices:	
West Texas Intermediate petroleum price, $US	46.9
West Texas Intermediate petroleum price, $CAN	39.4
Natural gas price, $US	46.3
Natural gas price, $CAN	42.0

*The coefficient of variation is the ratio (multiplied by 100) of the standard deviation of the differences from an exponential trend to the average value of the series.

** Sample period is 1994-2007. This shorter sample is employed because the use of these taxes changed considerably in the late 1980s and early 1990s.

Source: Authors' calculations using Statistics Canada data. See the *Data Appendix* for more information.

Table 3: Correlation Coefficient between the Percentage Change in Total Own-Source Revenue and the Percentage Change in the Variable Indicated, 1982-2007

	Alberta	*Saskatchewan*	*British Columbia*	*Ontario*
Own-source revenue minus royalties	.75	.86	.92	1.0
Royalties	.90	.67	.59	.23
Direct taxes corporations	.71	.33	.46	.83
Direct taxes persons	.42	.20	.66	.74
Retail sales tax	-	.53	.49	.75

Source: Authors' calculations using Statistics Canada data. See the *Data Appendix* for more information.

Table 4: Selected Revenue Types – Average Share of Real Per Capita Own-Source Revenues, 1981-2007 (percent)

	Alberta	*Saskatchewan*	*British Columbia*	*Ontario*
Royalties	31.1	14.6	10.3	0.5
Direct taxes persons	20.5	22.6	24.7	33.2
Retail sales tax*	2.0	16.0	18.0	22.6
Direct taxes corporations	8.3	4.4	4.9	8.8
Interest and other investment income	15.7	12.4	9.1	4.8
Contributions to social insurance and other transfers from persons	7.5	4.9	11.3	10.2

* Includes alcohol and tobacco taxes.

Source: Authors' calculations using Statistics Canada data. See the *Data Appendix* for more information.

Table 5: Alberta Real Per Capita Natural Resource Revenues by Type (2002 dollars)

Fiscal Year	*Natural Gas and By-Products*	*Crude Oil Royalties**	*Bonuses For Sale of Crown Leases*	*Synthetic Crude Oil and Bitumen*	*Total Non-Renewable Resource Revenue*
1981-82	1768	1970	503	208	4669
1982-83	1453	1815	261	281	4005
1983-84	1210	2059	348	217	4029
1984-85	1359	2137	463	na*	4203
1985-86	1235	1888	495	na*	3841
1986-87	718	665	191	na*	1585
1987-88	638	858	480	na*	1970
1988-89	600	581	273	na*	1554
1989-90	548	642	222	16	1522
1990-91	576	707	222	21	1630
1991-92	420	520	131	16	1192
1992-93	513	485	80	31	1204
1993-94	651	354	331	30	1463
1994-95	562	491	437	93	1688
1995-96	444	466	255	138	1410
1996-97	559	596	399	220	1890
1997-98	680	368	439	79	1559
1998-99	581	178	184	23	931
1999-00	927	419	282	162	1777
2000-01	2583	538	416	255	3797
2001-02	1376	337	331	63	2126
2002-03	1638	376	181	58	2279
2003-04	1665	300	295	60	2346
2004-05	1875	371	365	209	2838
2005-06	2289	399	952	259	3915
2006-07	1525	356	627	614	3122
2007-08	1247	397	270	699	2644
2008-09	1303	402	248	664	2661

Source: Revenues are from various issues of the *Annual Report*, Department of Energy, Government of Alberta. Data for population and the price index are from Statistics Canada as described in the *Data Appendix*. These population and price data are annual, so data for the calendar year in which the fiscal year begins are employed.

*Crude oil royalties for 1984/85-88/89 include synthetic crude products.

Table 6: Correlation Coefficients between Percentage Changes, 1982-2007

	Royalties	*Natural gas price ($C)*	*WTI petroleum price ($C)*
Real per capita Alberta government revenues:			
Total revenues	.90	.71	.73
Own-source revenues	.90	.68	.72
Own-source revenues minus royalties	.42	.13	.53
Direct taxes persons	.13	-.08	.28
Interest and other investment income	.26	.28	.19
Direct taxes corporations	.57	.28	.68
Royalties	--	.87	.70
Real per capita tax base variables, Alberta:			
Wages, salaries and supplementary labour income	.23	.24	.22
Personal income	.20	.14	.20
Expenditure on consumer goods	.16	.07	.25
Final demand	.31	.27	.30
Interest and miscellaneous investment income	.95	.81	.73
Corporation profits before taxes	.83	.70	.71
Prices:			
Exchange rate (Canadian dollars per US dollar)	-.13	-.06	-.31
Natural gas price, $US	.86	.98	.52
Natural gas price, $C	.87	--	.49
West Texas Intermediate petroleum price, $US	.66	.46	.98
West Texas Intermediate petroleum price, $C	.70	.49	--

Source: Authors' calculations using Statistics Canada data. See the *Data Appendix* for more information.

Table 7: Coefficients of Variation for Selected Revenue Types, 1981-2007*

	Alberta	*Saskatchewan*	*British Columbia*	*Ontario*
Total own-source revenue	15.4	6.5	7.8	6.2
Direct taxes persons	10.2	11.4	13.8	8.1
Direct taxes corporations	24.2	23.6	18.6	23.1
Interest and other investment income	14.8	18.3	29.9	8.9
Retail sales tax	−	9.5	5.4	8.8

*The coefficient of variation is the ratio (multiplied by 100) of the standard deviation of the differences from an exponential trend to the average value of the series.

Source: Authors' calculations using Statistics Canada data. See the *Data Appendix* for more information.

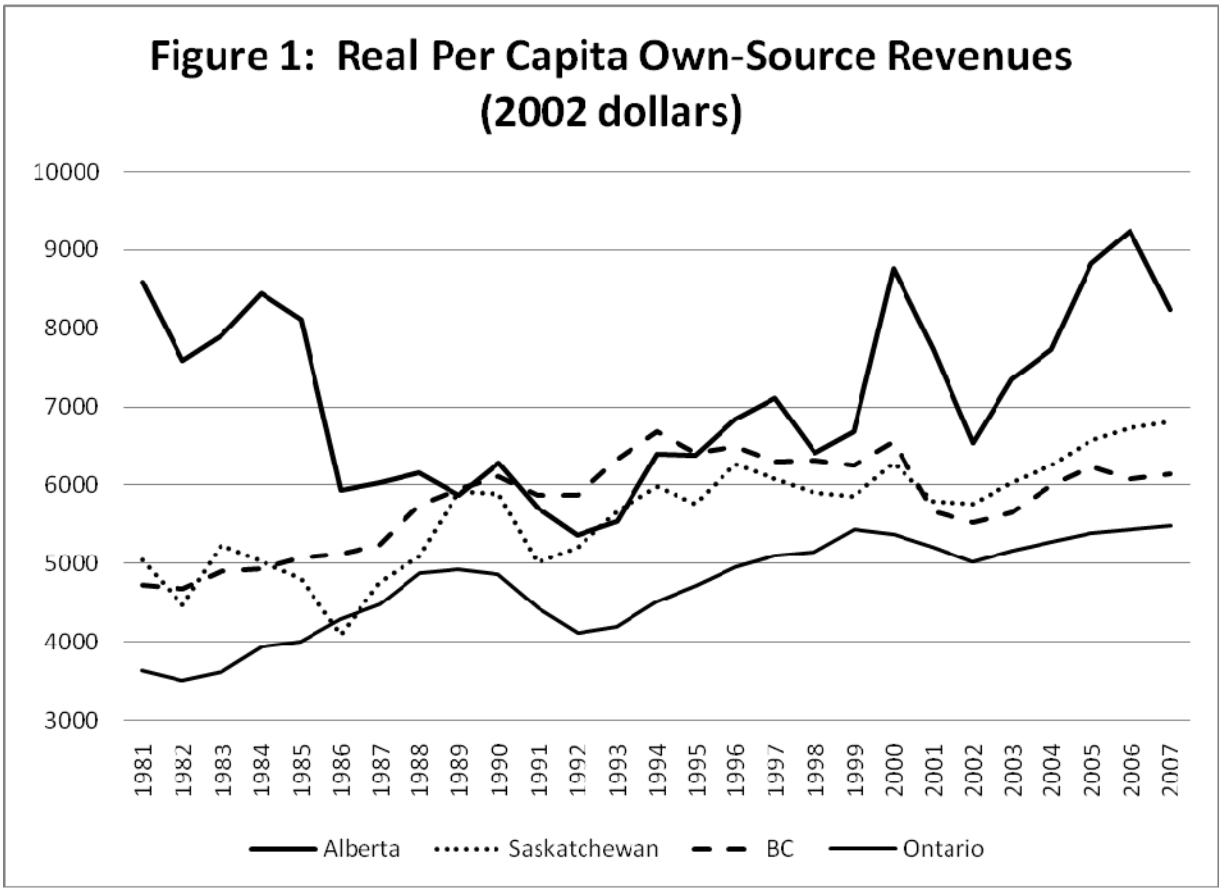
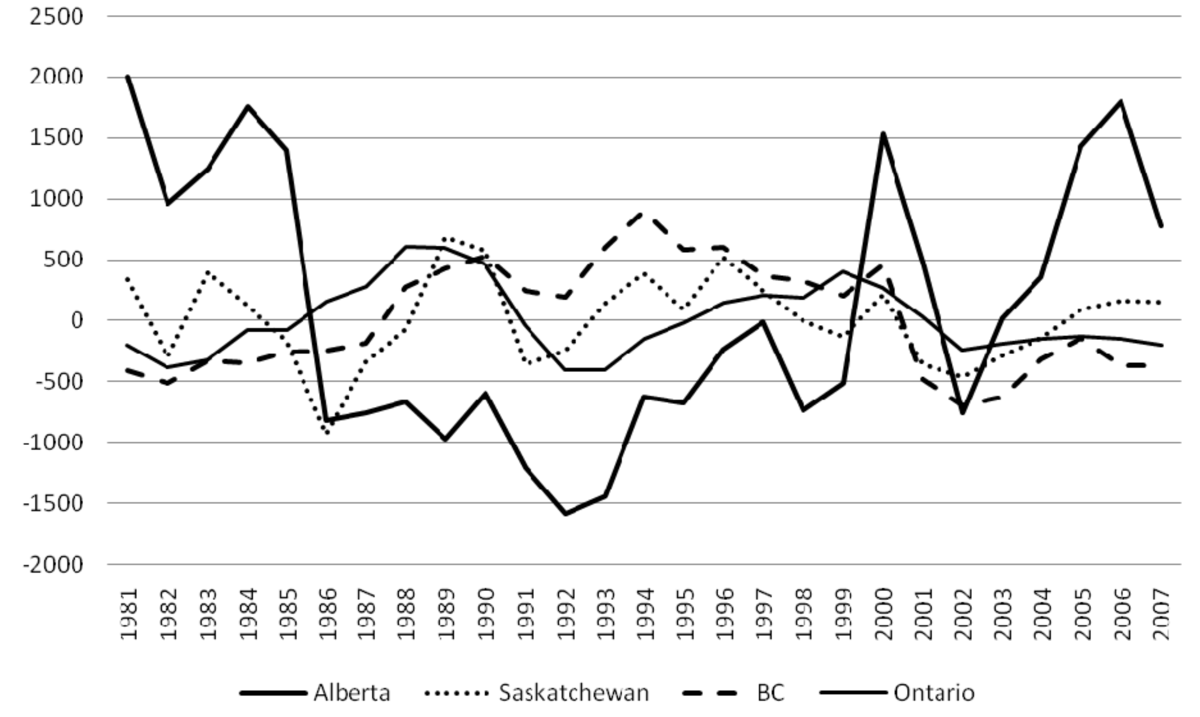


Figure 1: Real Per Capita Own-Source Revenues
(2002 dollars)
10000
9000
8000
7000
6000
5000
4000
3000
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Alberta
Saskatchewan
BC
Ontario

Figure 2: Real Per Capita Own-Source Revenue - Difference from Trend (2002 dollars)



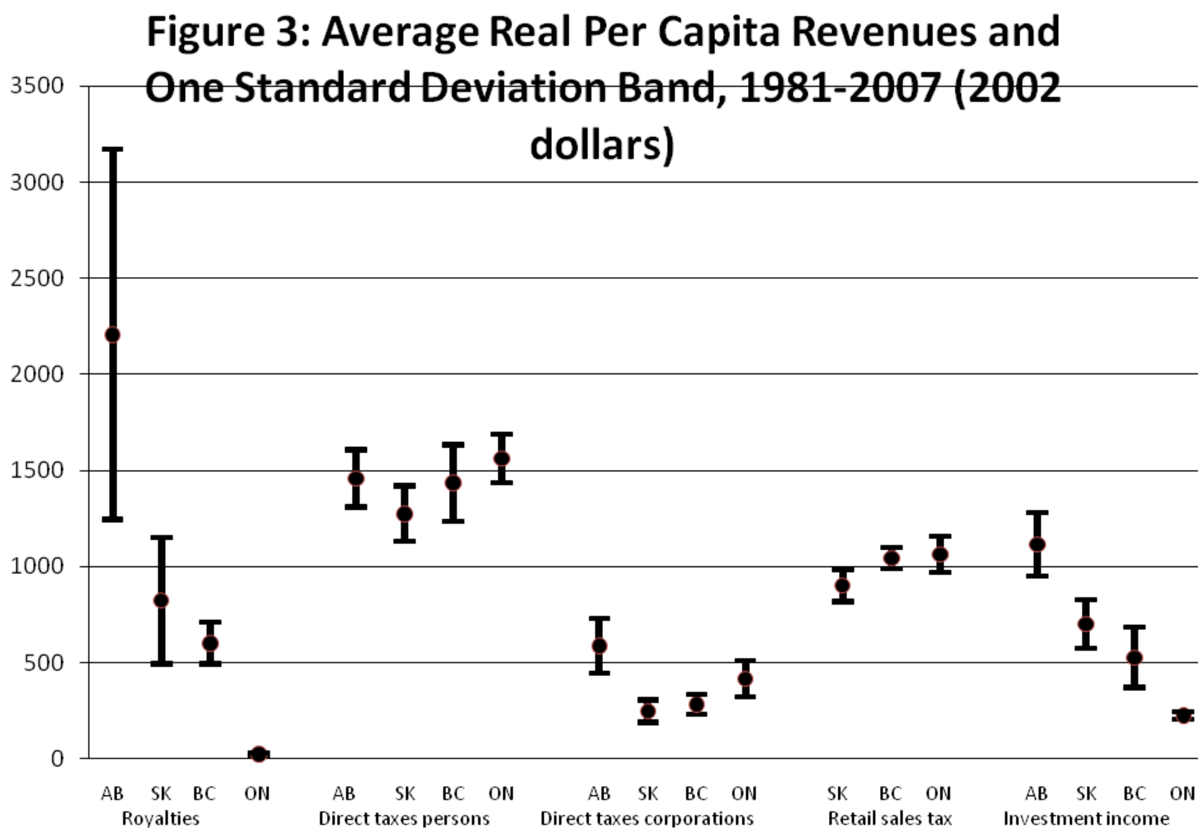


Figure 3: Average Real Per Capita Revenues and One Standard Deviation Band, 1981-2007 (2002 dollars)
3500
3000
2500
2000
1500
1000
500
0
AB SK BC ON
Royalties
AB SK BC ON
Direct taxes persons
AB SK BC ON
Direct taxes corporations
SK BC ON
Retail sales tax
AB SK BC ON
Investment income

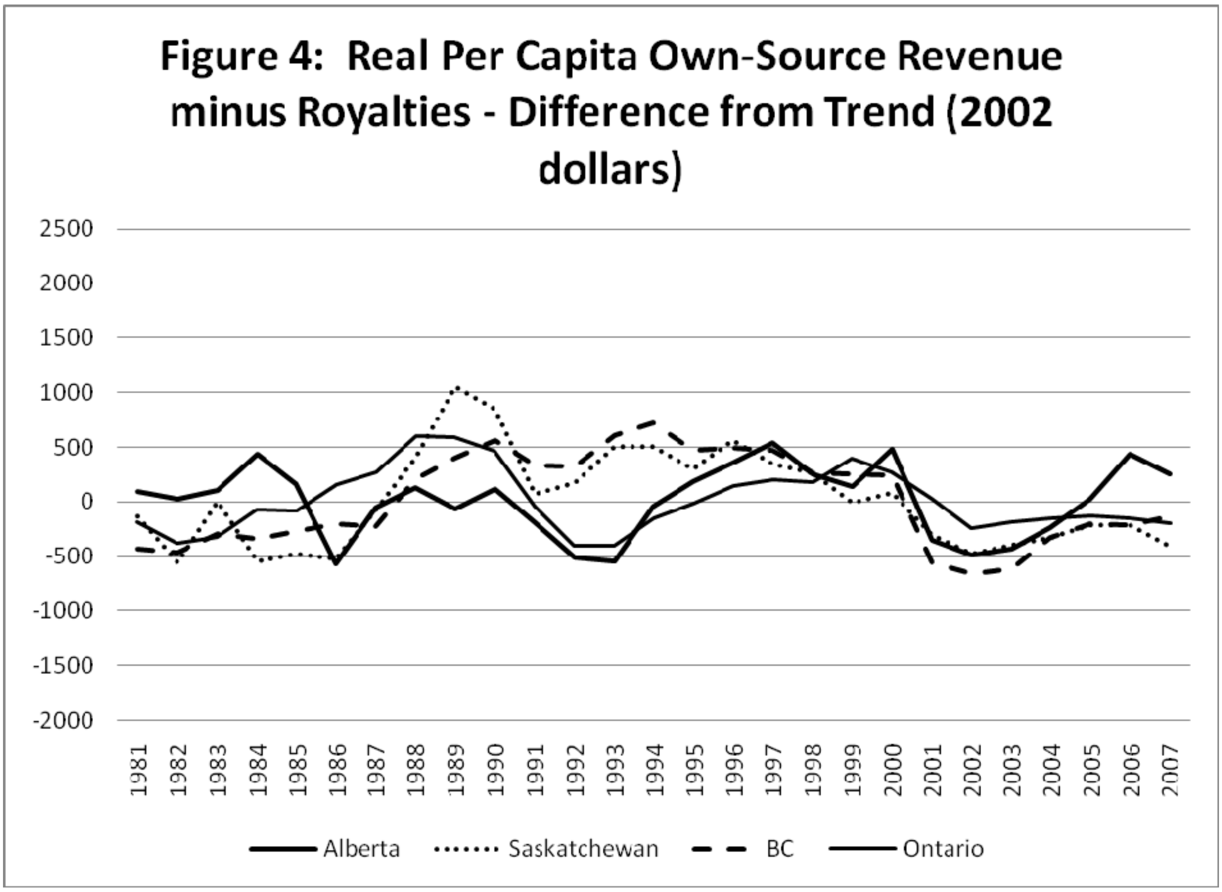


Figure 4: Real Per Capita Own-Source Revenue minus Royalties - Difference from Trend (2002 dollars)
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Alberta
Saskatchewan
BC
Ontario

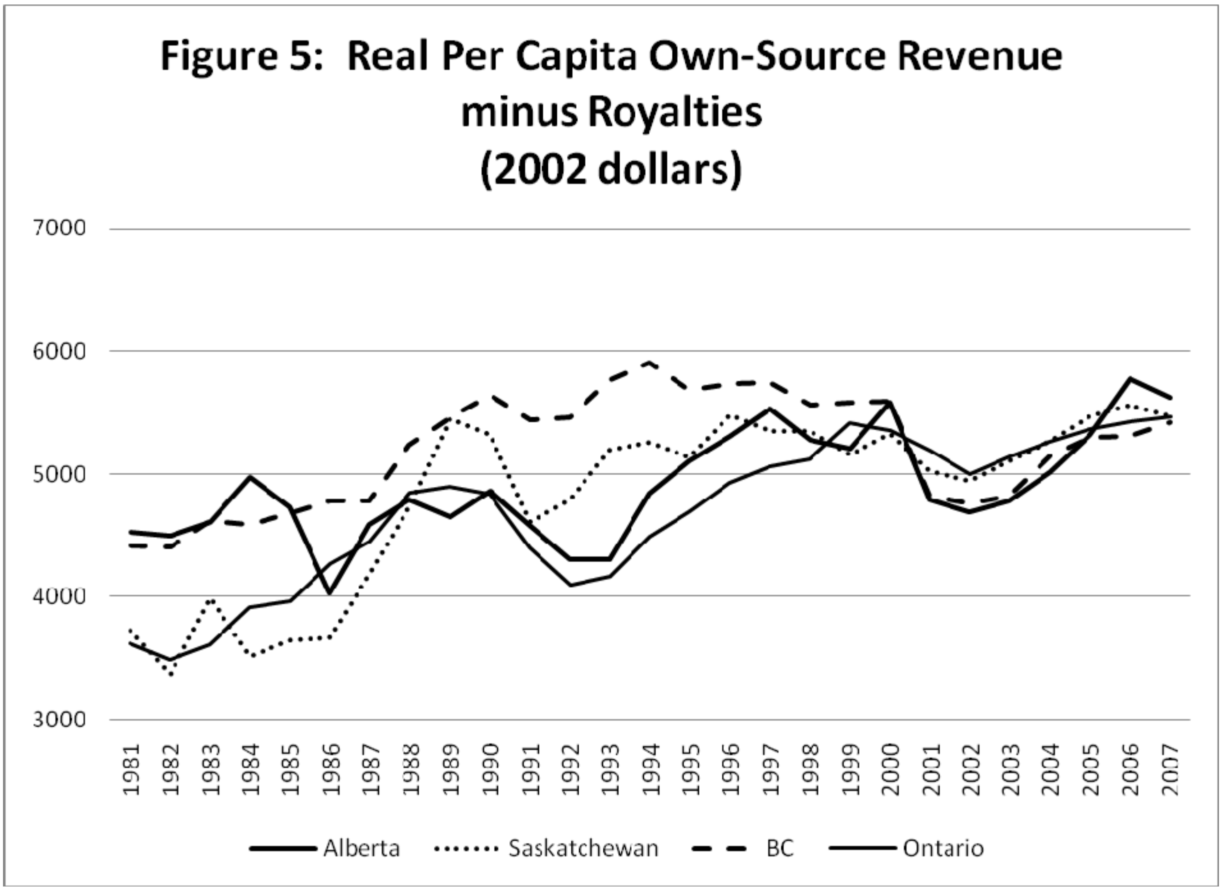


Figure 5: Real Per Capita Own-Source Revenue
minus Royalties
(2002 dollars)
7000
6000
5000
4000
3000
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Alberta
Saskatchewan
BC
Ontario